July 4, 1933. M. C. HUTTO 1,916,267

APPARATUS FOR GRINDING GUN BARRELS AND CYLINDRICAL SURFACES

Filed July 22, 1930 6 Sheets-Sheet 1

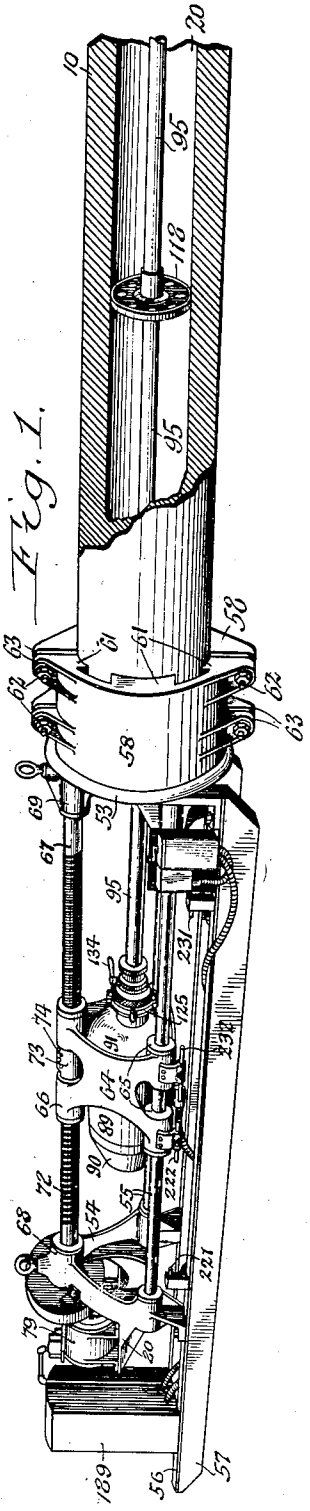


Fig. 1.

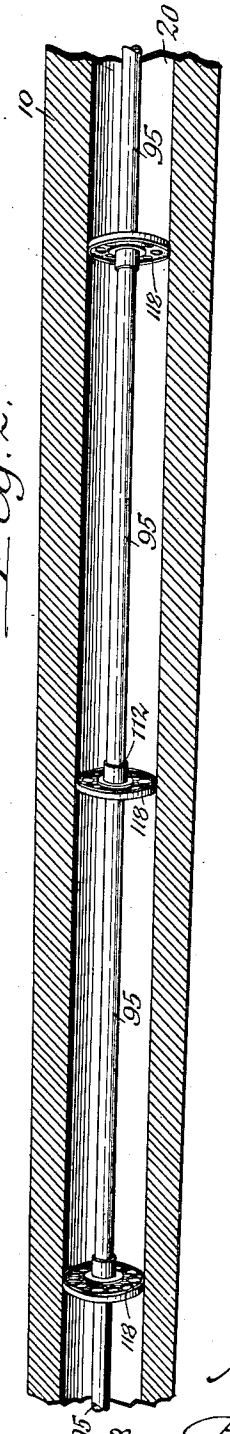


Fig. 2.

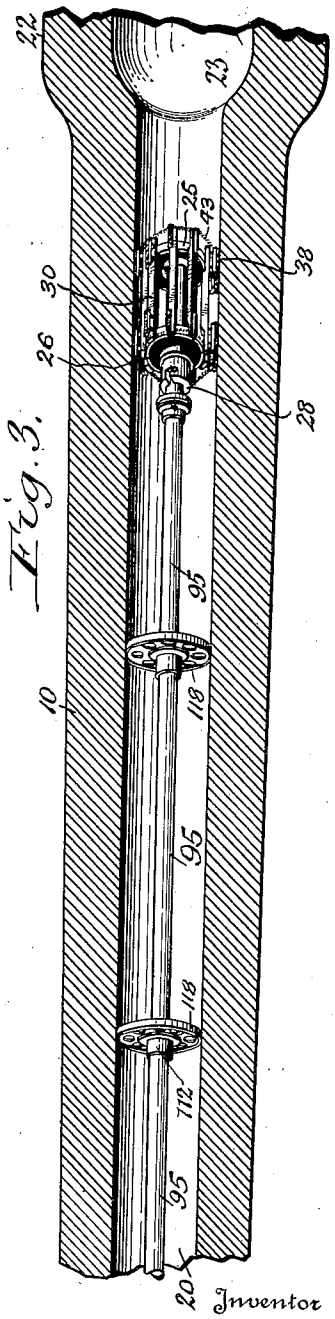


Fig. 3.

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July 4, 1933. M. C. HUTTO 1,916,267

APPARATUS FOR GRINDING GUN BARRELS AND CYLINDRICAL SURFACES

Filed July 22, 1930 6 Sheets-Sheet 2

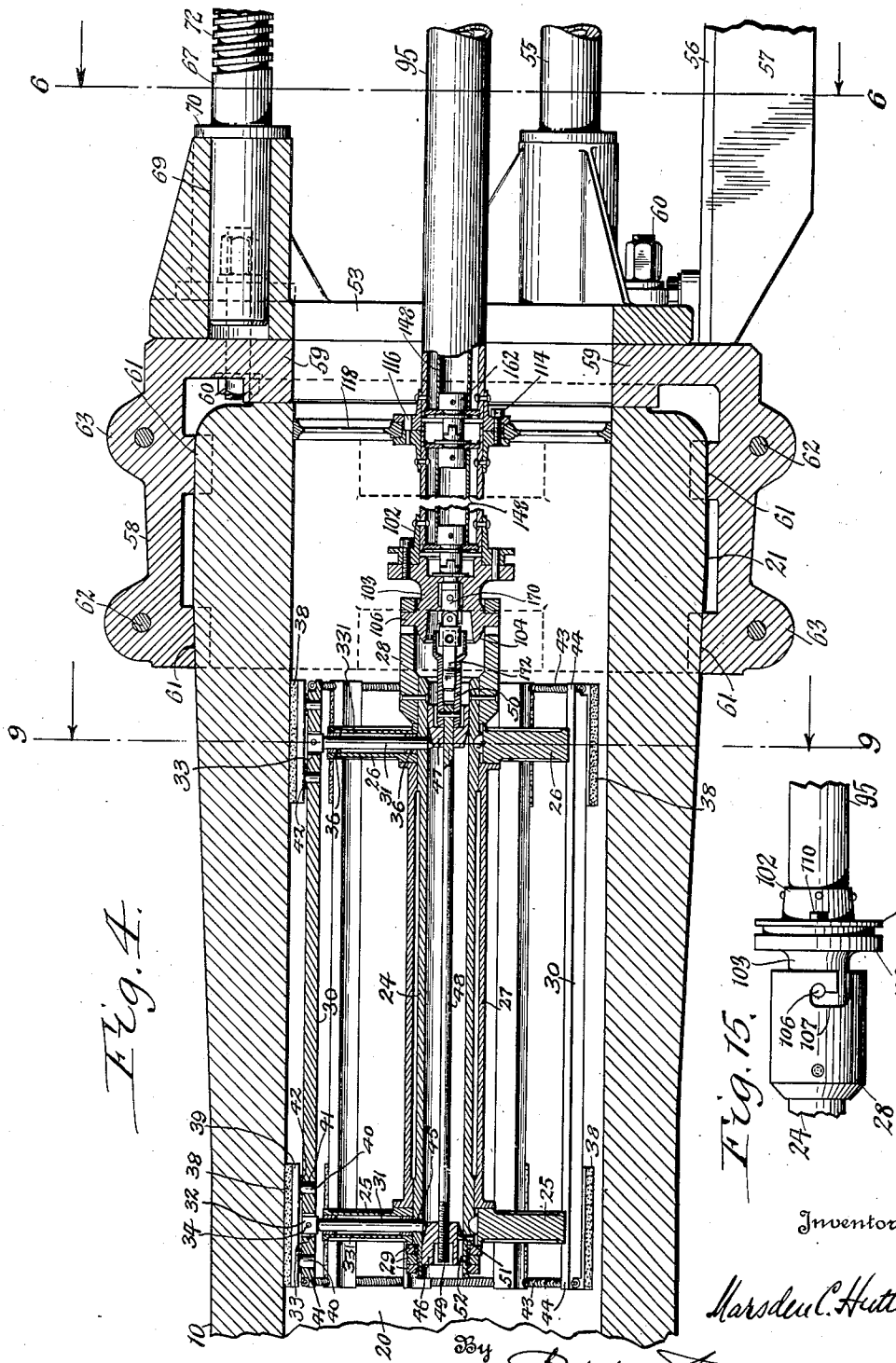


Fig. 4.

Fig. 15.

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July 4, 1933. M. C. HUTTO 1,916,267

APPARATUS FOR GRINDING GUN BARRELS AND CYLINDRICAL SURFACES

Filed July 22, 1930 6 Sheets-Sheet 3

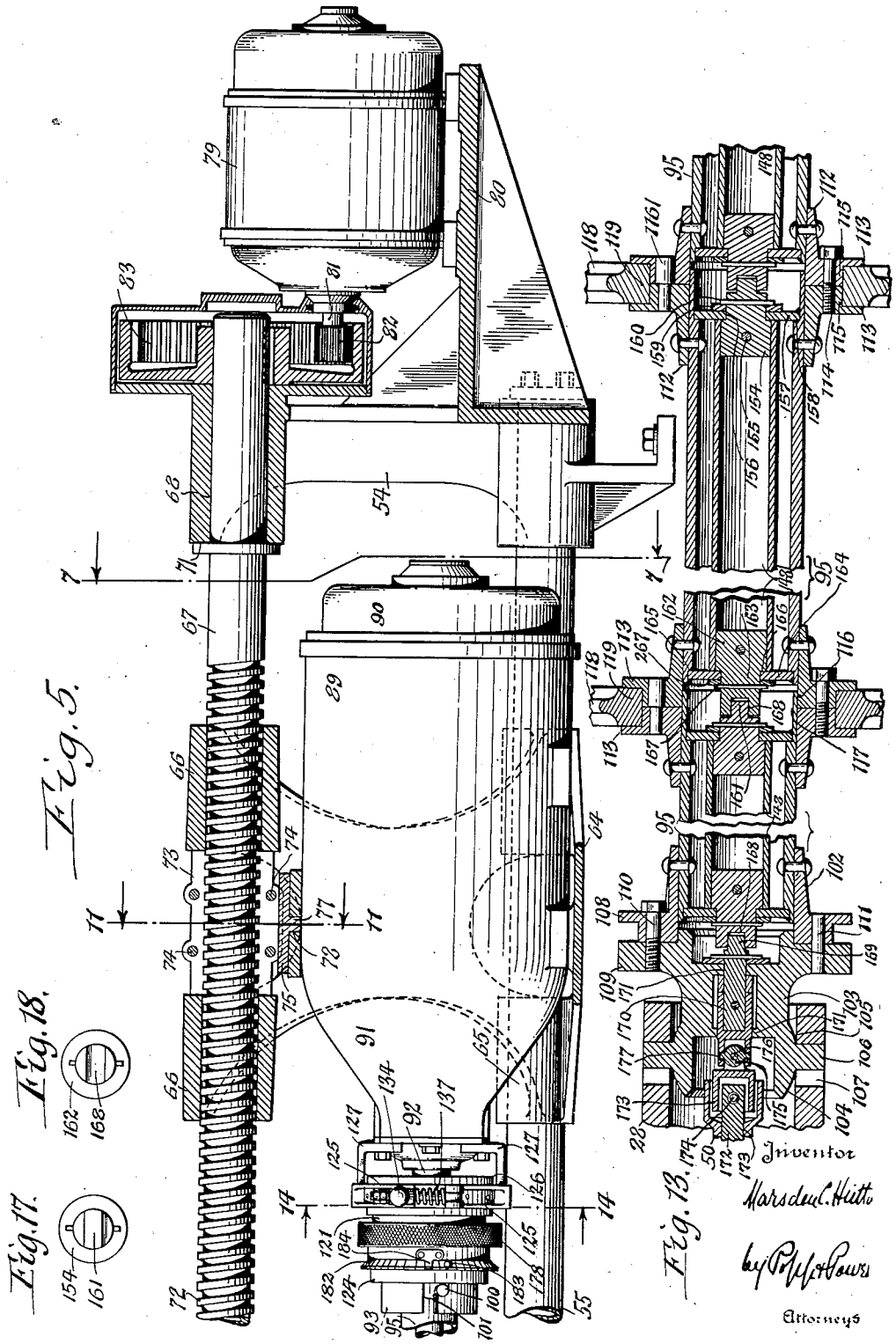


Fig. 5.

Fig. 18.

Fig. 17.

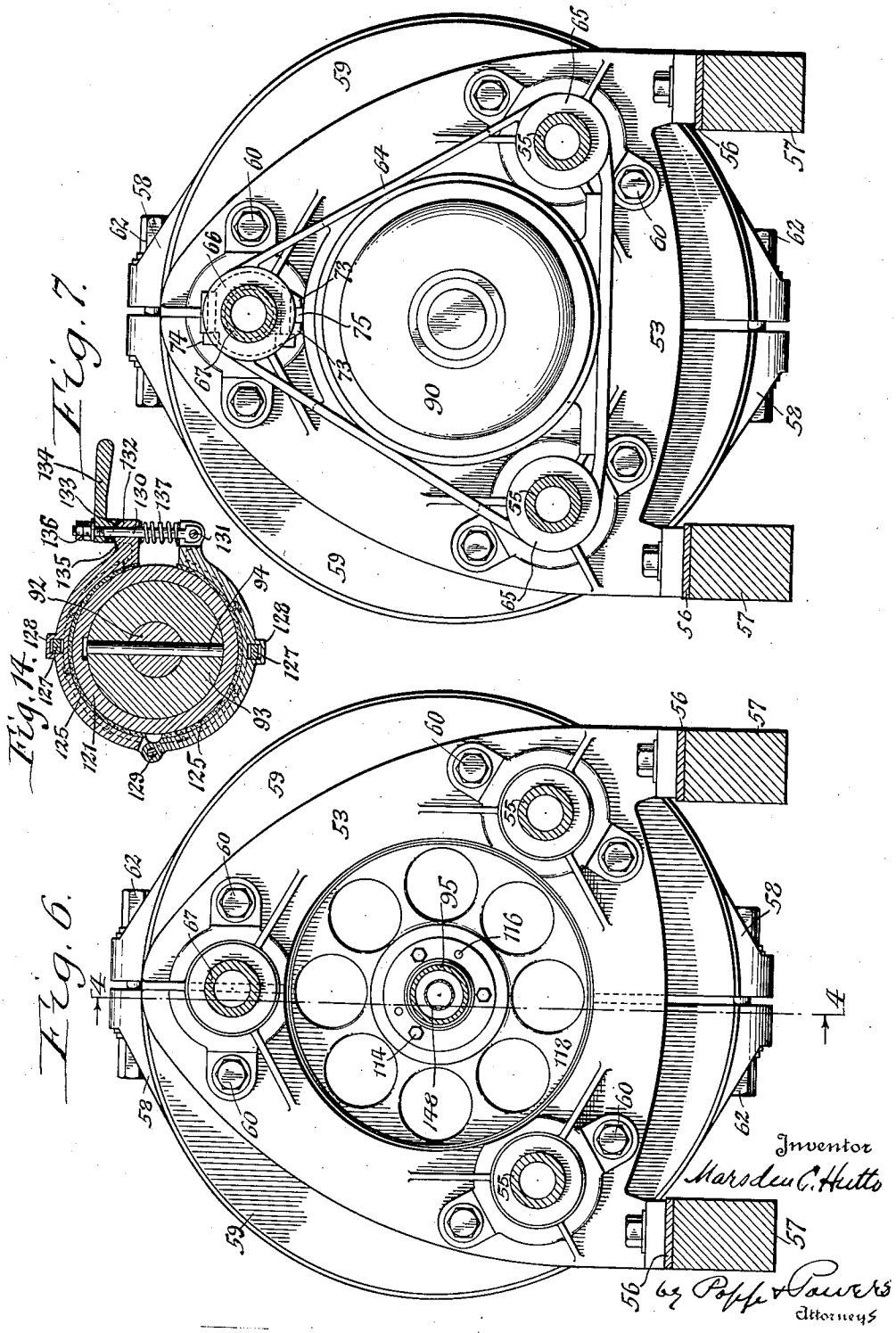
Fig. 13.

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July 4, 1933. M. C. HUTTO 1,916,267

APPARATUS FOR GRINDING GUN BARRELS AND CYLINDRICAL SURFACES

Filed July 22, 1930 6 Sheets-Sheet 4



July 4, 1933. M. C. HUTTO 1,916,267

APPARATUS FOR GRINDING GUN BARRELS AND CYLINDRICAL SURFACES

Filed July 22, 1930 6 Sheets-Sheet 5

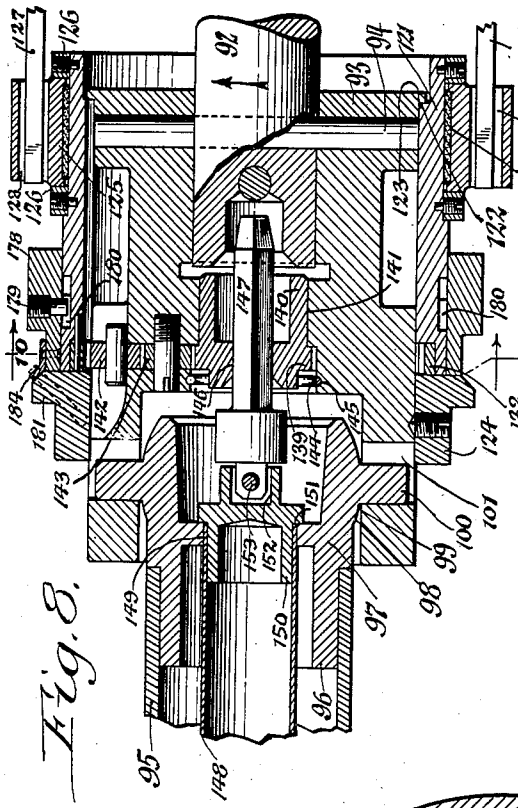


Fig. 8.

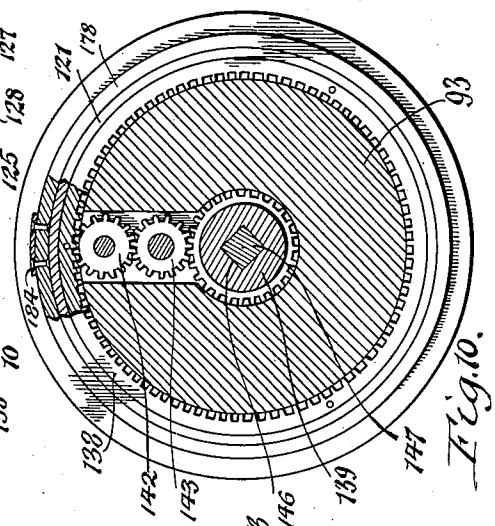


Fig. 10.

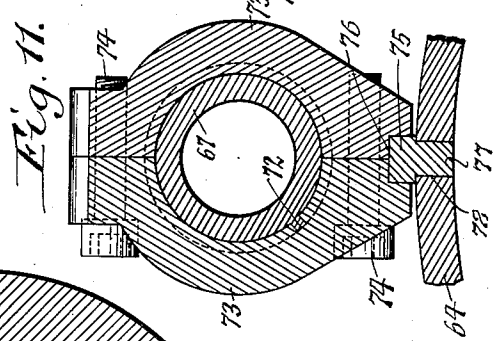


Fig. 11.

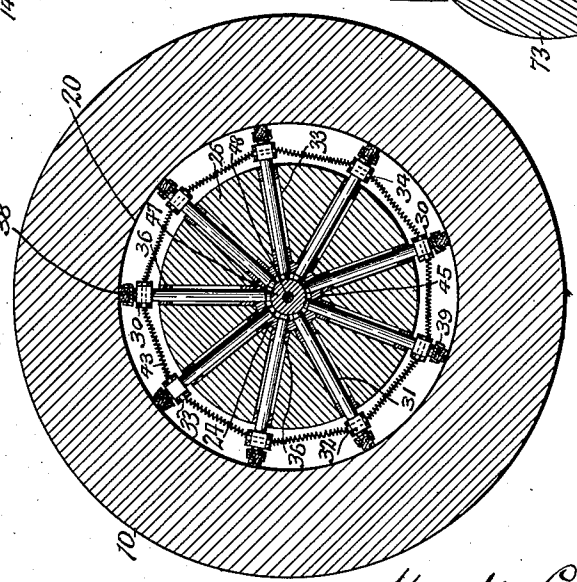


Fig. 9.

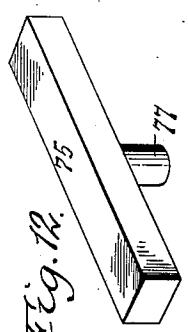


Fig. 12.

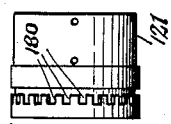


Fig. 16.

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July 4, 1933. M. C. HUTTO 1,916,267

APPARATUS FOR GRINDING GUN BARRELS AND CYLINDRICAL SURFACES

Filed July 22, 1930 6 Sheets-Sheet 6

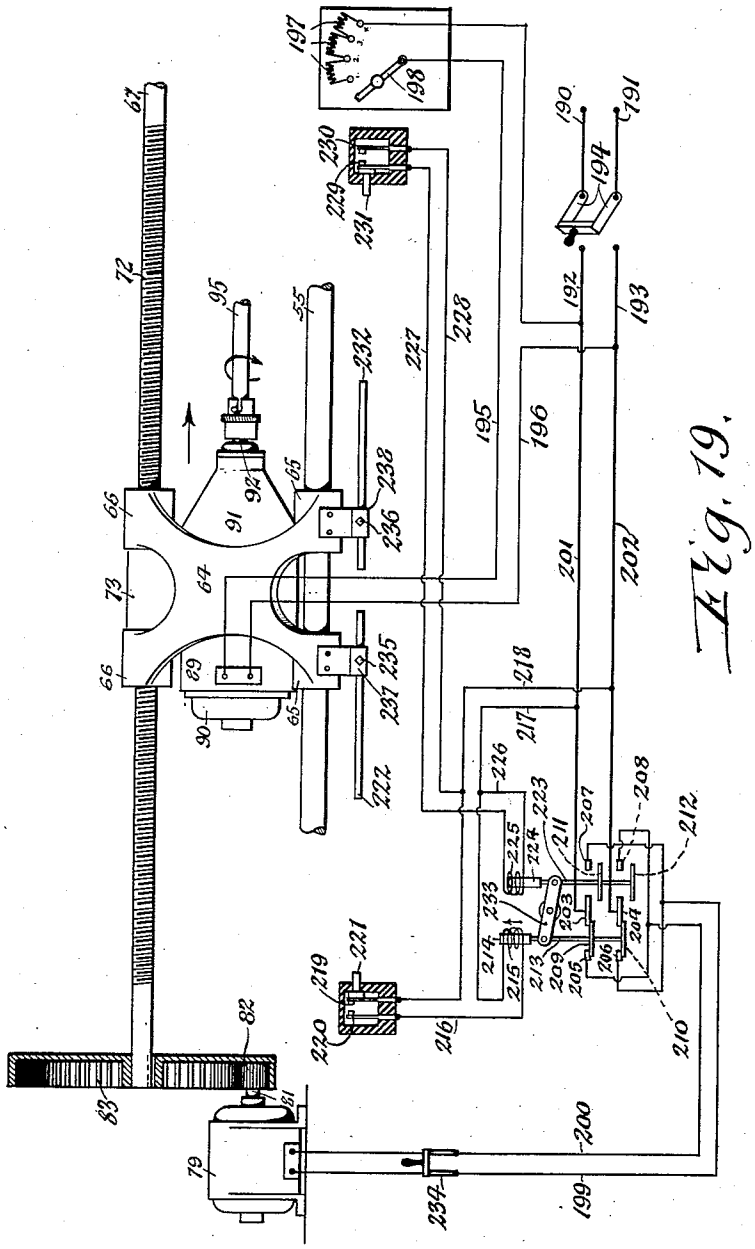


Fig. 19.

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Patented July 4, 1933 1,916,267

UNITED STATES PATENT OFFICE

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APPARATUS FOR GRINDING GUN BARRELS AND CYLINDRICAL SURFACES

Application filed July 22, 1930. Serial No. 469,302.

This invention relates to an apparatus for grinding cylindrical surfaces such as the barrels of large diameter guns, cannons or heavy ordnance, and more particularly to an apparatus of this character whereby guns of large caliber or bore may be reground or reconditioned without requiring the same to be dismounted or removed from their mountings which normally support them when installed for use.

When guns or cannons of large caliber have become worn due to repeated firing of the same it becomes necessary to rebore them in order to restore their accuracy. To do this it has been necessary to dismount the guns, transport the same to and from the machine shop where the regrinding was performed and then remount the guns. This not only involves a great deal of labor and expense but also is attended with a loss of time and long interruption in the use of the guns which is of great importance in the case of guns mounted on war ships and in fortifications inasmuch as the ships cannot be used most effectively when one or more of their guns are removed for purposes of reboring and a fortification is also handicapped when part of its equipment is temporarily removed.

One of the objects of this invention is to provide a grinding apparatus for boring or reconditioning the barrels of heavy ordnance which enables the grinding of the bores of such barrels to be accomplished efficiently, expeditiously and economically.

A further object of this invention is to enable the boring of such a barrel to be effected without removing the barrel from its mounting, thereby reducing to a minimum interruption in the use of the gun and the equipment associated therewith.

In the accompanying drawings:

Figure 1 is a fragmentary perspective view, partly in section, of my grinding apparatus applied to the front portion or muzzle of a large caliber gun barrel.

Figure 2 is a similar view of the mid-section of a gun barrel and a part of the grinding apparatus therein.

Figure 3 is a similar view of the rear part or breech section of a gun barrel and a part of the grinding apparatus therein.

Figure 4 is a vertical longitudinal section, on an enlarged scale, of the muzzle portion of the gun barrel and part of the grinding apparatus mounted thereon, the section being taken on line 4—4, Fig. 6.

Figure 5 is a fragmentary side elevation, partly in section, of the mechanism for driving the working parts of this grinding apparatus.

Figure 6 is a cross section taken on line 6—6, Fig. 4.

Figure 7 is a cross section taken on line 7—7, Fig. 5.

Figure 8 is a fragmentary vertical section, on an enlarged scale, of the means for connecting the tool with the driving shaft and the mechanism for adjusting the diameter of the tool.

Figure 9 is a vertical transverse section taken on line 9—9, Fig. 4.

Figure 10 is a vertical transverse section taken on line 10—10, Fig. 8.

Figure 11 is a vertical transverse section, on an enlarged scale, taken on line 11—11, Fig. 5.

Figure 12 is a perspective view of the key forming part of the mechanism for longitudinally reciprocating the grinding tool in the bore of the gun barrel.

Figure 13 is a fragmentary longitudinal section, on an enlarged scale, showing the mechanism for connecting the grinding tool with its driving shaft and the means for adjusting the diameter of the tool, and the means for guiding the driving shaft and associated parts in the gun barrel.

Figure 14 is a cross section taken on line 14—14, Fig. 5.

Figure 15 is a fragmentary side view of the means for coupling the main driving shaft at its front end with the body of the grinding tool.

Figure 16 is a side view of the adjusting collar forming part of the means for adjusting the working diameter of the tool.

Figures 17 and 18 are end views of the co-operating coupling plugs for connecting

opposing ends of two sections of the adjusting shaft.

Figure 19 is a diagrammatic wiring diagram of the electrical connections of the grinding apparatus.

In the following description similar characters of reference indicate like parts in the several figures of the drawings.

Although this grinding apparatus is adapted to grind the bores of ordnance of various constructions and mounted aboard ship or on fortifications, the same is concerned wholly with the barrel of such ordnance which in the present example consists of a forwardly tapering body 10 having a straight longitudinal cylindrical bore 20, a rearwardly tapering or conical external bead or collar 21 arranged on the muzzle or front end of the barrel and a breech 22 arranged at the rear end of the body and having an ammunition loading chamber 23 communicating with the bore of the gun barrel.

In its general organization this grinding apparatus comprises a tool which is adapted to rotate and reciprocate lengthwise in the bore of the gun barrel and provided with abrasive members or bits which engage with said bore for grinding and polishing the same, means for effecting such rotation and reciprocation of the tool from the exterior of the gun barrel, means for adjusting the working diameter of the tool, and means for detachably mounting the apparatus on the muzzle of the gun barrel and maintaining the same in the proper relation during the operation of grinding the bore of the same.

The tool for grinding the bore of the gun barrel may be variously organized but the construction shown in the drawings is preferred as it has worked satisfactorily in actual use and as there shown the same is constructed as follows:

The body of the tool comprises a central longitudinal hub 24 having preferably the form of an outer tube, and front and rear heads 25, 26 mounted on the front and rear ends of the body tube and having preferably the form of disks. The central hub and heads of the tool body are preferably held together by means of an outer spacing tube or sleeve 27 surrounding the hub and bearing at its opposite ends against the opposing sides of the disk shaped heads, a coupling sleeve or driven head 28 riveted or otherwise secured to the rear end of the hub 24 and engaging the outer side of the rear head 26, and clamping screw nuts 29 working on the externally screw threaded front end of the hub and engaging with the outer side of the front head 25. A rigid connection between the main body members is thus obtained so that as a whole the tool body is strong and light.

Around the periphery of the body heads is arranged an annular row of longitudinal supporting bars 30 which are capable of radial movement on the tool body by mounting each supporting bar at its opposite ends on guide rods 31 which are slidable radially on the respective body heads. The connection between each guide rod and the respective supporting bar is preferably effected by providing the outer end of the rod 31 with an enlarged head 32 which is arranged in an opening 33 in the adjacent part of the supporting bar and a pin 34 passing transversely through the head 32 and the adjacent part of the supporting bar. By this means a pivotal connection is obtained between the supporting bar and its guide rods which permits these members to turn slightly relatively to each other and prevents binding of the rods in their guideways in the body in case the rods at opposite ends of the body do not slide radially in unison. Each of the guide rods 31 slides at its outer end in guide bushings 36 secured in the inner and outer parts of a radial opening 331 in the respective body head which bushings are made of hardened material as compared with the body heads 25, 26 and are accurately fitted to said rod, thereby insuring proper guiding of the rods on the body heads and long wear of the cooperating surfaces in the rods and bushings.

On the outer side of each supporting bar adjacent to opposite ends thereof are mounted abrasive members or stones 38 which are adapted to engage the bore of the gun barrel and grind and polish the same and which preferably have the form of longitudinal sticks and each is mounted on a holder 39 provided on its inner side with retaining pins 40 engaging with openings 41 formed in the respective supporting bar on opposite sides of the adjacent guide rod 31 and said stone holder being spaced the proper distance from the outer side of the supporting bar by washers 42 surrounding the retaining pins 40 between said holders and the supporting bar, as shown in Figs. 4 and 9.

The several supporting bars are yieldingly drawn inwardly for contracting the working diameter of the tool by annular springs 43 engaging with seats 44 at opposite ends of the supporting bars, as shown in Figs. 4 and 9.

The inner ends of the sets of guide rods 31 project through openings 45 in the side of the body hub and beyond the bore thereof and into engagement with oppositely pointing or working cones, cams or wedge members 46, 47 which are slidable lengthwise in the front and rear parts of the body hub and form part of the means for adjusting the working diameter of the tool. The two cones are adjustably connected by an adjusting screw the body 48 of which passes lengthwise through axial openings in the cones and the front end of which is provided with a left hand screw thread 49 working in a thread in the central opening of the front cone and pro-

vided at its rear end with a head 50 which bears against the outer side of the rear cone 47. Turning of the front cone is prevented by a spline 51 arranged on the front part of the body hub and engaging with a longitudinal groove 52 in the side of the front cone. Upon turning the screw 48 in one direction the cones 46, 47 are drawn together thereby causing both ends of the supporting bars to be simultaneously moved outwardly and the working diameter of the stones thereon to be expanded, while upon turning the adjusting screw 48 in the opposite direction, the cones will be separated by the inward pressure of the springs 43 exerted against the same through the medium of the guide rods 31. The rear cone 47 is preferably free to slide and also turn in the bore of the tool body but the front cone 46 is free to slide lengthwise in the bore of the tool body but compelled to turn therewith by a key or pin 51 arranged on the hub of the body and engaging with the longitudinal keyway 52 on the side of the cone 46, as shown in Fig. 4.

The mechanism for rotating and reciprocating the tool in the bore of the gun barrel and also the means externally of the gun barrel for adjusting the working diameter of the tool are mounted on a frame which is temporarily secured to the gun barrel and in order to maintain the grinding mechanism in proper axial alinement with the gun barrel. This frame may be variously constructed but as shown in Figs. 1, 4, 5, 6 and 7, the same comprises a front cross head 53 which is detachably secured to the muzzle of the gun barrel, a rear cross head 54 and two lower longitudinal rods 55 connecting the lower parts of said front and rear cross heads. The lower sides of the front and rear cross heads are additionally connected by upper longitudinal metal plates 56 and lower longitudinal runners or shoes 57 of wood which serve as skids whereby the apparatus can be slid easily from one place to another during transportation.

The means for detachably connecting the supporting frame of the grinding apparatus include a clamping sleeve which is divided diametrically to form two like half sections, each section having a semi-cylindrical peripheral wall 58 adapted to surround one half of the muzzle of the gun barrel and a bearing flange 59 projecting radially inwardly from the outer end of the respective wall and adapted to bear against the transverse face on the end of the muzzle of the gun barrel and also connected with the front cross head of the supporting frame by bolts 60. On their inner sides the semi-cylindrical walls of the clamping sleeve are provided with jaws 61 which grip the periphery of the conical head or collar and secure the frame thereto in a position in which the parts of the grinder are properly alined or centered relatively to the bore of the gun barrel. The jaws of the clamping sleeve are thus drawn tightly against the collar of the nozzle by clamping bolts 62 connecting lugs 63 on the opposing ends of the clamping sleeve sections, as shown in Figs. 1 and 6.

By these clamping means the grinding apparatus may be readily attached to and removed from gun barrels of the same size, and by employing semi-cylindrical clamping sleeve sections of different sizes and grinding tools of corresponding sizes appropriate for given sizes of guns the same tool actuating and diameter adjusting mechanism may be used for grinding guns of different sizes or bores.

The mechanism for rotating and reciprocating the tool for grinding the bore of a gun barrel as shown in the drawings is constructed as follows:

The numeral 64 represents a carriage reciprocable lengthwise of the axis of the gun barrel and the frame of the grinding apparatus and guided in this movement by means of guide eyes 65 formed on opposite sides of the lower part of the carriage and slidable lengthwise on the lower longitudinal rods 55 of the main frame and also provided on its upper part with a pair of thrust guide eyes 66 arranged lengthwise in line but spaced apart and receiving a longitudinal horizontal shaft 67 which also serves as a guide rod for the carriage. This shaft is journaled at its rear end in a bearing 68 on the rear cross head 54 of the main frame while its front end is journaled in a bearing 69 on the front cross head 53 of this frame, but this shaft is held against longitudinal movement by means of front and rear shoulders 70, 71 thereon engaging the opposing ends of the front and rear bearings 69, 68, as shown in Figs. 1, 4 and 5. Nearly all that part of the shaft 67 between its front and rear bearings is provided with a screw thread 72. Between the upper guide eyes 66 of the carriage the screw threaded part of the shaft 67 works in an internally threaded screw sleeve which is composed of two semi-cylindrical sections 73, 73 which are detachably connected with each other by screws 74 connecting the corresponding longitudinal edges of the screw sleeve. The opposite ends of the latter engage with the opposing ends of the upper guide eyes 66 and this screw eye is coupled with the carriage by means of a key 75 arranged in a longitudinal seat 76 formed between the lower opposing longitudinal edges of the split screw sleeve and engaging its ends with the guide eyes 65, and provided on its under side with a depending coupling pin 77 engaging with an opening 78 in the upper part of the carriage, as shown in Figs. 5, 11 and 12.

Upon turning the screw shaft 67 in one direction, the carriage and the parts mounted

thereon are moved in one direction lengthwise of the main frame and gun barrel and upon turning the screw shaft in the opposite direction the direction of the longitudinal movement of the carriage and the parts mounted thereon is reversed; this reciprocating motion being due to the screw sleeve running on the main shaft as a screw nut and transmitting this motion to the carriage by means of the connection therebetween.

The rotation of the screw shaft 67 is produced by a motor 79, preferably of the electrically operated type, which is mounted on a platform or bracket 80 on the rear side of the rear main frame cross head and having its shaft 81 provided with a small gear pinion 82 which meshes with a large internal gear wheel 83 secured to the rear end of the screw shaft, as shown in Fig. 5. This electric motor is so constructed that the same can be reversed and thus permit of turning the screw shaft in opposite directions for reciprocating the carriage.

A controlling mechanism is provided for controlling the operations of the carriage reciprocating motor 79 which mechanism is so organized that this motor may be started and stopped at will, the length of the strokes or reciprocations of the carriage may be varied to suit the length of the cylindrical surface which is being ground, and the movement of the carriage is also automatically reversed at the end of each stroke so that the carriage reciprocates as long as desired without requiring any attention of the operator. This controlling mechanism is preferably of an electrical character and combined with the means which control the rotation of the tool, as will later appear. Some parts of this controlling mechanism are enclosed in a housing 189 mounted on the rear part of the main frame of the guiding apparatus, as shown in Fig. 1, so that the apparatus forms a complete portable unit.

Rigidly mounted within the carriage is a longitudinal shell or casing the rear part 89 of which contains an electric motor 90 for rotating the grinding tool and within the front part 91 of this shell is arranged a reducing gear whereby the rotary motion of the motor 90 is transmitted at a reduced speed to a longitudinal driving shaft 92 projecting from the front end of the shell section 91, as shown in Fig. 5. To the front end of the tool driving shaft a driving head 93 is secured by transverse pins 94, as shown in Fig. 8, or other suitable means. Motion is transmitted from this driving head 93 to the driven head 28 of the grinding tool body by a sectional motion transmitting shaft which is made in sections of like construction so that a larger or smaller number of such sections may be coupled for obtaining a shaft of the required length which will permit of reaching fully into gun barrels of various lengths. The several sections of this transmitting shaft are all alike and interchangeable and also combined with means for guiding the same and maintaining them centrally in the gun barrel which is being ground, and the endmost sections of this shaft are connected by universal joint couplings with the driving and driven heads 93 and 28, respectively. For this purpose each section of the transmitting shaft has a longitudinal tubular body 95. The tubular body 95 of the rearmost section of the intermediate transmitting shaft is provided internally at its rear end with a bushing 96 provided with a neck 97 terminating at its rear end in a spherical knuckle 98 which is arranged within a socket 99 at the front end of the driving sleeve 93 and which is provided on diametrically opposite sides with coupling pins 100 engaging with L-shaped or bayonet slots 101 in the adjacent parts of the driving head 93, as shown in Figs. 8 and 15, thereby permitting this head and the rearmost transmitting shaft section to be readily coupled and uncoupled and also forming a universal joint between the same which permits transmission of motion without any binding or cramping action if the axes of the driving head and transmitting shaft are not in absolute alinement.

The tubular body 95 of the foremost section of the transmitting shaft is provided externally at its front end with a coupling sleeve 102 and in front of the latter is arranged a neck 103 terminating at its front end in a spherical knuckle 104 which is arranged in a socket 105 at the rear end of the driven coupling head 28 and which is provided on its diametrically opposite sides with coupling pins 106 engaging with L-shaped or bayonet slots 107 in the sides of the driven sleeve or head 28, as shown in Figs. 13 and 16. The sleeve 102 and the neck 103 are provided with external flanges 108, 109, respectively, which are detachably connected and compelled to turn together by means of screws 110 and dowels 111, as shown in Figs. 13 and 16, or by other suitable means.

The opposing ends of the tubular bodies 95 of the several transmitting shaft sections are detachably connected by means of external sleeves or collars 112 secured to these ends by riveting brazing or otherwise and providing these collars respectively with annular flanges 115 which are detachably connected and compelled to turn together when coupled by means of screws 114 and dowels 1161. The end of the tubular body 95 of one intermediate shaft section having a collar 112 stops short of the outer face of this collar so as to form a socket 116 therein and the end of the tubular body 95 having the companion collar 112 extends beyond the outer face of the latter so as to form a tenon 117 thereon which fits or telescopes into the socket 116 of the adjacent collar 112, thereby causing the

opposing ends of the shaft bodies 95 to be maintained in alinement with one another when in use and still permit them to be readily assembled and disassembled.

In order to support the intermediate transmitting shaft centrally within the gun barrel and prevent the same from sagging, particularly when the same is very long for grinding gun barrels of great length, means are provided for guiding this shaft at intervals in the bore of the gun barrel. This is preferably accomplished by a plurality of pilot disks or circular guide members 118 each of which engages its periphery with the bore of the gun barrel and is provided with a central circular hub 119 which is seated on the periphery of a pair of opposed flanges 115 on two adjacent shaft bodies 95 and is clamped therein by engagement of rims 113 on said flanges with the opposite sides of said hub forming an annular groove for receiving the latter, as shown in Figs. 1, 2, 3, 4 and 13. These guide disks slide and turn in the bore of the gun barrel while the tool is reciprocated and rotated therein during the operation of grinding the bore and maintain the transmitting shaft in its central position within the bore of the gun barrel so that no cramping or binding will occur and the grinding can be accomplished easily and expeditiously and with a minimum expenditure of power.

The mechanism for shifting the abrasive members or stones radially on the tool body for adjusting the working diameter of the tool is constructed as follows:

The numeral 121 represents an adjusting sleeve rotatable on the driving head 93 but held against longitudinal movement thereon by a rearwardly facing shoulder 122 on the adjusting sleeve engaging a forwardly facing shoulder 123 on the driving head, and a collar 124 secured to the front part of the driving head engaging with the front end of the adjusting sleeve, as shown in Figs. 8 and 13. This adjusting sleeve may either turn clockwise with the driving head 93 when the working diameter of the tool is not to be changed or this adjusting sleeve may be held against turning with the driving head when the stone holders are to be moved radially outwardly for taking up stone wear or increasing the working diameter of the tool.

When the driving head 93 and the adjusting sleeve turn relatively to one another this effect is transmitted to the cone adjusting screw 48 for moving the cones 46, 47 lengthwise relative to each other. The means for holding the adjusting sleeve against turning comprise a pair of brake shoes 125 of semi-circular form engaging the periphery of the adjusting sleeve between collars 126 secured to this sleeve, anchoring brackets 127 secured to the adjacent part of the reducing gear casing 91 and engaging with openings 128 in the brake shoes so as to prevent the latter from rotating with the driving head, a hinge pin 129 pivotally connecting the brake shoes on one side of the axis of the driving head 93, and means for tightening the shoes on said adjusting sleeve or releasing the same comprising a draw rod 130 pivoted by a pin 131 to that end of one shoe opposite the hinge pin 129 and passing through an eye 132 on the corresponding end of the other brake shoe, a rotary cam 133 provided with a handle 134 and arranged on the draw rod 130 between a cam 135 on the eye 132 and screw nuts 136 on this draw rod, and a spring 137 surrounding the draw rod between the adjacent ends of said brake shoes. Upon turning the cam handle 134 in one direction the opposing cams 133, 135, operate to press the brake shoes against opposite sides of the adjusting sleeve and either stop or retard its rotary movement with the driving head, while upon turning the handle 134 in the opposite direction the brake shoes will be spread and released from gripping engagement with the adjusting sleeve by the expansion of the spring 137 whereby this sleeve is again permitted to turn with the driving head 93.

The means for transmitting motion from the adjusting sleeve 121 to the cone adjusting screw 48 includes gearing extending from the periphery to the axis of the driving head and shafting extending from this gearing to the cone adjusting screw 48. This gearing comprises an internal gear ring 138 secured to the inner side of the adjusting sleeve 121 at the front end thereof, a central gear wheel 139 journaled axially within the driving sleeve by means of a rearwardly projecting hub 140 on this gear wheel turning in a central bearing 141 in the driving head, an outer intermediate gear pinion 142 pivoted on the driving head 93 and meshing with the internal gear ring 138, and an inner intermediate gear pinion 143 pivoted on the driving head 93 and meshing on its outer side with the outer intermediate gear pinion 142 and meshing on its inner side with the central gear wheel 139, as shown in Fig. 8. The latter is confined in the driving head by a split retaining ring 144 engaging an internal groove 145 in the bore of the driving head in front of the central gear wheel. In its center the central gear wheel is provided with a square opening 146 which receives a square coupling rod pin or spindle 147 whereby this gear wheel and pin are compelled to turn together but are free to move lengthwise relatively to one another.

The shafting which transmits motion from the central gear wheel 139 to the cone adjusting screw 48 comprises a plurality of adjusting shaft sections corresponding to the sections of the intermediate driving shaft sections, each adjusting shaft section having a tubular body 148 which is of substantially

the same length as the companion driving shaft section and is mounted therein so as to be capable of turning but incapable of moving lengthwise relatively thereto so that in effect each outer driving shaft section and the companion inner adjusting shaft section together form a unit of this means for transmitting motion for driving the tool and for adjusting the working diameter of the same. The rear end of the body 148 of the rearmost adjusting shaft section is journaled in a bearing 149 in the neck 97 of the bushing 96 and is provided with a plug 150 having a forwardly facing annular shoulder 151 engaging the rear side of the bearing 149 and a rearwardly projecting socket 152 in which is loosely secured the front end of the coupling rod 147 by a transverse pin 153 passing loosely through the rod 147 and the socket 152 so as to form in effect a swivel joint or universally movable coupling between these members.

The rear end of each of the other adjusting shaft sections 148 is provided with a plug 154 which is secured therein by a transverse pin 155 or otherwise and has a reduced neck 156 journaled in a bearing disk 157 secured against an internal shoulder 158 in the adjacent part of the driving shaft section 95 by brazing or otherwise. If desired a washer 159 may be mounted on the neck 156 and held in engagement with the rear side of the bearing disk 157 by a pin 160 passing through the neck 156. The latter is provided with a forwardly projecting coupling tongue 161 which is flat sided or of prismatic form in cross section. In the front end of each adjusting shaft section is secured a plug 162 having a forwardly projecting reduced neck 163 which turns in a bearing disk 164 secured against an internal shoulder 165 in the adjacent part of the respective driving shaft section and engaging against a shoulder 166 on the respective plug, as shown in Fig. 13. If desired a washer 267 may be held on the neck 163 and in engagement with the front side of the respective bearing disk by a pin 167. Each of the necks of the front plugs of the adjusting shaft sections is provided with a transverse groove 168, each of which, except the foremost one, is adapted to be engaged by the tongue 161 on the rear end of the next rearward adjusting shaft section and thereby couple the several adjusting shaft sections so that the same in effect form one continuous shaft.

The foremost adjusting shaft section is connected with the rear end of the cone adjusting screw by a short coupling shaft 170 journaled axially in bearings 171 in the front driven head 103 and provided at its rear end with a flat coupling tongue 169 adapted to engage with the front groove 168 of the foremost adjusting shaft section, a longitudinal coupling rod 172 of square cross section engaging its front end with a square socket 173 at the rear end of the head 50 of the cone adjusting screw 48, and a universal joint connecting the rear end of the coupling rod 172 and the front end of the coupling shaft 170 and comprising a front swivel block 173 connected at its front end by a transverse pin 174 with the rear end of the coupling rod 172 and a rear swivel block 175 connected by a transverse pin 176 with the rear end of the front swivel block and having trunnions or pins 177 at right angles to the pin 176 for pivotally connecting the rear swivel block 175 with the front end of the short coupling shaft 170, as shown in Figs. 4 and 13.

By this means rotary movement of the adjusting sleeve 121 relative to the driving head and driving shaft sections will be transmitted by the sectional adjusting shaft to the means whereby the working diameter of the stones is adjusted which adjustment can be effected while the apparatus is in operation. By constructing the driving shaft and adjusting shaft in sections of corresponding length each of which forms a unit capable of being assembled with other units it is possible to vary the length of the means for driving the tool and adjusting the diameter of the same to suit different length of bores of guns and other conditions.

When the grinding apparatus is in normal operation the tool driving shaft and the adjusting shaft arranged in the driving shaft turn in unison clockwise or toward the right throughout the length of both of these shafts whereby the stones remain in the same radial position on the tool body and operate on the same working diameter while the tool is rotating and reciprocating in the bore of the gun barrel or other cylindrical body. Whenever it is desired to move the grinding stones outwardly for the purpose of increasing the working diameter of the same the operator turns the handle 134 of the brake shoes 125 so that the cooperating cams 133, 135, cause the brake shoes to grip the adjusting sleeve 121 and either stop rotation of the same or retard its rotation relative to the tool driving shaft. When this occurs the adjusting shaft holds the cone adjusting screw 48 against turning or retards rotation of the same relative to the tool body, whereby the front cone 46 which turns with the tool body is screwed further inwardly on the left hand thread 49 of the bolt 48 so that the two cones 46, 47 are drawn together and exert a wedge action on the guide rods 31 and force them radially outwardly together with the stone carriers or holders mounted thereon, thereby increasing the working diameter of the tool or taking up wear on the face of the stones. Upon releasing the grip of the brake shoes on the adjusting sleeve 121 the radially outward adjusting action on the stone carriers or holders ceases. This operation is repeated when-

ever the stones of the tool grind themselves free and require setting up again to the surface being ground. While the adjusting shaft is being thus held stationary for adjusting the stones radially outward the same in effect is operating in an anti-clockwise direction or opposite to the rotation of the tool body which movement of the latter is permitted due to the operation of the gear wheels 139, 142, 143 interposed between the relatively anchored gear ring 138 of the adjusting sleeve 121 and the adjusting shaft, which gearing operates to turn the latter anti-clockwise at the same rate as the driving shaft turns clockwise and thus holds the adjusting screw bolt 48 stationary relatively to the tool body. When the grinding stones are not being adjusted radially on the tool body the gearing interposed between the adjusting sleeve and the adjusting shaft is idle and turns bodily with the driving shaft and associated parts.

If at any time the grinding stones get stuck in the gun barrel or cylinder due to being set up too tight or other reason and the clockwise rotation of the driving shaft is continued under the action of the power applied to the rear end of the same, then this driving shaft will be subjected to a torque or twisting action during which its rear end will turn clockwise while its front end and the tool mounted thereon will be stationary. Whenever this occurs the adjusting shaft, which is locked at this time by the gearing 138, 139, 142, 143 at its rear end to the rear end of the driving shaft, is caused to turn clockwise throughout its length with the clockwise moving rear end of the driving shaft. This causes the adjusting bolt 48 which is coupled with the adjusting shaft to also turn clockwise, and as the adjusting bolt has a left hand screw thread 49 working in the internal thread of the front cone 46 the latter is unscrewed from the bolt 48. As a result of this the two cones 46, 47 are separated and present lower parts of their cam surfaces to the guide rods 31, whereby the outward pressure of the stones against the cylindrical surfaces of the gun barrel is relieved and the stones are permitted to release their grip on the bore of the gun. The instant this occurs the tool body is free to resume its clockwise rotation together with the driving shaft which gradually untwists itself and also causes the screw threaded front cone 46 to again screw onto the bolt 48 so that the cones 46, 47 are moved toward each other and present their higher parts to the guide rods 31, whereby the stones are again moved radially outwardly against the bore of the gun barrel. This automatic release of the stones from the bore of the gun barrel occurs as often as the stones get stuck in the barrel and the same are restored to their working position after each release, thereby preventing breaking of the driving and adjusting shafts and other parts of the apparatus which otherwise would be liable to occur if the power were not shut off in time.

Stop means are provided for limiting the expansion of the stones when the same have reached a predetermined working diameter which means are adjustable for varying this diameter. These stop means are preferably constructed as follows:

The numeral 178 represents a stop collar which is mounted on the adjusting sleeve 121 so as to be capable of circumferential adjustment thereon which is preferably accomplished by means of an internal adjusting pin 179 on the stop collar adapted to engage with one or another of an annular row of notches 180 on the periphery of the adjusting sleeve 121. At the front ends of the adjusting sleeve and stop collar a dial rim 181 is rigidly mounted on the rear driving head of the driving shaft which rim is preferably formed on the collar 124 and provided on its periphery with an annular row of graduations 182 and a stop 183. On the adjacent front edge of the stop collar is arranged a stop 184 which is adapted to traverse the scale or graduations 182 and also engage the dial stop 183.

In using this stop device the stop collar is moved longitudinally rearward so as to disengage its adjusting pin 179 out of engagement from the respective notch 180. Then the stop collar is turned clockwise on the adjusting sleeve until its stop 184 is arranged a predetermined distance in advance of the stop 183 on the ring 181 of the rear driving head 121 which position is gaged by the graduations on the dial ring and determines the limit which the stones are to be moved radially outward on the tool body. After the stop collar has been turned to the desired position its adjusting pin 179 is reengaged with the adjacent notch 180 for preventing rotation of the stop collar on the adjusting sleeve.

Upon now operating the apparatus the stop collar will be held against rotation together with the adjusting sleeve by means of the brake mechanism from time to time whenever radially outward adjustment of the stones is desired. During each of such stopping actions of the adjusting sleeve the stop 183 on the dial ring approaches closer to the stop on the stop collar due to the rotation of the rear driving head 94 in a clockwise direction, whereby the gearing 138, 139, 142, 143 is caused to turn the adjusting shaft anti-clockwise and move the stones radially outward through the medium of the cones 46, 47. This radially outward adjustment action of the stones continues until the stop 183 of the dial ring engages the stops 184 of the stop collar at which time the stones can be moved outwardly no further and the grinding of

the bore of the cylinder has reached the desired diameter.

When applying this grinding apparatus to a gun barrel the frame of the apparatus is suitably supported so that the weight of the apparatus is not liable to distort the grinding tool and the parts associated therewith out of alinement with the gun barrel.

Although various means may be employed for starting and stopping the motor 79 and also reversing the motion thereof for operating the tool reciprocating carriage, and also for starting and stopping the tool rotating motor 90, the electrical controlling mechanism shown in the diagram Fig. 19 is suitable and as thus shown the same is organized and operates as follows:

The numerals 190, 191 represent the two feed wires which are connected with an electric current source which is supplied in any desired manner. These feed wires are adapted to be connected with and disconnected from two main delivery wires 192, 193 by a hand switch 194. From the main delivery wires two branch wires 195, 196 lead to the winding of the tool rotating motor 90 one of these last mentioned wires also including a resistance 197 and a switch 198 whereby the circuit through this motor may be opened or closed and also more or less resistance included in the circuit of the same in accordance with the speed of rotation desired.

The field or winding of the electric motor 79 for reciprocating the grinding tool lengthwise is connected with two wires 199, 200 which are adapted to be connected with and disconnected from two branch wires 201, 202 of the delivery wires 192, 193 by a reversing switch having two central contacts 203, 204 connected respectively with the wires 201, 202, two pairs of side contacts 205, 206 and 207, 208 arranged on opposite sides of the central contacts 203, 204 and two pairs of reversing contacts 209, 210, and 211, 212 adapted to connect the central contacts 203, 204 either with the side contacts 205, 206 or with the side contacts 207, 208 and thereby cause the electric current to travel through the motor 79 in one direction or the other and thus turn the same accordingly.

The contacts 209, 210 are mounted on a shifting rod 213 which is connected with the armature 214 of a solenoid magnet the coil 215 of which is connected by wires 216, 217, 218 with the wires 201, 202 and with a rear tappet switch the contacts 219, 220 of which are adapted to be momentarily engaged by a plunger 221 which is shifted by a rear tappet 222 on the carriage 64.

The contacts 211, 212 are mounted on a shifting rod 223 which is connected with the armature 224 of a solenoid magnet the coil 225 of which is connected by wires 217, 218, 226, 227 and 228 with the wires 201, 202 and with a front tappet switch the contacts 229, 230 of which are adapted to be momentarily engaged by a plunger 231 which is shifted by a front tappet 232 on the carriage.

The two shifting rods are connected by a rock lever 233 so that these rods are moved in opposite directions and cause the movable switch contacts 209, 210 and 211, 212 to open and close the circuit through the motor 79 alternately in opposite directions. The circuit of the motor 79 also preferably contains a hand switch, as for example the switch 234 in the wires 199, 200.

In operating this grinding apparatus the required number of driving shaft sections and adjusting shaft sections are assembled and connected with the motor 91 and the grinding tool. The latter and the front parts of the driving and adjusting shafts are then pushed into the bore of the gun barrel and the frame of the apparatus is secured to the muzzle of the gun barrel so that the tool and shafts are in axial alinement therewith. The main switch 194 is now closed, and thereafter the switch 198 controlling the tool rotating motor 90 and the switch 234 controlling the tool reciprocating motor 79 are also closed. Assuming that the reversing switch associated with the reversible motor 79 is now in the position shown in Fig. 19 the carriage at this time will be moved longitudinally forward due to the circuit of the motor 79 being closed across contacts 203, 205, 209 and 204, 206, 210, and this circuit being open across contacts 203, 207, 211 and 204, 208, 212. When the carriage nears the limit of its intended forward stroke the tappet 232 pushes the plunger 231 and engages the contacts 229, 230 whereby the coil 225 is energized and caused to move the contacts 211, 212 into engagement with the contacts 203, 207 and 204, 208 and the contacts 209, 210 out of engagement with the contacts 203, 205 and 204, 206, whereby flow of the electric current through the motor 79 is reversed and the carriage together with the tool and other parts mounted thereon are moved backwardly relatively to the gun-barrel. When the carriage nears the limit of its intended rearward stroke the rear tappet 222 pushes the rear plunger 221 backwardly and engages the contacts 219, 220 whereby the rear solenoid coil 215 is energized and caused to move the contacts 209, 210 into engagement with the contacts 203, 205, and 204, 206, and the contacts 211, 212 out of engagement from the contacts 203, 207 and 204, 208, whereby the direction of the current through the motor 79 is again reversed and the carriage, tool and parts associated therewith are moved longitudinally forward relative to the gun barrel. The tool by this means is reciprocated continuously within the gun barrel while the switches 194 and 234 are closed. The length of the strokes may be adjusted to suit the length of the cy-

lindrical surface which is being bored, for example, by adjusting the tappets 222, 232 lengthwise by means of set screws 235, 236 in brackets 237, 238 on the carriage.

During the longitudinal reciprocation of the tool in the gun barrel the tool is also turned constantly in the same direction, preferably clockwise, by the motor 90 whereby the abrasive members or stones of the tool are caused to travel spirally back and forth in the bore of the gun barrel and grind all parts of the same.

As this grinding progresses the operator can set up the stones toward the cylindrical surface which is being ground and increase the working diameter of the tool in order to compensate for wear on the stones and removal of stock from the work piece by manipulating the stone adjusting mechanism in the manner described while the grinding apparatus is in operation. When the grinding has been completed the current is shut off from the motors and the apparatus removed from the gun barrel.

By means of this apparatus it is possible to recondition the bore of a gun barrel after the same has been fired a sufficient number of times to become pitted, scored or roughened in its bore, and remove such imperfections without dismounting the gun, thereby permitting of maintaining the gun in the highest state of efficiency with practically no interruption in its availability for constant use, which is an important item in warfare when accuracy of aim and continuous firing of the gun are necessary.

I claim as my invention:

1. A tool for grinding a cylindrical surface comprising a body having an inner longitudinal tube, disks mounted on opposite ends of said inner tube, an outer tube surrounding said inner tube and bearing at its opposite ends against the opposing inner sides of said disks, a head arranged at one end of said inner tube and engaging with the outer side of one of said disks, and a screw nut arranged on the opposite end of said inner tube and engaging with the outer side of the other disk; a plurality of stone holders arranged in an annular row around said body; and means for increasing and decreasing the working diameter of said stone holders.

2. A tool for grinding a cylindrical surface comprising a body having an inner longitudinal tube, disks mounted on opposite ends of said inner tube, an outer tube surrounding said inner tube and bearing at its opposite ends against the opposing inner sides of said disks, a head arranged at one end of said inner tube and engaging with the outer side of one of said disks, and a screw nut arranged on the opposite end of said inner tube and engaging with the outer side of the other disk, each of said disks being provided with a plurality of guide openings arranged in an annular row around the axis of said body; a plurality of supporting bars arranged around said disks; abrasive members mounted on said bars; guide rods slidable radially in said openings and connected at their outer ends with said supporting bars; and cones movable lengthwise in said inner tube and engaging with the inner ends of said rods.

3. A tool for grinding a cylindrical surface comprising a body having an inner longitudinal tube, disks mounted on opposite ends of said inner tube, an outer tube surrounding said inner tube and bearing at its opposite ends against the opposing inner sides of said disks, a head arranged at one end of said inner tube and engaging with the outer side of one of said disks, and a screw nut arranged on the opposite end of said inner tube and engaging with the outer side of the other disk, each of said disks being provided with a plurality of guide openings arranged in an annular row around the axis of said body; a plurality of supporting bars arranged around said disks; abrasive members mounted on said bars; bushings arranged in said openings, guide rods arranged in said openings and slidable radially in said bushings and connected at their outer ends with said supporting bars; and means arranged within said inner tube and engaging with the inner ends of said rods for moving the same radially.

4. An apparatus for grinding the bore of gun barrels comprising a frame having longitudinal guide ways, means for detachably connecting the frame with said gun barrel, a carriage movable lengthwise on the guide ways of said frame, a tool adapted to operate on the bore of said gun barrel, means mounted on said carriage for rotating and reciprocating the same, and means for moving said carriage lengthwise on said guide ways, including a longitudinal screw shaft journaled on said frame but held against longitudinal movement, thrust eyes arranged on the carriage and embracing said shaft and spaced apart from each other, a split screw nut having sections engaging with opposite sides of the thread of said screw shaft between said thrust eyes, means for connecting the sections of said split nut; and means for operatively connecting said screw nut with said carriage.

5. An apparatus for grinding the bore of gun barrels comprising a frame having longitudinal guide ways, means for detachably connecting the frame with said gun barrel, a carriage movable lengthwise on the guide ways of said frame, a tool adapted to operate on the bore of said gun barrel, means mounted on said carriage for rotating and reciprocating the same, and means for moving said carriage lengthwise on said guide ways, in-

cluding a longitudinal screw shaft journaled on said frame but held against longitudinal movement, thrust eyes arranged on the carriage and embracing said shaft and spaced apart from each other, a split screw nut having sections engaging with opposite sides of the thread of said screw shaft between said thrust eyes, means for connecting the sections of said split nut; and means for operatively connecting said screw nut with said carriage, consisting of a key secured between the sections of said screw nut and provided with a pin engaging with said carriage.

6. An apparatus for grinding the bore of gun barrels comprising a grinding tool adapted to operate on the bore of the gun barrel, a frame, means for actuating said tool mounted on said frame, and means for detachably connecting said frame with the gun barrel including a split clamping sleeve having sections embracing said gun barrel and connected with said frame, and means for connecting clamping sleeve sections and securing the same against opposite sides of the gun barrel.

7. An apparatus for grinding the bore of gun barrels comprising a grinding tool adapted to operate on the bore of the gun barrel, a frame, means for actuating said tool mounted on said frame, and means for detachably connecting said frame with the gun barrel including a split clamping sleeve having semi-cylindrical sections provided on their inner sides with jaws adapted to engage with opposite sides of the gun barrel, means for connecting said clamping sections with said frame, and bolts connecting adjacent ends of said clamping sleeve with each other.

8. An apparatus for grinding the bore of gun barrels comprising a grinding tool adapted to operate on the bore of the gun barrel, a frame, means for actuating said tool mounted on said frame, and means for detachably connecting said frame with the gun barrel including a split clamping sleeve having sections embracing said gun barrel and connected with said frame, and provided with bearing flanges engaging with the front end of the muzzle of the gun barrel, and means for connecting clamping sleeve sections and securing the same against opposite sides of the gun barrel.

9. An apparatus for grinding a cylindrical surface comprising a grinding tool having a body and abrasive members mounted on said body, a driving head, a driving shaft interposed between said head and body and composed of a plurality of sections arranged end to end, means for detachably connecting the opposing ends of said shaft sections including flanges secured to said ends, screws connecting said flanges, and dowels passing through said flanges.

10. An apparatus for grinding a cylindrical surface comprising a grinding tool having a body and abrasive members mounted on said body, a driving head, a driving shaft interposed between said head and body and composed of a plurality of sections arranged end to end, means for detachably connecting the opposing ends of said shaft sections, a bushing secured to the outer end of the rearmost shaft sections, a universal joint connecting said bushing and driving head, a flange arranged on the outer end of the foremost shaft section, a universal joint connecting said flange with said tool body.

11. An apparatus for grinding a cylindrical surface comprising a grinding tool having a body and abrasive members mounted on said body, a driving head, a driving shaft interposed between said head and body and composed of a plurality of sections arranged end to end, coupling means for detachably connecting the opposing ends of said shaft sections including flanges mounted on said ends and fastenings connecting the opposing flanges on said sections, the peripheral portions of said flanges being constructed to form an annular groove between them, and a pilot or guide disk having a hub seated in the groove between said flanges and adapted to engage its periphery with said cylindrical surface.

12. An apparatus for grinding a cylindrical surface comprising a grinding tool having a body and abrasive members mounted on said body, a driving head, a driving shaft interposed between said head and body, and composed of a plurality of sections arranged end to end, coupling means for detachably connecting the opposing ends of said shaft sections including flanges mounted on said ends and fastenings connecting the opposing flanges on said sections, the peripheral portions of said flanges being constructed to form an annular groove between them, and a pilot or guide disk having a hub seated in the groove between said flanges and adapted to be gripped between said flanges so as to turn with said shaft and adapted to engage its periphery with said cylindrical surface.

13. An apparatus for grinding a cylindrical surface comprising a tool adapted to engage the surface to be ground, a driving head, means for transmitting motion from said driving head to said tool including a driving shaft composed of a plurality of tubular sections arranged end to end, and means for detachably connecting opposing ends of adjacent shaft sections comprising coupling sleeves or ferrules secured to the ends of the shaft sections and provided with laterally projecting flanges, and fastenings connecting said flanges, the end of one of two opposing shaft sections terminating short of the outer side of the respective sleeve and forming a socket therein, and the end of the other of said shaft sections projecting beyond the outer side of its sleeve and form-

ing a dowel extending into the socket of the sleeve of the first mentioned shaft section.

14. An apparatus for grinding a cylindrical surface comprising a grinding tool having abrading elements adapted to engage the surface to be ground, a driving head, a sectional shaft connecting said head and tool, and means for enlarging and contracting the working diameter of said tool including a sectional adjusting shaft arranged within the driving shaft and laterally movable elements which actuate said abrading elements.

15. An apparatus for grinding a cylindrical surface comprising a grinding tool adapted to engage the surface to be ground, a driving head, a sectional shaft connecting said head and tool, and means for enlarging and contracting the working diameter of said tool including a sectional adjusting shaft arranged within the driving shaft, the sections of said adjusting shaft corresponding substantially in length to the length of the sections of the driving shaft.

16. An apparatus for grinding a cylindrical surface comprising a grinding tool adapted to engage the surface to be ground, a driving head, a sectional shaft connecting said head and tool, and means for enlarging and contracting the working diameter of said tool, including an adjusting shaft composed of a plurality of sections which are detachably connected with each other and each of which is arranged in one of said driving shaft sections and is of substantially the same length.

17. An apparatus for grinding a cylindrical surface comprising a grinding tool adapted to engage the surface to be ground, a driving head, a sectional shaft connecting said head and tool, and means for enlarging and contracting the working diameter of said tool, including an adjusting shaft composed of a plurality of sections which are detachably connected with each other and each of which is arranged in one of said driving shaft sections and is of substantially the same length, and bearings which are arranged in each driving shaft section and in which the companion adjusting shaft section is journaled.

18. An apparatus for grinding a cylindrical surface comprising a grinding tool adapted to engage the surface to be ground, a driving head, a sectional shaft connecting said head and tool, and means for enlarging and contracting the working diameter of said tool, including an adjusting shaft composed of a plurality of sections which are detachably connected with each other and each of which is arranged in one of said driving shaft sections and is of substantially the same length, bearings which are arranged in each driving shaft section and in which the companion adjusting shaft section is journaled, and means for coupling the adjacent ends of the adjusting shaft sections.

19. An apparatus for grinding a cylindrical surface comprising a grinding tool adapted to engage the surface to be ground, a driving head, a sectional shaft connecting said head and tool, and means for enlarging and contracting the working diameter of said tool, including an adjusting shaft composed of a plurality of sections which are detachably connected with each other and each of which is arranged in one of said driving shaft sections and is of substantially the same length, bearings which are arranged in each driving shaft section and in which the companion adjusting shaft section is journaled, and means for coupling the adjacent ends of the adjusting shaft sections, comprising a member arranged on the end of one adjusting shaft section and having a groove and a member arranged on the opposing adjusting shaft section and having a tongue engaging said groove.

20. An apparatus for grinding a cylindrical surface comprising a grinding tool adapted to engage the surface to be ground, a driving head, means for transmitting motion from said head to said tool including a driving shaft having a plurality of tubular sections arranged end to end and provided in their ends with internal outwardly facing shoulders, means for detachably connecting the opposing ends of said driving shaft sections, bearing disks arranged in said shaft sections and secured against said shoulders; and means for expanding and contracting the working diameter of said tool including an adjusting shaft having a plurality of sections each of which is journaled in the bearing disks of one of the driving shaft sections, the opposing ends of adjacent driving shaft sections being provided with cooperating pairs of plugs, one member of each pair of plugs having a flat side socket or groove and the other member of said pair having a flat side tongue or tenon engaging with said socket or groove.

21. An apparatus for grinding a cylindrical surface comprising a grinding tool having a body and a plurality of stones guided for radial movement on said body and adapted to engage said surface, a driving head, means for rotating said tool by motion derived from said head including a driving shaft composed of a plurality of sections which are detachably connected with each other, and universal joints connecting opposite ends of said driving shaft with said driving head and tool body, and means for adjusting the working diameter of said tool including shifting means on said body for expanding and contracting said stones, an adjusting spindle journaled in said driving head, an adjusting shaft having a plurality of sections journaled in the sections of said driving

shaft, and universal joints connecting opposite ends of said adjusting shaft with said adjusting spindle and said shifting means, and arranged adjacent to the universal joints between said driving shaft and said driving head and tool body.

22. An apparatus for grinding a cylindrical surface comprising a grinding tool adapted to engage the surface to be ground, a driving head, a sectional shaft connecting said head and tool, means for enlarging and contracting the working diameter of said tool, including a sectional adjusting shaft arranged within the driving shaft, and a stop device for limiting the adjusting movement of said adjusting shaft.

23. An apparatus for grinding a cylindrical surface comprising a grinding tool adapted to engage the surface to be ground, a driving head, a sectional shaft connecting said head and tool, means for enlarging and contracting the working diameter of said tool including a sectional adjusting shaft arranged within the driving shaft, and a stop device for limiting the adjusting movement of said adjusting shaft, including a stop mounted on the driving head, an adjusting sleeve rotatably mounted on the driving head, a stop ring capable of circumferential adjustment on said adjusting sleeve and provided with a stop adapted to engage with the stop on said driving head, and gearing operatively connecting said adjusting sleeve with said adjusting shaft.

24. An apparatus for grinding a cylindrical surface comprising a tool having a body and stones mounted for radial movement on said body toward and from the surface to be ground, a driving member operatively connected with said body, and means for adjusting said stones constructed to automatically withdraw the stones from said surface when the stones become stuck in engagement with said surface.

25. An apparatus for grinding a cylindrical surface comprising a grinding tool having a rotatable body, a plurality of stones capable of radial movement on said body toward and from the surface to be ground, a driving member, a driving shaft connecting said driving member with said body and adapted to be twisted when the stones become stuck against said surface and the driving member continues its forward rotary movement, and means for releasing said stones from said surface which are responsive to the differential position of the opposite ends of said driving shaft due to the torque in the same when twisted.

26. An apparatus for grinding a cylindrical surface comprising a grinding tool having a rotatable body, a plurality of stones capable of radial movement on said body toward and from the surface to be ground, a driving member, a driving shaft connecting said driving member with said body and adapted to be twisted when the stones become stuck against said surface and the driving member continues its forward rotary movement, cam means on said body for moving said stones toward the surface to be ground, and means which operate to withdraw said cam means from acting on said stones when the latter become stuck against the surface being ground and which are actuated by motion of the driving end of said shaft in advance of the driven end connected with the tool body.

27. An apparatus for grinding a cylindrical surface comprising a tool having a rotatable body, a plurality of stones guided on said body for radial movement toward and from the surface to be ground, and means mounted on said body for expanding and contracting the working diameter of said stones including cones movable lengthwise on said body and operating on said stones, a driving member, a driving shaft which connects said driving member with said body and which is capable of a twisting or torque action when the stones become stuck against the surface being ground and the rear or driving end of the shaft advances independently of the front end of the same, and stone releasing means for permitting the stones to free themselves from the surface being ground when stuck including an adjusting shaft arranged within the driving shaft, means for adjustably anchoring the rear end of said adjusting shaft on said driving shaft, and a screw member connected with the front end of said adjusting shaft and having a left hand thread operating on said cones to withdraw the latter when said torque action occurs in said driving shaft.

In testimony whereof I hereby affix my signature.

MARSDEN C. HUTTO.