March 22, 1960 E. C. AUMILLER 2,929,174

METHOD AND APPARATUS FOR AUTOMATIC LAPPING OF PISTON RINGS

Filed Nov. 13, 1956 3 Sheets-Sheet 1

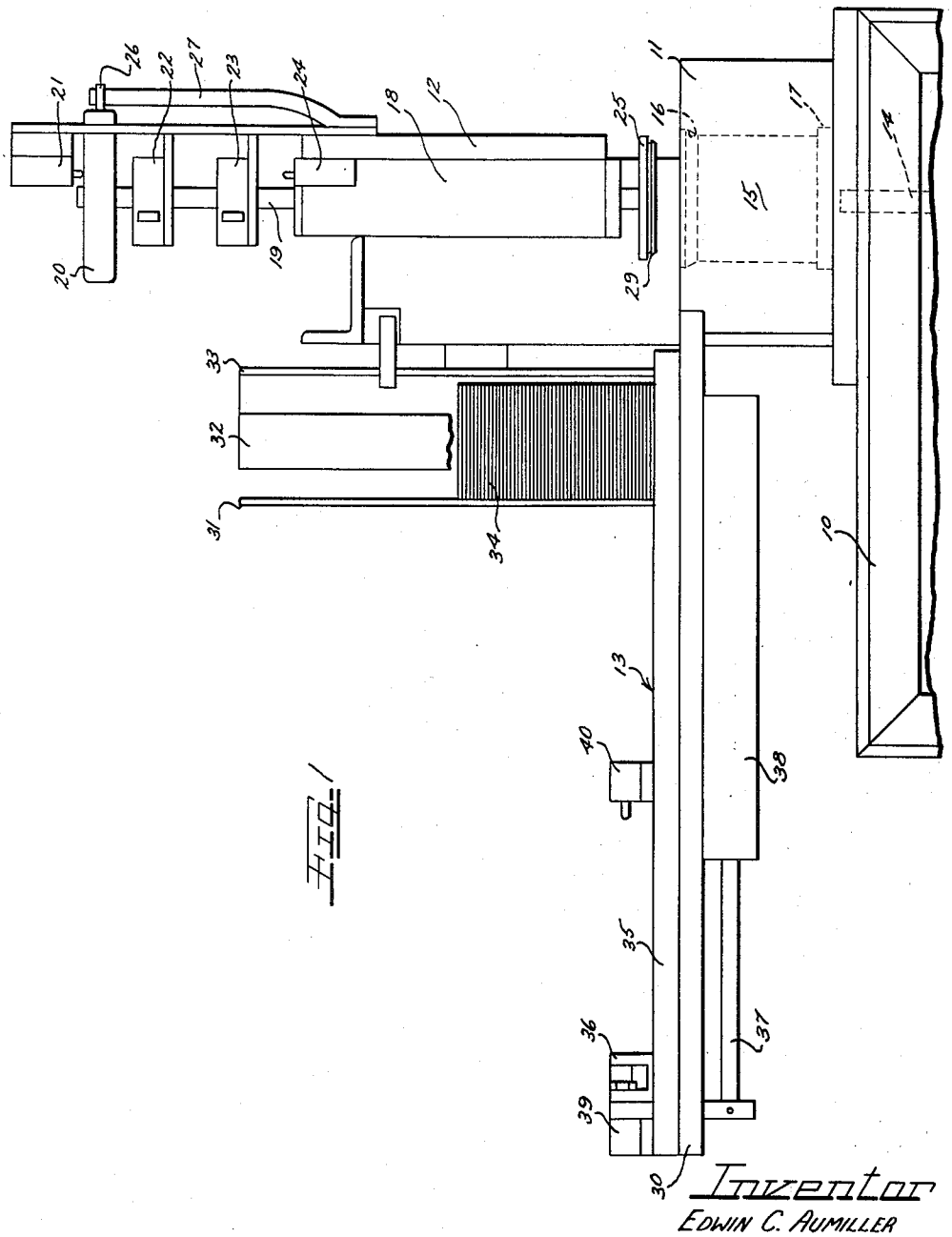


Fig. 1

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Fig. 2

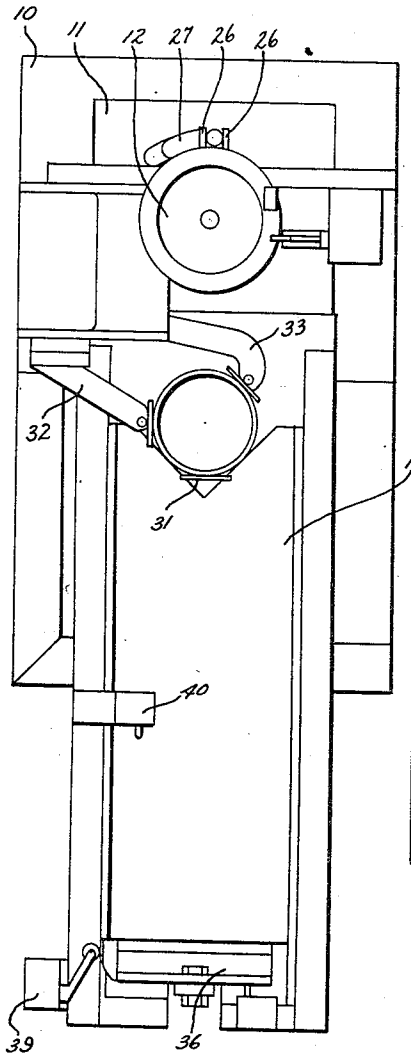
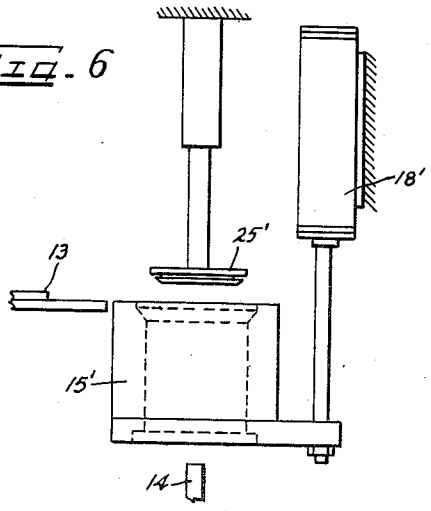


Fig. 6



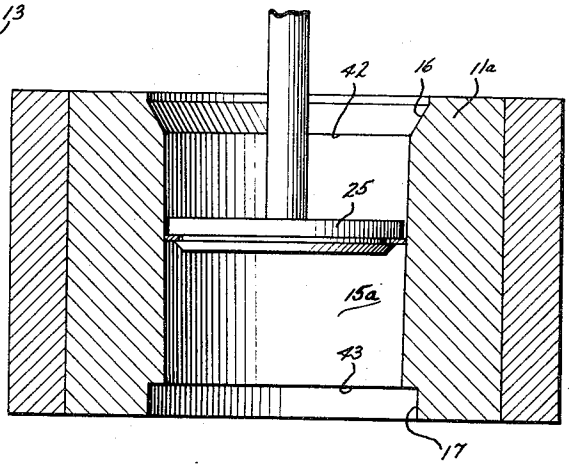


Fig. 5

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Fig. 3

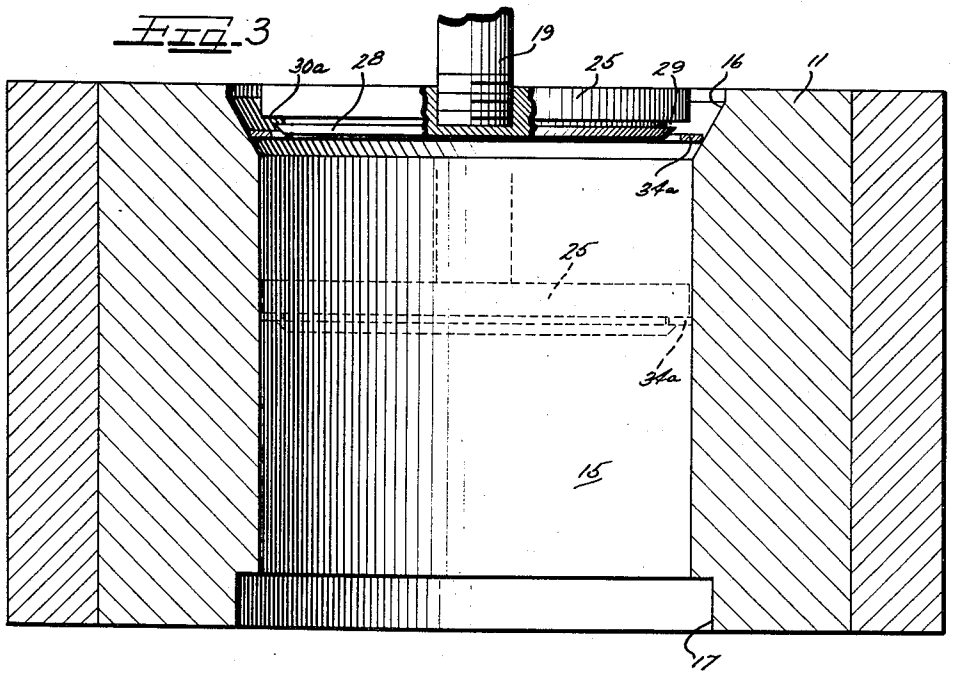
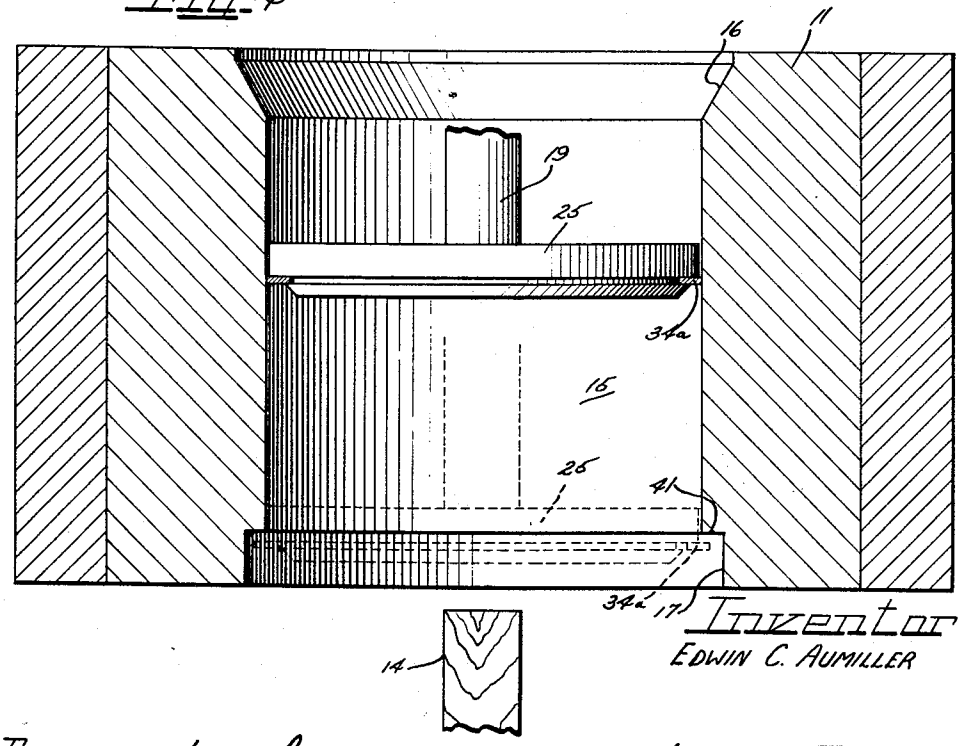


Fig. 4



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METHOD AND APPARATUS FOR AUTOMATIC LAPPING OF PISTON RINGS

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Application November 13, 1956, Serial No. 621,649

17 Claims. (Cl. 51—157)

This invention relates to a method of and apparatus for the automatic lapping of piston rings.

Piston rings are used with pistons to create seals between the piston and the cylinder in which the piston is operating in a wide variety of devices. Perhaps the best known is within reciprocating internal combustion engines, such as are used on automobiles. It is well known that rings should contact the cylinder over the entire periphery of the ring with a small degree of tightness. To insure this feature in the production of piston rings, the rings should be properly tensioned, should be flat, and should have an extremely smooth periphery. The smoothness at the periphery should extend across its entire width so that the cylinder can contact the ring face. Many rings are made with square faces, but some are made out of square or differently for some specific reason.

Once installed in the complete device, the ring functions to seal the cylinder pressure from the crank case or to control oil flow from the crank case to the combustion chamber. It is known that longer life may be obtained by chrome plating the outer face of the rings. The outer face of either the plain or chrome plated rings may be interrupted by grooves or may have a coarse thread finish to add scuff-resistance. Typically, the outer face is square but it may be desired to have the outer face tapered for installation as a lower compression ring with the scraping edge downward. Thus compression rings all present either a plated or unplated face and either a square or tapered face. Oil control rings may have various bevels and grooves, but nevertheless, they do present narrow faces which bear against the cylinder walls.

A common problem to all these different basic ring designs is found in the method and apparatus used in providing at manufacture a smooth cylinder contacting face. Typically this is done by lapping.

In the past, it has been customary to manually load groups of rings onto suitable arbors or mandrels which are then installed in a lapping machine. While this method is superior to lapping one ring at a time by hand, it has been found that a still quicker and lower cost method and apparatus for lapping piston rings can be obtained by using an automatic lapping machine which handles but one ring at a time. This machine operates in accordance with a method and is constructed in accordance with principles described herein. An economy is achieved in that manual loading and unloading is eliminated, a more uniform lapped finish is produced, and a lesser number of lapping strokes is required.

Accordingly, I have found that a superior method for lapping piston rings comprises simultaneously picking up and radially compressing the ring to its operating diameter, thereby restraining it; lapping the surface of the ring while it is so restrained and then releasing the ring by removing the external restraint. I have also found that one particular form of apparatus performs this method especially well which comprises a pot having

an opening with a circular cross-section, a frusto-conical surface at one end of the opening and an enlargement at the opposite end of the opening. Within this opening there moves a plunger which has a tapered end to center the ring, a shoulder which coacts with the frusto-conical portion of the opening to compress the ring squeezing it into a peripheral groove in the plunger, together with the associated equipment for driving the plunger and feeding unlapped rings to the apparatus.

Accordingly, it is an object of this invention to provide a method for picking up, lapping, and releasing a piston ring.

Another object of this invention is to provide means for radially compressing and picking up the ring, restraining and lapping the ring, and releasing the ring.

A further object is to provide a pot and plunger cooperative with said pot for picking up, lapping and releasing a piston ring.

Yet another object is the provision of an apparatus of the type described which will automatically lap piston rings individually.

A further object is the provision of an apparatus for picking up and lapping piston rings.

A still further object is the provision of a lapping machine which laps rings with both reciprocating and rockable motion.

Yet another object is the provision of a lapping machine for piston rings which has a release means for not only releasing but catching rings as they are snapped free.

A still further object is the provision of a lapping machine for square-faced piston rings.

Another object is the provision of a lapping machine for taper-faced piston rings.

Still another object is the provision of a lapping machine capable of automatically picking up lapping and discharging individual piston rings.

Another object is the provision of a lapping machine which is automatically fed piston rings to be individually lapped.

Other objects, features and advantages of this invention will be apparent from the following detailed description of the attached sheets of drawings, which by way of a preferred embodiment and a modification thereof illustrates the invention.

On the drawings:

Figure 1 is an elevational view of an automatic lapping machine for piston rings;

Figure 2 is a top view of the machine shown in Figure 1 on a slightly reduced scale;

Figure 3 is an enlargement of a portion of Figure 1, partly in section and partly in elevation, showing the plunger immediately prior to its picking up a ring;

Figure 4 is similar to Figure 3 except that the plunger is shown with the piston ring during one of the lapping strokes;

Figure 5 illustrates a modified lapping surface otherwise similar to Figure 4; and

Figure 6 schematically illustrates a modified form of the instant invention.

As shown on the drawings:

Referring to Figure 1, there is shown a schematic presentation of an elevational view of an automatic lapping machine constructed in accordance with this invention. The machine is illustrated as having a support **10** which carries a lapping pot **11**, a power drive and plunger assembly **12** and a feed mechanism **13**.

The support **10** may be constructed in any convenient way. The lapping pot **11** is placed over a hole in support **10** (not shown). In line with this hole and with the lapping pot, is a rack or spindle **14** onto which the lapped rings are discharged. The pot **11** has an open-

ing having a circular cross-section and extending through the pot, such opening being generally indicated by the numeral 15. At the upper end of the opening, there is a frusto-conical surface 16 while at the opposite end of opening 15, there is an enlarged portion 17, the diameter of which exceeds that of the piston ring in its free state. As will be shown later, this enlarged portion 17 is optional, but preferable. The lapping pot 11 may be made of a single piece or it may be comprised of an insert within a holding structure as shown in Figures 3 and 4, the latter form being preferable.

The piston and drive assembly 12 is carried by the support 10 and is made up of a conventional actuating cylinder assembly 18. As shown, a piston rod 19 projects from both ends of the drive cylinder. It will be seen that the apparatus shown connected to the upper end of piston rod 19 could also be attached at the opposite end of the piston rod, thereby enabling utilization of a drive cylinder having a piston rod which comes out of one end only. Secured to the upper end of piston rod 19 is a head 20 which is engageable with conventional electrical limit switches 21—24, each of which are stationary with respect to the housing 10 and to the casing of the power drive 18. At the opposite end of piston rod 19, there is shown a plunger or piston 25 which is rigidly secured to the piston rod 19. The structure is so arranged that power drive 18 acting through the piston rod 19 may reciprocate piston or plunger 25 through the opening 15 without contacting the same. Head 20, and piston rod 19 and plunger 25 may not only be reciprocated as a unit, but also may be rotated or rocked as a unit. Head 20 is provided with a pair of pins 26—26 which straddle a curved rod 27. Rod 27 has a straight portion at its upper end and may have a cam surface engageable by pins 26—26 whenever the head is so positioned anywhere between limit switches 22 and 23. The cam rod 27 is stationary with respect to housing 10. It can be seen that the pins 26 may be carried by the opposite end of piston rod 19 such as by plunger 25 if reshaped to continuously extend out of circular cross-section opening 15.

Referring to Fig. 3, the plunger or piston 25 is illustrated as being threadably engaged with piston rod 19. The mode of attachment is not important, it being preferable, however, that the piston be removable for ease of manufacture and assembly. Thus shoulders, washers, bushing, nuts and the like might also be used in making this connection in any manner. The plunger 25 has at its leading end a frusto-conical portion 28. The widest portion of the frusto-conical portion has a diameter which is less than the smallest inside diametral measurement of the ring to be lapped when the ring is in its uncompressed or free state. Thus when the plunger 25 is brought into the frusto-conical portion 16 of the lapping pot 11, the frusto-conical portion 28 will cause a piston ring lying in the frusto-conical portion 16 to be centered. The widest portion of the frusto-conical portion 28 also defines one edge of a groove 29. The other edge of groove 29 is formed by a shoulder 30*a* which extends outwardly from the piston rod but terminates in spaced relation to the narrowest portion of cylindrical opening 15. The specific dimensions chosen will be selected on the basis of the dimensions of the ring to be lapped.

Referring to Figs. 1 and 2, a feeding mechanism is shown as being part of the lapping machine, the details of which feeder are not part of this invention. Any other feeding mechanism capable of performing the same functions as performed by the one shown herein, may be used in place thereof. For purposes of illustration, a brief description of the instant feeding mechanism will be given. The feeding mechanism 13 is comprised of a base portion 30 which is stationary with respect to support 10. Secured to the base 30 are three upstanding ring guides 31, 32 and 33. These upstanding guides are here shown neatly aligning a stack of rings 34 to be lapped. Base 30 has a longitudinal slot (not shown) over which lies a slide plate 35 which has a bracket 36 secured thereto and which extends below plate 35 through the longitudinal slot in the base 30. Connected to the lower end of bracket 36 is a piston 37 which is received by a stationary cylinder 38. Conventional electrical limit switches 39 and 40 are engageable at the limits of travel of the slide plate 35 by bracket 36. When cylinder 38 is actuated, the slide plate 35 is moved toward the lapping pot bringing the lowermost ring 34*a* of rings 34 with it and depositing it in the frusto-conical portion 16 as shown in Fig. 3.

Electrical switches 21—24, 39 and 40 comprise one form of a synchronizing means. They are electrically interconnected between themselves to operate electric valves which bring fluid energy to feed mechanism cylinder 38 and to the power drive cylinder 18. The power to these electric switches and to the solenoid valves (not shown) which control the fluid energy is further controlled by an electrical sequential timer (also not shown) which either permits a certain number of lapping strokes by power drive 18 or which permits power drive 18 to reciprocate for a predetermined length of time. Of course a stepping switch-limit switch could be used at 22 or 23 to totalize the strokes in place of a timer.

At the beginning of the cycle, the feed mechanism 13 takes the lowermost of the stack of piston rings 34 and slides it into the frusto-conical end of opening 15 of lapping pot 11. When plate 35 reaches the end of its stroke, bracket 36 engages limit switch 40 which is connected to cause the return of slide plate 35. When slide 35 reaches its retracted position, bracket 36 engages limit switch 39 which upon engagement, permits the movement of piston rod 19 in a downward direction from the position shown in Figure 1.

When plunger 25 moves downward from its retracted position outside of the opening 15, it enters the opening 15 as shown in Figure 3. If piston ring 34*a* is not properly centered, frusto-conical surface 28 causes the ring to become centered by entering the ring opening. Thereafter shoulder 30*a* engages ring 34*a* and continues moving in a downward direction, thereby cooperating with frusto-conical surface 16 to inwardly move or compress the piston ring 34*a* into groove 29. As the downward movement continues, the compressing of the piston ring also continues until it reaches the diameter defined by the central or lapping portion of opening 15. This opening preferably is of a size corresponding to the outside operating dimension of the piston ring. The motion of plunger 25 continues inwardly, thus beginning the actual lapping.

Upon engagement with or actuation of limit switch 23, the piston is caused to reverse its direction of motion until limit switch 22 is engaged at which reversal again takes place. Reciprocation between limit switches 22 and 23 continues until the central control is satisfied (number of strokes or lapping time reached), whereupon switch 23 is shunted so that the piston 25 takes an extended downward stroke, terminated by limit switch 24 which in turn shunts switch 22. Thus the downward movement of the plunger is permitted to be extended so that groove 29 registers with enlarged portion 17 to release the lapped ring. On its return stroke, the head 20 moves past the now shunted switch 22 to engage switch 21 to remain there until the next ring has been fed. Switch 21 also initiates the next feeding cycle.

By moving the groove 29 beyond the point indicated at numeral 41 in Figure 4, the restraint was removed from the piston ring, thereby enabling it to snap outward due to its own resiliency. Upon taking its original natural form, the ring immediately becomes freed of the frusto-conical portion of plunger 25 and of groove 29. This transition condition is shown in dash lines in Figure 4 just before the ring 34*a* begins to fall around the rack, guide or spindle 14.

From this description it is apparent that the substantial enlargement **17** of the opening **15** is not necessary for the automatic removal of the ring from plunger **25**. However it can be seen that if the ring should disengage from one side only, it would hang up in the groove **29**. Therefore it is preferable to also have the substantially enlarged portion **17** which could mate with the newly lapped surface of the ring opposite to the point of such hang-up. This mating would come in the form of a springing blow at the time that the ring is released or that the restraint is removed, thereby causing the ring to be forced back or centered so as to fall freely out of the groove **29**.

While piston rod **19** is being reciprocated between limit switches **22** and **23**, pins **26, 26** engage the curved portion or cam **27**, most clearly shown in Figure 2. This cam imparts a rotational movement to plunger **25** and hence to the ring being lapped. This rotational or rocking movement prevents deep axial scratches on the lapped face of the ring. It can be seen that this optional feature is highly desirable.

It has been shown that when switch **23** was inactivated or shunted by the central control, that head **20** would continue past the limit switch **23** thus removing the restraint from the ring and releasing it. The downward movement of plunger **19** continues until head **20** reaches limit switch **24** which arrests the movement and causes its return to limit switch **21**. Limit switch **21** is connected to cause feeding movement of slide plate **35**, whereby the lapping program may be repeated indefinitely.

In the form illustrated in Figures 1–5, the piston or plunger **25** is reciprocated, and the lapping pot **11** remaining stationary. In some forms of this invention, it may be desirable to reciprocate and/or rock the lapping pot, leaving the plunger **25** stationary. Such a structure is schematically illustrated in Figure 6, wherein the plunger **25'** is rigidly supported in line with a reciprocable pot **15'** and is provided with an actuating cylinder assembly **18'**, the pot **15'** being shown at its lower limit of travel.

Referring to Fig. 5, there is illustrated a modified form of this invention. The lapping pot **11*a*** has an opening **15*a*** having a frusto-conical portion **16** and a substantially enlarged portion **17**. It will be observed, however, that the central lapping portion of the opening **15*a*** has been tapered slightly having its larger end **42** joined to the smaller end of frusto-conical portion **16** while its smaller end **43** terminates at enlarged portion **17**. The diameter of plunger **25** must be such as to clear the walls at portion **43**. By such a modification of the lapping pot **11**, a tapered face on the ring may be lapped.

Thus it will be seen that a completely automatic lapping machine has been provided which may be used to lap the cylinder contacting faces of piston rings at a somewhat reduced cost over that which was previously possible. It will also be seen that a uniformly lapped finish will be produced since each ring is treated exactly the same and since each works over the same surface. The method of lapping rings as taught herein may be accomplished by numerous variations of the apparatus, including substantial departures therefrom. Accordingly, a method has also been shown how piston rings may be picked up, lapped and released more efficiently than they previously could be. It will be seen that this method has been made particularly practical by the novel structure which has been provided to pick up and simultaneously compress the piston ring to its operating diameter, the lapping and release of the ring being also efficiently carried out.

It will be understood that numerous modifications and variations may be effected without departing from the scope of the present invention, but it is understood that this application is to be limited only by the scope of the appended claims.

I claim as my invention:

1. A lapping machine for a piston ring comprising, in combination: means for radially compressing and thereby and thereafter picking up the ring to be lapped; means for both radially restraining and for lapping the ring while it is so compressed; and additional means for removing the radial restraint, thereby releasing the lapped ring from the machine.

2. A lapping machine for a piston ring comprising, in combination: radial compression means including a frusto-conical surface for engaging the piston ring to pick it up; means for both radially restraining and for lapping the ring while it is so compressed; and means remote from said frusto-conical surface for removing the radial restraint, thereby releasing the lapped ring from the machine.

3. A lapping machine for a piston ring comprising, in combination: means for radially compressing and thereby and thereafter picking up the ring to be lapped; restraining means having a circular cross-section concentrically engageable with the ring for radially restraining the ring while it is so compressed; means for applying relative lapping motion to the ring while it is so restrained; and means disposed remotely from said compressing mean for removing the radial restraint, thereby releasing the lapped ring from the machine.

4. A lapping machine for a piston ring comprising, in combination: means for radially compressing and thereby picking up the ring to be lapped, restraining means having a circular cross-section concentrically engageable with the ring for radially restraining the ring while it is so compressed; means for applying relative lapping motion to the ring while it is so restrained; and means for removing the radial restraint, thereby releasing the lapped ring; said last mentioned means comprising a substantial enlargement of the circular cross-section of said restraining means remote from said compressing means and into which said motion means is adapted to move the ring.

5. A lapping machine for a piston ring comprising, in combination: radial compression means for picking up the ring including a frusto-conical surface for engaging the outer periphery of the piston ring before the ring is picked up; restraining means having a circular cross-section concentrically engageable with the ring for radially restraining the ring while it is so compressed; means for applying relative lapping motion to the ring while it is so restrained; and means for removing the radial restraint, thereby releasing the lapped ring; said last mentioned means comprising a substantial enlargement of the circular cross-section of said restraining means remote from said frusto-conical surface and into which said motion means is adapted to move the ring.

6. A lapping machine for a piston ring comprising, in combination: a pot having an opening with a frusto-conical surface blending at its smaller end into a circular cross-section lapping surface; and a plunger relatively axially movable into said opening for lapping the ring; said plunger having a peripheral shoulder and a peripheral ring groove, one edge of which is defined by said shoulder and the other edge of which is of lesser diameter and is fixedly spaced therefrom; said shoulder being located to cooperate with said frusto-conical surface to pick up the ring by compressing it into said ring groove, thus positioning it for lapping.

7. A lapping machine for a piston ring comprising, in combination: a pot having an opening with a frusto-conical surface blending at its smaller end into a circular cross-section lapping surface; and a plunger relatively axially movable into said opening for lapping the ring; said plunger having a tapered end, the widest portion of which defines a first edge of a peripheral ring groove; said plunger also having a peripheral shoulder which defines a second edge of said ring groove; said shoulder being located to cooperate with said frusto-conical surface to

pick up the ring by compressing it into said ring groove, thus positioning it for lapping.

8. A lapping machine for a piston ring comprising, in combination: a pot having an opening with a frusto-conical surface blending at its smaller end into a circular cross-section lapping surface; and a plunger having a ring receiving portion relatively axially movable into and completely through the entire length of said opening for picking up and lapping the ring at said frusto-conical and lapping surfaces respectively, and for releasing the ring by extending through said opening.

9. A lapping machine for a piston ring comprising, in combination: a pot having an opening with a circular cross-section lapping surface; plunger means entering one end of said opening to pick up and lap the ring; and release means at the other end of said opening comprising a substantial enlargement of said opening for releasing the ring from the machine, said plunger being extendible into said last named means.

10. A lapping machine for a piston ring comprising, in combination: a pot having an opening with a frusto-conical surface blending at its smaller end into a circular cross-section lapping surface; a plunger relatively axially movable into and through the length of said opening for lapping the ring; said plunger having a tapered end, the widest portion of which defines a first edge of a peripheral ring groove; said plunger also having a peripheral shoulder which defines a second edge of said ring groove; said shoulder being located to cooperate with said frusto-conical surface to pick up the ring by compressing it into said ring groove, thus positioning it for lapping; and release means at the other end of said opening comprising a substantial enlargement of said opening.

11. A lapping machine for a piston ring comprising, in combination: a pot having an opening with a frusto-conical pickup surface blending at its smaller end into the larger end of a frusto-conical lapping surface; and a plunger relatively axially movable into said opening and adapted to pick up and effect lapping movement of the ring.

12. A lapping machine for a piston ring comprising, in combination: a pot having an opening with a circular cross-section lapping surface; a relatively axially displaceable plunger movable into said opening and adapted to both pick up and reciprocatingly lap the ring; a pin member; and a cam member engageable therewith; one of said members being carried for reciprocation by one of said plunger and pot, and bearing against the other member and operative to rock said one of said plunger and pot about its axis while it reciprocatingly laps the ring.

13. A lapping machine for a piston ring comprising, in combination: a pot having an opening with a frusto-conical surface blending at its smaller end into a circular cross-section lapping surface; a relatively axially displaceable plunger movable into and through the length of said opening; said plunger having a tapered end, the widest portion of which defines a first edge of a peripheral ring groove, said plunger also having a peripheral shoulder which defines a second edge of said ring groove; said shoulder being located to cooperate with said frusto-conical surface to pick up the ring by compressing it into said ring groove, thus positioning it for lapping; cam means acting on said plunger to rock it about its axis while it reciprocatingly laps the ring; and release means at the other end of said opening comprising a substantial enlargement of said opening.

14. A method for lapping a piston ring comprising, the sequential steps of first radially compressing the ring to be lapped, thereby restraining it radially; secondly picking up the ring by effecting axial restraint; thereafter lapping a surface of the ring while it is so restrained; and releasing the ring by removing the radial restraint.

15. A method for lapping a piston ring comprising picking up the ring to be lapped by relatively moving it axially into engagement with converging and parallel surfaces of a lapping means, thereby also compressing and restraining it radially; simultaneously therewith, restraining the ring axially, lapping a surface of the ring while it is so restrained; and releasing the ring by removing the radial restraint while it is axially restrained.

16. A method for lapping a piston ring comprising picking up the ring to be lapped by relatively moving it axially into engagement with converging and parallel surfaces of a lapping means, thereby also compressing and restraining it radially; simultaneously therewith restraining the ring axially; applying relative lapping motion to the ring while it is so restrained, said lapping motion comprising relative movement of the ring rockably about its axis and reciprocatingly along its axis and releasing the ring by removing the radial restraint before the axial restraint is removed.

17. A method for lapping a piston ring comprising picking up the ring to be lapped by moving it axially into engagement with converging and parallel surfaces of a lapping means, thereby also compressing and restraining it radially; simultaneously therewith restraining the ring axially; lapping a surface of the ring while it is so restrained; and releasing the ring by axially moving it while axially restrained to a point remote from said converging and parallel surfaces beyond which said lapping means cannot restrain it.

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