May 25, 1954 J. M. HALDEMAN 2,679,129

PROCESS FOR HONING PISTON RINGS

Filed May 31, 1951 3 Sheets-Sheet 1

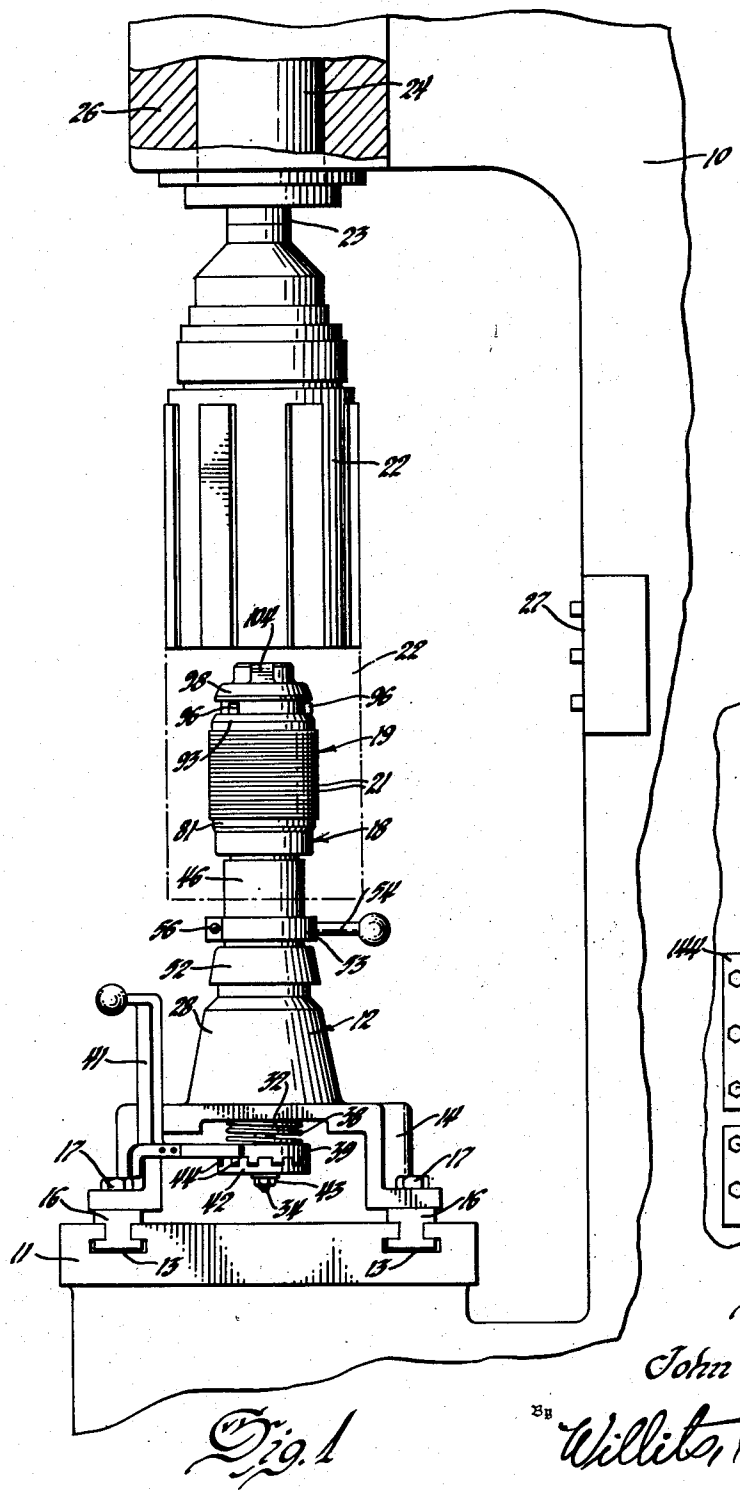


Fig. 1

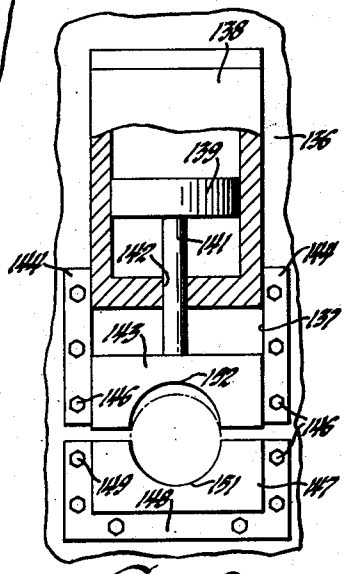


Fig. 2

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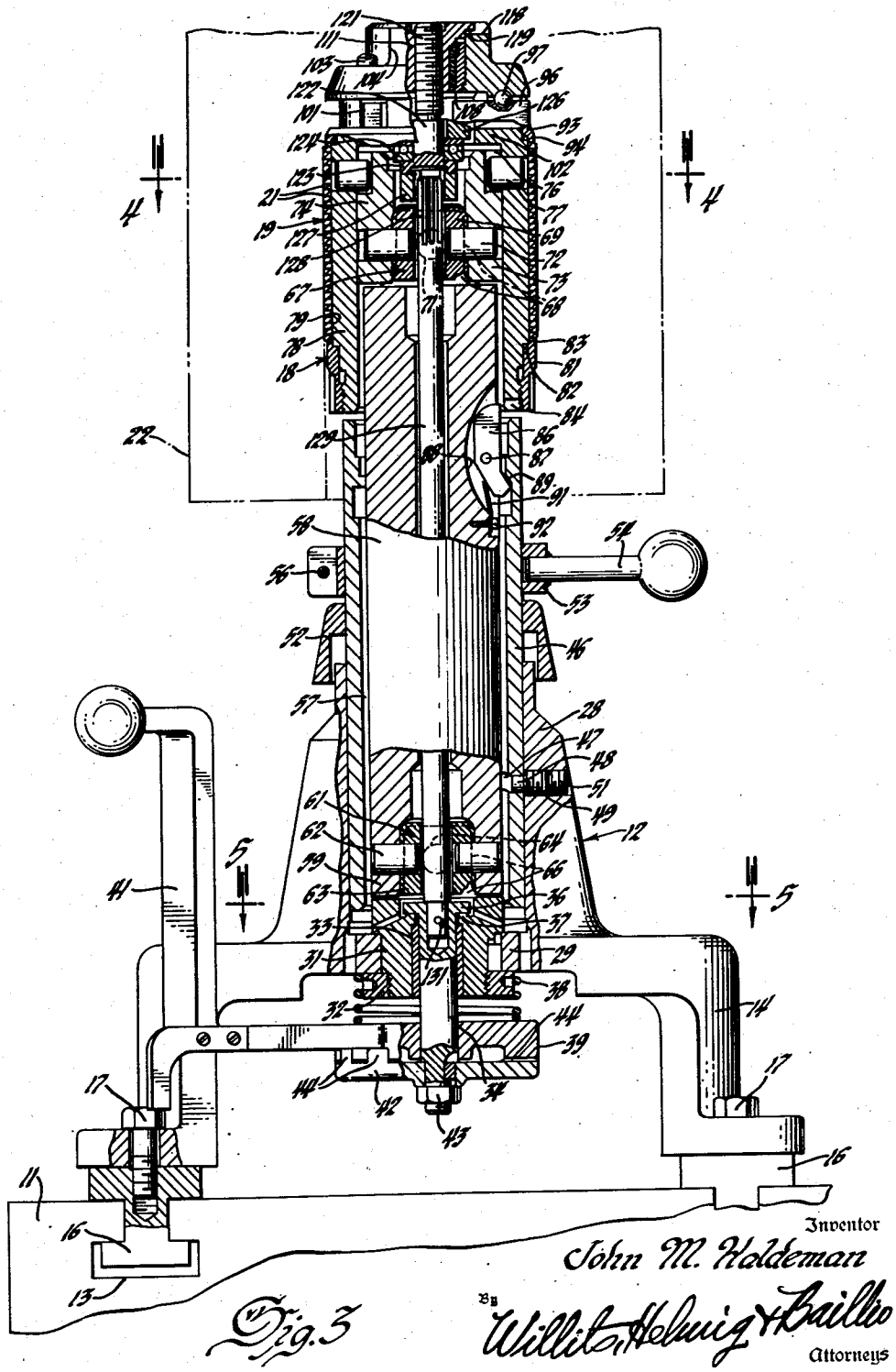


Fig. 3

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Filed May 31, 1951 3 Sheets-Sheet 3

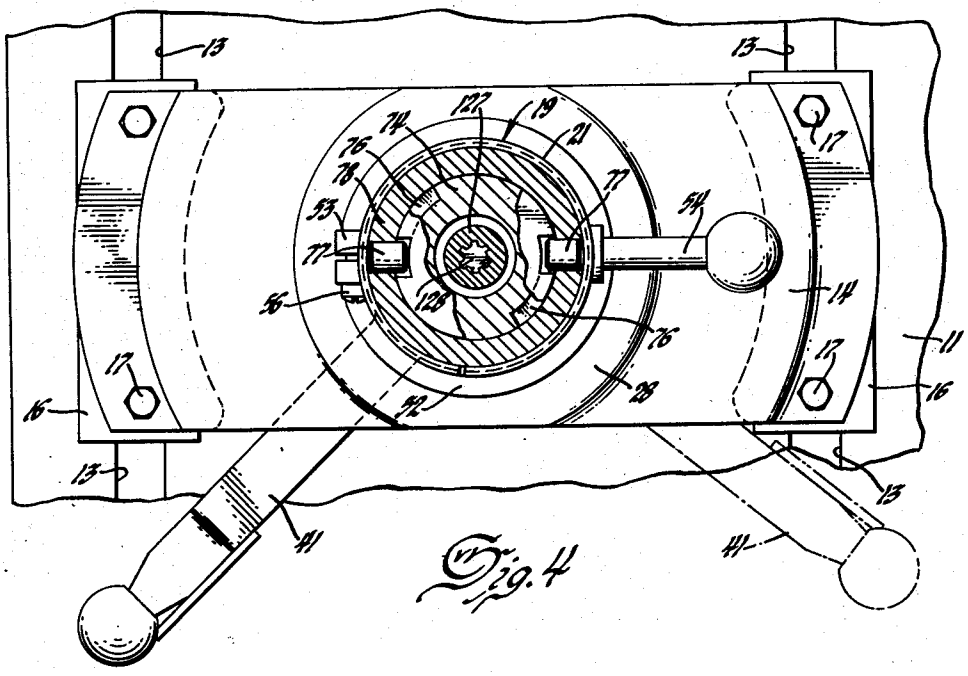


Fig. 4

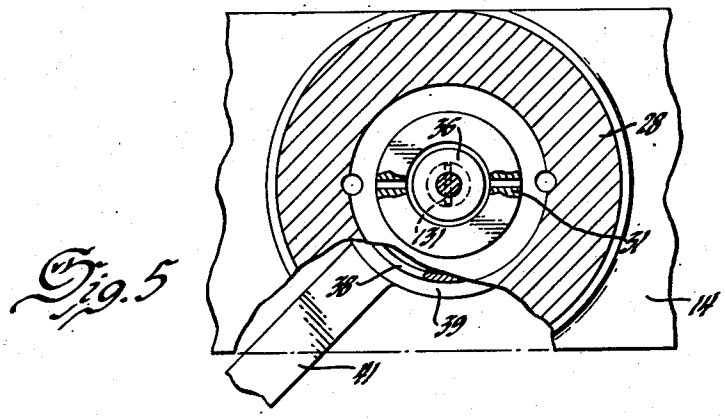


Fig. 5

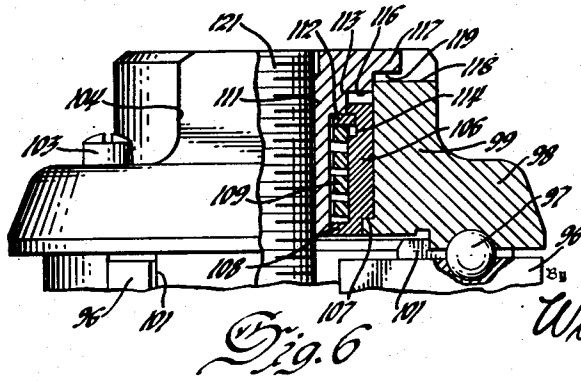


Fig. 6

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Patented May 25, 1954 2,679,129

UNITED STATES PATENT OFFICE

2,679,129

PROCESS FOR HONING PISTON RINGS

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Application May 31, 1951, Serial No. 229,105

13 Claims. (Cl. 51—290)

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This invention relates to a method of and an apparatus for finishing the exterior surfaces of split piston rings for use in the cylinders of internal combustion engines and for other purposes.

An object of the invention is to improve the methods of and apparatus for finishing the exterior surfaces of piston rings to obtain an improved pressure pattern between the rings and the cylinders with which the rings are to be employed. It is also an object of the invention to devise a more economical method of and apparatus for providing a satisfactory finish on the exterior surfaces of piston and other rings for such purposes.

To secure these and other ends, it is proposed to construct a honing or abrading machine in such a way as to provide an arbor on which the rings can be either rigidly or resiliently confined with respect to one another and then to provide a honing tool or abrading means for finishing the exterior surfaces of the rings while the rings are rigidly or resiliently confined.

For a better understanding of the invention, reference may now be had to the accompanying drawing forming a part of the specification, in which:

Figure 1 is a fragmentary side elevational view of a honing machine embracing the principles of the invention.

Figure 2 is a plan view of a diagrammatically illustrated ring loading fixture forming a part of the apparatus embracing the principles of the invention.

Figure 3 is a view partly in section and partly in elevation of the ring holding arbor and arbor support embraced in the structure disclosed by Figure 1.

Figures 4 and 5 are cross-sectional views taken substantially in the planes of 4—4 and 5—5 respectively on Figure 3.

Figure 6 is an enlarged fragmentary view of the upper end portion of the structure disclosed by Figure 3.

The structure disclosed by Figure 1 comprises a machine frame 10 having a bed plate 11 on which a work holding pedestal or arbor support 12 is slidably mounted in guideways 13 formed in parallel relation to one another within the bed plate 11. The support 12 comprises a spaced pair of supporting legs 14 to which the guide rails 16 disposed within the guideways 13 are secured by studs 17.

The upper end of the support 12 is adapted to receive an arbor 18 which is adapted to be removably mounted upon the support 12 and on which successive stacks 19 of split resilient piston rings 21 are adapted to be removably disposed. The arbor 18 and the ring stack 19 are adapted to project within a cylindrical honing or abrading tool indicated at 22 when the machine is operated in such a way as to move the tool into the dot-and-dash line position indicated in Figure 1. The tool 22 is supported by a shaft 23 having a piston 24 providing means by which the shaft is reciprocated and rotated within a cylinder 26 forming an integral part of the frame 10. The shaft 23 forms the driving part of a mechanical hydraulic, or other suitable means by which the honing tool 22 and the arbor 18 may be relatively rotated or reciprocated or rotated and reciprocated at any desired number of strokes per minute, revolutions per minute and at any desired length of stroke. Control panel 27 is provided on a front part of the frame 10 of the machine for so actuating the machine in any desired manner.

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The support 12 for the arbor 18 comprises an outer rigid frame 28 having an axially disposed cylindrical opening formed therein and having the legs 14 projecting therefrom. The opening in the frame 28 is adapted to terminate adjacent the lower extremity of the upper part of the frame 28 in a radially inwardly disposed flange 29. The flange 29 is adapted to receive the reduced end of a flanged collar 31 which is secured in a cylindrical opening formed in the flange 29 by a ring 32 engaging the threaded lower end of the collar 31. A cylindrical opening formed in the collar 31 is adapted to receive a bushing 33 for rotatably receiving a shaft 34 having a flange 36 formed on the end thereof beyond the bushing 33. The flange 36 projects within a cylindrical opening formed in the upper surface of the flanged end of the collar 31 and is adapted rotatably to engage an annular thrust ring 37 which is formed on the collar 31 in opposed relation to the lower surface of the flange 36. The flange 36 is resiliently held against the thrust ring 37 by a spring 38 which is disposed about the threaded ring 32 and is confined between the lower surface of the frame 28 and the adjacent surface of a cylindrical hub 39 from which a crank arm 41 projects outwardly from beneath the frame 28 and between the legs 14. The hub 39 has an axial opening formed therein for rotatably receiving the shaft 34 and is supported upon the end of the shaft 34 by a circular clutch plate indicated at 42. The clutch plate 42 is supported upon the reduced end of the shaft 34 by a nut 43 which engages the

threaded and reduced end of the shaft 34. The adjacent surfaces of the hub 39 and the plate 42 are provided with opposed and complementary teeth indicated at 44.

It will be apparent that the shaft 34 can be rotated in either direction by the crank arm 41 at least to the extent that the crank arm 41 can move between the legs 14. However, the shaft 34 can be rotated to any desired extent in either direction by lifting upwardly upon the crank arm 41 to compress the spring 38 to such an extent that the teeth 44 can be moved with respect to one another.

Slidably disposed within the cylindrical opening formed in the frame 28 is a sleeve 46 which is adapted to extend above the frame 28 and to terminate just below the lower extremity of the arbor 18. The sleeve 46 is provided with a plurality of cam slots 47 formed circumferentially and axially in spaced relation to one another therein and each of these slots is adapted to receive an inwardly projecting end 48 of one of a plurality of studs indicated at 49. The studs 49 are secured by locking studs 51 in radially disposed openings formed in opposed relation to one another around the periphery of the frame 28. Secured to the sleeve 46 and above the frame 28 is a guard and stop ring indicated at 52 which is adapted to prevent abrasive material from injuring the bearing surface between the sleeve 46 and the member 28 and to limit the downward movement of the sleeve 46 with respect to the member 28. Secured to the sleeve 46 above the member 52 is a split ring 53 having a handle 54 projecting therefrom and by which the sleeve 46 may be rotated upon the pins 49 for vertically moving the sleeve 46 with respect to the frame 28 and upon the cam slots 47. The ring 53 may be removably secured to the sleeve 46 by a stud indicated at 56.

Disposed within the sleeve 46 and separated therefrom by an annular clearance space indicated at 57, is a cylindrical arbor support or support member indicated at 58. The lower extremity of the support 58 is formed in such a way as to provide spaced and downwardly projecting lugs indicated at 59. The lugs 59 form one of the movable parts of a universal joint 61 by which the support 58 is adapted to be secured to the collar 31. Disposed in diametrically disposed radial openings formed in the lugs 59 is a pair of pins 62 which are adapted to project inwardly within similar diametrically disposed openings formed in a block 63 which serves the purpose of providing the intermediate element for the universal joint 61. Secured in other diametrically opposed openings formed in the block 63 in normal relation to the openings for receiving the pin 62 is another pair of pins 64 which project outwardly into similar diametrically opposed openings formed in a spaced pair of lugs 66 which are similar to the lugs 59 and which project upwardly from the flanged upper end of the collar 31.

It will be apparent that the universal joint 61 provides means by which the support 58 can be moved in any direction within the limitation opposed by the width of the clearance space 57 at the upper extremity of the sleeve 46.

The upper extremity of the support 58 is provided with a similar universal joint which is indicated by the numeral 67. The universal joint 67 is formed by another spaced pair of lugs indicated at 68. The lugs 68 project from the opposite end of the support 58 in such manner as to receive a block 69 which likewise forms the intermediate element of the universal joint 67. The block 69 is secured within the lugs 68 by diametrically opposed pins 71 which project into aligned openings formed in the lugs 68 and the block 69. Also projecting into the block 69 in normal relation to the pins 71 is a second pair of pins indicated at 72. The latter pair of pins project into diametrically opposed openings formed in an opposed pair of lugs 73 projecting downwardly from a supporting collar 74 which forms the outer universally movable member of the universal joint 67. Formed inwardly from the upper end of the collar 74 is a plurality of axially and circumferentially disposed bayonet slots 76 adapted to receive pins 77 which project inwardly from and are secured within radial openings formed in a cylindrical support 78 which comprises the main body member for the mandrel 18.

It will be apparent that when the arbor 18 is projected over the universal joint 67 and the upper end of the support 58 in such manner that the pins 77 project within the bayonet slots 76, the arbor 18 then can be rotated for rigidly clamping the arbor to the collar 74 within the bayonet slots 76.

The outer surface of the support 78 is made in cylindrical or other suitable form for the purpose of projecting within a stack of rings 21 such as that indicated generally at 19. A slight clearance should be provided between the interior surface of the rings in the stack 19 and the exterior surface of the support 78 so that the rings can be assembled upon the support 78 without being deformed by the configuration of the exterior surface of the support 78. The clearance referred to is indicated by the line 79.

The lower end of the arbor 18 is adapted to be secured against rotational movement by the abrading tool 22 in such manner that the lower extremity of the arbor can move angularly upon the support 58 and the universal joint 67. Such movement is made possible by slots 84 which are formed in the lower edge of the support 78 for receiving the ends of levers 86 which are slidably secured by pins 87 across slots 88 formed radially inwardly around the support 58 in parallel relation to the axis thereof. The opposite ends of the levers 86 are formed in such a way as to be engageable by an annular cam surface 89 which is formed around the interior surface of the sleeve 46. The levers 86 are adapted to be held out of contact with the notches 84 when the levers are not engaged and moved by the cam surface 89 by springs 91 which project into the notches 88 behind the levers 86. The springs 91 are secured to the support 58 by screws indicated at 92.

The lower end of the ring stack 19 may be supported on the support 78 by a ring 81 adapted to be secured on the threaded lower end of the support 78. The ring 81 which is adapted to seat against a shoulder 82 formed on the support 78 is provided with an inner flange 83 that extends around the outer surface of the support 78 to engage the lower end of the ring stack 19. The thickness of the flange 83 is somewhat less than the thickness of the rings 21 so as not to be contacted by the abrading tool 22 when the rings 21 are being finished.

The lower end of the ring stack 19 is adapted to be secured rigidly or resiliently against the flange 81 of the ring 83 by a second ring 93 which is also provided with a flange 94 similar to the flange 83 for engaging the upper end of the ring stack 19. The ring 93 is adapted to

be moved axially with respect to the support 78 by a plurality of levers 96 having intermediate portions adapted to be supported by ball bearings indicated at 97. The ball bearings 97 are seated in spherically formed openings formed respectively in the upper surfaces of the levers 96 and the lower end surface of a peripheral flange 98 projecting outwardly from the lower extremity of a supporting collar indicated at 99. The levers 96 are slidably mounted in radially disposed slots 101 which are formed inwardly from the end of a flange 102 that projects upwardly and inwardly from the upper extremity of the support member 78. The slots 101 engage the side surfaces of the levers 96 in such manner as to permit the levers to pivot upon the balls 97 but to prevent lateral movement of the levers within the slots. The flange end of the collar 99 is secured rigidly to the upper end surface of the flange 102 by screws indicated at 103. The upper end surface of the collar 99 is formed in such manner as to provide oppositely disposed flats indicated at 104, these being provided for the purpose of receiving a wrench which may be employed for loosening the pins 77 of the arbor 18 within the bayonet slots 76.

The collar 99 has an axially disposed opening adapted to receive an annular bushing 106. The bushing 106 is supported in the opening by an inwardly projecting flange 107 that engages a shoulder formed at the lower extremity of the bushing 106. The bushing 106 is provided with a similar inwardly projecting shoulder indicated at 108 adapted to support the lower end of a spring 109 and slidably to engage the outer peripheral surface of the lower end of an axially movable adjusting sleeve indicated at 111. The upper end of the spring 109 is supported by a ring 112 which in turn is supported by a shoulder 113 formed outwardly from adjacent the upper extremity of the sleeve 111. The ring 112 which projects outwardly beyond the spring 109 is adapted to be slidably disposed in an annular slot 114 which is formed in the upper extremity of the bushing 106. Beyond the shoulder 113 is a second outwardly projecting shoulder indicated at 116, the end surface of the latter being adapted to be disposed within and slidably to engage the cylindrical surface of the opening in which the bushing 106 is mounted. Projecting outwardly from the upper extremity of the shoulder 116 is a plurality of radially disposed lugs 117 adapted to be slidably disposed within radially disposed slots 118 formed in the end of the collar 99. A clearance 119 is provided between the adjacent surfaces of each of the lugs 117 and the collar 99, within the slots 118. It will be apparent that the clearance 119 will permit considerable movement of the sleeve 111 with respect to the collar 99 before the clearance is closed by engagement between the lugs 117 and the collar 99.

The sleeve 111 is adapted to be supported upon the threaded upper end 121 of a shaft 122. The lower end of the shaft 122 is provided with an outwardly projecting flange 123 adapted to support a ball bearing 124. The ball bearing 124 in turn supports a ring 126 which is adapted to be engaged by and to support the inner extremities of the levers 96.

It will be apparent that rotation of the shaft 122 within the sleeve 111 will tend to compress the spring 109 in response to the force exerted by the levers 96 upon the ring 93 and involved in compressing the rings 21 in the stack 19 in frictional engagement with one another. It will be further apparent that when the shaft 122 is rotated to such an extent as to close the clearance 119 between the lugs 117 and the collar 99, a further rotation of the shaft 122 will tend positively to move the levers 96 in such manner as to rigidly clamp the ring stack 19 between the opposing rings 81 and 93.

The shaft 122 may be rotated in either direction as described by an internally splined collar 127 which is secured rigidly to the flange 123 and which is adapted to receive the upper splined end 128 of an actuating shaft 129. The spined end 128 of the shaft 129 is adapted to loosely fit the spined interior surface of the collar 127 to permit angular movement of the arbor 18 upon the universal joint 67. The shaft 129 projects downwardly through an enlarged axial opening formed in the block 69, the support 58, the block 63 and into an opening formed axially within the upper end of the shaft 34. The shaft 129 is loosely secured within the opening in shaft 34 by a pin indicated at 131.

It will be apparent that the shaft 129 can be rotated as previously described by the operation of the crank arm 41.

The structure disclosed by Figure 3 is shown with the rings in the position in which they will be held by the arbor 22 at the end of a finishing operation and just prior to the removal of the arbor 18 from the support 12 for the purpose of unloading the stack of rings 19 from the arbor 18 and prior to the reloading of the arbor 18 with a new stack of rings 19. It will be apparent that the lever 54 has been operated in such manner as to move the sleeve 46 upwardly with respect to the frame 28 so as to release the levers 66 from the cam surfaces 89. The abrading tool 22 which is shown in dot-and-dash lines in Figure 3, may be removed from the arbor 18 with the adjusting means for the arbor in the position shown, or the rings in the ring stack 19 may be tightened upon the arbor 18 to prevent the expansion of the rings when the abrading tool 22 is removed. To so tighten the rings upon the arbor, it is necessary merely to rotate the crank 41 until the clearance 119 is closed between the lugs 117 and the collar 99. When the clearance 119 is closed, a certain amount of pressure may be applied to the crank 41 to further rotate the lever in the same direction. Such further rotation of the lever will cause the ring 126 to operate the levers 96 in such a way as to rigidly secure the rings between the clamping rings 93 and 81 thereby to prevent expansion of the rings when the tool 22 is removed. To remove the tool 22 it is necessary only to operate the control panel 27 of the machine in such manner as to elevate the tool 22 into the position in which it is shown in full lines in Figure 1. The arbor 18 may thereafter be removed from the support 12 by employng a wrench upon the flats 104 to loosen the pins 77 within the bayonet slots 76. When the pins 77 are so loosened, the arbor 18 may be removed by lifting it off the upper end of the supporting shaft 58 and the universal joint 67. The rings may be removed from the arbor 18 by applying a crank having a splined end to the splined interior surface of the collar 127 or by loosening the ring 81 by the use of a spanner wrench. When the ring 81 is removed, the rings 21 in the stack 19 may be displaced from the end of the support 78 and a new stack of rings to be finished may thereafter be secured upon the arbor 18.

The structure illustrated by Figure 2 may be employed in reloading the arbor 18 with a new stack of rings to be finished. The structure so illustrated by Figure 2 comprises a plate 136 having an elongated opening 137 formed therein and in one end of which a cylinder 138 is secured. The cylinder 138 is provided with a piston 139 adapted to actuate a piston rod 141 which projects from one end of the cylinder through an opening 142. The end of the rod 142 beyond the cylinder 138 is rigidly secured intermediate the opposite ends of a clamping member 143 which projects transversely through the opening 137 adjacent the end thereof opposite the cylinder 138, The clamping member 143 is secured to the plate 136 by transversely disposed guides 144 which are secured to the plate 136 by bolts indicated at 146. Disposed beyond the clamping member 143 and projecting across the plate 136 adjacent the end of the opening 137 is another clamping member 147 having outwardly projecting flanges 148 formed intermediate the ends thereof which are secured to the plate 136 by bolts indicated at 149. The opposing surfaces of the clamping members 143 and 147 are formed in such manner as to provide complementary semi-cylindrical surfaces 151 and 152. The surfaces 151 and 152, when the clamping members 143 and 147 are closed with respect to one another, form a perfect and complete cylindrical surface comparable to the cylindrical surface of a cylinder in which the piston rings being finished are intended to be employed. The clamping member 143 may be closed or opened with respect to the clamping member 147 by applying fluid pressure to the cylinder 138 for actuating the piston 139.

In order to reload the arbor 18, it is necessary only to place a stack of piston rings in the clamping members 143 and 147 with the clamping members open sufficiently to receive the rings when the rings are expanded. The arbor 18 thereafter may be inserted in the rings with the ring 81 removed. After insertion of the arbor, the ring 81 may be tightened on the end of the support 78 by turning the ring with a spanner wrench. The rings in the stack 19 thereafter may be contracted about the support 78 by actuating the piston 139 in such manner as to close the jaws 143 and 147 with respect to one another. After the exterior surfaces of the rings in the ring stack 19 have been made to conform to the cylindrical interior surface of the jaws or clamping members 143 and 147, the rings in the stack may be rigidly secured with respect to one another to prevent expansion thereof with respect to the support 78 by applying the splined end of the crank previously referred to to the splined interior surface of the collar 127. Thereafter the crank is turned in the proper direction until the clearance 119 is closed and after which considerable force is applied to the crank for the purpose of positively moving the ring 126 in such manner as to move the levers 96 to rigidly clamp the ends of the stack 19 between the clamping rings 93 and 81. When the rings are tightened upon the arbor to a sufficient extent, the piston 139 is thereupon actuated in such manner as to open the jaws 143 and 147 so that the arbor 18 containing the confined stack of rings 19 can be removed from the apparatus. The arbor 18 is thereafter reapplied to the end of the supporting shaft 58 and the universal joint 67 by inserting the pins 77 in the bayonet slots 76 and applying a wrench to the flats 104 to tighten the pins 77 with respect to the bayonet slots 76. The lever 54 is thereupon actuated in such manner as to lower the sleeve 46 within the frame 28 so that the cam surface 89 will be made to actuate the levers 86 to engage the slots 84. The control panel 27 is thereupon actuated in such manner as to bring the abrading tool 22 down upon the arbor 18 into the position indicated in dot-and-dash lines in Figure 1.

The initial or preliminary part of the finishing operation is thereafter performed by again actuating the control panel 27 in such manner as to cause reciprocation and rotation of the abrading tool 22 with respect to the mandrel 18 and the stack of rings 19. It has been found to be preferable to actuate the abrading tool throughout a relatively long stroke and at a relatively small number of strokes per minute and at a relatively large number of revolutions per minute throughout the preliminary finishing operation upon the stack of rings 19. During such preliminary finishing operation, the rings in the stack 19 will be confined upon the arbor 18 in such manner that the resilient forces within the rings, caused by the contraction of the rings upon the arbor 18, will be ineffective to expand the rings against the interior surface of the abrading tool 22.

When the preliminary finishing operation is completed, the control panel 27 may be actuated in such manner as to stop the rotation and reciprocation of the abrading tool 22. The rings in the stack 19 thereafter may be released with respect to one another to permit the expansion of the rings within the interior surface of the abrading tool 22 by actuating the lever 41 in such manner as to open the clearance 119 between the lugs 117 and the collar 93. When the clearance 119 is opened to the desired extent, the rings in the stack 19 thereafter will be resiliently held together by the force of the spring 109 which is exerted upon the rings 93 and 81 by operation of the levers 96. The rings thereupon will be made to engage the interior surface of the abrading tool 22 by reason of the resilient force exerted by the tendency of the rings to expand and the rings will be frictionally held together within the stack 19 by the resilient force exerted by the spring 109. It has been found to be satisfactory thereafter to finish the rings by actuating the control panel 27 in such manner as again to cause relative rotation and reciprocation between the arbor 18 and the abrading tool 22. It has also been found to be desirable during such final finishing operation to reciprocate and rotate the tool 22 with respect to the arbor 18 at a relatively large number of strokes per minute, throughout a relatively short stroke and at a relatively large number of revolutions per minute.

After such final finishing operation has been completed, the control panel 27 may be actuated in such manner as to remove the honing tool 22 so that the arbor 18 may be removed and a new stack of rings applied thereto as previously described.

I claim:

1. A method of finishing piston rings which comprises contracting a split resilient ring blank until the exterior surface thereof is of smaller cylindrical form, rigidly securing said ring blank against radial movement out of said contracted form, projecting said ring within an abrading tool adapted to engage a plurality of areas around the exterior surface of said ring, relatively rotating said abrading tool and said ring so secured against radial movement while axially moving said abrad-

ing tool and said ring with respect to one another throughout a plurality of reciprocating operations, releasing said ring to permit the resilient expansion thereof against said abrading tool, and relatively rotating and reciprocating said ring and said abrading tool while said ring is so resiliently expanded in said tool.

2. A method of finishing piston rings which comprises contracting a stack of split resilient rings to form a cylindrical exterior surface thereon, clamping said rings rigidly in said contracted form to prevent radial expansion of said rings, continuously abrading the exterior surfaces of said rings in said contracted form to provide a roughly finished cylindrical surface thereon, releasing said rings to permit the resilient radial expansion of each of said rings, holding said rings in frictional engagement with one another in said resiliently expanded form, and thereafter rotatively abrading the exterior surfaces of said rings while said rings are so held in frictional engagement with one another.

3. A method of finishing piston rings which comprises contracting a stack of split resilient rings upon the exterior surface of an arbor, applying axially disposed forces to the end surfaces of said rings to clamp said rings rigidly together upon said arbor, abrading the exterior surfaces of said rings to form a roughly finished cylindrical surface, releasing said rings to permit radial expansion of said rings into resilient engagement with the abrading surface, holding said rings while so released in frictional engagement with one another, and relatively rotating said abrading tool and said rings and arbor while said rings are so held for finally finishing the exterior surfaces of said rings.

4. A method of finishing piston rings which comprises rigidly securing a stack of split resilient rings with respect to one another and with the exterior surfaces thereof forming approximately a continuous cylindrical surface, roughly finishing said stack of rings with an abrading tool engaging a plurality of areas on each of said rings around the periphery of said cylindrical surface by relatively reciprocating said rings and said abrading tool while so secured and throughout a plurality of continuous reciprocating movement, releasing said rings within said abrading tool for resilient radial expansion therein, holding said rings together with a force limited enough to permit further expansion of said rings within said abrading tool but great enough to cause driving frictional engagement between the surfaces of said rings, and relatively rotating said abrading tool and said rings while said rings are so held.

5. A method of finishing piston rings which comprises rigidly securing a stack of split resilient rings with respect to one another with the exterior surfaces thereof forming a continuous cylindrical surface, roughly finishing said stack of rings with an abrading tool engaging a plurality of areas on each of said rings around the periphery of said cylindrical surface by relatively rotating said rings and said abrading tool while said rings are so secured in said stack, releasing said rings within said abrading tool for resilient radial expansion therein, holding said rings together in said stack with sufficient force to permit further expansion of said rings within said abrading tool and to cause driving frictional engagement between the surfaces of said rings, and thereafter continuing the relative rotation of said abrading tool and said rings while said rings are so held.

6. A method of finishing piston rings which comprises rigidly securing a stack of split resilient rings with respect to one another with the exterior surfaces thereof forming approximately a continuous cylindrical surface, roughly finishing said stack of rings with an abrading tool engaging a plurality of areas on each of said rings around the periphery of said cylindrical surface by relatively rotating and reciprocating said rings and said abrading tool while said rings are so secured in said stack, releasing said rings within said abrading tool for resilient radial expansion therein holding said rings together in said stack with sufficient force to permit further expansion of said rings within said abrading tool and to cause driving frictional engagement between the surfaces of said rings, and relatively rotating said abrading tool and said rings while said rings are so resiliently held together within said abrading tool and while said rings are free to expand in radially contacting engagement with said abrading tool.

7. A method of finishing piston rings which comprises rigidly securing a stack of split resilient rings with respect to one another with the exterior surfaces thereof forming approximately a continuous cylindrical surface, roughly finishing said stack of rings with an abrading tool engaging a plurality of areas of each of said rings around the periphery of said cylindrical surface by relatively rotating and reciprocating said rings and said abrading tool while said rings are so held in said stack, releasing said rings within said abrading tool for radial expansion therein, holding said rings together in said stack with sufficient force to permit further expansion of said rings within said abrading tool and to cause driving frictional engagement between the surfaces of said rings, and thereafter relatively rotating and reciprocating said abrading tool and said rings while applying said force to hold said rings together and while applying the radial force in said rings tending to expand said rings into abrading contact within said abrading tool.

8. A method of finishing piston rings which comprises contracting a stack of split resilient rings until the exterior surfaces thereof form an exposed and rigid and continuous cylindrical surface, abrading said rigid and continuous cylindrical surface while said rings are so contracted, releasing said rings for expansion against the rigid interior surface of a cylindrical abrading tool, and thereafter relatively rotating said rings and said cylindrical abrading tool surface.

9. A method of finishing piston rings which comprises contracting a stack of split resilient piston rings to form a continuous cylindrical exterior surface, rigidly securing said rings in said stack with said exterior surfaces exposed and in said contracted form, abrading said exterior surfaces of said rings while so contracted and secured, externally confining said exterior surfaces of said rings to limit the radial expansion thereof, releasing said rings to permit such limited radial expansion thereof, and abrading the exterior surfaces of said rings while so expanded and limited and by an abrading movement directed obliquely with respect to the axis of said stack.

10. A method of finishing piston rings which comprises confining a stack of split rings against the resilient internal forces therein to form a rigid and continuous cylindrical exterior surface

on said rings, securing said rings in said contracted relation with said exterior surface exposed to retain said cylindrical exterior surface thereon, abrading the exterior surface of said rings while said rings are so contracted and secured, enclosing the exterior surface of said rings within a cylindrically formed tool to limit the expansion of said rings, releasing said rings to resiliently engage the internal surface of said tool, and rotatably abrading the exterior surfaces of said rings while resiliently expanded within said tool.

11. A method of finishing piston rings which comprises radially contracting a stack of split piston rings against the resilient forces therein to provide a continuous cylindrical surface on the exterior of said rings, rigidly securing said rings in said contracted relation, abrading the exterior surface of said rings, confining the exterior surface of said rings within a cylindrical tool to limit radial expansion thereof by said resilient forces, releasing said rings to permit said rings resiliently to engage the interior surface of said tool, applying opposed forces to the ends of said stack to provide frictional driving forces between the rings in said stack while said rings are so released and abrading the exterior surfaces of said rings while so released in said tool and in opposition to said frictional force between said rings.

12. A method of finishing piston rings which comprises radially contracting a stack of piston rings against the resilient forces therein to provide a continuous cylindrical surface on the exterior of said rings, rigidly securing said rings in said contracted relation, abrading the exterior surface of said rings, confining the exterior surface of said rings within a cylindrical tool to limit radial expansion thereof by said resilient forces, releasing said rings to permit said rings resiliently to engage the interior surface of said tool, applying opposed forces to the ends of said stack while said rings are so resiliently released to provide frictional driving forces between the rings in said stack, and rotatively abrading said rings while so released in said tool and in opposition to said frictional forces between said rings.

13. A method of finishing piston rings which comprises contracting a stack of split resilient rings to form a continuous cylindrical exterior surface, rigidly securing said rings in said stack with said exterior surface exposed and in said contracted form, abrading said exterior surfaces of said rings while so contracted and secured, externally confining said exterior surfaces of said rings to limit the radial expansion thereof, releasing said rings to permit such limited radial expansion thereof, and abrading the exterior surfaces of said rings while so expanded and limited and by intersecting abrading movements directed obliquely with respect to the axis of said stack.

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