Oct. 30, 1923. 1,472,036

O. A. ANDERSON ET AL

MEANS FOR RESURFACING CYLINDERS

Filed July 14, 1919 3 Sheets-Sheet 1

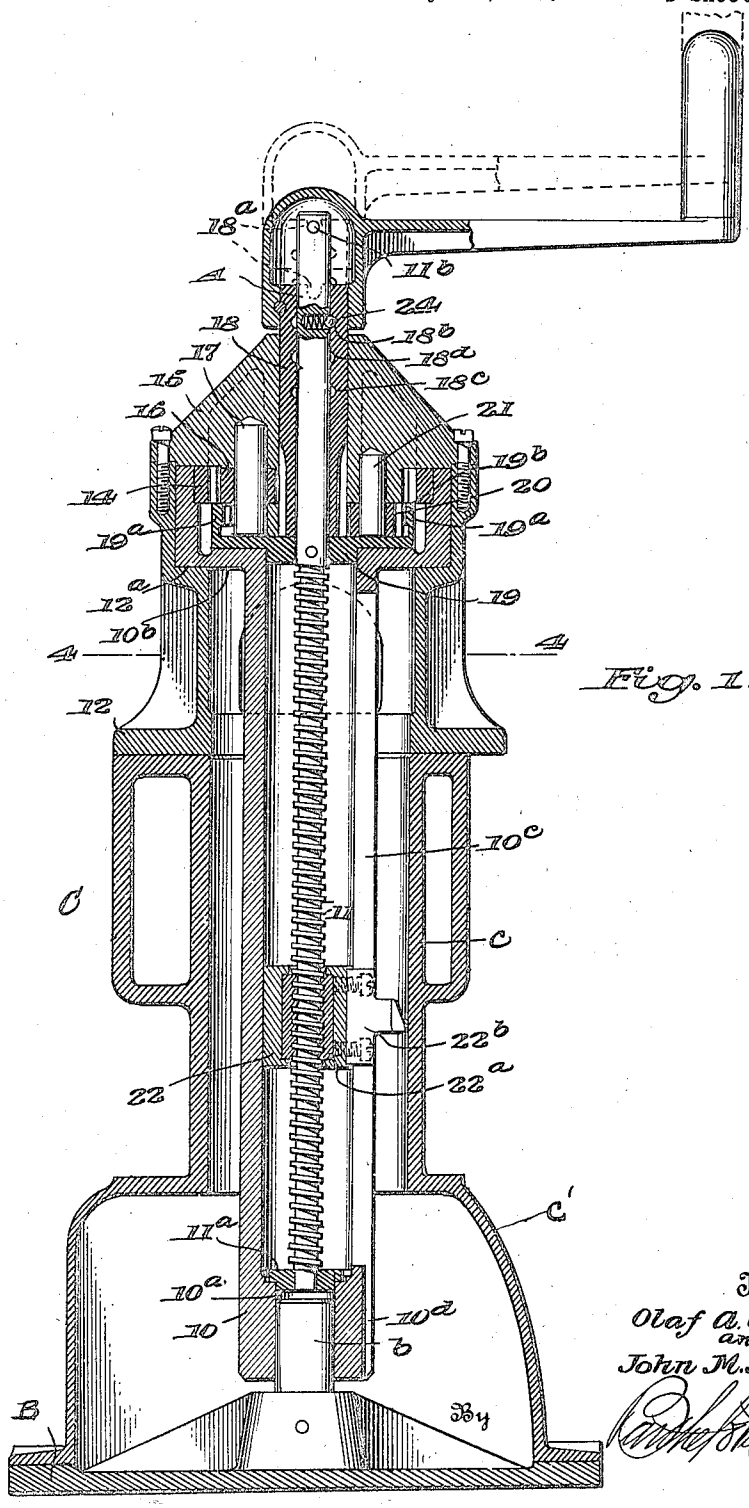


Fig. 1.

Inventors
Olaf A. Anderson
and
John M. Macrae,
Attorneys

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Fig. 2.

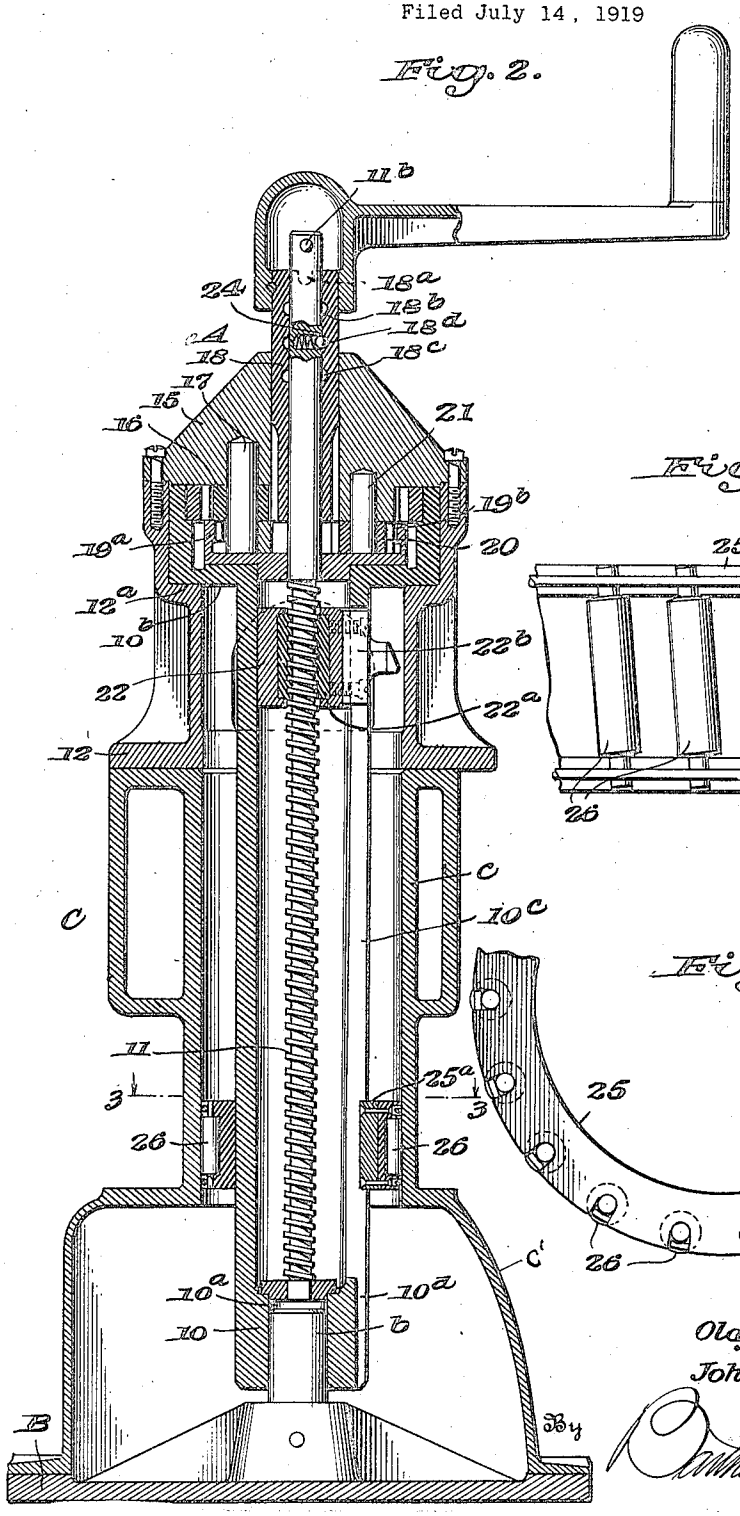


Fig. 7.

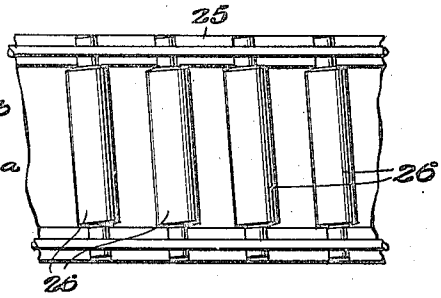


Fig. 6.

Inventors
Olaf A. Anderson
and
John M. Macrae,

Attorneys

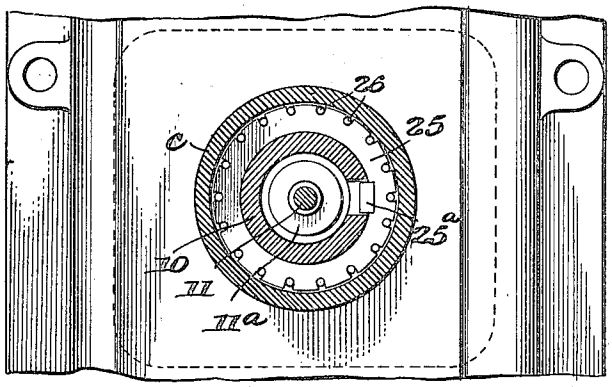
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MEANS FOR RESURFACING CYLINDERS

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Fig. 3.



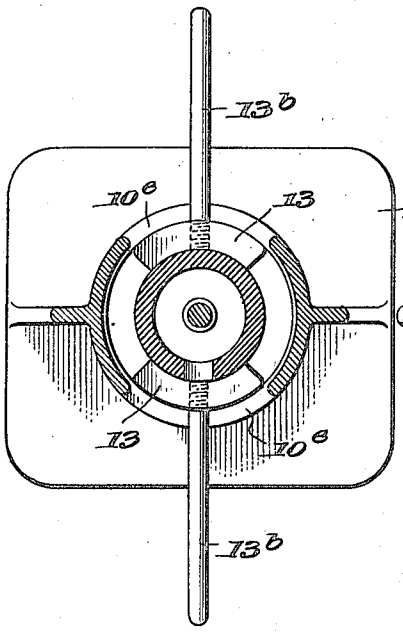


Fig. 4.

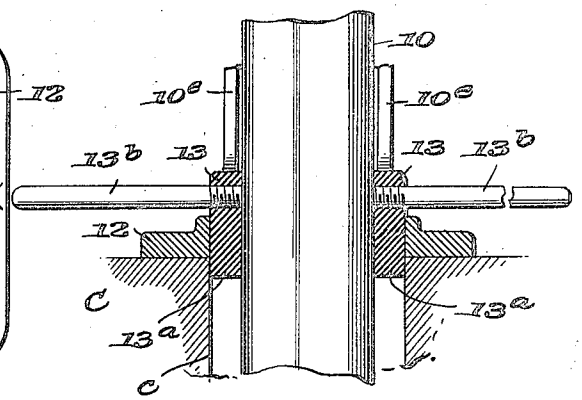


Fig. 5.

Inventors
Olaf A. Anderson
and
John M. Macrae,

By

Attorneys

Patented Oct. 30, 1923. 1,472,036

UNITED STATES PATENT OFFICE.

OLAF A. ANDERSON AND JOHN M. MACRAE, OF DETROIT, MICHIGAN, ASSIGNORS TO MICHIGAN MACHINE CO., OF DETROIT, MICHIGAN, A CORPORATION OF MICHIGAN.

MEANS FOR RESURFACING CYLINDERS.

Application filed July 14, 1919. Serial No. 310,770.

To all whom it may concern:

Be it known that we, OLAF A. ANDERSON and JOHN M. MACRAE, citizens of the United States of America, residing at Detroit and Dearborn, respectively, in the county of Wayne and State of Michigan, have invented certain new and useful Improvements in Means for Resurfacing Cylinders, of which the following is a specification, reference being had therein to the accompanying drawing.

This invention relates to improvements in means for resurfacing cylinders, pertaining more particularly to tractors adapted for resurfacing the cylinders of internal combustion motors.

As is well understood, the cylinders of internal combustion motors become worn and otherwise made inefficient through decrease in compression ability, etc., and it is the general practice—when this condition becomes excessive—to renew the original conditions by producing a new surface in the cylinder bore and substitute a piston of an increased diameter, thus producing more or less the original conditions excepting possibly in the slightly increased capacity of the cylinder space through the slight increase in diameter of the cylinder bore. This re-surfacing may be provided by simply re-boring the cylinder, or by providing such re-boring action and then subjecting the surface thus produced to a burnishing action.

The difficulties of re-surfacing cylinders flow mainly from the fact such cylinders are generally cast as part of a block, thus requiring special machinery or tools for producing either a single re-boring operation or such operation with a burnishing operation; it being readily understood that where a plurality of cylinders are in the form of a unitary structure, it becomes a difficult matter to provide relative movements between the cylinder and the boring or burnishing tool necessary in providing the re-surfacing operation. Machines capable of producing this result have of course, been developed, but such machines are generally of a special type and are to be found mainly in the manufacturing plants of the motors. As a result, it is a general practice to remove the cylinder blocks from a motor found to be sufficiently faulty to require such re-surfacing, and then ship the blocks to a manufacturing plant where it can be properly re-surfaced, thus not only entailing considerable loss of time but making it a more or less expensive operation. Where machines for the purpose are installed at non-manufacturing plants, the cost to the owner of the cylinder is generally excessive, since the operations of such machines at isolated plants is infrequent, and hence the charge for service must be sufficiently high to cover the cost and overhead charges for operating machines of this special type at infrequent intervals.

The present invention is designed to meet these conditions by the production of a mechanism of relative low cost of manufacture, which will provide for efficient operation, and which is portable. Such apparatus can be carried among the tools of a garage without materially increasing overhead charges, so that such re-surfacing operation can be provided without shipping the cylinder blocks to the manufacturer, since the resurfacing can be provided at the point where the motor is taken down to remove such block, thus not only decreasing the cost of installation of the tool, but providing for a saving in time required to place the cylinder into service and decreasing the cost of the resurfacing operation.

To these and other ends, the nature of which will be readily understood as the invention is hereinafter disclosed, said invention consists in the improved construction and combination of parts, hereinafter fully described, illustrated in the accompanying drawings, and more particularly pointed out in the appended claims.

In the accompanying drawings, in which similar reference characters indicate similar parts in each of the views,—

Figure 1 is a central longitudinal sectional view of an apparatus or tool assembly constructed in accordance with one embodiment of the invention, the apparatus being shown in operative position relative to a cylinder of the cylinder block of a standard type of internal combustion motor, the view illustrating the arrangement of parts when the re-boring of the cylinder is taking place;

Fig. 2 is a similar view showing the position of parts and the general arrangement when a burnishing action in employed;

Fig. 3 is a sectional view taken on the line 3—3 of Fig. 2.

Fig. 4 is a detailed sectional view taken on the line 4—4 of Fig. 1;

Fig. 5 is a detail sectional view.

Fig. 6 is a detail sectional view taken through the burnishing tool or member; and

Fig. 7 is a fragmentary view in elevation of the burnishing tool.

The apparatus is of a type adapted to operate upon one cylinder at a time and is of such construction as to permit of its being temporarily secured in position relative to the cylinder to be surfaced, the arrangement being such that the work-performing element—the cutting tool or the burnishing tool—is rotated within the cylinder, the rotation operating to provide the desired speed of the tool in the direction of length of the cylinder during such rotation. Since it is an absolute requirement that an apparatus of this kind provides for accuracy, the apparatus is of such type as to permit it to be accurately positioned relative to the cylinder so as to cause the tool to produce the proper surface.

The apparatus is composed generally of two elements or parts A and B, these elements being structurally independent but cooperating in locating the apparatus in proper position relative to the cylinder, element A being adapted to be secured in position relative to one end of the cylinder or cylinder block, element B being secured at the opposite end of the cylinder or block, the two elements cooperating within the cylinder or block in producing the general assembly.

For purposes of illustration, we have shown the apparatus as positioned within a cylinder —*c*— of a cylinder block C, the latter being a unit of a well known type of motor in which a portion of the crank case is formed integral with the block, this portion being indicated at —*c'*—. In the particular embodiment shown in the drawings, element B has a configuration such as will permit it to be secured to the flanged portions of the crank case section of the block, as for instance, by being bolted thereto with the bolts occupying the usual bolt openings of the flange normally used for securing the block in its proper position in the motor structure. The general arrangement of element B is such that when secured in position, a pin or stud —*b*—, projecting inwardly into the crank case section, will be axially alined with the axis of the cylinder bore, said pin or stud forming a steadying member for element A when the latter is in position.

Element A comprises an assembly of parts supported at the opposite end of the cylinder bore, and is adapted to be bolted to the cylinder casing after the assembly has been properly positioned as presently pointed out, the element carrying suitable openings or recesses through which the bolts extend.

In the particular embodiment of the invention disclosed in the present application element A embodies a tubular member 10 operative to carry the tool in a generally circular path during the work-performing operation and a feed screw 11 rotatably mounted to feed the boring tool while the latter is providing its cutting operation, the element carrying means for properly locating these parts and providing their operation.

As shown in Figs. 1 and 2, the tool carrying member 10 has a length greater than the length of the bore of the cylinder, the projecting lower end having an opening 10^a which is adapted to receive the pin or stud —*b*— of element B, member 10 extending into the crank case section a distance sufficient to provide this result. The opposite end of member 10 is shown as being enlarged diametrically, thus providing an external surface extending in two different planes, these being joined by an annularly extending flange portion which is adapted to produce a shoulder face 10^b, seated on a seating face 12^a of a supporting frame member 12, the latter in turn having a face which seats on the end of the cylinder block—the open end of the cylinder being operated upon.

As shown more particularly in Figs. 1 and 2, the member 10 is provided with a longitudinal slot 10^c, this slot extending throughout the major portion of the length of the smaller diameter portion of member 10, said slot communicating with the interior of the member for a distance which extends beyond the opposite end of the cylinder bore, the inner end of the slot being adjacent the plane of shoulder 10^b—Figs. 1 and 2—the outer end of the slot being closed to the interior of the member, but continued to the latter in the form of a keyway 10^d for a purpose presently described.

As shown in Figs. 1 and 2, seating face 12^a is spaced a considerable distance from the plane of the end of the cylinder block, the intermediate portion of the support 12 having a cylindrical bore of greater diameter than the smaller-diameter portion of member 10, and having at least a major portion of this bore of greater diameter than the bore of the cylinder, for reasons presently pointed out, this portion of the support being preferably provided with diametrically located openings 10^e—Fig. 4—these openings being adapted to receive the centering or locating members 13, shown more particularly in Figs. 4 and 5, each consisting of a segmental portion 13^a and a handle 13^b, the segmental portions 13^a being of a thickness corresponding to the thickness between the inner face of the cylinder and the outer face of the member 10, and serving to locate the member 10 with its axis in correspondence with the axis of cylinder bore.

Centering of member 10 by members 13 is

made possible by the fact that the travel of the piston within the cylinder bore of a cylinder does not carry the piston to the outer end of the bore, the result being that there is a portion of the cylinder bore at the outer end of the bore maintained unaffected by wear of the piston, so that at this end of the bore the cylinder retains the characteristics of the original bore. Since it is the practice of manufacturers to provide bores of similar diameter, it will be readily understood that this particular portion of the cylinder bore remains on the general standard of diameter regardless of wear of other parts of the bore, so that it is possible to provide a corresponding standard diameter to that portion of the bore of support 12 which is located between the seating face of the support and openings 12b, thus producing an internal bore of support 12 which can be accurately alined with the adjacent portion of the cylinder bore. If, then, a part 13a be introduced through one of the openings 12b and dropped between the alined bore surface and the outer surface of member 10, with the member extending beyond the plane of the seating face of support 12—see Fig. 4—support 12 will be held in its alined position with member 10 extending in axial alinement with the axis of the bore and be maintained in such position during the time required for securing element A to the block by the bolts after which the locating members are removed; pin or stud —b— serves to prevent springing or otherwise shifting the opposite outer end of member 10 during the cutting operation.

The upper enlarged portion of member 10 is provided with an internal gear 14, the particular embodiment disclosed in the drawings showing this gear located substantially at the inner end of the enlarged bore of the member, the gear being formed integral with or as a separate structure secured to the member in suitable manner.

Member 10 is held against endwise movement by means of cap 15 removably seated on the upper face of support 12, being secured in position by any suitable means such as bolts. Said cap member serves as a supporting structure for a number of operating parts which will now be described.

16 indicates a pinion mounted on a stub shaft 17 carried by the cap member, pinion 16 being in mesh with gear 14. Pinion 16 is also normally in mesh with the teeth of a sleeve 18 mounted in the cap member and through which the feed member 11 extends, sleeve 18 serving as a support for the inner end of the feed member 11, the outer or opposite end of said member 11 being supported in a block 11a located at the outer end of the bore of member 10, block 11a having a portion extending into opening 10a of member 10, the walls of said opening thus acting to definitely locate this end of the feed member axially alined with the axis of member 10. The opposite end of the feed member is held on such axis through its location in sleeve 18, said sleeve being also arranged to be axially alined with the axis of member 10.

19 designates a member secured to and rotatable with the feed member 11, member 19 having a portion fitting within the bore of member 10, and also having a flange extending laterally (in the direction of the axis of the member), said flange, indicated at 19a, being located between the plane of pinion 16 and the inner face of member 19 as shown in Figs. 1 and 2. Flange 19a also carries a gear face as indicated at 19b, said gear face being in mesh with a pinion 20 carried by a stub shaft 21 supported in the cap member 15. Pinion 20 is also adapted to mesh with the teeth of sleeve 18, the general arrangement being such that pinions 16 and 20 are located on different planes extending transversely of feed member 11, and therefore have their meshing planes with the teeth of sleeve 18 on different portions of the teeth, the sleeve teeth length being sufficient to operate in connection with both pinions.

As will be understood, stub shafts 17 and 21 are located at any desired points within the cap member out of alinement with each other, the drawings showing the locations to be substantially on one of the diameters of member 10, the shafts being located on opposite sides of the feed member 11.

22 indicates the boring tool assembly, this being of any suitable type, the drawings showing a member threaded on feed member 11 and having its outer face substantially fitting the bore of member 10, the particular structure indicating the use of a Babbitt metal face contacting with the thread of the feed member. This portion of the assembly indicated at 22a is adapted to detachably receive a cutting tool 22b of proper configuration and which extends through the slot of member 10, the walls of said slot serving to guide the cutting member 22b and prevent relative rotational movement between member 22a and member 10.

By reason of this latter construction it will be readily understood that if member 10 be rotated, the cutting assembly 22 will be carried around with the member, and if the assembly 22 be shifted longitudinally of member 10 through the action of the feed member 11, the rotation of member 10 will cause the cutting tool 22b to provide a cutting action on the bore face of the cylinder, the cutting tool having a circular path of movement which varies from a single transverse plane of the feed member 11 equal to the amount of advance which said feed member is designed to provide. Obviously,

any attempt to produce the small advance ratio to assembly 22 required in attempting to produce a boring cut to the cylinder by simply carrying the assembly about the thread of a stationary member, would be commercially useless, lacking the power to force the cutting tool to advance if the thread pitch be of a type to provide for this small advance.

To provide for proper feed action, and at the same time produce the desired resistance of the tool during the strain of cutting, members 10 and 11 are both rotated in the same direction but at different speeds, this differential movement between members 10 and 11 being provided by the pinions 16 and 20. This differential may be provided in any suitable manner, the drawings obtaining the desired result through the different diameters of the gear face of member 10 and the gear face of member 19. In the particular structure shown the ratios are such that during one revolution of member 10, member 11 gains one-twelfth of a revolution, so that as member 10 makes twelve revolutions, assembly 22 will be advanced a distance corresponding to the pitch of one thread of the feed member 11 in the direction of the axis of member 10. Obviously, the differential of gears may be varied to meet the general requirements, that pointed out being one which permits the cutting operations to be performed within the limits of safety and efficiency.

The drive is provided by a suitable mechanism operatively connected with sleeve 18. The structure shown in the drawings is adapted for use in connection with hand labor, and for this reason the operating device is shown as in the form of a handle 23, removably secured to the upper end of sleeve 18. Rotation of the handle causes the sleeve to drive the pinions and the gear faces of members 10 and 11, thus causing these members to rotate in the same direction but at different speeds. Obviously, the power may be applied otherwise by suitable gearing on the sleeve or the drive may be from a power device, the particular form of drive for sleeve 19 being such as may be found desirable or preferable.

As will be understood, if the cutting assembly be located to bring the cutting point of its tool at the proper point at the upper end of the cylinder, Fig. 1, and the handle be rotated, the gradual advance will carry the assembly to the bottom or outer end of the member 10 and through the inner end of the cylinder bore, thus providing an enlargement on the bore to the dimensions provided by the cutting tool itself. Obviously, this places the cutting tool at the opposite end of the cylinder bore from that at which support 12 is located, and it is therefore essential, in order that element A may be readily removed, that the cutting assembly be returned to the opposite end of the element. In order to permit this to be done in a rapid manner and without materially affecting the face which was produced during the boring operation, provision is made for returning the cutting assembly rapidly and in a straight line through the bore, this result being obtained by retaining member 10 against movement and increasing the speed of rotation of member 11. To provide this action sleeve 11 is moved axially a distance sufficient to cause its teeth to be disengaged from the teeth of pinions 16 and 20, this movement bringing a notch 18^a at the outer end of the sleeve into engagement with a pin 11^b carried by member 11. When this latter engagement is had, it will be readily understood that feed member 11 is operatively connected direct to the handle, so that rotation of the latter will cause the feed member 11 to rotate at equal speed therewith without activity of either pinion 16 or 20, member 10 thus remaining stationary, member 11 being connected direct to sleeve 18 instead of indirect through member 19 and pinion 20.

As will be understood, this change in operation thus described, practically requires the shifting of sleeve 18 between two positions. As it is desirable that assurance will be had that the sleeve will be properly operative in either of said positions, we prefer to provide the bore of the sleeve with annular grooves 18^b and 18^c, and provide a yieldable element, shown as in the form of a ball 24, within the feed member 11. The positions of grooves 18^b and 18^c are such that when the ball engages groove 18^b, sleeve 18 will be in position to provide a differential feed movement to the tool to advance the latter in the cutting path; when the sleeve is shifted to provide engagement of the ball with groove 18^c, disengagement of the sleeve teeth and the teeth of pinions 16 and 20 will take place and the direct drive of the feed member will be provided. As will be understood the particular retaining structure by which the sleeve may be positioned in either of a plurality of positions, is more or less illustrative; the particular arrangement shown permits the shifting of the sleeve to be had without affecting the handle, the shift being obtained by simply moving the handle outwardly, thus carrying the sleeve with it.

The normal inoperative position of the assembly 22 is with the cutting tool located within that portion of the bore of support 12 which is of larger diameter, thus locating the tool above the plane of the cylinder block and therefore out of position within the bore, the position shown in Fig. 2.

Shuld it be desired that the operation include only this boring of the cylinder, the

apparatus can be readily removed by simply removing element B from the crank case portion of the cylinder block and element A from the opposite end of the cylinder bore. However, it is preferable in producing a proper re-surfacing action that the bored surface be subjected to a burnishing action, and this is provided by the use of an attachment shown more particularly in Figs. 6 and 7 and shown in position in Figs. 2 and 3.

This attachment is shown as in the form of an annular member 25 having an internal diameter adapted to fit over the outer face of member 10, said member 25 having an inwardly extending key 25^a which is adapted to travel in slot 10^c of member 10, the key being of a size to prevent relative rotation of member 25 and member 10 yet be capable of passing through the keyway 10^b of member 10.

The outer periphery of member 25 is provided with a plurality of rolls 26, mounted in suitable bearings formed in member 25, said rolls having their axes extending in a direction inclined to the axis of the member, as shown more particularly in Fig. 7, each roll having its axis inclined at the same angle as the other rolls.

When it is desired to use the burnishing attachment, element B is removed from its position, and the attachment 25 located over the outer or lower end of member 10, key 25^a passing through keyway 10^b into slot 10^c, the movement of the attachment being continued until it is entered into the bore of the cylinder, whereupon element B is returned to its position.

Burnishing action is had by rotating member 10, rotation of this member not only causing the rolls 26 to act to burnish the interior of the bore, but the inclination of the roll axis acts to provide a feed movement of the attachment in a direction upward in Fig. 2, carrying the attachment toward the opposite end of the bore, the several movements combining to burnish the interior of the cylinder and practically eliminate any markings that might have been provided by the cutting action or during the return of the tool.

During this burnishing action it is preferable that the cutting tool remain in its normal inactive position, and to provide this result, the feed member 11 is temporarily disconnected from sleeve 18 by positioning the latter at such point as will permit engagement of the teeth of the sleeve with the teeth of pinion 16 but will prevent engagement of sleeve 18 with pinion 20, this result being brought about through the location of pinions 16 and 20 on different planes heretofore described. The sleeve is maintained in this position during rotation by the engagement of ball 24 with an additional groove 18^c of the sleeve, this groove being located between grooves 18^a and 18^b. With the sleeve in this position member 11 is free from direct connection with the sleeve, and member 19 is free from drive engagement with the teeth of sleeve 18, so that member 11 and member 19 are free to rotate with member 10 as the latter carries the cutting assembly around it, the latter simply carrying the tool around within the space surrounding the member 10 within the support 12, members 10 and 11 thus traveling in unison and not at differential speeds during this period.

Obviously the apparatus may be removed after completion of the travel of attachment 25^a in this manner, or if desired, the direction of rotation of member 10 may be reversed and the attachment caused to retrace its movement through the bore and thus subject the surface of the bore to a second burnishing action.

From the above it will be seen that we have provided an apparatus of simple form and comparatively light weight capable of successfully and efficiently re-surfacing the bores of cylinders with accuracy and in such manner as not to require the use of special and expensive machinery; the various parts are not only rugged and substantial, but the general arrangement is such as to resist pressures which might tend to affect the accuracy of cutting and damage the interior of the cylinder. Obviously, the structure is of a portable character and is such as can be carried as a part of the apparatus of the usual general garage so that there is no necessity for transporting cylinder blocks with a view to re-boring operations, thus providing a material saving in time to the user through the ability to produce the re-surfacing action at the point where the block is removed from the motor assembly.

While we have herein shown and described a preferred embodiment of the invention, it will be understood that changes or modifications therein may be required or found desirable in meeting the various exigiencies of use and of the different characteristics of individual types of cylinder blocks; we therefore desire to be understood as reserving the right to make any and all such changes or modifications therein as may be found necessary or essential, in so far as the same may fall within the scope of the invention as expressed in the accompanying claims when broadly construed.

What we claim is:—

1. In portable apparatus for re-surfacing cylinders, a cutting tool, and means for supporting such tool relative to the cylinder bore to provide tool movement in the direction of length of the bore with the movement selectively through a cutting helical path or a path differing from such helical path in the rate of advance through the

bore under similar speed conditions of power application, said means including a rotatable tubular element extending axially of the bore and operative to drive and guide the tool, means for advancing the tool relative to the element during tool movement in either path, and means positionable at opposite ends of the cylinder bore for supporting said tubular element with its axis alined with the bore axis, said advancing means including an actuating means forming the power source for said elements during tool movement in either of such paths.

2. In portable apparatus for re-surfacing cylinders, a cutting tool, and means for supporting such tool relative to the cylinder bore to provide tool movement in the direction of length of the bore with the movement selectively through a cutting helical path or a path differing from such helical path in the rate of advance through the bore under similar speed conditions of power application, said means including a rotatable tubular element extending axially of the bore and operative to drive and guide the tool, means for advancing the tool relative to the element during tool movement in either path, and means positionable at opposite ends of the cylinder bore for supporting said tubular element with its axis alined with the bore axis, said advancing means including a rotatable threaded element operative to advance the tool during tool movement in either of such paths, said advancing means including an actuating means forming the power source for said elements during tool movement in either of such paths.

3. In portable apparatus for re-surfacing cylinders, a cutting tool, and means for supporting such tool relative to the cylinder bore to provide tool movement in the direction of length of the bore with the movement selectively through a cutting helical path or a path differing from such helical path in the rate of advance through the bore under similar speed conditions of power application, said means including a rotatable tubular element extending axially of the bore and operative to drive and guide the tool, means for advancing the tool relative to the element during tool movement in either path, and means positionable at opposite ends of the cylinder bore for supporting said tubular element with its axis alined with the bore axis, said advancing means including a threaded element rotatable in synchronism with the tubular element to produce an advancing movement of the tool an axial distance less than the thread pitch, said advancing means also including an actuating means forming the power source for said elements during tool movement in either of such paths.

4. In portable apparatus for re-surfacing cylinders, a cutting tool, and means for supporting such tool relative to the cylinder bore to provide tool movement in the direction of length of the bore with the movement selectively through a cutting helical path or a path differing from such helical path in the rate of advance through the bore under similar speed conditions of power application, said means including a rotatable tubular element extending axially of the bore and operative to drive and guide the tool, means for advancing the tool relative to the element during tool movement in either path, and means positionable at opposite ends of the cylinder bore for supporting said tubular element with its axis alined with the bore axis, said advancing means including a threaded element rotatable in differential synchronism with the tubular element to produce an advancing movement of the tool an axial distance less than the thread pitch, said advancing means also including an actuating means forming the power source for said elements during tool movement in either of such paths.

5. Apparatus as in claim 4, characterized in that the rotative movements of the tubular and threaded elements are concurrent when the tool is moving in one of such paths and relatively timed to require a plurality of rotations of the tubular element to advance the tool an axial distance equal to the pitch of a thread of the threaded element.

6. Apparatus as in claim 2 characterized in that both tubular and threaded elements have lengths greater than the lengths of the bore of the cylinder.

7. Apparatus as in claim 2, characterized in that the tubular and threaded elements ex-driven by a drive member operatively contend on a common axis and are concurrently nected to both elements to produce synchronous movements therebetween at differential speed when the tool is moving in one of such paths.

8. In portable apparatus for resurfacing cylinders, a cutting tool, and means for supporting such tool relative to the cylinder bore to provide tool movement in the direction of length of the bore with the movement selectively through a cutting helical path or a path differing from such helical path in the rate of advance through the bore under similar speed conditions of power application, said means including a rotatable tubular element extending axially of the bore and operative to drive and to guide the tool, means for advancing the tool relative to the element during tool movement in either path, and means positionable at opposite ends of the cylinder bore for supporting said tubular element with its axis alined with the bore axis, said tubular element and said advancing means being operatively connected in such manner that the advancing means may move concurrently with or independent of the tubular element at will, with the concurrent action

operative to produce tool movement in one path and the independent action operative to produce tool movement in such path.

9. In portable apparatus for re-surfacing cylinders, a cutting tool, and means for supporting such tool relative to the cylinder bore to provide tool movement in the direction of length of the bore with the movement selectively through a cutting helical path or a path differing from such helical path in the rate of advance through the bore under similar speed conditions of power application, said means including a rotatable tubular element extending axially of the bore end operative to drive and guide the tool, means for advancing the tool relative to the element during tool movement in either path, and means positionable at opposite ends of the cylinder bore for supporting said tubular element with its axis alined with the bore axis, said tubular element having an opening at one end, said supporting means including an element detachably secured to the cylinder casing and having a pin projecting into said opening to form a support to retain the tubular element in axial alinement.

10. In portable apparatus for resurfacing cylinders, a cutting tool, and means for supporting such tool relative to the cylinder bore to provide tool movement in the direction of length of the bore with the movement selectively through a cutting helical path or a path differing from such helical path in the rate of advance through the bore under similar speed conditions of power application, said means including a rotatable tubular element extending axially of the bore and operative to drive and to guide the tool, means for advancing the tool relative to the element during tool movement in either path, and means positionable at opposite ends of the cylinder bore for supporting said tubular element with its axis alined with the bore axis, said tubular element and said advancing means being operatively connected to permit concurent movement of the element and advancing means or independent movement of the advancing means at will, independent movement of the advancing means being operative to move the tool in one of such paths, concurrent movement of the element and advancing means at differential speeds being operative to move the tool in the other of such paths, concurrent movement of element and advancing means at equal speeds being operative to move the tool in a circular path free from advance in the direction of length of the element.

11. In portable apparatus for re-surfacing cylinders, a cutting tool, and means for supporting such tool relative to the cylinder bore to provide tool movement in the direction of length of the bore with the movement selectively through a cutting helical path or a path differing from such helical path in the rate of advance through the bore under similar speed conditions of power application, said means including a rotatable tubular element extending axially of the bore and operative to drive and guide the tool, means for advancing the tool relative to the element during tool movement in either path, and means positionable at opposite ends of the cylinder bore for supporting said tubular element with its axis alined with the bore axis, said advancing means including a rotatable threaded element operative to advance the tool a distance less than the axial length of a thread during a complete revolution of such threaded element, said tubular element having an opening at one end, said supporting means including an element detachably secured to the cylinder casing and having a pin projecting in said opening to form a support to retain the tubular element in its axial alinement.

12. In portable apparatus for resurfacing cylinders, a cutting tool, and means for supporting such tool relative to the cylinder bore to provide tool movement in the direction of length of the bore with the movement selectively through a cutting helical path or a path differing from such helical path in the rate of advance through the bore under similar speed conditions of power application, said means including a rotatable tubular element extending axially of the bore and operative to drive and guide the tool, means for advancing the tool relative to the element during tool movement in either path, and means positionable at opposite ends of the cylinder bore for supporting said tubular element with its axis alined with the bore axis, said advancing means including a rotatable threaded element operative to advance the tool a distance less than the axial length of a thread during a complete revolution of such threaded element, said tubular element having an opening at one end of less diameter than the internal diameter of the element to produce an internal shoulder, and a member supported on said shoulder and positioned by said opening for supporting one end of the threaded element.

13. In portable apparatus for re-surfacing cylinders, a cutting tool, and means for supporting such tool relative to the cylinder bore to provide tool movement through a circular path and advancement in the direction of the axis of such path, said means including a rotatable tubular element extending axially of the bore and operative to drive and guide the tool, means for advancing the tool during element rotation, and means positionable at opposite ends of the cylinder bore for supporting said tubular element with its axis alined with the bore axis, said tubular element being slotted longitudinally, said

cutting tool having a body portion within the bore of the tubular element and having its cutting portion positioned external of the element, said cutting and body portions being joined by connecting portions extending through and substantially fitting the width of the element slot.

14. In portable apparatus for re-surfacing cylinders, a cutting tool, and means for supporting such tool relative to the cylinder bore to provide tool movement through a circular path and advancement in the direction of the axis of such path, said means including a rotatable tubular element extending axially of the bore and operative to drive and guide the tool, means for advancing the tool during element rotation, and means positionable at opposite ends of the cylinder bore for supporting said tubular element with its axis alined with the bore axis, said advancing means including a rotatable threaded element extending axially of said tubular element, said tubular element being slotted longitudinally, said cutting tool having a body portion within the tubular element with the cutting portion connected thereto through said slot to locate the cutting portion external of the tubular element, said body portion having a threaded connection with the threaded element.

15. Apparatus as in claim 14 characterized in that the rotatable movements of the tubular and threaded elements are in differential synchronism.

16. Apparatus as in claim 14 characterized by a rotatable drive member, and independent drive connections between said drive member and the tubular and threaded elements.

17. Apparatus as in claim 14 characterized by a rotatable drive member, and independent drive connections between said drive member and the tubular and threaded elements to cause rotation of said elements in the same angular direction and at different angular speeds to produce a differential synchronous movement therebetween.

18. In portable apparatus for re-surfacing cylinders, a cutting tool, and means for supporting such tool relative to the cylinder bore to provide tool movement in the direction of length of the bore with the movement selectively through a cutting helical path or a path differing from such helical path in the rate of advance through the bore under similar speed conditions of power application, said means including a rotatable tubular element extending axially of the bore and operative to drive and guide the tool, said element being rotatable at will, means for advancing the tool relative to the element during tool movement in either path, said advancing means including a threaded element rotative in the same angular direction and concurrently with the tubular element during tool movement of one of such paths, and means for rotating said elements at different speeds of rotation when the tool is traveling in such path.

19. In portable apparatus for re-surfacing cylinders, a cutting tool, and means for supporting such tool relative to the cylinder bore to provide tool movement through a circular path and advancement in the direction of the axis of such path, said means including a rotatable tubular element extending axially of the bore and operative to drive and guide the tool, means for advancing the tool during element rotation, said advancing means including a threaded element rotative in the same angular direction and concurrently with the tubular element, and means for rotating said elements at different speeds of rotation, said latter means including a drive member axially alined with said element, and independent operative connections between said drive member and said element.

20. Apparatus as in claim 19 characterized in that the connections between the drive member and the threaded element includes a member movable in unison with the threaded element and having an internal gear, and a pinion operatively connecting said gear with the drive member.

21. In portable apparatus for re-surfacing cylinders, a cutting tool, and means for supporting such tool relative to the cylinder bore to provide tool movement through a circular path and advancement in the direction of the axis of such path, said means including a rotatable tubular element extending axially of the bore and operative to drive and guide the tool, means for advancing the tool during element rotation, said advancing means including a rotatable threaded element, said elements each carrying an internal gear face, and a drive member operative concurrently on said gear faces for providing element rotational movements.

22. In portable apparatus for re-surfacing cylinders, a cutting tool, and means for supporting such tool relative to the cylinder bore to provide tool movement through a circular path and advancement in the direction of the axis of such path, said means including a rotatable tubular element extending axially of the bore and operative to drive and guide the tool, means for advancing the tool during element rotation, said advancing means including a rotatable threaded element, said elements each carrying an internal gear face with the respective gear faces axially alined, and extending on different planes transverse of the gear face

axis, and a drive member operatively connected to the respective faces to drive the latter concurrently.

23. In portable apparatus for re-surfacing cylinders, a cutting tool, and means for supporting such tool relative to the cylinder bore to provide tool movement through a circular path and advancement in the direction of the axis of such path, said means including a rotatable tubular element extending axially of the bore and operative to drive and guide the tool, means for advancing the tool during element rotation, said advancing means including a rotatable threaded element, said elements each carrying an internal gear face with the respective gear faces axially alined and extending on different planes transverse of the gear face axis, and a drive member operatively connected to the respective faces to drive the latter concurrently, and in the same angular direction.

24. Apparatus as in claim 23 characterized in that the gear formation of the drive member is of equal diameter on the respective planes of the gear faces, and the mean diameters of the respective gear faces differ from each other to cause rotational movement of the tubular and threaded elements at different but synchronous speeds.

25. In portable apparatus for re-surfacing cylinders, and wherein a cutting tool is moved in a circular cutting path having an axis coincident with the axis of the cylinder bore and concurrently advanced in the direction of such axis during the cutting operation, means including a tubular and a threaded element for supporting the cutting tool during such tool movements, and means for independently rotating said elements, said rotating means being operative to provide tool movements either in such cutting path or in a path parallel to the axis of such cutting path at will, said rotatable means including an actuating means forming the power source for said elements during tool movement in either of such paths.

26. In portable apparatus for re-surfacing cylinders, and wherein a cutting tool is moved in a circular cutting path having an axis coincident with the axis of the cylinder bore and concurrently advanced in the direction of such axis during the cutting operation, means including a tubular and a threaded element for supporting the cutting tool during such tool movements, and means for independently rotating said elements, said rotating means being operative to provide tool movements either in such cutting path or in a path parallel to the axis of such cutting path at will, said rotating means including a drive member forming the power source for said elements during movement of the tool in either of such paths, the speed of advancing movement of the cutting tool in one of said paths differing from that when advanced in the other path in the presence of uniform speed of the drive member.

27. In portable apparatus for re-surfacing cylinders, and wherein a cutting tool is moved in a circular cutting path having an axis coincident with the axis of the cylinder bore and concurrently advanced in the direction of such axis during the cutting operation, means including a tubular and a threaded element for supporting the cutting tool during such tool movements, and means for independently rotating said elements, said rotating means including a drive member adapted to be operatively connected to and drive both elements at will, concurrent connection with both elements advancing the tool in such cutting path, said member being shiftable to limit operative connection to a connection with the threaded element, said latter connection being operative to move the tool in a path parallel to the axis of said cutting path.

28. In portable apparatus for re-surfacing cylinders, and wherein a cutting tool is moved in a circular cutting path having an axis coincident with the axis of the cylinder bore and concurrently advanced in the direction of such axis during the cutting operation, means including a tubular and a threaded element for supporting the cutting tool during such tool movements, and means for independently rotating said elements, said rotating means including a drive member adapted to be operatively connected to and drive both elements at will, concurrent connection with both elements advancing the tool in such cutting path, said member and said tubular element being relatively movable to limit such operative connections to a connection with the threaded element, said latter connection being operative to move the tool in a path parallel to the axis of such cutting path.

29. In portable apparatus for re-surfacing cylinders and wherein a cutting tool is moved in a circular cutting path having an axis coincident with the axis of the cylinder bore and concurrently advanced in the direction of such axis during the cutting operation, means including a tubular and a threaded element for supporting the cutting tool during such tool movements, said elements being held against longitudinal movement during tool movements, and means for independently rotating said elements, said means including a drive member adapted to be operatively connected to and drive both elements at will, and shiftable to provide sole connection with the threaded element.

30. In portable apparatus for re-surfacing cylinders and wherein a cutting tool is

moved in a circular cutting path having an axis coincident with the axis of the cylinder bore and concurrently advanced in the direction of such axis during the cutting operation, means including a tubular and a threaded element for supporting the cutting tool during such tool movements, said elements being held against longitudinal movement during tool movements, and means for independently rotating said elements, said means including a shiftable drive member adapted to be operatively connected to the threaded element in either of two position of shift of the member, said connections being relatively arranged to produce different speeds of advance of the tool when the member is shifted from one position to the other.

31. In portable apparatus for re-surfacing cylinders and wherein a cutting tool is moved in a circular cutting path having an axis coincident with the axis of the cylinder bore and concurrently advanced in the direction of such axis during the cutting operation, means including a tubular and a threaded element for supporting the cutting tool during such tool movements, said elements being held against longitudinal movement during tool movements, and means for independently rotating said elements, said means including a drive member adapted to be operatively connected to and drive both elements at will, and shiftable to provide sole connections with the threaded element, said member being operative to drive both elements concurrently when in one of said positions.

32. In portable apparatus for re-surfacing cylinders and wherein a cutting tool is moved in a circular cutting path having an axis coincident with the axis of the cylinder bore and concurrently advanced in the direction of such axis during the cutting operation, means including a tubular and a threaded element for supporting the cutting tool during such tool movements, said elements being held against longitudinal movement during tool movements, and means for independently rotating said elements, said means including a drive member adapted to be operatively connected to and drive both elements at will, and shiftable to provide sole connections with the threaded element, said member being operative to drive both elements concurrently when in one of said positions, and inactive with respect to the tubular element when in its other position.

33. In portable apparatus for re-surfacing cylinders, and wherein a cutting tool is moved in a circular cutting path having an axis coincident with the axis of the cylinder bore and concurrently advanced in the direction of such axis during the cutting operation, means including a tubular and a threaded element for supporting the cutting tool during such tool movements, said elements each carrying an internal gear face held against axial movement during tool movements, and means for independently rotating said elements, said means including an axially shiftable drive member, independent pinions positioned to operatively engage the respective gear faces with the drive member when the latter is in one position to concurrently drive said elements, shifting of said member being operative to render one or both of said gear faces inactive at will.

34. In portable apparatus for re-surfacing cylinders and wherein a cutting tool is moved in a circular cutting path having an axis coincident with the axis of the cylinder bore and concurrently advanced in the direction of such axis during the cutting operation, means including a tubular and a threaded element for supporting the cutting tool during such tool movements, said elements carrying internal gear faces held against axial movement during tool movement, and means for independently rotating said elements, said means including an axially shiftable drive member, independent pinions positioned to operatively engage the respective gear faces, with the drive member when the latter is in one position, said gear faces, and pinions being in permanent mesh, each gear face and its pinion extending on a plane intersecting the member axis, the respective planes being spaced apart a distance to permit sole activity of the member with one of said elements.

35. In portable apparatus for re-surfacing cylinders, and wherein a cutting tool is moved in a circular cutting path having an axis coincident with the axis of the cylinder bore and concurrently advanced in the direction of such axis during the cutting operation, means including a tubular and a threaded element for supporting the cutting tool during such tool movements, and means for independently rotating said elements, said rotating means including an axially shiftable drive member, and independent operative connections between said member and the threaded element and operative respectively to provide activity of said elements when the member is at either extreme of its shifting movement.

36. In apparatus for re-surfacing cylinders and in combination, a cutting tool and its support, said support having means to permit positioning thereof in predetermined position relative to the cylinder to be resurfaced with the support extending axially of the cylinder bore, means carried by the support for providing cutting movements of the tool while the support is in position, said support and means being formed to permit location of the tool in an inactive position relative to the bore while the support is in position, and a burnishing instrumentality

positionable relative to the bore and to said means to provide burnishing action by means movement while the cutting tool is located in its position of inactivity, said support having a formation to permit positioning of the instrumentality while the support is maintained in the position occupied during cutting tool activity.

37. Apparatus as in claim 36, characterized in that the support includes two elements positionable relative to the bore from opposite ends of the cylinder structure, said elements having complemental configurations adapted to retain both elements in definite relation beyond the cutting zone when one of the elements is secured to the cylinder structure.

38. Apparatus as in claim 36 characterized in that the support includes two elements positionable relative to the bore from opposite ends of the cylinder structure, one of said elements extending through the cylinder bore with the other element positioned to concurrently engage the free end of the first element and an external wall of the cylinder structure, said elements being operative to retain said free end in predetermined position.

39. In portable apparatus for re-surfacing cylinders and wherein a cutting tool and a burnishing tool are made active successively upon a cylinder bore, means including a rotatable tubular element for supporting the cutting tool to provide movement of the cutting face in a circular path having its axis coincident with the cylinder bore, means for feeding the tool in the direction of length of said element, said element having a configuration to permit location of a burnishing tool in contact with the bore face and rotate it by rotating movements of the element.

40. In portable apparatus for re-surfacing cylinders and wherein a cutting tool and a burnishing tool are made active successively upon a cylinder bore, means including a rotatable tubular element for supporting the cutting tool to provide movement of the cutting face in a circular path having its axis coincident with the cylinder bore, means for feeding the tool in the direction of length of said element, said element having a configuration to permit location of a burnishing tool in contact with the bore face and rotate it by rotating movements of the elements, and during inactivity of the cutting tool feeding means.

41. In a portable apparatus for re-surfacing cylinders, a tubular element, means positionable at the opposite ends of a cylinder bore for supporting the opposite ends of said element, said means having a configuration to produce a space external of the element at points external of the bore when the apparatus is in position, a feeding element, axially alined with the tubular element, a cutting tool supported by said elements advancing to permit tool movements through the bore by action of the feeding element, a shiftable drive member, and means for operatively connecting the drive member to said elements, said member being positionable to cause said connecting means to produce the following cycle of operations: rotate both elements in the same angular direction and at differential speeds to cause advancement of the cutting tool in a circular cutting path through the cylinder bore, render the connections with the tubular element inactive to permit return movement of the tool cutting face to said space in a path parallel to the cylinder axis, and render the connections with the tubular member active and the connection with the feeding element inactive to permit concurrent rotating movement of both elements at the same speed.

42. Apparatus as in claim 41 characterized in that the tubular element is of a configuration to permit location of a burnishing tool thereon and in contact with the bore face and permit feeding movement of the latter longitudinally of the bore by element rotation while both tubular and feeding elements are rotating at the same speed.

43. In portable apparatus for re-surfacing cylinders, and wherein a cutting tool is advanced in a circular cutting path having its axis coincident with the cylinder bore axis, means for supporting the cutting tool during such advancing movement, said means including an element extending through the cylinder bore and rotatable during such tool advancing movement, and means for positioning said element with its axis coincident with the bore axis, said positioning means including a supporting frame adapted to contact with and be secured to a face of the cylinder casing, said frame having a bore external of the element with the frame bore wall provided with openings, and locating means insertible through said openings and movable into position between the element and the cylinder bore face to locate the element in proper axial relation and retain the frame against lateral displacement to disturb such relation during the frame securing period.

44. In portable apparatus for re-surfacing cylinders, and wherein a cutting tool is advanced in a circular cutting path having its axis coincident with the cylinder bore axis, means for supporting the cutting tool during such advancing movement, said means including an element extending through the cylinder bore and rotatable during such tool advancing movement, and means for positioning said element with its axis coincident with the bore axis, said positioning means including a supporting frame adapted

to contact with and be secured to a face of the cylinder casing, said frame having a bore external of the element with the frame bore wall provided with openings, and a pair of locating devices insertible through said openings and each having a portion movable into position between the element and the cylinder bore face to locate the element in proper axial relation and retain the frame against lateral displacement to disturb such relation during the frame securing period.

In testimony whereof we affix our signatures in presence of two witnesses.

OLAF A. ANDERSON.
JOHN M. MACRAE.

Witnesses:
ANNA M. DORR,
CHAS. W. STAUFFIGER.