

March 27, 1945.

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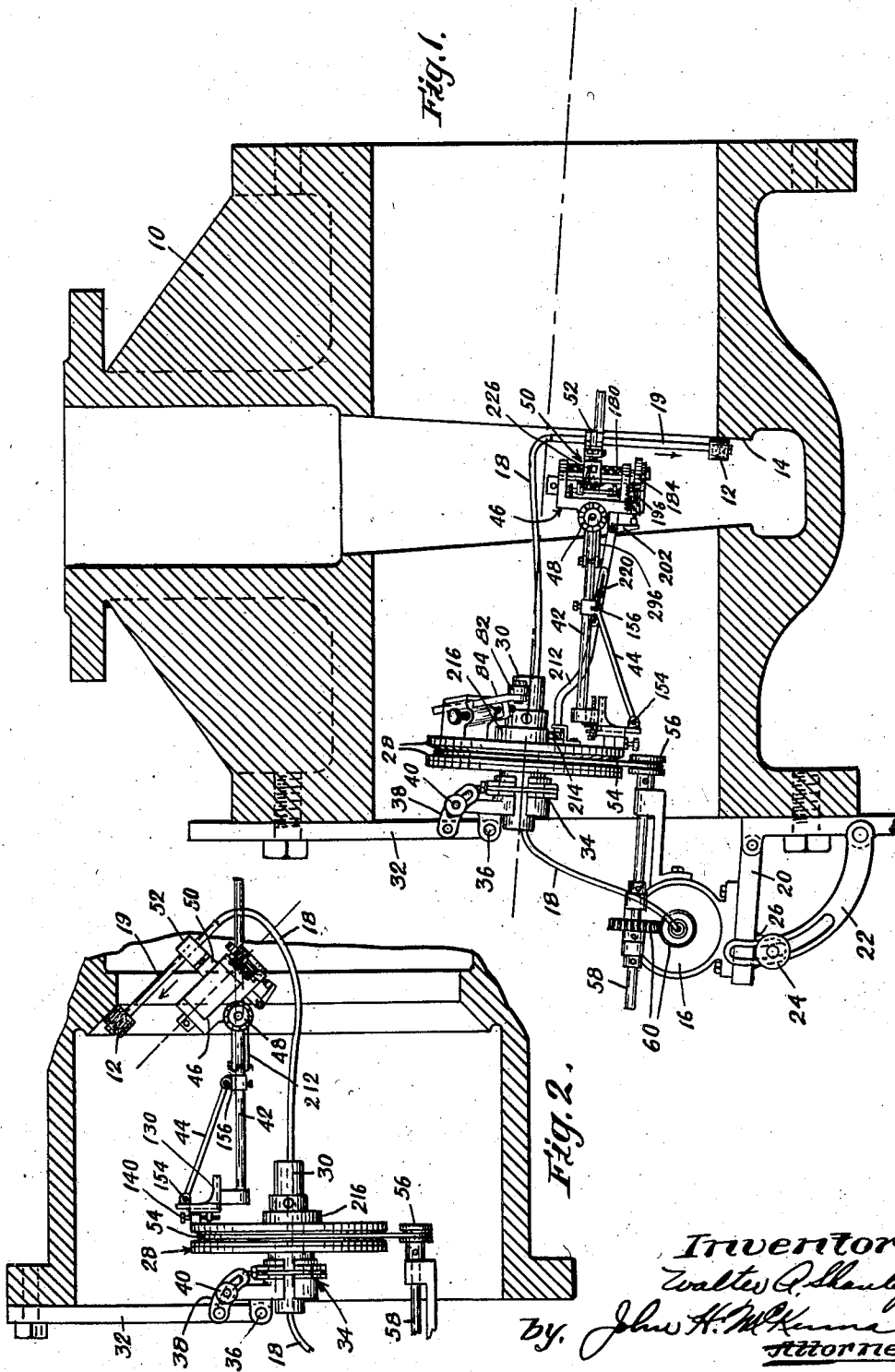
2,372,341

GRINDING MACHINE

Filed Sept. 1, 1942

5 Sheets-Sheet 1

Fig. 1.



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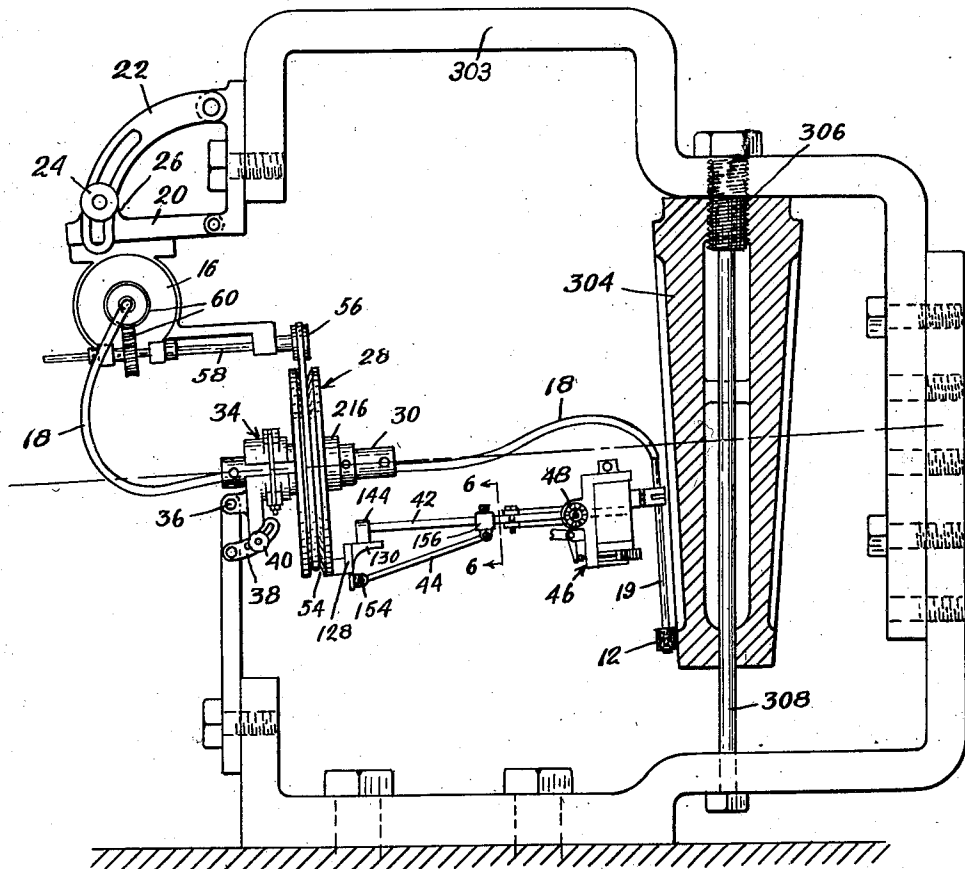


Fig. 3.

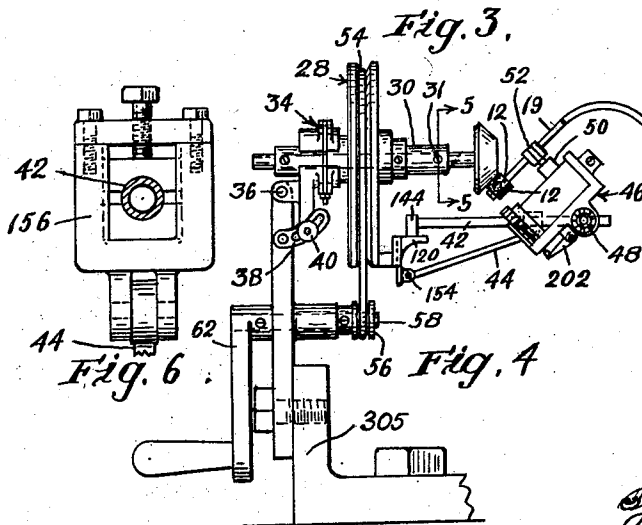


Fig. 4.

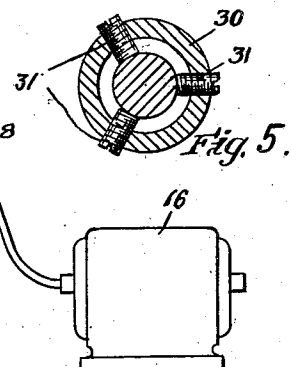


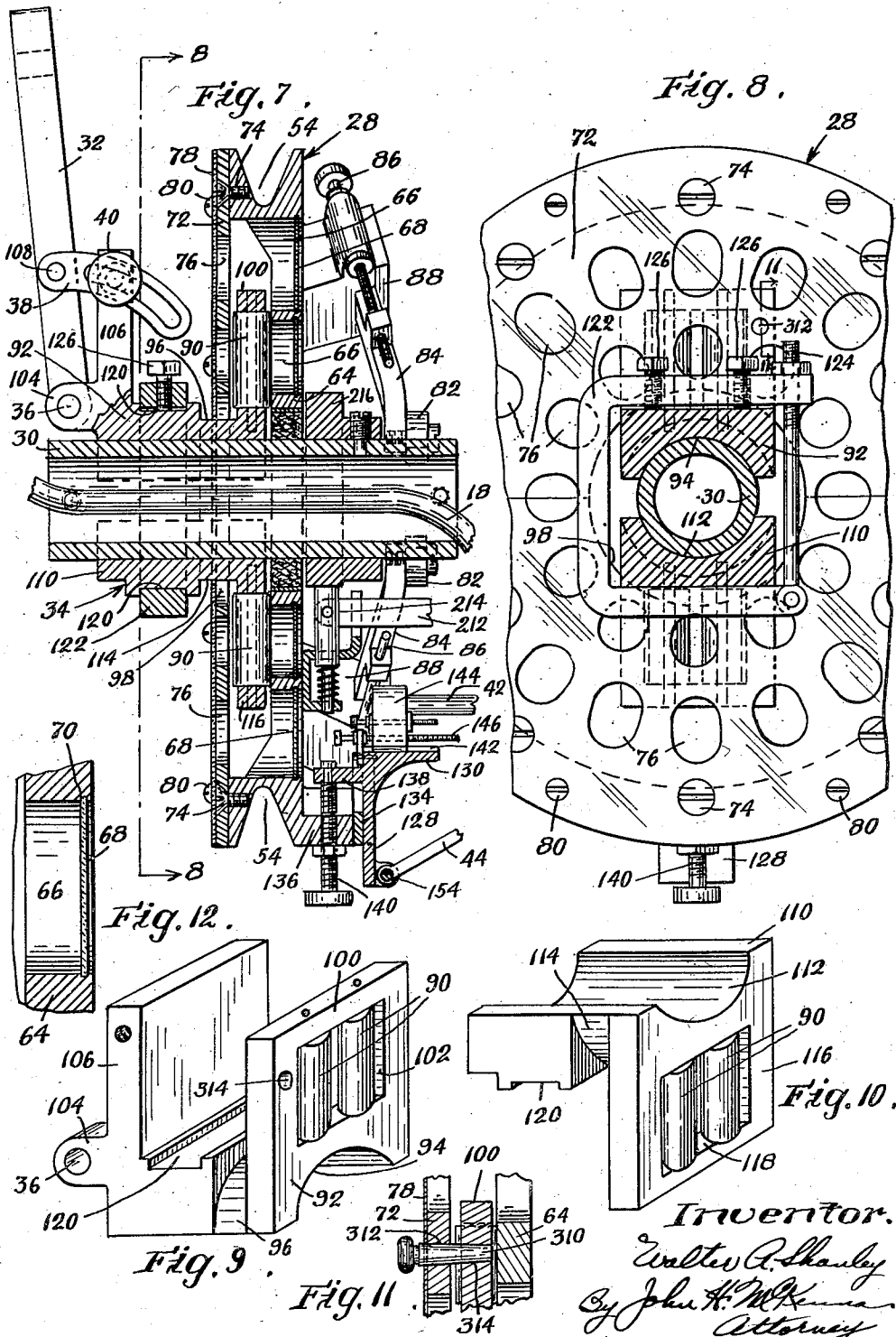
Fig. 5.

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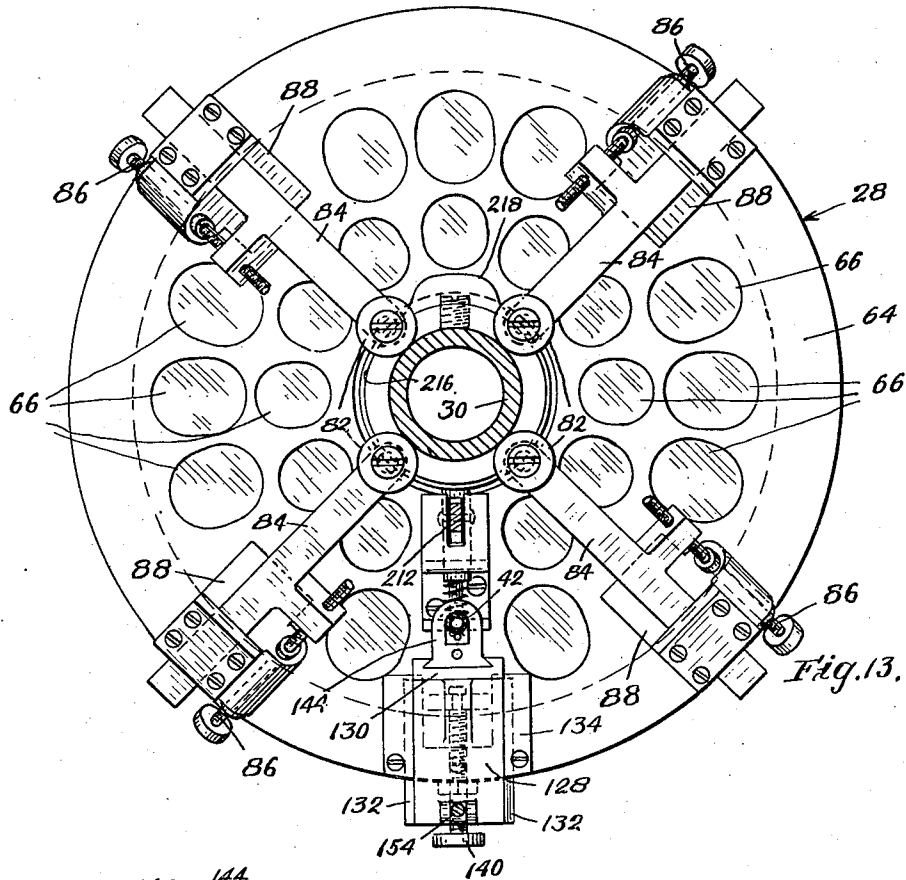


Fig. 13.

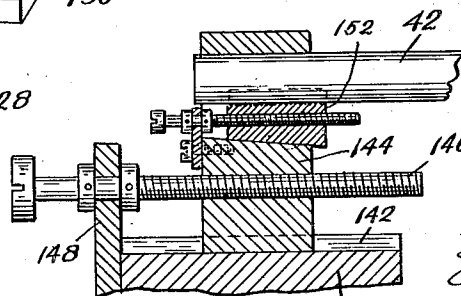
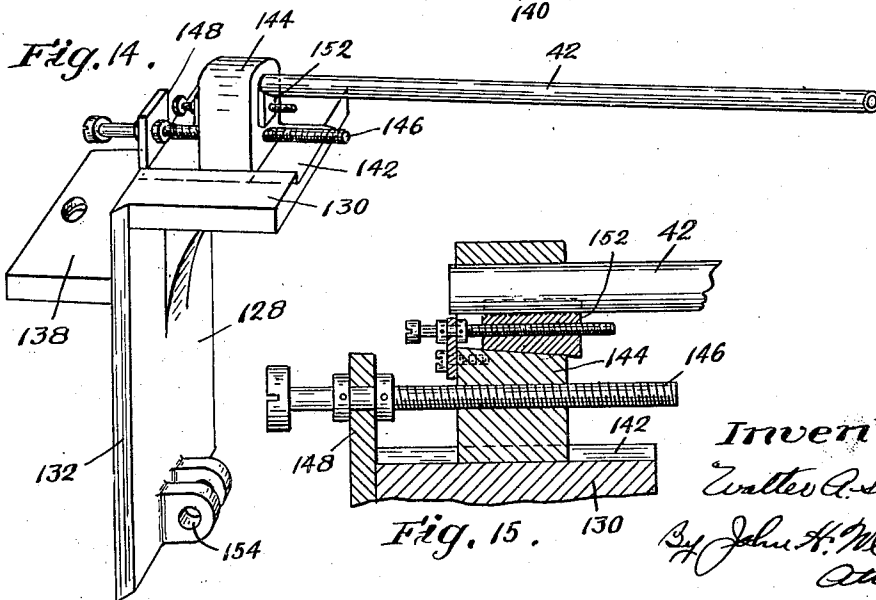


Fig. 15.

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GRINDING MACHINE

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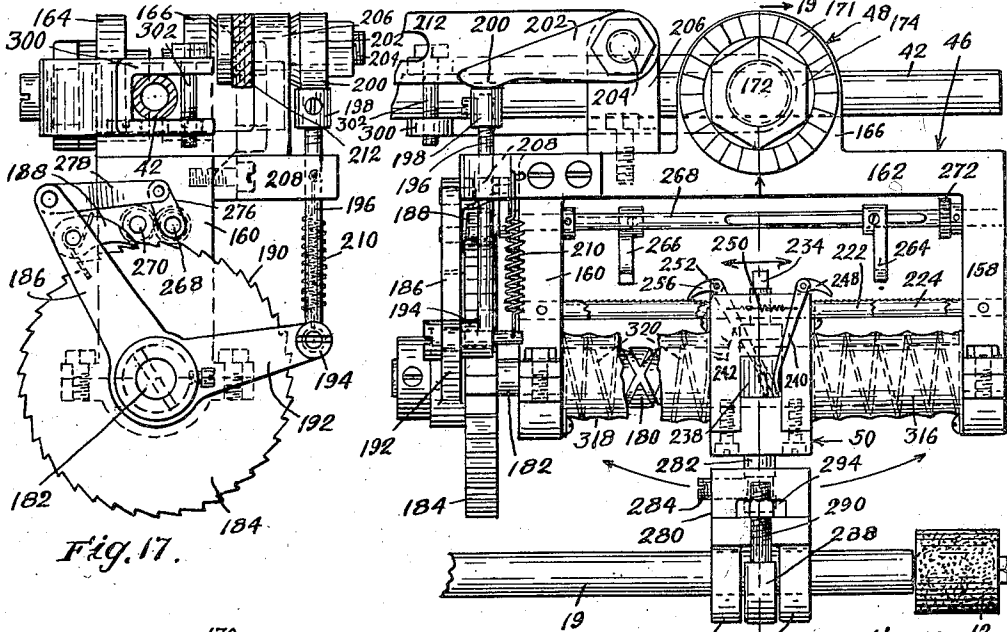


Fig. 17.

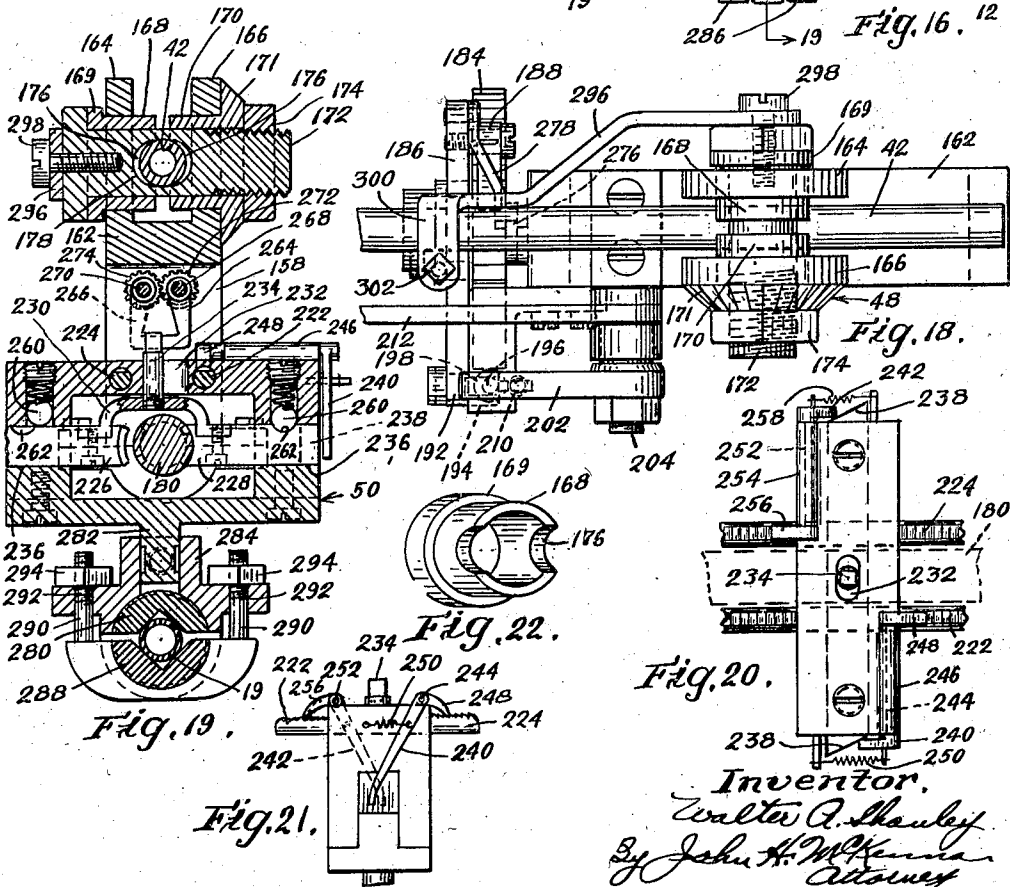


Fig. 19.

Fig. 21.

Fig. 22.

Fig. 20.

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UNITED STATES PATENT OFFICE

2,372,341

GRINDING MACHINE

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Application September 1, 1942, Serial No. 456,855

8 Claims. (Cl. 51—241)

This invention relates to improvements in grinding machines.

More particularly it provides a grinding machine which is portable in character and which is adapted to be mounted on any convenient support at the location where a grinding operation is to be performed. The grinding tool is power driven and is caused to traverse the surface which is being ground either automatically or by manual operation. The invention has special utility for grinding a wide variety of valves and their seats and is particularly advantageous for servicing the larger types of valves such as are found on ocean-going craft, for example. However, the numerous features of the invention, as a whole or in part, are applicable and usable in connection with practically every conceivable type of rotary grinding operation.

It is among the objects of the invention to provide a portable grinding mechanism which may be quickly mounted on a valve casing or other element having a surface to be ground, or on an adjacent support, and having an universality of adjustment of its grinding tool which permits surface grinding at any of a multiplicity of angles relative to the axis of its power unit.

Another object is to provide means for supporting my grinding mechanism and any of a variety of valve elements in valve-grinding relation.

A feature resides in a planetary mounting of the power-driven grinding tool whereby the tool can traverse the circle of a valve seat or valve, slowly with manual feed of the tool around the circle, or power driven at any predetermined suitable speed.

A further feature is that the tool reciprocates transversely of the surface which is being ground simultaneously with its planetary travel.

Still another feature resides in a radially adjustable plural roller mounting of the rotating carrier of the power driven grinding tool thereby to permit adjustment of the carrier relative to a fixed tubular axle, and leaving the axle free to serve as a chuck for mounting stem-type valves in position to be ground, or as a hollow tube guiding support for the flexible shaft of the grinding tool when the power unit is mounted, relative to the location of the grinding tool, at the remote side of the carrier.

Additional features involve the various provisions for angular adjustments and settings of the carrier, the power unit, and the reciprocating carriage which mounts rotatably the stiff end portion of the tool shaft, each contributing to the

universality of grinding functions possible of accomplishment with the mechanism of the invention.

The mentioned objects and results may be attained with the mechanism now to be described in detail in connection with the accompanying drawings in which

Figure 1 shows a large gate valve casing in medial vertical section having my grinding mechanism mounted thereon with the grinding tool in valve-seat-grinding position;

Figure 2 shows a large size disk valve casing, in medial vertical section having my grinding mechanism mounted thereon in position to grind its valve seat;

Figure 3 is a side elevation of a frame support mounting my grinding mechanism and a gate valve in valve grinding relation, the valve being in medial vertical section;

Figure 4 is a side elevation of grinding mechanism embodying features of the invention and showing a stem type of plug valve in position to be ground.

Figure 5 is a detail cross-section on line 5—5 of Figure 4, on a larger scale;

Figure 6 is a detail sectional view on line 6—6 of Figure 3;

Figure 7 is a medial vertical section through my planetary carrier and its fixed tubular axis;

Figure 8 is a sectional view on line 8—8 of Figure 7;

Figure 9 is a perspective view of the upper jaw of the axle clamp of Figures 7 and 8;

Figure 10 is a perspective view of the lower jaw of the axle clamp;

Figure 11 is a fragmentary detail sectional view on line 11—11 of Figure 8;

Figure 12 is a detail sectional view of one of the windows at the front face of the planetary carrier;

Figure 13 is an elevation of the front face of the planetary carrier with its roller bearings on the fixed axle, which latter is cross-hatched for clearness;

Figure 14 is a perspective view of the support for the tool holding carriage, the support being radially and axially adjustable on the front face of the planetary carrier relative to the latter's axis;

Figure 15 is a view on a larger scale in medial vertical section through the upper portions of the mechanism of Figure 14;

Figure 16 is a side elevation of the adjustable tool holding carriage and its reciprocating tool holder;

Figure 17 is an end elevation of the mechanism of Figure 16, showing the ratchet and pawl for actuating the reciprocating tool holder;

Figure 18 is a top plan view of the mechanism of Figure 16;

Figure 19 is a vertical sectional view on line 19—19 of Figure 16;

Figure 20 is a top plan view of the tool holder reversing racks and pawls;

Figure 21 is a side elevation of the mechanism of Figure 20; and

Figure 22 is a perspective view of one of the jaws of the adjusting clamp of the carriage, shown best in its clamping relation in the upper portion of Figure 18.

Referring to the drawings, and more particularly to Figure 1 thereof wherein the invention is shown complete, mounted on a valve casing 10, with the grinding tool 12 in position for grinding the valve seat 14, it will be obvious that the grinding tool 12 is operated by an electric motor 16 through the medium of flexible shaft 18 whose outer flexible casing is rotatably secured at its motor end so that this casing as a whole is rotatable. The motor 16, in Figure 1, is mounted on a hinged shelf 20 which may be secured to the valve casing, as illustrated, or to any other convenient support. Or the motor may be mounted directly on such another support. When the hinged shelf 20 is employed, it may be adjusted and set at various angles relative to the axis of the valve casing for a purpose which will later appear, the adjustment being accomplished by the slotted bracket 22 through whose slot the thumb screw 24 passes for threaded engagement with a depending ear 26 on the under side of the shelf. Tightening of the thumb screw clamps the bracket 22 to retain the shelf in any selected angular relation to the axis of the valve casing.

According to the invention, however, the power driven grinding tool 12 is caused to travel in a generally planetary course around the axis of the valve casing whose seat is being ground. For this purpose a planetary carrier 28 is rotatably mounted on a fixed tubular axle 30 which in turn is adjustably supported on a plate 32 which is secured to the end of the valve casing but which might be mounted on any other convenient support. The axle is held in a suitable clamp 34 which is pivotally mounted on plate 32 as at 36 and angularly adjustable by the slotted bracket 38 and thumb screw 40 similar to the adjustment for the motor shelf 20. By this means the rotatable planetary carrier 28 may be adjusted about the pivot 36 to bring its axis into perpendicular relation to the plane of a surface which is to be ground.

Mounted on the front face of the planetary carrier 28 and radially adjustable thereon is a carriage supporting bar 42 extending outward from the carrier 28 in parallelism with its axis and braced as at 44. A carriage 46 is mounted on bar 42 and is adjustable thereon, by means of the universal clamp 48, both along and around the bar as well as angularly relative to the bar. The carriage 46 includes a reciprocating tool holder 50 wherein the stiff end portion 19 of the flexible shaft 18 may be clamped as at 52. The flexible shaft 18 conveniently is threaded through and supported by the tubular axle 30.

The planetary carrier 28 may be manually rotated, as shown in Figure 4, or may be power driven as in Figures 1 and 2. The carrier is circumferentially grooved as at 54 for belt drive

from the relatively small pulley 56 which may be mounted on shaft 58 connected by reduction gearing 60 to the motor shaft, as in Figure 1, or shaft 58 may have a crank 62, as in Figure 4, for manual turning of the planetary carrier 28.

Figure 2 shows generally the same grinding mechanism of Figure 1, but the carriage 46 is adjusted on bar 42 to bring the grinding tool 12 into proper relation to the valve seat in the disk valve type of casing there portrayed.

Figures 3 and 4 similarly show grinding mechanisms comparable to that of Figure 1, Figure 3 having a special support for holding both the grinding mechanism and the gate valve which is being ground; and Figure 4 having the motor on the work side of the planetary carrier 28 for the grinding of a stem type of valve held in axle 30 as a chuck.

The foregoing general description in connection with Figures 1-4 shows the general utility of my improved grinding mechanism, and suggests the great multiplicity of types and varieties of grinding operations the invention is capable of accomplishing.

The structural details will now be described with reference to Figures 5-22.

Referring to Figures 7, 8 and 13, the planetary carrier 28 may be a hollow disk or wheel whose circumferential belt groove 54 constitutes it a pulley which may be belt driven as previously described. The front wall 64 of the carrier is shown integral with its grooved periphery, and has window openings 66 therethrough in each of which is an insert 68 of a suitable transparent material, preferably a flexible material so that the inserts may be snapped into grooves 70 as indicated in Figure 12.

The rear wall 72 of the carrier is represented as a removable plate secured in place by the screws 74. This plate wall also has window openings 76 covered by a disk 78 of transparent material secured to the plate by screws 80.

The carrier is rotatably mounted on the tubular axle 30 by a roller bearing structure which is best seen in Figure 13. A four point bearing is illustrated although, obviously, a three point bearing will suffice. The rollers 82 are carried at the inner ends of arms 84 which are independently adjustable radially of the carrier by the screws 86 in their respective supporting blocks 88 mounted on the front face of the carrier. Thus the carrier may be concentric with the axle 30 or may be adjusted to various degrees of eccentricity.

The carrier is maintained against movement axially of axle 30 by the roller thrust bearings 90 disposed in the hollow of the carrier. There are two sets of the rollers 90 mounted respectively on upper and lower jaws of the axle clamp 34. The upper jaw 92 of the clamp has the concavity 94 (Fig. 9) in its under side for fitting the exterior curvature of axle 30, and has a forward-projecting part 96 for extending through opening 98 in the rear cover plate 72 and transparent disk 78 of the carrier, terminating in the plate part 100, apertured at 102 for receiving the upper set of roller bearings 90. The rearward extending portion of the upper jaw 92 has ear 104 thereon on which the mounting plate 32 is pivoted at 36. It has also a plate part 106 in which the thumb screw 40 threadedly engages in coacting with the slotted bracket 38, pivoted at 108 on plate 32, for adjustably clamping plate 32 in adjusted posi-

tions. This upper jaw 92 of the clamp is shown in detail in Figure 9.

The lower jaw 110 of the clamp has the concavity 112 in its upper side for fitting the exterior curvature of axle 30, and has forward projecting part 114 extending through the opening 98 in the carrier, terminating in the plate part 116, apertured at 118 for receiving the lower set of roller bearings 90. Details of this lower jaw are best seen in Figure 10.

The jaws 92, 110 each has a seat 120 for seating a clamping strap 122 which may be drawn tight around the jaws by means of the screws 124, 126, best seen in Figure 8.

Mounted on the exposed face of front wall 64 of the planetary carrier is a vertically adjustable plate 128 (Figures 7 and 14) carrying at one end the right-angularly disposed shelf 130. Plate 128 has its side edges bevelled as at 132 for sliding adjustment in a complementally bevelled slide block 134 on the front face of wall 64 of the carrier. Wall 64 also has an outward projecting lug 136, and plate 128 has a rearwardly projecting part 138 by means of which plate 128 may be adjusted radially of the carrier through the medium of adjusting screw 140 which threadedly engages lug 136 of wall 64 and has a rotatable securement at its end to the part 138 of plate 128.

Shelf 130 has a bevelled side wall channel 142 in its upper face for slidably receiving the adjustable block 144 whose adjustment may be accomplished by screw 146 rotatably anchored in lug 148 on the shelf and threadedly engaging the block 144.

One end of a stiff bar 42 is removably clamped in the block 144 by the wedge and screw clamp 152 best seen in Figure 15, and the bar projects outwardly a considerable distance for mounting the carriage 46 and reciprocating tool holder 50. Preferably bar 42 is braced by the brace rod 44 pivotally secured at one end to plate 128, as at 154, and adjustably clamped at its other end to bar 46, as at 156.

Carriage 46 is adjustably mounted at any desired location along bar 42 by means of the universal clamp 48. The carriage comprises a yoke frame having the parallel side arms 158, 160 connected by the bridge part 162. Projecting from the bridge part 162 are the two spaced ears 164, 166, each apertured to receive one of the clamping sleeves 168, 170. The sleeves are tubular for receiving a clamping bolt 172 headed at one end to engage flange 169 of sleeve 168, and threadedly engaging nut 174 at its other end for drawing the nut against flange 171 of sleeve 170. The inner ends of the sleeves are spaced apart, and each is notched as at 176 (Figs. 19, 22) to fit the exterior contour of bar 46 which extends through the elongated hole 178 in bolt 172. When the clamp is loosened, the carriage is universally adjustable relative to bar 42, and tightening of the clamp effectively secures the carriage in a selected position.

Journalled in the arms 158, 160 of the carriage is a drive screw 180 having both right and left hand threads thereon. As illustrated in Figure 16, each arm 158, 160 has a cap bearing at its end for mounting screw 180. A bearing portion of the screw at one end projects outward beyond arm 158 as at 182, and a ratchet wheel 184 is fixed thereon. Loose on this projecting portion of the screw is a bell-crank lever whose one arm 186 carries a spring pressed pawl 188 which is constantly urged by its spring toward the teeth

190 of the ratchet wheel. The teeth of the ratchet are such that a clockwise movement of the bell-crank and pawl advances the ratchet wheel clockwise a distance corresponding to one tooth space, and the screw 180 is simultaneously rotated an equal amount.

The other arm 192 of the bell-crank has connected to it, as at 194, one end of an actuating rod 196 whose other end has a head 198 engaging the cam end 200 of a rocker arm 202 which is mounted to turn with short shaft 204 journalled in bracket 206 on the bridge part 162 of the carriage. Actuating rod 196 is maintained in operative relation to the rocker arm 202 by a slidable engagement with guiding block 208 projecting from arm 160 of the carriage, and by spring 210 which constantly urges the head 198 of the rod against the cam of the rocker arm 202. Thus a counter-clockwise rotation of rocker-arm 202 (Figure 16) depresses the actuating rod 196 and advances the ratchet wheel one tooth space in clockwise direction (Figure 17). Spring 210 restores the pawl to its position of Figure 17 as soon as rocker-arm 202 permits.

Intermittent rocking movements of rocker-arm 202 are accomplished through the long lever 212 which, as seen in Figure 1, extends from a fixed connection to short shaft 204, which constitutes a pivot, to a location adjacent to the outer face of the planetary carrier 28 where it has spring pressed engagement as at 214 (Figure 7) with a cam 216 fixed on the stationary axle 30. The cam has a single high spot 218 (Figure 13) which rocks lever 212 and the rocker arm 202 to advance the ratchet wheel once during each rotation of the planetary carrier 28 about the axle 30 and cam 216. The lever 212 may be adjusted in length to suit any particular operating conditions, by having it in two sections releasably clamped together as at 220 in Figure 1.

It will be obvious from the foregoing description that, regardless of where or how the carriage 46 may be set relative to supporting bar 42, each rotation of planetary carrier 28 will result in one tooth-space clockwise advance of ratchet wheel 184 and a corresponding slight rotation of the screw 180 in the carriage.

The tool holder 50 is mounted in carriage 46 for reciprocatory travel between the arms 158, 160. It comprises a rectangular hollow frame slidably suspended on the two parallel and spaced stiff rack-rods 222, 224. Within the frame are the two half nut members 226, 228 connected together across screw 180 by the yoke 230. The half nut members and yoke are slidable as a unit within the frame to bring one or the other of the half nuts into threaded engagement with the screw, the spacing being such that only one half nut 226 or 228 can engage the screw at any one time. An opening 232 in the top wall of the frame permits projection to the exterior of a shift pin 234 connected to the yoke 230. Opening 232 is of size to permit pin 234 to move therein sufficient to shift the half nuts 226, 228 alternately into engagement with screw 180. The threads on one of the half nuts fits the right hand threads of screws 180, and the threads of the other half nut fit the left hand threads of the screw, so that, as they alternately engage the screw, the intermittent rotations of the screw by pawl 188 and ratchet wheel 184, cause intermittent movements of the tool holder 50 first in one direction and then in the opposite direction along screw 180.

Referring to Figures 19 and 21, the half nut

and yoke unit 226, 228, 230 has a sliding bearing in the front and rear walls of the hollow frame of the tool holder 50, the walls being suitably apertured as at 236 to permit bevelled outer end portions 238 of the half nuts to be projected out of the frame, for actuating respectively the pawl levers 240, 242 pivotally mounted one at the front side and one at the rear side, (Figure 16), of the tool holder frame. The pivot for lever 240 is a shaft 244 journaled in the long boss 246 (Figures 19, 20) forward and at the right top edge of the frame. Lever 240 is fixed to the forward end of shaft 244, and pawl 248 is fixed to its rear end for overhanging the frame and engaging the teeth rack rod 227 when permitted to do so. A spring 250 constantly urges lever 240 and its pawl 248 to rack rod engaging position. But when half nut 226 is in engagement with screw 180, the bevelled end 238 of half nut 228 will be projected as a cam into position to disengage pawl 248 as in Figure 16, holding it disengaged until half nut 228 is shifted toward screw engagement past a neutral position in which both half nuts will be free of the screw 180.

Lever 242 is similarly mounted on shaft 252 which is journaled in the long boss 254 (Figures 19, 20) rearward and at the left top edge of the frame. Lever 242 and pawl 256 are fixed at opposite ends of shaft 252, with the pawl in position to engage the teeth of rack rod 224 when the cam end 238 of half nut 226 permits. A spring 258 urges lever 242 and its pawl 256 to rack rod engaging position.

When the tool holder 50 is connected for intermittent travel in either direction along screw 180, as when half nut 226 is engaged with the screw, for example, a pawl and rack rod engagement prevents movement of the carriage in the opposite direction, as when the pawl 248 engage rack rod 222. Also, during the interval of reversal of travel of the tool holder, when both half nuts will be momentarily disengaged from the screw 180, both pawls 248 and 256 will be simultaneously engaged with their rack rods, thus eliminating any chance of the tool holder accidentally sliding along the screw. As soon as a half nut engages screw 180, the proper one of the pawls 248 or 256 will have been cammed free of its rack rod.

In Figure 19, spring-pressed balls 260 coact with depressions 262 in the half nuts to retain the half nut unit yieldingly in one or the other of its screw-engaging positions.

Reversal of the direction of intermittent travel of tool holder 50 on screw 180 is accomplished by the dogs 264, 266 (Figures 16, 19) respectively engaging the shift pin 234. The dogs are adjustably mounted on the parallel rocker shafts 268, 270 extending between and journaled in the arms 158, 160 of the carriage 46. The rocker shafts are geared together at one end by the meshing pinions 272, 274, as seen in Figure 19, and the left hand end of shaft 268 (Figure 16) projects outward beyond the arm 160 and has fixed thereon the crank arm 276 (Figure 17) which is connected by link 278 to the work arm 186 of the ratchet-actuating bell crank lever. Thus each time the ratchet wheel 184 is advanced to rotate screw 180, the rocker shafts 268, 270 are rocked in opposite directions, shaft 268 clockwise and shaft 270 counter-clockwise. The dogs 264, 266 depend from their respective shafts and may have the generally inverted L shape indicated in Figure 19, where dog 264 is shown in its position after having been rocked into shifting engagement with

pin 234. Pin 234 is free of the dogs throughout the full length of its travel in each direction. But when the tool holder reaches a position on screw 180 where shift pin 234 is opposite one or the other of the dogs, the next rocking of shafts 268, 270, and the dogs thereon, will cause that dog which is opposite the shift pin 234 to shift the pin and the half nut unit to bring a different half nut into engagement with screw 180. The tool holder 50 then travels intermittently in the opposite direction until pin 234 comes opposite the other dog and another reversal is effected.

The tool holder 50 includes a clamp for securely gripping the stiff end portion 19 of the flexible shaft 18 at whose end the tool 12 is mounted. One jaw 280 of the clamp is rotatably adjustable on stud 282 projecting from the screw-surrounding frame of the tool holder, and is adapted to be set in any selected position by the screw 284. This jaw 280 has spaced ears 286 through openings in which the shaft 19 loosely extends. The other jaw 288 of the clamp fits between the ears 286 and may be drawn toward jaw 280, to clamp shaft 19 between them, by the threaded rods 290 projecting in parallelism through holes 292 in the jaw 280, and having nuts 294 screwed tight thereon against the jaws 280.

Obviously the tool end of shaft 19 may be adjusted in the clamp 280, 288 to position the tool 12 at varying distances from the clamp. And the shaft may be set at various angles around stud 282 by adjusting screw 284.

As a measure of safety against accidental slip of carriage 46 along bar 42 when clamp 48 is loosened, as when the bar 42 is vertical or tilted, I provide the safety bar 296 (Figure 18) which has one end secured as by screw 298 to the head of clamping bolt 172, and has at its other end the yoke 300 which may be clamped around bar 42 by screw 302 as best seen in Figure 17. The yoke may be clamped tight on bar 42 prior to loosening of the main carriage clamp 48, to hold the carriage at a fixed location along the bar while the carriage is being otherwise adjusted relative to the bar.

In operation, my grinding mechanism conveniently may be carried to a ship or other location where a grinding operation is required on a valve or valve seat, or other element which cannot be brought conveniently to a grinding machine.

It is a feature of the invention that my mechanism may be readily mounted on or operatively adjacent to a valve casing or other object having a surface or surfaces needing to be ground, as suggested in the showings of Figures 1 and 2 of the drawings. Or a special supporting frame 303, as in Figure 3, can support my grinding mechanism in grinding relation to work also held in the frame, such as the gate valve 304 shown suspended from screw 306 and additionally sustained and braced by the rod 308.

In the arrangement of Figures 1-3, and many others, the flexible shaft 18 will be threaded through the stationary axle 30, to avoid its becoming entangled during the planetary travel of its tool end.

In Figure 4, however, the axle 30 is utilized as a chuck for holding the work, it having set screws 31 for engaging the valve stem as shown in the detail view of Figure 5. In such case the motor is brought over to the work side as in Figure 4. A frame support 305, in Fig. 4, is shown, mounting the carrier 28 with adjusting means similar to that described in connection with Figs. 1 and 2.

The planetary carrier may be adjusted on axle 30 to be concentric therewith or eccentric to varying degrees, by adjusting its arms 84 carrying the supporting rollers 82. Also the carrier may be tilted to various angles as suggested in Figures 1 and 3.

Radial adjustment of bar 42 on which carriage 46 is mounted, toward or from the axle 30, may be accomplished by screw 140 on the carrier. And longitudinal adjustment of bar 42 and the carriage 46 toward or from the carrier 28 can be effected by screw 146 on the vertical slide plate 128.

These adjustments can be made by the operator while observing the tool 12 through the windows 76, 66 in the planetary carrier, to get precision adjustment of tool 12.

Previously the tool will have been adjusted to approximate precision setting by means of the universal carriage clamp 48 and the tool holder clamps 280, 288 and 284. Also the dogs 264, 266 will have been set to determine a proper reciprocating travel of the tool holder 50 in carriage 46.

The mechanism thus is adapted to serve practically every grinding situation, a suitable kind and style of tool 12 being selected for particular grinding operations.

In case it may be desired, under certain conditions, to utilize the rotary grinder 12 without planetary movement of the tool, I provide a tapered pin 310 (Figures 8 and 11) for insertion in hole 312 in the rear wall 72 of the carrier and hole 314 in the bearing plate 100 which is fixed on axle 30.

It may be desirable in some cases to provide a protective cover for the drive screw 180 of carriage 46, to prevent foreign matter interfering with a proper operation of the tool holder 50. In Figure 16 I show such a protective cover comprising the two flexible tubes 316, 318. Tube 316 is connected at one end to arm 158 of carriage 46 and at its other end to the tool holder 50. Tube 318 is similarly connected at one end to arm 160 of the carriage and at its other end to the tool holder. A light coil spring 320 may be mounted interiorly of each tube maintaining the tube walls out of contact with the screw but permitting the tool holder to travel in either direction with an accordion-like collapsing of the tube toward which the tool holder is moving.

Although the invention is illustrated and described in connection with grinding operations, it will be apparent to those skilled in the art that my improved mechanism may employ a tool other than a grinding wheel, and thus the features of the invention may be used for various operations outside of the field of grinding.

I claim as my invention:

1. Grinding mechanism having a rotating grinding tool, a drive shaft and power means therefor, combined with a rotatable carrier having a rigid bar projecting from its front side in parallelism with its axis and at a radial distance outward from its axis, a carriage on said bar, the carrier and carriage being relatively adjustable along the bar, and the carriage being adjustable around the axis of the bar, means for securing the carrier and carriage relatively in adjusted positions, means on said carriage holding the work end of the drive shaft, means at the rear side of the carrier for supporting the carrier rotatably, and means for rotating the carrier to move the rotating tool through an arcuate course.

2. Grinding mechanism having a rotating

grinding tool, a drive shaft and power means therefor, combined with a rotatable carrier having a rigid bar projecting from its front side in parallelism with its axis and at a radial distance outward from its axis, a carriage adjustable along and around said bar including a clamp for fixing it on the bar in adjusted positions, a tool holder in said carriage clamping the work end of the said drive shaft, means projecting at the rear side of the carrier for supporting the carrier rotatably, and means for rotating the carrier to move the rotating tool through an arcuate course.

3. Grinding mechanism having a rotating grinding tool, a flexible drive shaft and power means therefor, combined with a rotatable carrier and a support therefor; a carriage mounted on the carrier radially outward from the axis of the carrier; a tool holder in said carriage holding the work end of said drive shaft at a location remote from said power means; means for rotating said carrier to move the rotating tool through an arcuate course; and means associated with the carrier and carriage for intermittently shifting the position of the tool holder and rotating tool relative to the carriage in response to rotation of the carrier.

4. Grinding mechanism having a rotating grinding tool, a drive shaft and power means therefor, combined with a rotatable carrier and a support therefor; a carriage mounted on the carrier radially outward from the axis of the carrier; a tool holder in said carriage holding the work end of said drive shaft; means for rotating said carrier to move the rotating tool through an arcuate course; a screw in said carriage threadedly engaging said tool holder; a ratchet connected to the screw; and ratchet actuating means responsive to rotation of the carrier for intermittently rotating the screw to move the tool holder and rotating tool intermittently along the screw.

5. Grinding mechanism having a rotating grinding tool, a drive shaft and power means therefor, combined with a rotatable carrier and a support therefor; a carriage mounted on the carrier radially outward from the axis of the carrier; a tool holder in said carriage holding the work end of said drive shaft; means for rotating said carrier to move the rotating tool through an arcuate course, a screw in said carriage threadedly engaging said tool holder; a ratchet connected to the screw; and ratchet actuating means responsive to rotation of the carrier for intermittently rotating the screw to move the tool holder and rotating tool intermittently along the screw; and means for reversing the direction of travel of the tool holder and rotating tool on the screw.

6. Grinding mechanism having a rotating grinding tool, a drive shaft and power means therefor, combined with a rotatable carrier and a support therefor; a carriage mounted on the carrier radially outward from the axis of the carrier; a tool holder in said carriage holding the work end of said drive shaft; means for rotating said carrier to move the rotating tool through an arcuate course; a screw in said carriage threadedly engaging said tool holder; a ratchet connected to the screw; and ratchet actuating means responsive to rotation of the carrier for intermittently rotating the screw to move the tool holder and rotating tool intermittently along the screw; and a longitudinally expansible and contractible flexible protective covering connected to the carriage and tool holder and enclosing the screw.

7. Grinding mechanism having a rotating

grinding tool, a drive shaft and power means therefor, combined with a rotatable carrier having means radially outward thereon adjustably holding the work end of the drive shaft; an axle rotatably supporting the carrier and itself free from rotation, said carrier being hollow, and there being thrust bearings in its hollow, and the carrier having radially adjustable roller bearing suspension on the axle.

8. Grinding mechanism having a rotating 10

grinding tool, a drive shaft and power means therefor, combined with a rotatable carrier having means radially outward thereon adjustably holding the work end of the drive shaft; an axle rotatably supporting the carrier and itself free from rotation, and mounting means for said grinding mechanism independent of said axle having provision for mounting a piece of work thereon in grinding relation to the grinding tool.

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