W. H. MARKLAND.

METAL BORING APPARATUS.

APPLICATION FILED MAR. 19, 1910.

1,012,091.

Patented Dec. 19, 1911.

4 SHEETS—SHEET 1.

Fig. 1.

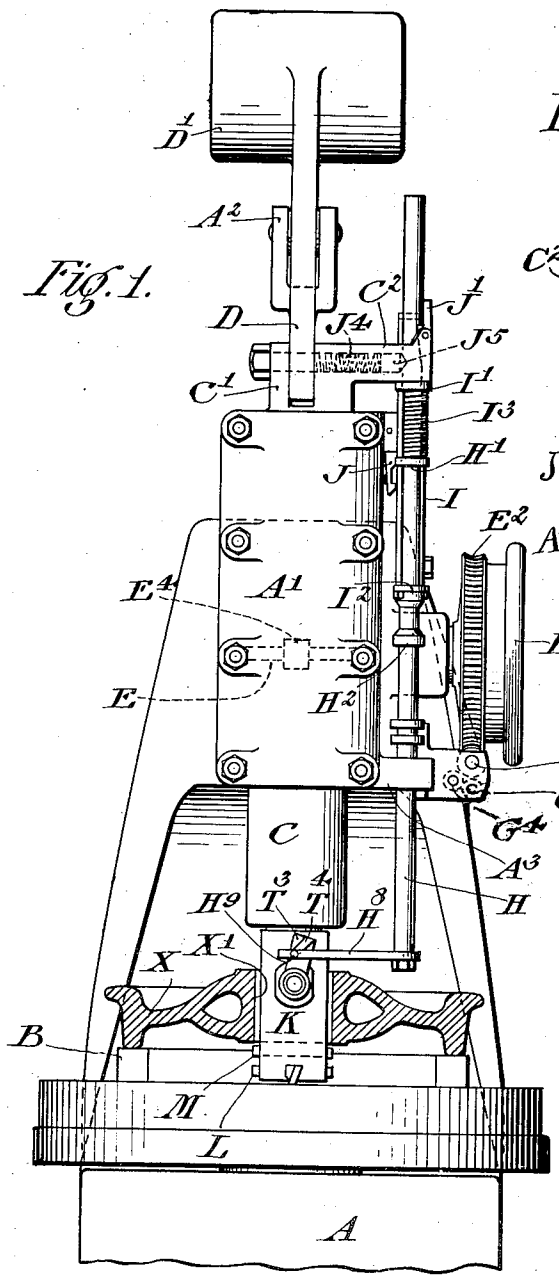
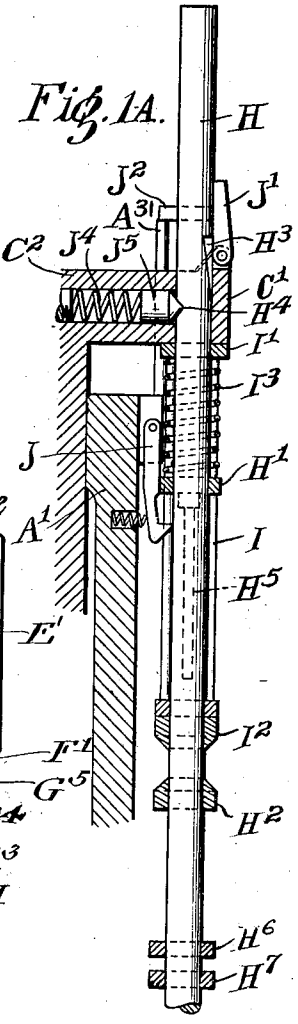


Fig. 1A.



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4 SHEETS—SHEET 2.

Fig. 2.

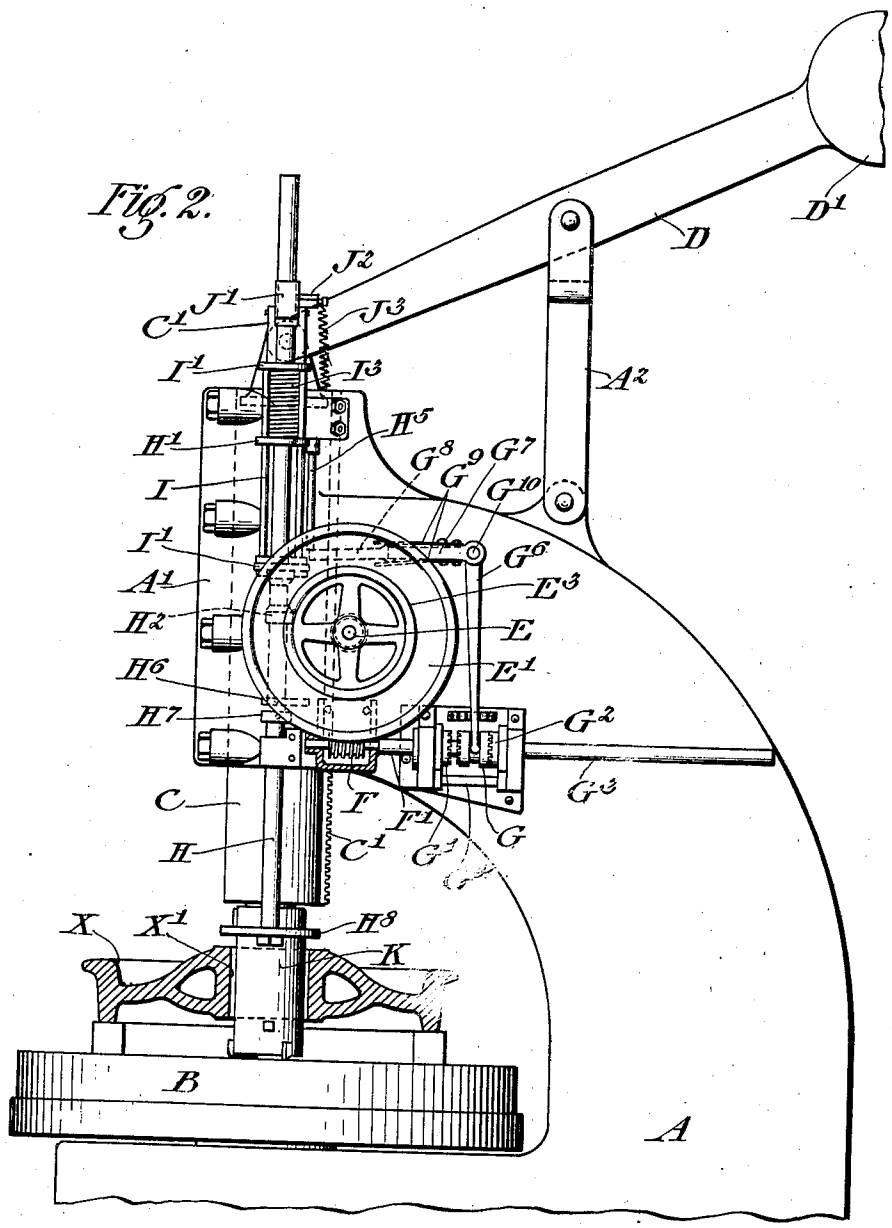
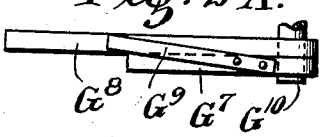


Fig. 2-A.



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4 SHEETS—SHEET 3.

Fig. 4.

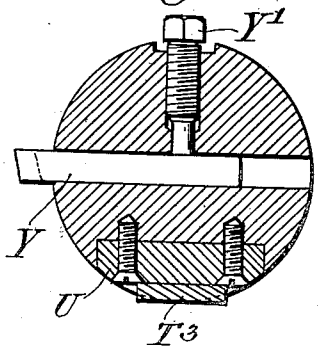


Fig. 5.

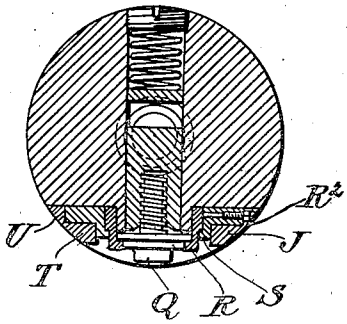


Fig. 3.

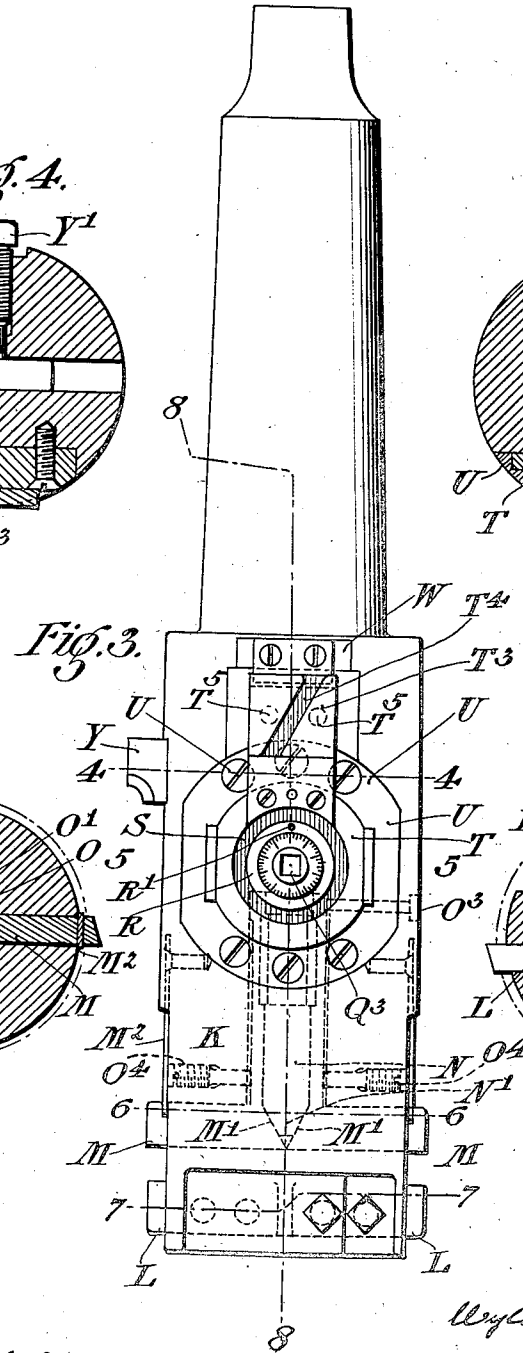


Fig. 6.

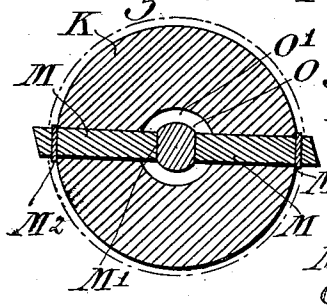
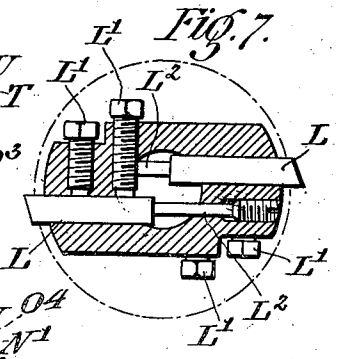


Fig. 7.



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4 SHEETS—SHEET 4.

Fig. 8.

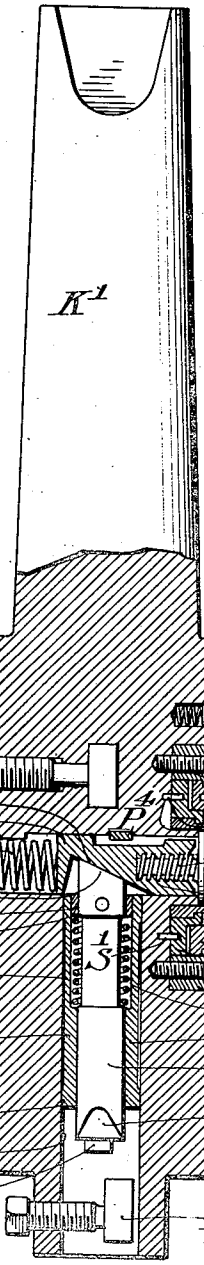


Fig. 9.

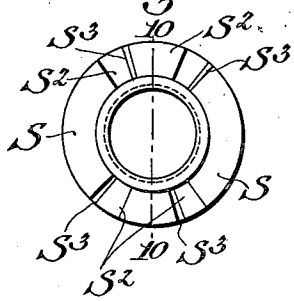


Fig. 10.

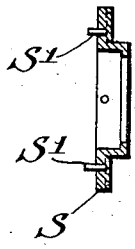


Fig. 11.

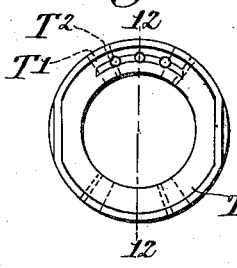


Fig. 12.

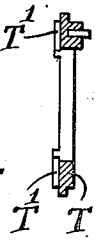


Fig. 13.

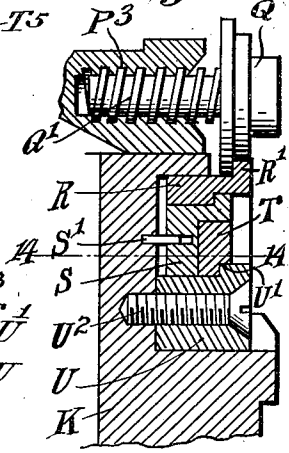
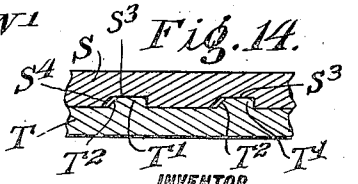


Fig. 14.



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UNITED STATES PATENT OFFICE

WYLLIS H. MARKLAND, OF ALTOONA, PENNSYLVANIA.

METAL-BORING APPARATUS.

1,012,091. Specification of Letters Patent. Patented Dec. 19, 1911.

Application filed March 19, 1910. Serial No. 550,508.

To all whom it may concern:

Be it known that I, WYLLIS H. MARKLAND, a citizen of the United States of America, residing in the city of Altoona, county of Blair, and State of Pennsylvania, have invented a certain new and useful Improvement in Metal-Boring Apparatus, of which the following is a true and exact description, reference being had to the accompanying drawings, which form a part thereof.

My present invention relates to boring apparatus, and particularly metal boring apparatus, and was primarily devised, and is peculiarly adapted, for boring out the axle receiving holes in car wheels, although the invention is by no means limited to such specific use.

One specific object of the invention is the provision of a machine provided with a boring bar containing a set of roughing cutters and a set of finishing cutters, and mechanism for so manipulating the cutters in the boring bar, and for reciprocating the latter, that when the boring bar is moved through the axle receiving hole of a car wheel or like object in one direction a roughing cut will be taken with the finishing cutters retracted, and at the completion of the roughing cut the finishing cutters are thrown into position to finish the hole on the return movement of the boring bar. By preference, the machine is provided with mechanism for automatically shifting the finishing cutters and reversing the movement of the boring bar at the completion of the roughing cut.

Other objects of the invention are to improve the apparatus in various features, some relating particularly to the boring bar proper and others to the mechanism for giving the boring bar the reciprocatory movements.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, however, and the advantages possessed by it, reference may be had to the accompanying drawings and descriptive matter in which I have illustrated and described one of the forms in which the invention may be embodied.

Of the drawings, Figure 1 is a front elevation of an assembled machine primarily devised for boring out car wheels. Fig. 1[A] is an elevation, with parts broken away and in section, taken similarly to Fig. 1, but on a larger scale and showing a portion only of the apparatus shown in Fig. 1. Fig. 2 is a side elevation of the machine. Fig. 2[A] is a plan view of a portion of the machine showing the clutch shifting mechanism. Fig. 3 is an enlarged front elevation of the boring bar proper. Figs. 4, 5, 6 and 7 are transverse sections taken on the line 4—4, 5—5, 6—6 and 7—7, respectively, of Fig. 3. Fig. 8 is an elevation, partly in section, on the line 8—8 of Fig. 3. Fig. 9 is an elevation of one of the parts of the cutter adjusting mechanism. Fig. 10 is a section on the line 10—10 of Fig. 9. Fig. 11 is an elevation of another of the parts of the cutter adjusting mechanism. Fig. 12 is a section on the line 12—12 of Fig. 11. Fig. 13 is an enlarged section taken similarly to Fig. 8, but showing a portion only of the apparatus there shown. Fig. 14 is a section on the line 14—14 of Fig. 13.

In the drawings, A represents the frame of the boring mill formed with a support for the rotating work holding chuck B. The specific construction of the chuck and the mechanism for rotating it form no part of the present invention and are not illustrated herein. The frame is formed with an arm or goose neck extending above the chuck B and provided at its upper end with a vertical guiding sleeve or housing A′ for a ram or boring bar spindle C. The spindle C is provided at its upper end with a head C′ to which is pivotally connected one end of the counter balancing lever D. The latter is pivotally supported in the frame work A by the yoke A^2 and carries at its free end a counter weight D′. The spindle C has mounted in its lower end in the usual manner, the boring bar K proper. The boring bar K carries at its lower end roughing cutters L, and a short distance above the roughing cutters, finishing cutters M.

In the operation of boring out a car wheel the boring bar is first moved down through the wheel into the position shown in Figs. 1 and 2, and on this downward stroke of the boring bar the roughing cutters L roughcut the axle receiving passage X′ in the wheel X. After the boring bar has been moved down into the position shown in Figs. 1 and 2, in which the finishing cutters M are below the lower end of the passage X′, the

cutters M are thrown out into operating position and the boring bar is then retracted, thus giving the passage X′ its finishing cut. After the boring bar is moved above the wheel the latter may be removed and replaced by another. It will be understood that during the operations described, the wheel is rotated by the chuck B and that the ram and boring bar have axial but no rotating movement.

The ram or spindle C is provided at one side with a longitudinally extending rack bar C′. The latter is in mesh with a pinion E^4 (see Fig. 1) carried by a transverse shaft E. The shaft E has secured to it at its outer end a hand wheel E′, by means of which the shaft may be rotated by hand, and a locking mechanism comprising a hand wheel E^3 is provided for detachably locking a gear wheel E^2 to the shaft E for power actuation. The gear wheel E^2 meshes with a driving worm F secured to a spindle F′ on which is splined a movable clutch member G. The latter may be shifted axially of the shaft F′ to engage a right hand clutch member G^2 or a left hand clutch member G′. The right hand clutch member G^2 is secured on the end of the driving shaft G^3 which rotates in the direction to raise the ram C when clutch members G and G^2 are in engagement. By means of a counter shaft G^4 and gearing connecting the counter shaft to the shaft G^3 and to a gear mounted on the stub shaft G^5 (see Fig. 1) the shaft G^3 serves to rotate the clutch member G′ in a direction opposite to that in which the shaft G^3 rotates. In consequence, when the clutch member G is shifted so that it engages the clutch member G′ the shaft F′ is rotated in a direction to move the ram or spindle C down. I have not thought it necessary to illustrate the gearing and clutch mechanism referred to in much detail, as the specific construction of these parts are well known and form no part of the present invention.

To shift the clutch member G a bell crank lever, pivoted at G^{10}, is provided. One arm G^6 of the bell crank engages the clutch member G and the other arm G^7 is resiliently connected by flat springs G^9 to an operating arm G^8 also pivoted at G^{10}. The springs G^9 are secured to the arm G^7 and overlap the arm G^8, and arm G^8, arm G^7, and springs G^9 may be regarded as forming the operating arm for the bell crank, the springs serving to make the arm yielding so that in case of improper adjustment of the arm relative to the actuating mechanism hereinafter described, such improper adjustment will not cause injury to the parts.

To automatically shift the bell crank arm G^8 into the position shown in Fig. 2, in which the clutch members G and G^2 are in engagement, a pin H^5 is adjustably secured to a collar H′ secured on the tripping bar H as by a set screw. Tripping bar H passes through and is guided by an ear A^3 at the lower end of the frame sleeve A′ and through an ear or bracket C^2 extending laterally from the head C′ of the spindle C. Collars I′ and I^2 are slidingly mounted on the tripping bar H above and below the collar H′. Between the sliding collar I′ and the fixed collar H′ a helical spring I^3 surrounds the rod H. The collars I′ and I^2 are connected together by rods I which are slidingly received in apertures provided in the collar H′. At the upper end of the housing sleeve A′ is pivoted a latch J adapted to engage a collar H^2 on the tripping bar H to hold the latter elevated under certain conditions as hereinafter explained, and to thereafter release the collar H^2 when engaged by sliding collar I^2. A pawl or locking dog J′, pivoted to the spindle carried ear C^2 and adapted under one condition to enter the notch H^3 in the tripping bar H, is provided with an extension J^2 adapted to be engaged by the frame carried stop A^3 which may be adjustable to carry the dog J′ out of the clutch H^3, when the spindle reaches the lower limit of its movement. A spring J^3 tends to hold the dog J′ in the locking position. The bracket ear C^2 is formed with a passage receiving a sliding dog or detent J^5 and a spring J^4 for urging the latter into the position in which it enters the beveled notch H^4 formed in the tripping bar H. The clutch shifting bell crank lever may be held by friction in any position in which it has been moved until the bell crank is positively moved into another position.

The apparatus, as shown in Figs. 1, 1^A, and 2, is in the position for making the finishing cut. In this condition of the parts the tripping bar H is secured to the spindle C by a detent J^5 which is entered in the notch H^4, the rod H^5 has engaged the arm G^8 to shift the clutch member G into engagement with clutch member G^2, and the plate or arm H^8, secured to the lower end of the tripping bar H, through the pin H^9 entering cam slot T^4 in the cutter shifting member T^3 has thrown the finishing cutters M into operating position in a manner hereinafter described. With this condition of the apparatus, the rotation of the shaft G^3 causes the spindle C to be raised to thereby make the finishing cut. The upward movement of the spindle is continued until the trip collar H^6 adjustably secured to the tripping bar H engages the clutch shifting arm G^8 and thereby shifts the sliding clutch member G out of engagement with the clutch member G^2. When this occurs, further movement of the spindle is interrupted and the finished wheel may be removed and replaced by another. To facilitate the removal and insertion of wheels, the spindle C may be raised by

hand after the clutch mechanism has been operated to interrupt the power actuation as described. After the new wheel is put in place, the ram or spindle C is started down either by manual actuation of the hand wheel E′, or in the construction shown, by shifting the clutch actuating bell crank by hand to bring the clutch member G into engagement with the clutch member G². The initial return movement of the spindle C, however, does not bring about a corresponding return movement of the bar H because the pawl J is then in engagement with the collar H² fixed to the tripping bar H, and the bar H remains stationary until the descent of the spindle C brings the collar I² into position to engage the pawl J and carry it out of engagement with collar H². This does not take place until after the locking dog J′ has been carried down into the position in which it snaps into the notch H⁸. The relative movement of the spindle and tripping bar occurring prior to the disengagement of pawl J and collar H² through arm H⁸ and cutter shifting device T³ retract the finishing cutters as hereinafter described. After the pawl J is forced out of engagement with collar H² the tripping bar H and spindle C descends together until the finishing cut is completed, and indeed until the cutter Y has rounded the upper end or mouth of the passage X′. When this is completed the pawl J′ is forced out of the notch H⁸ by the engagement of the pawl arm J² with the frame stop A⁸¹ whereupon the spring I⁸, put under tension by the movement of the collar I′ toward the tripping rod carried collar H′ while the tripping rod was prevented from moving down with the spindle C through pawl J, forces the tripping rod H down with a snap action to cause the arm H⁸ and the cutter shifting device T³ to throw the finishing cutters M out into the operating position, and at the came time the rod H⁵ carried by tripping rod H engages clutch shifting arm G⁸ and throws clutch member G into engagement with clutch member G² to thereby bring about the return or finishing cut movement of the spindle. The collar H⁷ engages the frame bracket ear A³ to limit the downward movement of trip rod H under the action of spring I⁸ when pawl J′ is carried out of notch H⁸.

The boring bar K is provided with the usual tang K′ adapted to be received in a socket (not shown) in the boring bar. At its lower end the boring bar K is provided with transverse sockets for the roughing cutters L which are clamped in place by screws L′ and may be adjusted in the direction of their length by screws L² to adjust the diameter of the hole cut by these cutters. The finishing cutters M project from the opposite ends of a transverse passage formed in the boring bar a short distance above the sockets for the roughing cutters. The finishing cutters are provided at their outer ends with sockets receiving the ends of flat springs M² secured to the boring bar and tending to force the cutters M into the boring bar. The inner ends M′ of the cutters M are oppositely beveled. The cutters M are forced out as desired by the wedge shaped end N′ of a plunger N which is axially movable in a sleeve O mounted in an axial passage K² formed in the boring bar. The sleeve O is formed with a collar O² at its upper end which fits snugly in the upper end of the passage K² and is prevented from movement therein by one or more screws O³. The body of the sleeve O is of an external diameter somewhat less than the diameter of passage K² to permit the sleeve to be adjusted as by the screws O⁴ extending parallel to the cutters M to thereby adjust one cutter in, and the other cutter out, to compensate for any inequality of the parts due to unequal wear or the like cause.

To obviate unnecessary motion of the sleeve O in a direction transverse to the length of the cutters M, the sleeve O is preferably provided at its lower end with ears or shoulders O′, the diameter of the curved surface of which is only slightly less than that of the passage K². The plunger N is normally urged upward by a spring O⁵ which bears at its lower end against the bottom of an enlargement of the bore of the sleeve O and at its upper end against a collar N² secured to the plunger N. The upper end of the plunger is beveled at N³ and engages against the corresponding beveled surface P′ of a notch formed in the underside of the plunger P which is movable in a transverse passage K³ formed in the boring bar. A spring P² urges the plunger P to the right as viewed in Fig. 8, in the direction in which plunger P must move to permit plunger N to rise and thereby permit the finishing cutters M to be retracted. A key P⁴ carried by the plunger P and working in a key way formed in the boring bar, prevents rotative movement of the plunger P. At its right hand end, the plunger P is formed with a threaded socket P³ receiving a threaded extension Q′ of the adjusting head or dial member Q. The index member Q is surrounded by an annular member R provided with an internal collar R′ which engages the outer end of a rib formed at the periphery of the member Q so that when the member R is moved in toward the axis of the boring bar the index head Q will be correspondingly moved, and through the lock formed by the threaded connection between members Q and P, the latter also will be moved inward. The member R is surrounded by an annular

member S formed with an internal rib S^2 engaging the outer end of a shoulder formed on the periphery of the member B. The member S is held by pins S′ against rotative movement about its own axis relative to the boring bar, but has freedom for movement in a direction parallel to its axis, as hereinafter described. The member R is normally held against rotative movement about its own axis by means of the set screw R^2 (see Fig. 5) by the member S but by loosening the set screw R^2 the member R may be angularly adjusted to thereby angularly adjust the index point R′ carried at the outer end of the member R. The index point R′ serves as the zero point for the scale carried at the outer end of the dial member Q. The latter may be rotated as by a tool inserted in the socket Q^3 to thereby adjust the plunger P relative to the member Q through the threaded connection between the plunger and the member Q. The member S is formed in its face with a plurality of pockets S^3, one side wall S^4 of each pocket being beveled. In front of the member S is mounted an annular member T which is formed on its back side with teeth T′ each having one side edge T^2 beveled to correspond to the beveled edge S^3. In one adjustment of the apparatus shown in Figs. 13 and 14, the teeth T′ enter the pockets S^3, in which case the front side proper of member S is engaged by the back side proper of the member T, as shown in Figs. 13 and 14. In another position of the parts shown in Fig. 8 the teeth T′ ride up on the body surface of the member S, thus spreading the members S and T apart and forcing the former inward. Since the plunger P moves with the member S, the finishing cutters M are forced out when the members N and T are spread apart, and are retracted when the member T is moved to permit the teeth T′ to enter the pockets S^3 formed in the face of the member S. The member T is held in position by an annular guide member U formed with a shoulder U′ which bears against the outer end of a shoulder formed on the periphery of the member T. The member U is secured in place by screws U^2. To shift the member P axially and thereby force out the finishing cutters M or permit them to be retracted the arm T^3 is rigidly secured to the member T. This arm is formed with an inclined cam slot T^4 receiving a pin H^9 carried by the arm H^8 secured to the end of the tripping bar H previously described. To properly guide the member T it is formed at its upper end with a slot receiving the plate or guide W secured to the boring bar. To hold the member T^3 in each of its two operative positions two shallow sockets T^5 are formed in its back side into one or the other of which springs a holding detent W′ mounted in a socket formed in the boring bar and spring pressed into the position in which it enters the sockets T^5.

The general operation of the mechanism will be plainly apparent to those skilled in the art from the drawings and the foregoing description. Attention is called to the fact that by rotating the member Q the position of the plunger P with respect to the rest of the mechanism may be given a micrometer adjustment to thereby compensate for wear of the finishing cutters or to initially set the finishing cutters to bore a hole of any particular diameter. By properly proportioning the thread pitch of the threaded connection between the members Q and P and the angle of the beveled surfaces N^3 and P′ and the angle of the surfaces of the wedge end N′ of the plunger N and the corresponding surfaces of the cutters M, rotation of the member Q can be caused to produce definite and easily read variations in the diameter of the hole bored by the cutters M. For instance, in the practical use of the invention I have so proportioned these parts that an adjustment of the head Q through an angle corresponding to one unit of the scale indication produces change in diameter of the hole cut of 1/1000 of an inch.

While, as before stated, I may through the adjusting screws O^4 hold the sleeve O in different positions to compensate for small variations in the way in which the tools M are ground, these screws are not always necessary to the successful use of the invention, and in some cases I prefer to temporarily or permanently dispense with the screws O^4 even while providing freedom of movement of the lever O relative to the operating bar K. In such cases the cutters M will float, so to speak, and will adjust themselves to the hole being bored even if the latter is a trifle out of true with respect to the axis of the operating bar as is not unfrequently the case where the roughing cut has been taken under conditions, known to those skilled in the art, which are conducive to the boring of a hole slightly out of true.

The construction described is simple and effective in operation and I have found in actual practice that it permits of boring the axle holes in car wheels more accurately than has heretofore been feasible from a practical standpoint. The provisions for automatically reversing the movement of the boring bar and shifting the finishing cutters at the completion of the roughing cut permits of the effective practical operation of two mills of this character by a single operator.

While in accordance with the provisions of the statutes I have herein illustrated and described the best form of my invention now known to me, it will be obvious to those

skilled in the art that many changes in form may be made without departing from the spirit of my invention, and that some features of the invention may advantageously be employed in some cases without a corresponding use of other features, and in particular that it may sometimes be desirable to dispense with the automatic mechanism for shifting the clutches by which the direction of movement of the boring bar is reversed and by which the finishing cutters are automatically forced out and retracted.

Having now described my invention, what I claim as new, and desire to secure by Letters Patent, is:

1. In a boring mill, the combination of a boring bar, means for giving it a to and fro movement, a set of cutters carried thereby and sharing in said movement, and means dependent on said movement for automatically shifting the cutters relative to the bar into a position, during a movement of the bar in one direction, different from that occupied by them during the preceding movement of the bar in the opposite direction.

2. In a boring mill, the combination of a boring bar, means for giving it a to and fro movement, a set of cutters carried thereby and sharing in said movement, and means dependent on said movement for automatically extending the cutters from one position occupied by them relative to the bar during a movement of the bar in one direction, into a second position, and maintaining them in said second position during the movement of the bar in the opposite direction.

3. In a boring mill, the combination of a boring bar, means for giving the bar a to and fro movement, and two sets of cutters carried by said bar, one set being adapted to operate during a movement of the bar in one direction, and the other set being held in an inoperative position during the movement of the bar in said one direction and adapted to be extended into the operative position when the bar is making its return movement, and mechanism for automatically shifting said second set of cutters in accordance with the movement of the boring bar.

4. In a boring mill, the combination of a boring bar, means for giving the bar a to and fro movement in the direction of its length, a set of cutters carried by the bar adapted to make a rough cut during a movement of the bar in one direction, a set of finishing cutters carried by the bar for making a finishing cut on the return movement of the bar, said finishing cutters being movable from one position in which they do not extend far enough to engage the surface cut by the first set of cutters, to a second position in which they extend far enough to engage and finish said surface, and mechanism for automatically shifting the finishing cutters into said second position after the conclusion of the roughing cut.

5. The combination with a boring bar and a set of cutters movably mounted therein, of a cutter shifting mechanism comprising an actuator pivotally mounted on said bar, to turn relative thereto about an axis transverse to the axis of the bar, a member mounted on said bar to move transversely of the axis of the latter, said actuator and said member being provided with coöperating cam surfaces, whereby, when said actuator is turned on its axis, said member is moved transversely to the axis of the bar, and connections between said cutters and said movable member whereby the movement of the latter transverse to the axis of the bar shifts said cutters.

6. The combination, with a boring bar and a set of cutters movably mounted therein, of a cutter shifting mechanism comprising a movable actuator, and a second movable member mounted on said bar, said actuator and said second movable member being provided with coöperating cam surfaces, and adjustable connections between said second member and the cutters, whereby said cutters are shifted by the relative movement of said actuator and said movable member.

7. The combination, with a boring bar and a set of cutters movably mounted therein, of a cutter shifting mechanism comprising a movable actuator and a second movable member mounted on said boring bar, said actuator and said second movable member being provided with coöperating cam surfaces, a third member adjustably connected to said second member, and means whereby the movement of said third member shifts said cutters.

8. In a boring mill, the combination, with the boring bar, and means for giving it a to and fro movement, of a set of cutters movably mounted in the bar, and means for shifting the cutters as the bar moves back and forth, including an operating member, means holding the member against movement with the bar during an initial movement of the latter in one direction, and automatically rendered ineffective at the end of said initial movement, resilient means acting between the member and bar and put under tension when the member is held against movement with the bar by said holding means, other means preventing relative movement between the bar and member under the action of said resilient means when said holding means are first rendered ineffective, and means for rendering said second holding means ineffective after a further movement in the same direction of said bar, and connections whereby said cutters are shifted by the relative movement of said operating member and said movable member.

9. In a boring mill, the combination, with the boring bar, and means for giving it a to and fro movement, of a set of cutters movably mounted in the bar, and means for shifting the cutters as the bar moves back and forth, including an operating member, and connections whereby said cutters are shifted by the relative movement of said operating member and said movable member, means holding the member against movement with the bar during an initial movement of the latter in one direction, and automatically rendered ineffective at the end of said initial movement, resilient means acting between the member and bar and put under tension when the member is held against movement with the bar by said holding means, other means preventing relative movement between the bar and member under the action of said resilient means when said holding means are first rendered ineffective, and means for rendering said second holding means ineffective after a further movement in the same direction of said bar, and mechanism for reversing the movement of the bar actuated by the movement of said member relative to the bar occurring when said second holding means is rendered ineffective.

10. In a boring mill, the combination, with the boring bar and means for giving it a to and fro movement, of a set of cutters movably mounted in the bar, and means for shifting the cutters at predetermined points in the movement of the bar including an operating member, means for holding the member against movement relative to the bar during intermediate portions of the movement of the bar in each direction, and means for moving the member relative to the bar in one direction at one end of the to and fro movement of the bar and in the opposite direction at the opposite end of the to and fro movement of the bar, and connections whereby said cutters are shifted by the relative movement of said operating member and said movable member.

11. In a boring mill, the combination, with the boring bar and means for giving it a to and fro movement, of a set of cutters movably mounted in the bar and means for shifting the cutters at predetermined points in the movement of the bar including an operating member, means for holding the member against movement relative to the bar during intermediate portions of the movement of the bar in each direction, and means for moving the member relative to the bar in one direction at one end of the to and fro movement of the bar and in the opposite direction at the opposite end of the to and fro movement of the bar, and clutch mechanism controlling the to and fro movement of the bar actuated by said member as it reaches the ends of its path of movement.

12. In a boring mill, the combination, with the boring bar, of means for giving it a to and fro movement, a set of cutters movably mounted in the bar, and means for shifting the cutters at one end of the stroke of the bar, including an operating member, means for holding the member against movement relative to the bar during the intermediate portion of the movement of the bar toward said one end of its movement, means for moving the member relative to the bar as the latter reaches said one end of its movement, and mechanism actuated by said member on said relative movement for reversing the movement of the bar.

13. The combination, with a boring bar and a set of cutters movably mounted therein, of a cutter shifting mechanism comprising a plunger slidingly mounted in said bar and provided with a head and a threaded connection between said plunger and the head thereof, resilient means urging the plunger in one direction, and means for moving the plunger in the opposite direction, comprising an actuator movably mounted on said bar, and camming provisions acting between said head and actuator.

14. The combination, with a boring bar and a set of cutters movably mounted therein, of a cutter shifting mechanism comprising a plunger slidingly mounted in said bar and having a compound head comprising a central portion in threaded engagement with the plunger to permit the head to be adjusted toward and away from the plunger, and a second portion, an actuator member movably secured to the bar, said actuating member and said second portion being provided with coöperating cam surfaces whereby when said actuating member is moved the plunger is caused to move away from or allowed to move toward the actuating member, means for urging the plunger toward said actuating member, and provisions whereby the movements of the plunger cause the cutters to be shifted.

15. The combination, with a boring bar and a set of cutters movably mounted therein, of a cutter shifting mechanism comprising a plunger slidingly mounted in said bar and having a compound head comprising a central portion in threaded engagement with the plunger to permit the head to be adjusted toward and away from the plunger, and a second portion, an actuator member movably secured to the bar, provisions including coöperating cam surfaces on said actuating member and said second portion whereby when said actuating member is moved the plunger is caused to move relatively to said actuating member, resilient means for urging the plunger toward said actuating member and provisions whereby the movements of the plunger cause the cutters to be shifted.

16. The combination, with a boring bar and a set of cutters movably mounted therein, of a cutter shifting mechanism comprising a plunger slidingly mounted in said bar and having a compound head formed of one member connected to the body of the plunger by a threaded connection and rotatable to adjust the head toward and away from the plunger, a member surrounding the first mentioned member and provided with an index mark whereby the rotary adjustment of the first member may be measured, said second member being rotatable to adjust the setting of the index mark, and a third member held against rotative movement, and a rotatable actuating member pivotally connected to the bar, said actuating member and said third member being provided with cam surfaces whereby when the actuating member is rotated, the third member is moved also, said first, second and third members having engaging portions whereby the movement of the third member causes a movement of the entire head and thereby of the plunger, resilient means for moving the plunger in a direction opposite to that in which it is moved by the rotation of the actuating member, and provisions whereby the movement of the plunger causes the tool to be adjusted.

17. The combination, with a boring bar having a longitudinal passage formed in it and intersecting transverse tool receiving passages, of tools located in said transverse passages, a plunger mounted in said longitudinal passage, said tools and plunger having coöperating wedging surfaces whereby when the plunger is axially adjusted the tools are adjusted transversely of said bar, means for axially adjusting said plunger, said plunger being mounted to permit its lower end to move transversely to the boring bar, and means for adjusting the lower end of said plunger transversely of the boring bar.

18. The combination, with a boring bar having a longitudinal passage formed in it and intersecting parallel transverse tool receiving passages, of tools located in said transverse passages, a sleeve mounted in said longitudinal passage, means for adjusting the lower end of said sleeve transversely of said passage in a direction parallel to the direction of the tool receiving passages, a plunger slidingly mounted in said sleeve, said tools and plunger having coöperating wedging surfaces whereby when the plunger is slidingly adjusted in said sleeve the tools are forced outward, and means for slidingly adjusting said plunger.

19. The combination, with a boring bar having a longitudinal passage formed in it and intersecting transverse tool receiving passages, of tools located in said transverse passages, a plunger mounted in said longitudinal passage, said tools and plunger having coöperating wedging surfaces whereby when the plunger is axially adjusted in one direction the tools are adjusted transversely of the bar, means for axially adjusting said plunger, said plunger being mounted to permit its lower end to move transversely of the boring bar.

20. The combination with a boring bar formed with a longitudinal passage, transverse tool receiving passages intersecting said longitudinal passage, and another transverse passage intersecting the longitudinal passage at a distance from said tool receiving passages, of tools located in said tool receiving passages, a plunger mounted in said longitudinal passage, said tools and plunger having coöperating wedging surfaces whereby when the plunger is adjusted axially the tools are moved transversely of the boring bar, a second plunger located in said other transverse passage, the two plungers having coöperating wedging surfaces whereby when said second plunger is moved in its receiving passage transversely of the boring bar, the first mentioned plunger is axially adjusted.

21. The combination with a boring bar formed with a longitudinal passage, transverse tool receiving passages intersecting said longitudinal passage, and another transverse passage intersecting the longitudinal passage at a distance from said tool receiving passage, of tools located in said tool receiving passages, a plunger mounted in said longitudinal passage, said tools and plunger having coöperating wedging surfaces whereby when the plunger is adjusted axially the tools are moved transversely of the boring bar, a second plunger located in said other transverse passage, the two plungers having coöperating wedging surfaces whereby when said second plunger is moved in its receiving passage transversely of the boring bar, the first mentioned plunger is axially adjusted, means for producing a substantial movement of said second plunger in its receiving passage transversely of the boring bar to throw tools into and out of the operative position, and provisions for obtaining a micrometer adjustment of said second plunger to thereby obtain a micrometer adjustment of the tools.

22. The combination, with a boring bar formed with a longitudinal passage, transverse tool receiving passages intersecting said longitudinal passage, and another transverse passage intersecting the longitudinal passage at a distance from said tool receiving passages, of tools located in said tool receiving passages, a plunger mounted in said longitudinal passage, said tools and plunger having coöperating wedging surfaces whereby when the plunger is adjusted axially the tools are moved transversely of the boring bar, a second plunger located in

said other transverse passage, the two plungers having coöperating wedging surfaces whereby when said second plunger is moved transversely of the boring bar, the first mentioned plunger is axially adjusted, means carried by the bar for giving said second plunger a transverse movement of determined extent, and provisions for maintaining a transverse micrometer adjustment of said second plunger.

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Witnesses:
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