July 14, 1931. C. B. COLE ET AL 1,814,078

MACHINE FOR BORING CYLINDERS

Filed Feb. 3, 1930 3 Sheets-Sheet 1

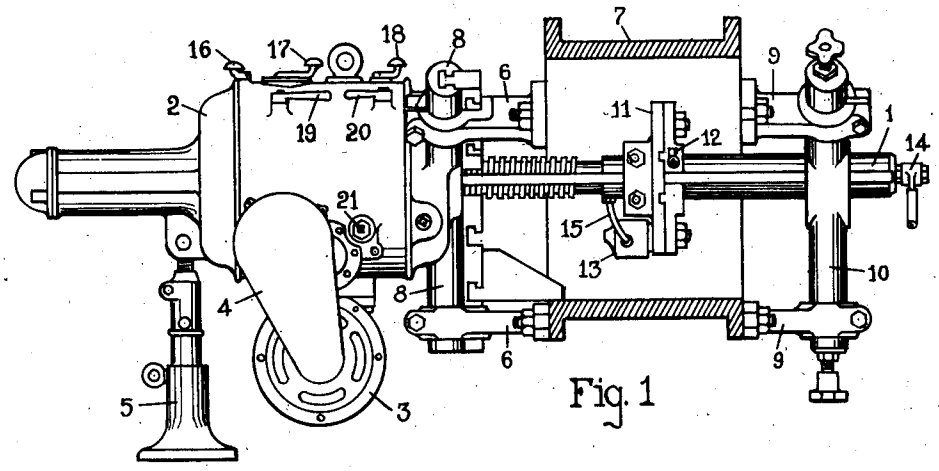


Fig. 1

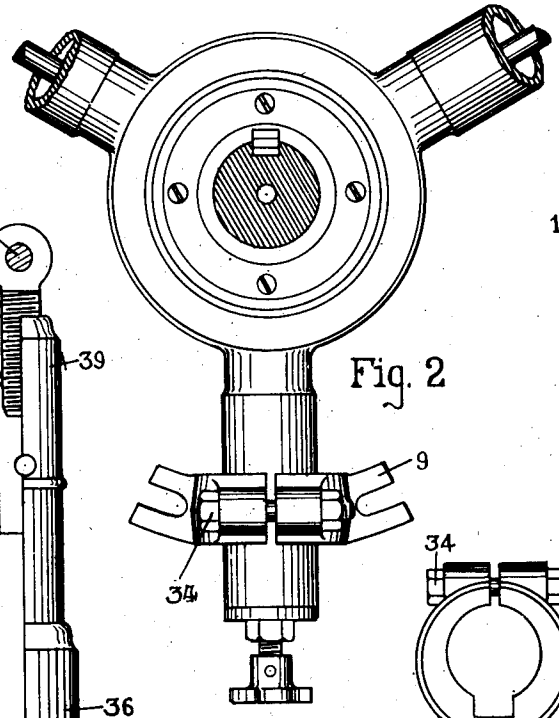


Fig. 2

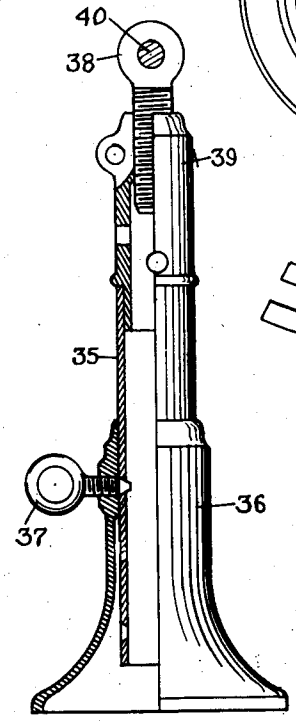


Fig. 5

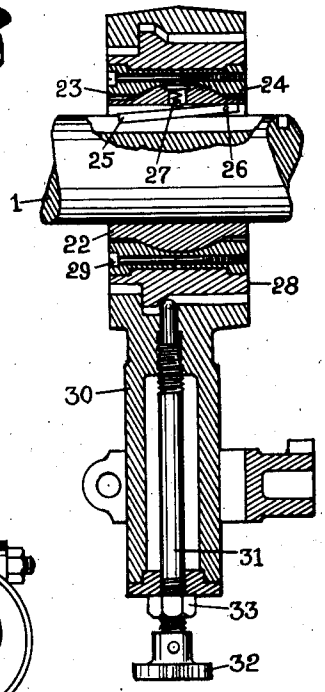


Fig. 3

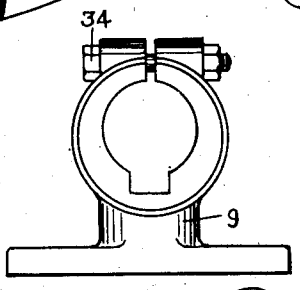


Fig. 4

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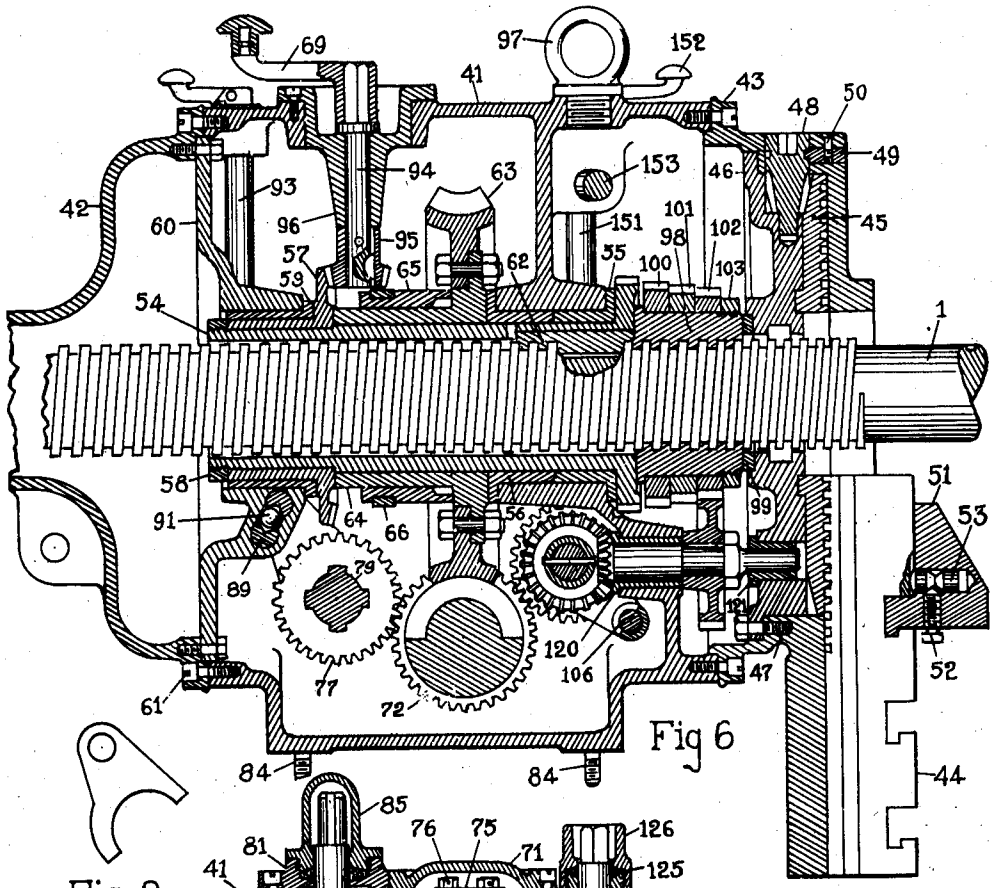


Fig 6

Fig. 9

Fig. 8

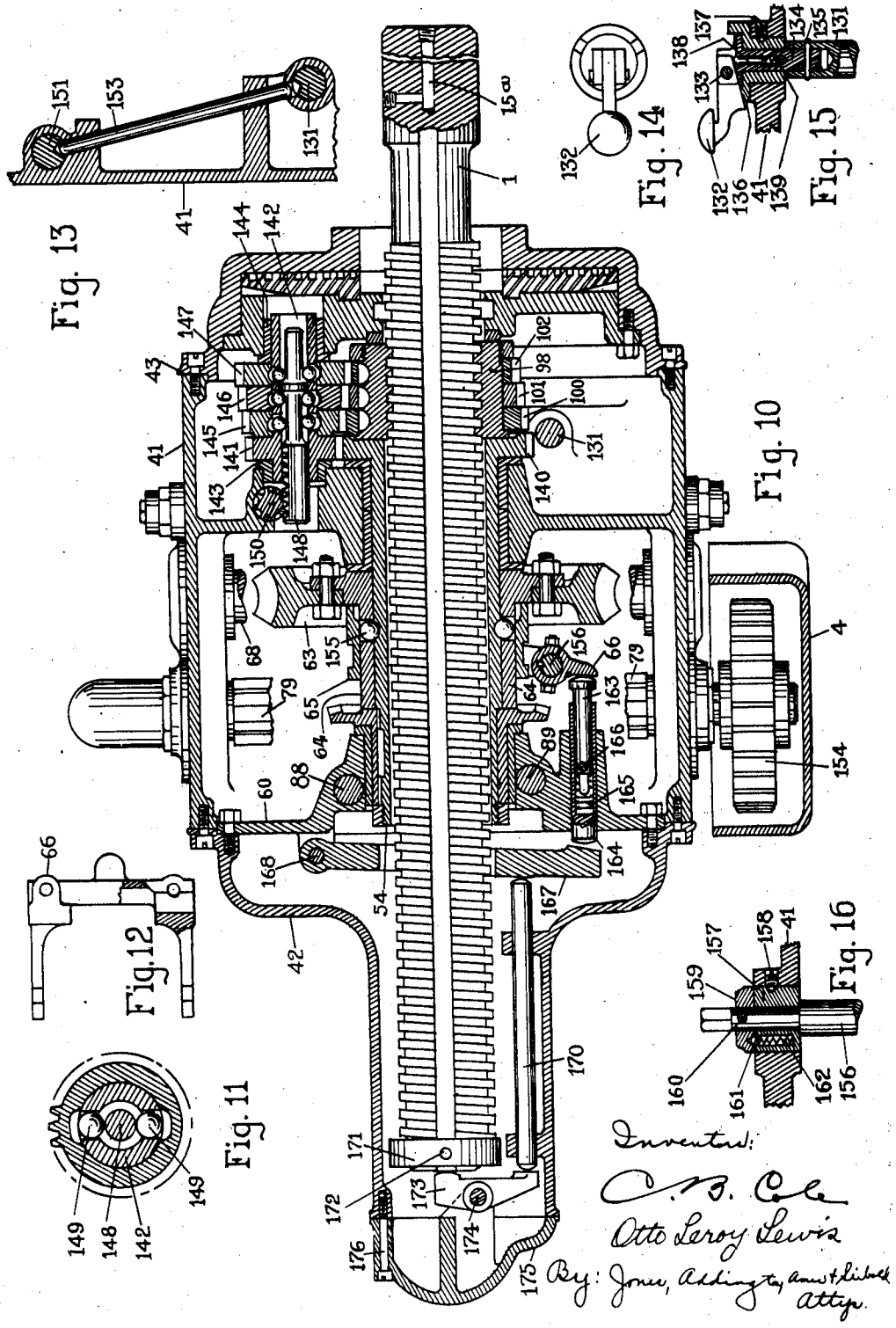
Fig. 7

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Patented July 14, 1931 1,814,078

UNITED STATES PATENT OFFICE

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MACHINE FOR BORING CYLINDERS

Application filed February 3, 1930. Serial No. 425,385.

Our present invention relates in general to machines for boring cylinders or grinding the internal diameter of the same, and more particularly to the portable type of such machines, commonly used for reboring operations. This invention is not limited to the portable type, however, as it is also applicable to stationary machines both vertical and horizontal.

Portable machines as at present constructed require a long and tedious set up; involving the changing of pulleys and pick-off gears to obtain the necessary speeds and feeds, the clamping of the machine in operating position without adequate means for centering and aligning the bar, and the installation of a power unit for driving.

One of the objects of this invention is to decrease set up and operating time by making the outfit self contained, easily centered and installed, and convenient to operate.

Another object is to provide suitable lubrication and exclude the dust from the working parts.

Another object is to provide a machine easily handled by a crane, the operating levers being disposed so as to avoid their being knocked off or damaged by striking objects while the machine is being handled by the crane.

A still further object is to provide a machine which may be used for either boring or grinding the internal diameter of the cylinder simultaneously or consecutively, securing greater accuracy than at present usually obtained.

These objects we obtain by the means and mechanism illustrated in the accompanying drawings, showing a preferred construction; these drawings forming a part of this specification, in which—

Figure 1 is an elevation giving a general view of the machine as set up for boring a cylinder, the cylinder being shown in section;

Fig. 2 is an end view of the out-board support for the boring bar;

Fig. 3 is a sectional view of the same, the section being taken on the vertical center line through Fig. 2;

Fig. 4 is an end view of any one of the several supporting brackets used to attach the machine to the cylinder;

Fig. 5 is a view partly in section showing the jack for supporting the overhanging end of the machine;

Fig. 6 is a sectional view of the body of the machine, including the transmission and the centering device, the section being taken in a vertical plane through the axis of the boring bar;

Fig. 7 being a projection of one supporting arm shown in Fig. 6 showing the form of the end of the supporting arm;

Fig. 8 is a sectional view showing the relation between the various gears, clutches and shifting members, the section being taken on a line through the axes of the shafts shown;

Fig. 9 shows the general form of the sliding gear shifting forks;

Fig. 10 is a sectional view of the body of the machine, including the transmission, centering device and boring bar, the section being taken in a horizontal plane through the axis of the boring bar;

Fig. 11 is a sectional view of one of the feed gears, showing the ball drive construction;

Fig. 12, partly in section, shows the general form of the worm wheel clutch throwout fork;

Fig. 13 is a sectional view showing the interlock between the feed change control shaft and the rapid traverse control shaft;

Fig. 14 is a plan view and Fig. 15 is a sectional view showing the general construction of the feed change and speed change controlling devices; and

Fig. 16 is a sectional view of the position retaining device for the rapid traverse shifter and the worm wheel clutch throwout.

Referring to the drawings in detail, and first, to Figure 1, the construction shown comprises a boring bar 1 driven and supported at one end by the transmission 2, power being furnished the transmission from the motor 3 attached to the transmission case, the motor driving the transmission through a chain enclosed in chain housing 4. The transmission is supported at one end by a jack 5. The other end of the transmission is supported by brackets 6 which are bolted to one end

of a cylinder 7 which is to be bored, the other ends of the brackets being arranged to grip the arms 8 extending from the transmission case. Similar brackets 9 attached to the other end of the cylinder 7 support the outboard bearing 10 for the boring bar 1. The boring bar carries a boring head 11 on which are mounted a boring tool 12 and a grinder 13, this combination being described in our co-pending application, Serial No. 425,386, filed February 3, 1930, entitled "Tool Carrying Head." The power (which may be compressed air) is furnished the grinder (which may include an air motor) through flexible coupling 14 and a connection 15 which passes from the grinder through a hole 15ª in the boring bar to the coupling 14. The levers at the top of the transmission have the following functions: a lever 16 (of which there are two, one mounted behind the other), speed change; a lever 17, hand rotation of the boring bar; a lever 18, feed change; a lever 19, worm wheel clutch throwout; a lever 20, rapid traverse control by power. The lever 17 is detachable and when applied to the squared end of a shaft 21 it may be used to operate the rapid traverse by hand.

Referring to Figs. 2, 3 and 4, the boring bar 1 is slidably supported in a bearing bushing 22 which has a spherical seat in the bearing bushing retainers 23 and 24, this spherical seat permitting the bearings to line up properly with the bar. The bearing retainers 23 and 24 are adjusted, if necessary, by shimming under the shoulders so that the bearing bushing spherical seat is a free running fit in the retainers. At the ends, the bearing bushing clears the retainers sufficiently to permit the bearing bushing to rock slightly on its spherical seat. The bearing bushing 22 is slotted to receive a key 25 pivoted on a pin 26 and depressed by a spring 27 into the keyway in the boring bar 1, driving the bearing bushing in unison with the boring bar. This arrangement permits the boring bar to enter the bearing bushing regardless of the relative positions of the key and keyway, the key snapping into place when the bar has rotated sufficiently to bring the key way in line with the key. The bearing retainers 23 and 24 are firmly clamped against the shoulders in an adjusting ring 28 by screws 29, shims being placed under the shoulders, if necessary, to adjust the spherical bearing, as previously explained. The adjusting ring 28 is radially adjustable in an outboard bearing housing 30 by means of screws 31 operated by a hand knob 32 and after adjusting locked by a nut 33. The inner ends of the screws 31 are rounded and supported in the housing 30 so as to bear against the tapered face of a collar forming a part of the adjusting ring 28, the other face of the collar being flat and seating against a shoulder in the bore of the housing 30. Pressure from the screw tends not only to move the adjusting ring 28 radially, but also to keep it tight against the shoulder in the bore of the support 30, securing rigidity. The protruding arms of the housing 30 are machined to receive the supporting brackets 9 which may be clamped on the arms by means of screws 34 after installation on the cylinder; the angular spacing between the arms tending to centralize the bearing bushing with the cylinder, final adjustment being made by the shifting ring 28 by means of the screws 31.

Referring to Fig. 5, a tubing 35 is slidably mounted in the jack base, being retained in position by a screw 37 threaded in a base 36 and having a tapered end to engage one of a series of tapered holes in the tubing 35, thereby securing rough vertical adjustment. The ring end of the screw 37 provides means for attaching a lifting hook as well as forming a socket for a bar or wrench to tighten the screw. For fine vertical adjustment, a screw 38 is threaded into a nut 39, which is provided with slotted ears and a clamp-bolt for tightening the nut on the screw, this clamping construction being the same as shown in Fig. 4. The lower end of the nut 39 is a free fit in the tubing 35. A shoulder on the nut 39 bears against the end of the tubing 35. The nut is provided with cross holes for inserting a bar to turn it. The jack is attached to transmission 2 by means of a cross pin 40.

Referring to Figs. 6, 7, 8 and 9, the mechanism for driving and feeding the boring bar 1 is encased in a housing consisting of a center piece 41, a rear end plate 42 and a front end plate 43. The front end plate 43 is provided with protruding arms for attaching the supporting brackets 6, as shown in Figure 1. These arms are machined, as shown in Fig. 7, to receive the universal chuck jaws 44 operated by a scroll 45 supported in the end plate 43 and retained in the same by a plate 46 which is bolted to the end plate 43 by screws 47. The scroll is operated by turning the bevel pinions 48 having sockets to receive a wrench, the pinions engaging gear teeth cut on the back of the scroll. The pinions 48 are retained in position by a key 49 retained by a screw 50. The arrangement of the pinion and the scroll is standard chuck construction and is not claimed as novel.

The chuck jaws 44 are provided with L-shaped slots for retaining the slip jaws 51 at various radial positions, so that a limited movement of the chuck jaws 44 will take care of a large range of chucking diameter; the distance between the L-shaped slots being somewhat less than the allowable travel of the chuck jaws 44. The slip jaws 51 may be locked in place on the jaws 44 by tightening the screws 52, the tapered points of which

bear against the lower sides of the tapered grooves turned in the plungers 53, forcing the rounded ends of the plungers into grooves in the top of the jaws 44. In operation, the scroll is turned so as to run the chuck jaws 44 in as far as possible. The slip jaws 51 are then inserted in the L-shaped slots at a radial position somewhat less than the diameter of the cylinder to be bored. After the transmission has been lightly clamped in position on the cylinder by means of the support brackets 6, the jack 5 being adjusted to take the weight of the other end of the transmission, the scroll of the chuck is rotated by the pinions 48, moving outward the chuck jaws 44 carrying the slip jaws 51 until the slip jaws 51 engage the inner diameter of the cylinder, thereby centering the transmission and the boring bar with the cylinder. The supports 6 are then rigidly clamped to the cylinder and to the arms of the end plate 43, the jack 5 finally adjusted to support the weight of the rear end, the jack screw locked to secure rigidity, the screw 52 loosened and the chuck jaws 44 run in far enough so that the slip jaws 51 may be removed. The slip jaws 51 are then removed to provide clearance for the boring head 11, Figure 1.

The boring bar 1 is supported in the transmission case by a driving sleeve 54. One end of this sleeve is supported in bearing bushings 55 and 56 pressed into the housing 41. A bevel gear 57 is pressed on the other end of the sleeve 54 and secured by a nut 58. The hub of the bevel gear 57 takes a bearing in a bushing 59 pressed in a plate 60, the plate 60 being secured to the end plate 42 by screws 61. The outer diameter of the plate 60 fits a counterbore in the end plate 42 and it also fits a bore in the end of the housing 41, centralizing the housing 41 with the end plate 42. The sleeve 54 acts as a driver for the boring bar 1, driving through a key 62 which is a sliding fit in the keyway in the boring bar 1 and is securely fastened in the sleeve 54. The sleeve 54 is driven from a worm wheel 63 bolted to a worm wheel hub 64 through a ball drive shown in Fig. 10, the drive between the worm wheel hub 64 and the sleeve 54 being engaged and released by movement of a worm wheel shifter collar 65 operated by shifting fingers 66 as later explained. The worm wheel 63 is driven by a worm 67 integral with a worm shaft 68 supported by the thrust and radial load bearings 70 in the bearing retainers 71 mounted in the transmission housing 41. Mounted on the worm shaft 68 in driving relation are gears 72 and 73, the gears being spaced from the bearings by spacing collars 74; the gear spacing collar and the inner bearing race at each end of the shaft being clamped against a shoulder on the shaft by a washer 75 tightened by screws 76.

The gears 72 and 73 are driven from the gears 77 and 78, respectively, mounted in slidable driving relation on a power shaft 79 which is supported by anti-friction bearings 80 in bearing retainers 81 mounted in the transmission housing 41. At one end of the shaft a dust excluding and grease retaining packing 82 is held in place by a packing nut 83, this end of the shaft being exposed and arranged for attaching the sprocket 154, Fig. 10, driven by the chain from the motor mounted under the transmission case and attached to it by studs 84. The other end of the power shaft is covered by a cap 85, the cap 85 and the plug 83 being interchangeable so that the drive may be taken from either end of the shaft.

The sliding gears 77 and 78 are shifted into operating position by the shifting forks 86 and 87, respectively, the general form of these forks being shown in Fig. 9. The forks are firmly fastened to the rods 88 and 89 by the nuts 90. The rods are supported in a lug projecting from the plate 60 which is drilled to hold an interlocking ball 91 between the rods in such a relation that the ball must enter the countersink on one rod, locking it in neutral position, before the other rod can be shifted to engage a gear. The shifting rod 89 is actuated by a pinion 92 engaging a rack; the pinion 92 forming the lower extremity of a shifting rod 93, the construction of the upper end of which is shown by Fig. 15. The shifting rod 88 is actuated by a similar rod and pinion. The sliding gears 77 and 78 and the gears 72 and 73 are double gears, the ratio between each set of gears varying so that four different speeds of the worm shaft are obtainable.

The boring bar 1 may be rotated by hand by turning wrench 69 engaging in driving relation one end of a shaft 94 to the other end of which is securely fastened a pinion 95 engaging the bevel gear 57. The shaft 94 is supported by a bearing bushing 96 mounted in the transmission housing 41, the bearing bushing 96 covering a large inspection hole in transmission housing 41. A plug 97 serves as a lifting ring and oil filler cap.

The boring bar 1 is fed longitudinally by a rotating nut 98 threaded on the boring bar, this nut being limited for end movement by a thrust washer 99 at one end bearing against the plate 46 and at the other end the nut 98 bears against the sleeve 54 supported endwise by the bushing 55. The gears 100, 101 and 102 are securely fastened in driving relation to the nut 98 and retained by a nut 103. Rapid traverse either forward or backward may be imparted to the boring bar 1 through the following mechanism: One portion of the gear 72 on the worm shaft engages a gear 104 rotatably mounted on a hub 105 which is fixed in driving relation on a rapid traverse shaft 106. The gear 104 drives the hub 105 through friction washer 107, the

gear being pressed against the friction washer by a spring 108 retained by a washer 109 secured endwise by a locking wire 110. The friction drive lessens the shock of sudden engagement. The bevel gears 111 and 112 are rotatably mounted on the shaft 106. Either of these gears may be engaged in driving relation with the shaft 106 by the shifting collars 113 and 114 so as to depress balls 115 into countersinks in the shaft 106, the balls being located in holes in the hubs of the bevel gears. As collars 113 and 114 are operated by the same shifter 116, one gear will not be engaged until the other has been disengaged. These bevel gears mesh with the bevel pinion on the end of the shaft 117 on which shaft is mounted in driving relation a spur gear 118 secured by a nut 119. The gear 118 engages the gear 102 on the nut 98. The direction of rotation of the nut, and therefore the direction of longitudinal movement of the boring bar 1, will therefore depend upon whether gear 111 or the gear 112 engages the shaft 106 in driving relation.

The shaft 117 is supported at the pinion end by a bearing bushing 120 pressed in the transmission housing 41, and at the other end by a bearing bushing 121 pressed in the plate 46. The shaft 106 is supported in bearing bushings 122 and 123 secured in the housing 41 by set screws 124. The ends of these bushings are cupped to receive packing washers 125 which are retained by collars 126 threaded on the ends of the bushings 122 and 123. These collars also form a guard for the squared ends of the shaft 106, the ends being squared so that a wrench may be applied for operating the rapid traverse by hand. The gears 111 and 112 are spaced by a collar 127 pinned on the shaft 106. The shifter 116 slides on a shifter shaft 128 which is secured in the housing 41 by screws 129. The shifter 116 is operated by a pinion 130 forming the lower extremity of a shaft 131 shown in section in Fig. 10.

Referring to Figs. 10 to 16, inclusive, a rapid traverse control lever 132 having a limited vertical movement on a pin 133 is used to impart rotary motion to a shaft 131 through a lever support 134 firmly secured to the shaft 131 by a pin 135. The lever support 134 is free to turn in a bushing 136, which is securely locked in the transmission housing 41 by a screw 137. The bushing 136 has a notched rim, the notches being used to retain the lever 132 in the desired position. The lever 132 is depressed into the notches by a plunger 138 actuated by a spring 139.

The boring bar 1 is given a slow longitudinal movement by rotating the nut 98, this rotation being accomplished by means of the following described differential gearing. A gear 140 forms the end of the driving sleeve 54 and meshes with a pinion 141 integral with a pinion shaft 142 supported in a bearing bushing 143 in the transmission housing 41 and by a bearing bushing 144 pressed into the end plate 43. The pinions 145, 146 and 147 are free to rotate on a shaft 142 in the position shown; but should the plunger 148 be moved to the left, the enlarged portion of the plunger 148 would push the balls 149 into recesses in the pinion 146, engaging in driving relation the shaft 142 and the pinion 146. This ball drive arrangement is clearly shown in Fig. 11. A further movement of the plunger 148 to the left will engage the pinion 145 and release the pinion 146, while moving the plunger 148 to the extreme right will engage the pinion 147, the pinions 145 and 146 being released. The action is as follows: The gear 140 constantly drives the shaft 142 through the pinion 141. When disengaged, the pinions 145, 146 and 147 revolve idly on the shaft 142, the nut 98 revolving in unison with the boring bar 1. If one of the pinions 145, 146 or 147 is engaged with the shaft 142, however, it will drive the nut 98 faster or slower than the bar, depending upon the ratio of the number of teeth on the driving pinion and its mating gear on the nut. Various feeds may therefore be obtained by using gears of different ratios, the combination shown giving three feeds.

The plunger 148 is operated by a pinion 150 engaging a rack on the plunger and forming the lower extremity of a feed control shaft 151, shown in Fig. 6. The shaft 151 is imparted rotary motion by a hand lever 152, Fig. 6, the mechanism being identical with that shown in Figs. 14 and 15 and previously described. The feed control shaft 151 is interlocked with the rapid traverse control shaft 131, Fig. 13, by an interlocking rod 153, the shafts being countersunk to engage when in neutral position the ends of the rod 153, the length of which is such that when one shaft has been rotated, the other is locked in neutral position, making it impossible to engage the rapid traverse and the slow feed at the same time. The rod 153 is supported by lugs forming a part of the housing 41.

In Fig. 10, the outboard portion of the boring bar 1 is shown in section to disclose the holes drilled and tapped in the bar for installing the connections for transmitting power to the grinder mounted on the bar, as shown in Figure 1.

The drive chain for the sprocket 154 on the power shaft 79 is guarded by the chain housing 4, supported by the transmission housing, as shown in Figure 1.

The worm gear 63 is engaged in driving relation with the driving sleeve 54 by the balls 155 being depressed into countersinks in the sleeve 54 by shifting the collar 65 which has an overhanging portion to retain the balls when in disengaged position and a groove to receive the shifting fingers of the

shifting fork 66, the general form of which is shown in Fig. 12. The shiften fork is keyed and bolted to a shifter shaft 156, which is supported by a bearing bushing 157 secured in the housing 41 by a screw 158. A collar 159 retained on the shaft 156 by a cross pin 160 is provided with countersinks on its lower surface to engage a ball 161 operated by a spring 162 to hold the shifter 66 in engaged and disengaged positions. The upper end of the shaft 156 is squared to receive the lever 19, Figure 1.

The shifter fork 66 may be thrown to a disengaged position by a plunger 163 supported in a plunger barrel 164, pressure between the barrel and the plunger being maintained by a spring 165; the plunger being retained by a cross pin 166 operating in the slots in the barrel 164. A swinging lever 167 hinged by a pin 168 passing through lugs in the plate 60 may be pushed against the barrel 164 by a pin 170 or by a collar 171 secured to the boring bar 1 by a pin 172. The pin 170 may be pushed endwise by a lever 173 pivoted on a pin 174 supported by lugs projecting from an end cover 175 secured to the end plate 42 by screws 176. The action of this mechanism is as follows:

Referring to Fig. 10, should the boring bar 1 be fed as far as it should go to the left, the end of the bar will press against the lever 173, which, being pivoted on the pin 174, will push the pin 170 to the right. The end of the pin 170, pushing against the swinging lever 167, will cause the lever 167 to move the barrel 164 to the right, compressing the spring 165, which will move the plunger 163 to the right; which bearing against a projecting lug on the shifter fork 66, causes the shifter fork 66 to shift the worm wheel clutch throughout the collar 65 to the left, thereby disengaging the worm wheel hub 64 from the driving sleeve 54, stopping the feed and rotation of the bar. In order to feed the bar forward, the rapid traverse lever 20 is set in forward feeding position, and the worm gear clutch control lever 19, Figure 1, is swung into engaging position, the spring 165 compressing to allow this movement. Should the bar 1 be fed to its extreme right position, the collar 174 will engage the swinging lever 167, which operating through the barrel 164, the spring 165, the plunger 163, the shift fork 66 and the collar 65 will disengage the worm wheel, thereby stopping feed and rotation of the bar.

The above mechanism prevents damage to the machine by feeding the bar too far in either direction.

We realize that considerable variation from the above construction may be made without departing from the spirit of our invention, and, therefore, we desire that our invention shall not be limited to the details shown. In particular, we mention the addition of oil holes and oil grooves, the substitution of anti-friction bearings for plain bearings, or vice versa, the addition of an anti-friction lining to the sleeve 54, and the substitution of the geared scroll chuck as described for centering the transmission end in the outboard bearing 10 in place of the hand screw adjustment shown; the bearing bushing 22 and the bearing bushings 23 and 24 being installed in the chuck body instead of the adjusting ring 28.

Likewise, the centering device shown in Fig. 3 could be applied to the transmission end instead of the scroll chuck.

We claim:

1. A machine for grinding cylinders including a bar capable of rotary and longitudinal motion, an enclosed transmission for imparting rotary and longitudinal motion to the bar, means for installing the transmission and bar in operating position, means for supporting the outboard end of the bar, a head mounted on the bar for supporting the grinder in operating position, and a grinder, driven by power transmitted through the bar from an outside source.

2. A machine for boring and grinding cylinders, including a bar capable of rotary and longitudinal motion, an enclosed transmission case for imparting rotary and longitudinal movement to the bar, means for installing the transmission and bar in operating position, means for supporting the outboard end of the bar, a driving head mounted on the bar and carrying a boring tool and a grinder adjustably mounted for boring and grinding the cylinder individually or simultaneously, the grinder being driven by fluid pressure transmitted through the bar.

3. A boring and grinding machine of the character described, in combination with a supporting member consisting of a base, a member telescoping with the base, means for locking in fixed relation the base and telescoping member, a member shouldering against and rotatable in the telescoping member, means for rotating said member, an adjusting screw threaded in said member, means for locking the adjusting screw in said member, and means for attaching the adjusting screw to the machine described.

4. A cylinder boring and grinding machine, including a bar capable of rotary and longitudinal motion, a transmission case enclosing the mechanism for imparting motion to the bar, and carrying a plurality of projecting arms, brackets for rigidly attaching the transmission by means of the arms to the cylinder to be bored, means for clamping the brackets to the arms, an outboard bearing for the bar having a plurality of projecting arms, means for attaching the arms to the cylinder to be bored, and a tool-carrying head mounted on the bar.

5. A cylinder boring and grinding machine of the character described, including

a bar capable of rotary and longitudinal movement, a transmission case enclosing the mechanism for imparting motion to the bar and carrying a plurality of projecting arms, chuck jaws slidably retained within the arms and having means for retaining slip jaws, means for moving the chuck jaws outward or inward in a universal manner, an outboard bearing for the bar and a tool carrying head mounted on the bar.

6. A cylinder boring and grinding machine of the character described, including a bar capable of rotary and longitudinal movement, a transmission case enclosing the mechanism for imparting motion to the bar, means for attaching in operating position the transmission to one end of the cylinder to be bored, an outboard support for the bar including a bearing having means for aligning itself with the bar, means for revolving the bearing in unison with the bar, means for adjusting the bearing fit, means for centralizing the bearing with the supporting arms and with the cylinder to be bored, means for attaching in operating position the outboard bearing to one end of the cylinder to be bored, and a tool-carrying head mounted on the bar.

7. In a cylinder boring and grinding machine of the character described, an outboard support comprising a bearing bushing provided with a pivoted key for engaging the boring bar, slidably fitting the boring bar and having a partly spherical outer diameter seated betwen two adjustable retaining collars mounted in an annular member capable of limited radial adjustment in a housing having raidal arms carrying brackets for attaching the housing to the cylinder to be bored; the annular member having a flat shoulder to bear against a flat shoulder in the housing, and a tapered shoulder against which pressure is brought by means of screws within the arms of the housing for radially adjusting the annular member, means for radially adjusting the annular member, and means for locking it in place.

8. In a cylinder boring and grinding machine of the character described, a centering and holding device including a plurality of arms projecting from the transmission case, means for centering the boring bar with the cylinder by mechanism within the arms, an outboard support having a plurality of projecting arms, means for attaching the arms to the cylinder and means for centralizing the bar with the cylinder by mechanism within the arms.

9. In a cylinder boring and grinding machine of the character described, a centralizing device consisting of a plurality of arms projecting from the portion of the housing surrounding the bar, a pinion driven chuck scroll retained within the housing concentric with the bar, chuck jaws engaging the scroll and slidably mounted in the projecting arms, retaining slots in the outer face of the chuck jaws concentrically spaced with the boring bar, slip jaws for gripping the bore of the cylinder retained in the slots by a plunger depressed in a groove in the upper face of the sliding jaws, means for depressing the plunger.

10. In a cylinder boring and grinding machine of the character described, a supporting case, a transmission enclosed in said supporting case, a boring bar, means for selectively rotating the bar at desired speeds by hand and power, means for selectively feeding the bar longitudinally by hand and power, means for rapidly traversing the bar by hand and power, means for interlocking the speed control mechanisms and the feed control mechanisms, and means for automatically stopping feed and rotation of the bar at its extreme forward and reverse positions.

11. In a cylinder boring and grinding machine of the character described, a boring bar splined for driving rotarily and threaded for feeding longitudinally, a sleeve surrounding said bar and having a driving key engaging the spline in the bar in sliding driving relation, bearings for supporting the sleeve within the transmission housing, a worm gear mounted on the sleeve to rotate freely on the same, means for engaging and disengaging the worm wheel and sleeve in driving relation, means for driving the worm wheel at a plurality of speeds, a gear on one end of the sleeve engaging a pinion on a countershaft supported by bearings in the transmission case housing, a plurality of gears rotatably mounted on the countershaft, means for engaging and disengaging the gears with the countershaft, a nut threaded on the boring bar, supported against endwise movement and carrying in fixed relation gears to mesh with the several gears on the countershaft, this gearing constituting a differential feed for the boring bar, a bevel gear rigidly mounted on the driving sleeve supporting the bar, engaging a bevel pinion having means for hand operation, a worm shaft having a threaded worm engaging the worm wheel, a plurality of fixed speed change gears, and bearings retained and supported in the transmission housing, a power-driven sliding gear shaft, sliding gears mounted on said shaft to engage corresponding gears on worm shaft, means for shifting sliding gears and locking them in position, a rapid traverse gear supporting shaft in bearings in the transmission housing for said rapid traverse shaft, a driving hub fixedly mounted on said shaft, a friction member driving said hub, a gear for driving said friction member mounted rotatably on the hub and engaging one of the speed

gears on the worm shaft, means for maintaining friction between the gear, hub and friction member, a pair of bevel gears rotatably mounted in spaced relation on the rapid traverse shaft, means for engaging either of these gears in driving relation with said shaft, a pinion engaging both bevel gears from which it receives clockwise or anti-clockwise motion, depending upon which is the driver, a shaft integral with the pinion, supported in bearings in the transmission housing and carrying a gear in driving relation meshing with one of the gears on the nut on the boring bar, and a transmission case consisting of a central member having suitable ribs for supporting bearings, an end member enclosing the centralizing device and carrying the supporting arms, an end member forming the housing for the screw end of the bar and supporting a part of the automatic stop mechanism and a follower plate centralizing said member with the center member and supporting one sleeve bearing and the speed gear shifting rods, and means for automatically stopping the traverse of the bar at its extreme forward and reverse positions.

12. In a machine for boring and grinding cylinders, of the character described, a mechanism for automatically stopping the bar at its extreme forward and reverse positions, including a pivoted lever, one end of which engages the end of the bar at its extreme reverse position, the other end of the lever engaging a push pin bearing against a swinging member imparting motion to a plunger supported in the follower plate of the transmission and through the plunger imparting motion to a mechanism disengaging the worm wheel from the driving sleeve, thereby stopping all motion of the bar, a collar firmly fastened on the bar engaging at the extreme forward position of the bar the swinging member, pressing it against the plunger and thereby imparting motion to the mechanism disengaging the worm wheel, thereby stopping the bar, said plunger including two telescoping members, a cross pin firmly fixed in one member and engaging slots with closed ends in the other so that the members have a limited travel regarding each other, and a spring interposed between the two members to maintain pressure between the same.

13. In a cylinder boring and grinding machine of the character described, a power driven worm shaft supported in a transmission case by bearings taking thrust and radial load, a worm wheel mounted concentric with a boring bar and rotating freely upon a sleeve surrounding the boring bar, a collar mounted upon the hub of the worm wheel and free to slide a limited distance upon the same, a plurality of balls retained in holes in the hub of the worm wheel and by the collar, countersinks in the sleeve surrounding the bar, a tapered shoulder on the collar for depressing the balls into the countersinks when shifted to proper position, means for shifting the collar, and means for engaging the sleeve and boring bar in slidable driving relation.

14. In a cylinder boring and grinding machine of the character described, a power driven sliding gear shaft having sliding gears for imparting motion to the bar driving mechanism, shifting members engaging grooves in the sliding gears and secured to shifting rods suitably supported and provided with interlock, a rack on said rods engaging pinions at one end of control shafts, the other end of the control shaft being suitably supported and provided with means for indexing and maintaining the sliding gears in proper relation with their mating gears.

15. In a cylinder boring and grinding machine of the character described, a gear shifting control shaft having a pinion at one extremity for engaging a rack on the shifting member, at the other end bored to receive the round portion of a lever bracket carrying a pivoted lever, means for firmly fastening the bracket to the control shaft, a bearing bushing interposed between the end of the shaft and a shoulder on the bracket, the bushing having a notched rim, the notches to engage the lever thereby holding the gears in proper position, a spring and plunger for depressing the lever into the notches, a raised portion on the rim of the bushing to act as a stop for the lever, and means for supporting the bushing.

16. In a machine of the character described, a feed nut supported endwise and threaded upon a boring bar for the purpose of feeding said bar, a plurality of gears firmly secured to said nut, a gear mounted on a sleeve revolving in unison with the bar, a countershaft suitably supported and carrying in fixed relation a pinion meshing with the gear on the sleeve, a plurality of gears rotatably mounted on the countershaft and meshing with corresponding gears on the nut, a plunger operated by rack and pinion, slidably mounted in a bore in the countershaft and having a collar for engaging selectively balls retained in holes in the countershaft with countersinks in the bore of the rotatable gears on the countershaft, thereby engaging selectively the gears with the countershaft and providing a differential rotary movement between sleeve and nut, the plunger being formed to act as a ball retainer for the idle gears.

17. A cylinder boring machine comprising a boring bar, an outboard support for the boring bar comprising a bearing bushing provided with a pivoted key for slidably engaging the boring bar, said bushing having a spherical outer surface, two adjustable retaining collars engaging said spherical surface, an annular member in which said collars are mounted, means for adjusting said annular member radially, a housing in

which said annular member is adjustably mounted, provided with radial arms, brackets carried by said arms for attaching the housing to the cylinder to be bored, said annular member and housing having interengaging flat shoulders, said annular member having a tapered shoulder, and screws mounted in said arms for engaging said tapered shoulder for radially adjusting the annular member.

18. A cylinder boring machine comprising a centralizing device including a boring bar, a housing surrounding said bar, a plurality of arms projecting from said housing, a chuck scroll within the housing concentric with the bar, chuck jaws engaging the scroll and slidably mounted in the projecting arms, said chuck jaws having retaining slots in their outer faces concentrically spaced with respect to the boring bar, slip jaws for gripping the bar of the cylinder mounted in said slots, plungers slidably mounted in said slip jaws for holding the slip jaws in the slots, the face of the sliding jaws being provided with grooves for receiving the ends of the plungers, and means for forcing the plungers into the grooves.

19. A cylinder boring machine comprising a transmission case, a power-driven worm shaft supported in said transmission case, thrust and radial bearing means for said worm shaft, a boring bar, a worm wheel concentric with the boring bar, a sleeve surrounding the boring bar, said worm wheel being freely rotatable on said sleeve, a collar slidably mounted on the hub of the worm wheel, a plurality of balls seated in openings in the hub of the worm wheel, and retained therein by said collar, said sleeve being provided with countersinks in alinement with said balls, said collar being provided with a tapered shoulder for depressing the balls into the countersink when shifted to proper position, means for shifting the collar, and means for engaging the sleeve and boring bar in a slidable driving relation.

20. A cylinder boring and grinding machine of the character described, including a bar capable of rotary and longitudinal movement, a transmission case enclosing the mechanism for imparting motion to the bar and carrying a plurality of projecting arms, chuck jaws slidably retained within the arms, means for moving the chuck jaws outward or inward in a universal manner, an outboard bearing for the bar, and a tool-carrying head mounted on the bar.

21. A cylinder boring machine comprising a boring bar mounted for longitudinal and rotary movement, transmission for said boring bar mounted as a unit therewith, expansible means engageable with the bore of the cylinder for centering the bar in the cylinder, and means outside of the cylinder for guiding the unit in its centering movement and for securing it in centered position, said guiding means comprising guide members outside the cylinder and secured thereto and radially extending arms on said unit guided in said guide members.

22. A cylinder boring machine comprising a boring bar mounted for longitudinal and rotary movement, transmission for said boring bar mounted as a unit therewith, expansible means engageable with the bore of the cylinder for centering the bar in the cylinder, and means outside of the cylinder for guiding the unit in its centering movement and for securing it in centered position, said guiding and securing means comprising a guide member outside the cylinder and secured thereto, arms on said unit guided in said guides, and means for securing said arms against movement in said guide members.

23. A cylinder boring machine comprising a boring bar mounted for longitudinal and rotary movement, transmission for said boring bar mounted as a unit therewith, expansible means engageable with the bore of the cylinder for centering the bar in the cylinder, and means outside of the cylinder for guiding the unit in its centering movement and for securing it in centered position, said guiding and securing means comprising a guide member outside the cylinder and secured thereto, radially extending arms on said unit guided in said guides, and means for securing said arms against movement in said guide members.

24. A cylinder boring machine comprising a boring bar mounted for longitudinal and rotary movement, transmission for said boring bar mounted as a unit therewith, said transmission comprising variable speed means for effecting the ordinary axial movement of the boring bar, rapid traverse means for effecting extraordinary axial movement of the boring bar, and means for preventing interference due to concurrent use of said variable speed means and rapid traverse means.

25. A cylinder boring machine comprising a boring bar mounted for longitudinal and rotary movement, transmission for said boring bar mounted as a unit therewith, said transmission comprising two sets of variable speed transmissions, and means for preventing interference due to concurrent use of said two sets of variable speed transmissions.

26. A grinding head construction comprising a bar mounted for rotary and axial movement, a cutting head mounted on said bar, a power grinder mounted on said head, and a fluid conduit leading through said shaft to said grinder for supplying the power to the grinder as the head rotates.

In witness whereof, we have hereunto subscribed our names.

CHARLES B. COLE.
OTTO LEROY LEWIS.