

June 9, 1931.

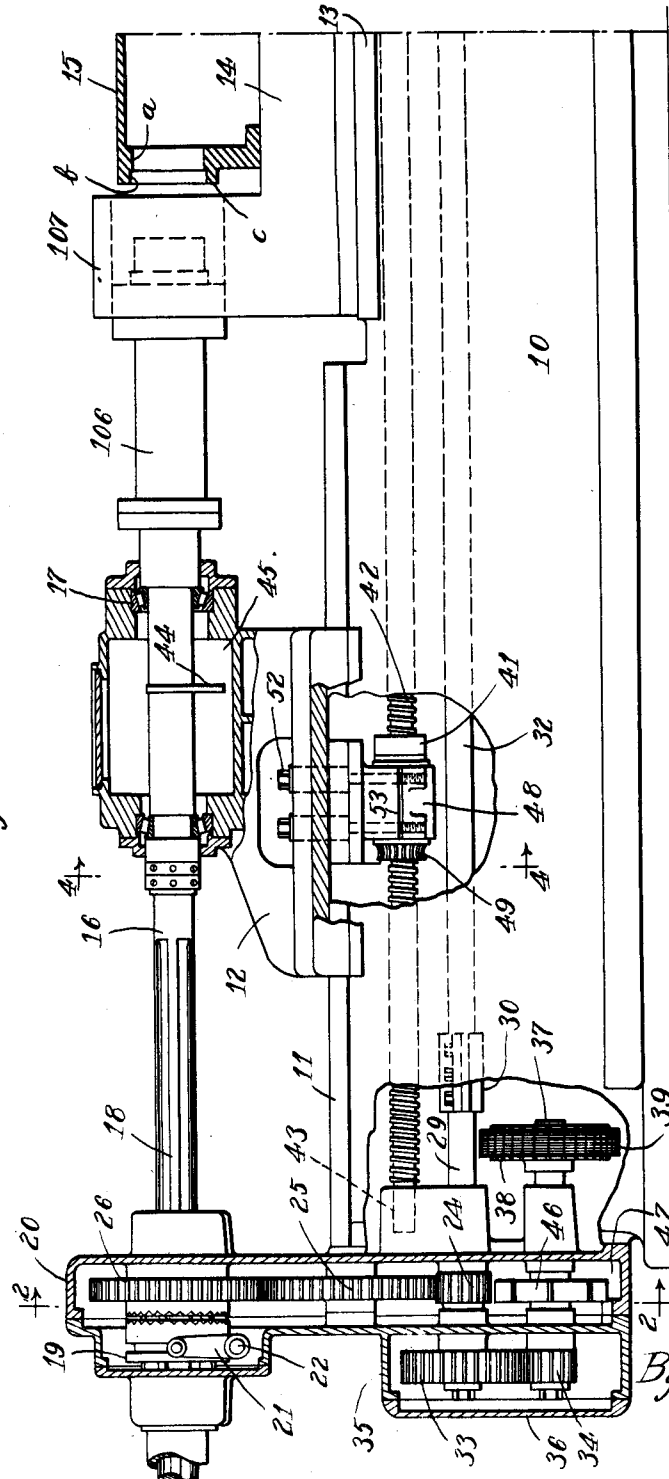
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1,809,188

HORIZONTAL BORING AND TAPPING MACHINE

Filed Jan. 28, 1927 7 Sheets-Sheet 1

Fig. 1.



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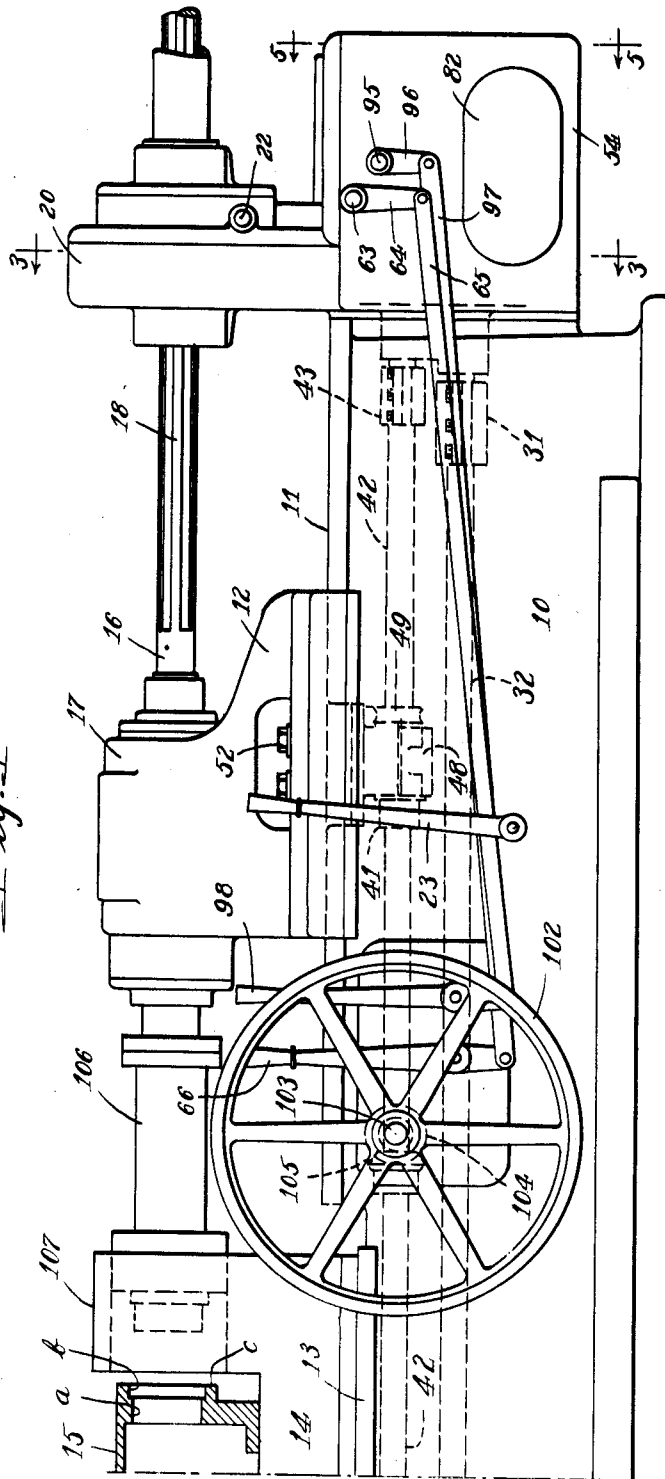
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HORIZONTAL BORING AND TAPPING MACHINE

Filed Jan. 28, 1927 7 Sheets-Sheet 2

Fig. 1a



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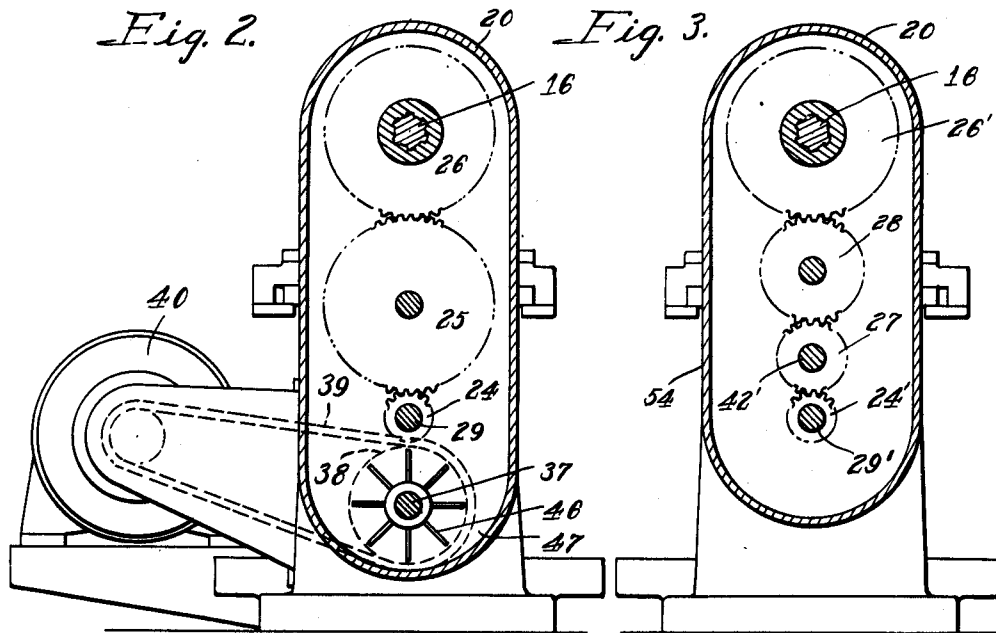
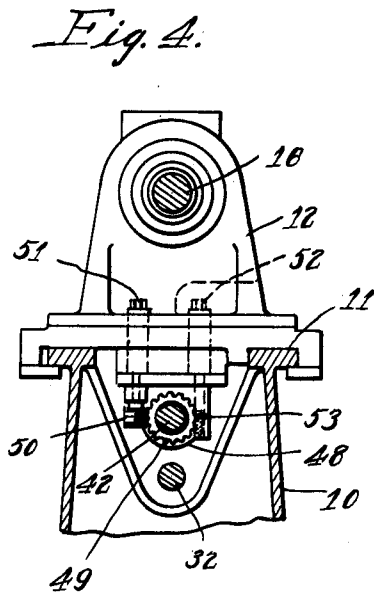
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HORIZONTAL BORING AND TAPPING MACHINE

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HORIZONTAL BORING AND TAPPING MACHINE

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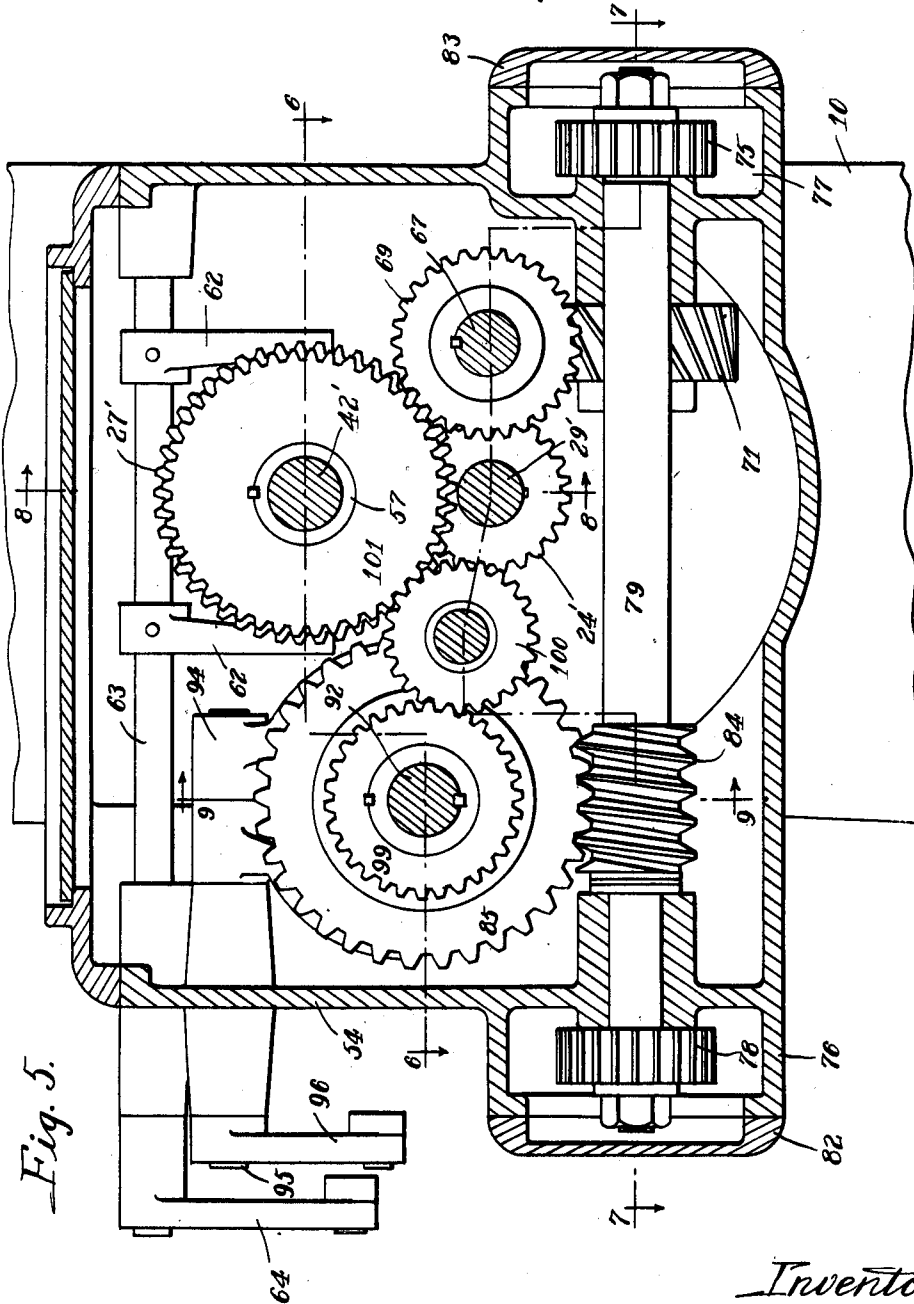


Fig. 5.

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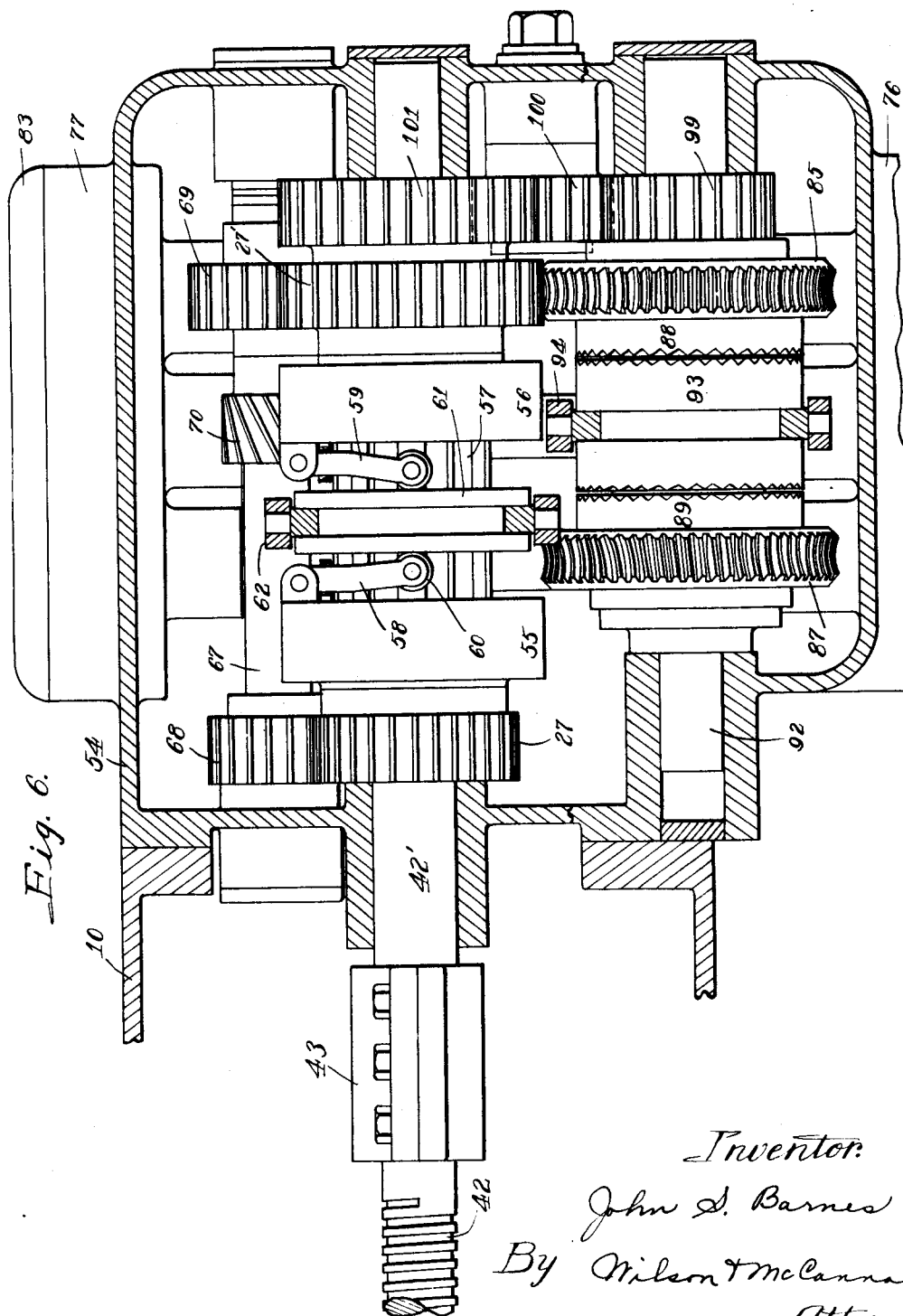
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HORIZONTAL BORING AND TAPPING MACHINE

Filed Jan. 28, 1927 7 Sheets-Sheet 5



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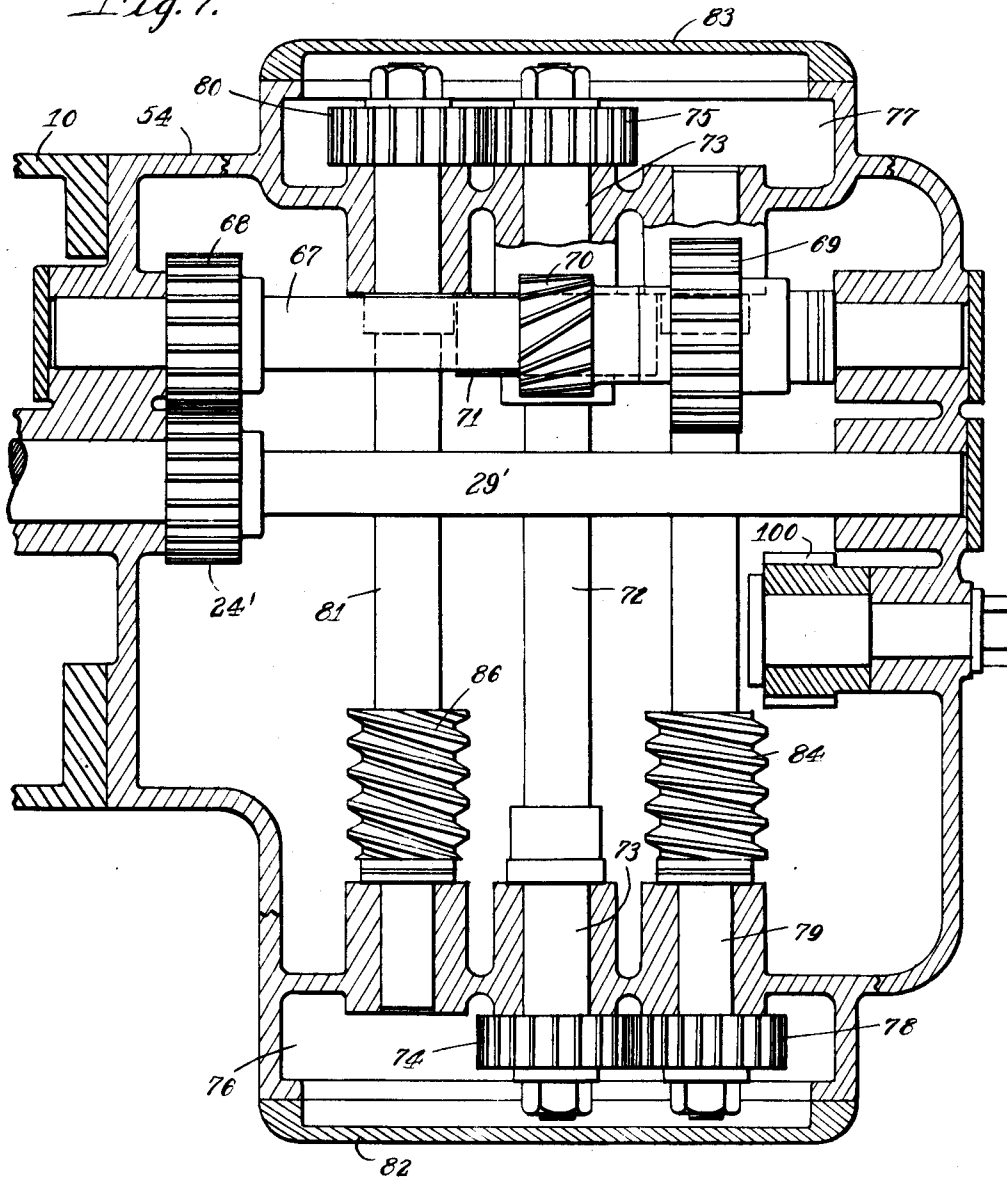
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HORIZONTAL BORING AND TAPPING MACHINE

Filed Jan. 28, 1927 7 Sheets-Sheet 6

Fig. 7.



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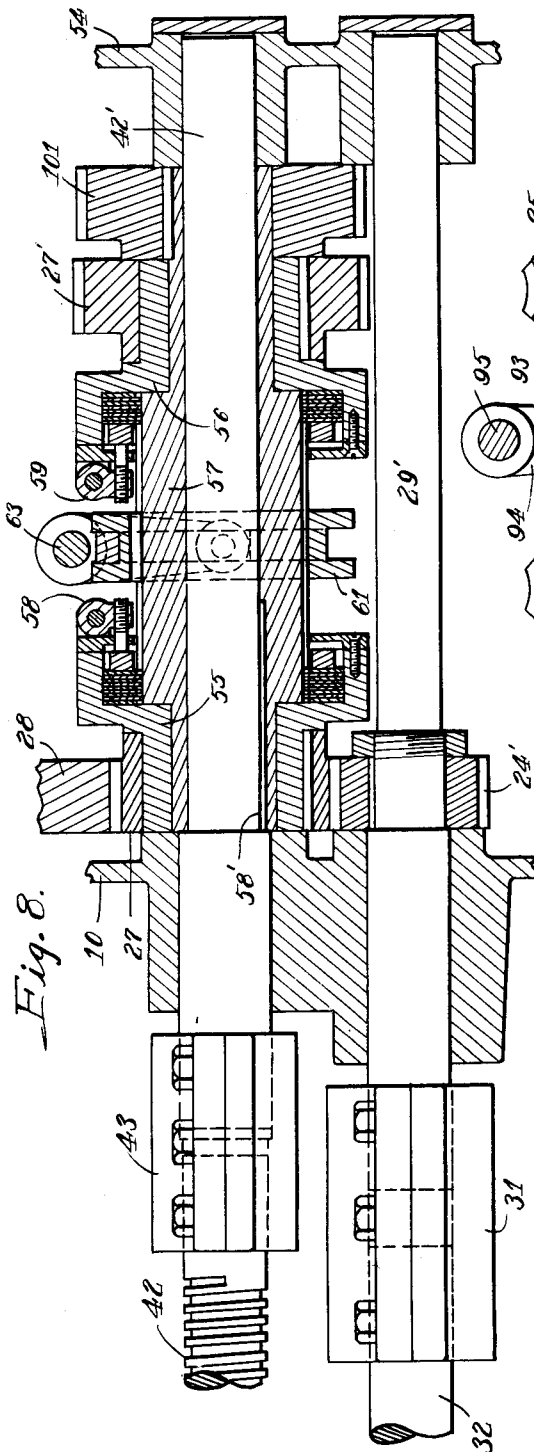
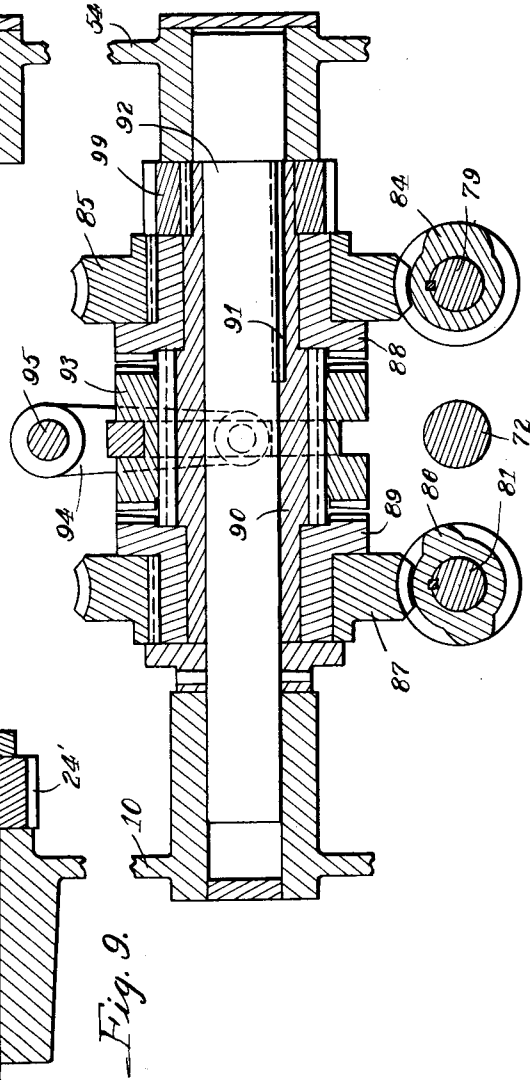
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HORIZONTAL BORING AND TAPPING MACHINE

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UNITED STATES PATENT OFFICE

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HORIZONTAL BORING AND TAPPING MACHINE

Application filed January 28, 1927. Serial No. 164,226.

This invention relates to a machine for performing such operations as boring, reaming, tapping and facing, and is especially concerned with a machine of this kind designed for general utility in the handling of many different kinds of work, such as are encountered in general production where any one or more, or all, of the operations referred to may be required.

One of the principal objects of the invention lies in the provision of an improved type of double end horizontal boring machine having the two spindle carriages thereof arranged for operation in unison and through the same cycle to complete similar operations at both ends of a piece of work as, for example, in the case of a rear axle housing, although the invention is not particularly limited in certain of its phases to the double end type of machine but may also be employed in a machine of the single end type or some other plural-way types depending on the use to which the same is to be put.

As applied more particularly to the double end or plural way type of machine, but also of utility on a single end machine, my invention provides novel means whereby the individual spindle carriages may be adjusted on the end ways as required by the particular job being handled, the operator being enabled to complete the set-up of the machine with accuracy, ease, and facility so that the carriages, in going through the cycle of movements will enable the performance of the operations required on the work.

An important feature of my invention lies in the provision of a machine having a carriage with a spindle mounted therein operated by a feed screw driven by positive gearing from the drive shaft, the spindle and feed screw being also interconnected by positive gearing in close coupled relation, and there being gearing in a feed box providing for a positive boring feed followed by a positive tapping feed, the speed of the spindle having a direct relationship to the tap feed drive of the feed screw, so that the tap is bound to have precisely the proper lead and there will be no elongation or

crowding of the threads. A machine of this kind is particularly well adapted for boring and tapping both ends of an automobile rear axle housing, where, in order to have a theoretically perfect running set of gears, it is imperative that the bearings for the two shaft sections be accurately aligned, and, not only that, but the threaded portions of the bores be in exact alignment with the bores themselves.

Another important feature of my invention consists in the provision of a drive for the spindles interconnected with the screw feed shaft drive, the former being driven by transmission means extended thereto from the screw feed shaft, the latter in turn being driven through changeable pick-off gears in the bed of the machine. This relationship of the screw feed shaft drive and spindle drive is of particular importance as regards the performance of tapping operations since it allows the screw feed shaft to back up sufficiently to take up any backlash in the gears before the spindle reverses and thereby prevents the breakage of the taps. This relationship of the two drives with the same pick-off gears also results in a predetermined relationship being maintained between the driving of the screw feed shaft and the driving of the spindles, any changes in the ratio of the pick-off gears resulting only in a stepping up or down of the speed of both alike.

Also worthy of special mention, in connection with the first feature discussed above, is the novel gearing in the feed box of the machine affording rapid approach or traverse and rapid return movements for the spindle carriages and two different feed speeds as, for example, a slow feed for boring and reaming and a faster feed for tapping, the gearing being so arranged that the shifting of clutches brings about a change from rapid approach to the boring feed, for example, or from the boring feed to a tapping feed, and eventually the rapid return. In the case of the tapping feed, the carriage is fed positively to give the correct lead to the tap. In connection with the gearing, I also prefer to provide changeable

pick-off gears for varying the tapping feed or the boring feed, or both. The gearing referred to is particularly well adapted for automatically operated machines, although for simplicity in the present disclosure, manually operated shifting means is shown. In conjunction with the feed box, I have also provided for hand feeding of the spindle carriages to perform facing operations since the rate of feed for such operations depends on the cut to be made and will accordingly be considerably different for different jobs and, in most cases, will be considerably slower than either of the tapping or boring feeds.

The invention is illustrated in the accompanying drawings, in which—

Figure 1 is a front view of one end of a double end horizontal boring machine embodying my invention, certain parts being broken away for purposes of better illustration;

Fig. 1a is a view constituting an extension of Fig. 1 and showing the other end of the same machine, namely the control end at which the operator is stationed;

Figs. 2 and 3 are vertical sections through the two ends of the machine taken on the lines 2—2 and 3—3 of Figs. 1 and 1a respectively;

Fig. 4 is a vertical sectional detail taken on the line 4—4 of Fig. 1 serving to illustrate the means for manual adjustment or setting of the spindle carriages;

Fig. 5 is an enlarged, vertical section through the feed box and is taken on the line 5—5 of Fig. 1a;

Figs. 6 and 7 are horizontal sections taken on the broken lines 6—6 and 7—7 respectively of Fig. 5; and

Figs. 8 and 9 are vertical sections taken on the lines 8—8 and 9—9 of Fig. 5.

Throughout the views the same reference numerals are applied to corresponding parts.

The machine selected for the purposes of the present description is one especially designed for performing the boring, tapping, and facing operations on automobile rear axle housings and, for this reason, is a machine of the double end type in order to take care of these operations at both ends of the work at the same time, the two spindle carriages employed being operated in unison and through the same cycle for each piece of work. However, the invention is in no way limited to the double end type of machine but may be embodied in a single end type as well, any plural-way type, depending on the class of work to be handled. Furthermore, as regards the operations to be performed, the present invention contemplates use of the machine for general production purposes in the handling of many different kinds of work in performing any one or more, or all, of the operations of boring,

reaming, tapping, and facing, as required by the particular job encountered. In actual practice, a machine of this kind, while designed for general utility, is usually set up for certain special work and, when so employed, permits of volume production especially because of the novel feed box gearing and the controls therefor which lend themselves to automatic operation so that a cycle of movements for the carriages may be plotted consisting of rapid traverse or approach, a shift from this feed to a boring feed, for example, and from that feed to a tapping feed and then, unless further operations are to be performed, such as a facing operation, a shift may be made to the rapid return feed to withdraw the carriage from the work. A cycle of operations such as this is merely one instance of the way in which a machine embodying my invention may be used. The cycle referred to is similar to that used in operating on rear axle housings and is varied to suit the special requirements of the particular work being handled. The machines of the present type have been found suitable for performing any multiple drilling and tapping by use of the proper multiple tool heads and have been used in the boring and reaming of holes in engine cylinder blocks for the crank shaft, cam shaft, and pump and generator shafts. In passing from these general introductory remarks in regard to the invention to the description of the construction and operation of the machine illustrated, it will be pointed out that, while the machine is particularly designed and adapted for automatic operation of the clutches in the feed box whereby the cycle of operations of the spindle carriages is automatically controlled from start to finish, the present machine is illustrated as equipped with hand levers for accomplishing the shifting of the clutches since, after all, the automatic shifting means usually employed, such as engaging and releasing dogs, are well known in the art and no novelty is claimed therein. The addition of this mechanism would, therefore, serve more to confuse than to clarify the description.

The machine illustrated comprises an elongated bed 10 providing ways 11 at the opposite ends thereof for the spindle carriages 12 and providing between these ways a table 13 on which may be mounted suitable fixtures such as that shown at 14 to carry the work to be operated upon. In the present case, an automobile rear axle housing 15 is shown mounted in the fixture, only the ends thereof, on which the operations of boring, tapping and facing are performed, being illustrated. The carriages 12 support the operating ends of the spindles 16 in suitable bearings 17, the spindles being splined, as indicated at 18, for a sliding driving fit in clutch collars 19 in the end

housings 20. The spindles are arranged to be thrown into and out of operation by the yokes 21 pivoted at 22 and operated through suitable intermediate linkage by the hand lever 23. The clutch collars 19 for the two spindles are interconnected so that the spindles are thrown into and out of operation together. The drive for the spindles is extended from the base through a train of gears 24, 25, and 26 in the end housing at one end of the machine and through a train of gears 24', 27, 28, and 26' in the end housing at the other end of the machine. The gears 26 and 26' turn freely on the splined ends of the spindles and have the hubs thereof provided with clutch jaws to fit complementary jaws on the clutch collars 19, as shown in Fig. 1. The single idler gear 25 at the one end of the machine and the two idler gears 27 and 28 at the other end serve to communicate drive to the spindles in opposite directions which, of course, is required in operating on both ends of the same piece of work inasmuch as the threads at one end of the housing 15 have to be right handed and those at the other end left handed. The gears 24 and 24' are mounted on stub shafts 29 and 29' respectively, and are interconnected by couplings 30 and 31 through a shaft 32 extending lengthwise of the bed. The couplings 30 and 31 are preferably cast so as to fracture under excessive load and thus prevent the stripping of gears or the breakage of other parts in the event of a jam. The couplings also facilitate the assembling of the machine by providing a detachable connection between the stub shafts and the shaft 32. The end housings may be assembled separately and be bolted to the ends of the bed when all of the parts of the latter have been assembled. The gears 24 and 24' are driven with the gear 33 which is one of two changeable pick-off gears 33 and 34 mounted in a casing 35 on the housing 20 (Fig. 1) and accessible when the cover plate 36 is removed. The gear 34 is mounted on a shaft 37 bearing a sprocket 38 driven through a linked chain 39 by the electric motor 40 mounted on a suitable bracket alongside the lower end of the end housing 20 (Fig. 2). The motor 40 is of any suitable reversible type in order that the direction of rotation of the spindles may be reversed at will. The spindle carriages 12 are moved on their ways by the threaded engagement of nuts 41 carried thereby with the right hand and left hand threads of the screw feed shaft 42. The latter, or at least a short end section 42' thereof, is journaled at one end, as shown in Fig. 8, in one end wall of the bed 10 and is arranged to be driven in either direction by two gears depending on which gear the shaft is clutched to, one of these gears being the gear 27 previously referred to, and the other a gear 27' to be hereinafter referred to. The screw feed shaft 42 extends lengthwise of the bed 10 parallel with the shaft 32 previously referred to, and the right and left hand threads thereof, each of which extend half the length of the shaft, serve to feed the carriages in opposite directions so that they travel either toward one another or away from one another, depending on the direction in which the screw feed shaft is driven. The shaft 42 is also preferably provided with a coupling 43 similar to the couplings 30 and 31 for a similar purpose, the said end section 42' for the screw feed shaft being journaled in the feed box and joined with the screw feed shaft in the coupling 43. From the description thus far advanced, it will appear that the drive for the spindles is provided by trains of intermediate gears extending thereto from the base and that the screw feed shaft has its drive gear interposed in one of the trains nearest the first gear of the train. This arrangement permits the screw feed shaft to back up so as to take up the back lash in the gears before the spindles are reversed whenever the motor 40 is reversed as, for example, at the end of a tapping operation when the taps are to be withdrawn. The usual difficulty in machines of this type previously available where the spindles were usually driven independently of the screw feed shaft was that the taps twisted off because the spindles reversed an interval before the spindle carriages commenced to back up, the lag in the movement of the carriages being the direct result of back lash in the train of gears driving the screw feed shaft. This outstanding defect in the design of these other machines is entirely obviated by the driving arrangement provided in accordance with my invention. This difficulty was, of course, of no consequence where the taps were collapsible but it is obvious that this necessity for using collapsible taps placed a serious limitation on the uses to which a machine could be put, inasmuch as collapsible taps cannot be used where the holes are any smaller than a certain size, usually about seven-eighths of an inch in diameter. The expense involved in the breakage of the taps can be readily appreciated when it is considered that certain jobs require multiple tool heads requiring perhaps a dozen or more taps all of which would be broken in one reverse of the spindle. Another advantage derived by the driving arrangement illustrated is that one set of changeable pick-off gears suffices for both the screw feed shaft and the spindles and by changing these gears the operation of the entire machine is sped up or slowed down as desired, without disturbing the predetermined driving relationship between the screw feed shaft and the spindles. In passing, attention may be

called to the oiling ring 44 one of which is provided in each of the spindle bearings on the carriages 12 to pick up oil from a basin 45 for distribution to the bearings 17. Attention may also be called to the paddle wheel 46 which serves to splash oil from the basin 47 in the bottom of the housing 20 onto the lowermost gear of the train of gears therein, the oil being carried from this gear to its companion gear and so on through the train.

In the setting up of the machine, the spindle carriages may have to be adjusted with respect to one another which, of course, would necessitate the individual adjustment thereof lengthwise relative to the screw feed shaft. For this purpose, I have provided means for manually rotating each nut 41 in its bearing 48 (see Fig. 4). The nut 41 of each of the carriages is provided with a worm gear 49 on one end thereof meshing with a worm 50 arranged to be rotated by hand by engaging a crank or the like with the stud 51 projecting from the base of the carriage at one side of the spindle. The nut, by reason of its threading on the screw feed shaft, will obviously move the carriage in either direction depending on the direction of rotation thereof. After the required adjustment has been made, the nut 41 is suitably clamped in its position in the bearing 48 by the tightening of the bolts 52. The bearing 48 is suitably split lengthwise of one side thereof, as indicated at 53, to afford the desired clamping action. It will be apparent that the adjustment makes it possible to set the carriages in any desired position with respect to one another, the one being advanced or retracted with respect to the other depending on the requirements of the job being handled.

Referring now to Figs. 5 to 9 inclusive for the description of the novel gearing and controlling clutch mechanism therefor, this gearing is disposed in the feed box 54 mounted at one end of the bed of the machine. The feed box, as shown in Fig. 1a, preferably has the end housing 20 formed as an extension thereof. The stub shaft 29', above referred to, is obviously the constantly rotating drive shaft of the feed box since it constitutes an extension of the drive shaft 32. The gears 27 and 27', previously referred to, are keyed to the driving parts of two clutches 55 and 56 respectively. These parts, in the disengaged condition of the clutches, turn freely on the driven part 57 common to the two clutches, the latter being splined as at 58' to the stub shaft 42' which, as stated before, constitutes an extension of the screw feed shaft 42. The driving and driven parts of the clutches 55 and 56 carry friction disks, as shown in Fig. 8, arranged to be brought into frictional engagement by operation of the levers 58 and

59 respectively. These levers have rollers 60 on the free ends thereof operating against the opposite sides of the collar 61 splined on the driven member 57. The collar 61 is arranged to be shifted by yoke arms 62 in the oscillation of a shaft 63 to engage either one of the clutches, the clutch 55 serving to communicate the rapid return drive and the clutch 56 the rapid approach or traverse drive to the screw feed shaft 42. The shaft 63 is oscillated by a lever 64 connected by means of a link 65 to a hand lever 66 disposed at the operator's end of the machine. The driving connection for the rapid return clutch 55 is believed to be clear from the foregoing description and consists merely in the driving of the gear 27 by the gear 24'. The drive for the rapid traverse clutch 56 involves the driving of an intermediate counter shaft 67 in order to secure a drive in the reverse direction. The gear 24' meshes with a gear 68 fixed on the counter shaft 67 at one end of the latter, and another gear 69 fixed on the other end of the shaft meshes with the gear 27'. It is believed to be clear from the foregoing how the reversal in direction of drive as between the two clutches 55 and 56 is secured.

Turning now to the gearing providing a slow feed such as is used for boring or reaming and a faster feed such as is used for tapping, attention is called to the spiral gear 70 fixed on the shaft 67. This gear drives another spiral gear 71 fixed on a cross shaft 72 journaled in bearings 73 in the front and rear walls of the feed box. This shaft carries pick-off gears 74 and 75 on the opposite ends thereof in the casings 76 and 77 respectively. The gear 74 has a companion pick-off gear 78 mounted on a shaft 79 disposed in parallel relation with the shaft 72. The gear 75 meshes with a companion pick-off gear 80 mounted on another shaft 81 parallel to the other two shafts referred to. The two pairs of pick-off gears are accessible when the cover plates 82 and 83 on the casings 76 and 77 are removed. The pick-off gears 74 and 78 are arranged to be changed to provide any desired variation of the slow feed for boring and reaming while the pair of pick-off gears 75 and 80 may be changed to provide for any desired variation in the faster feed used for tapping. The shafts 79 and 81 are obviously driven in the same direction, but the speeds of these shafts will be different according to the gear ratios provided by the pairs of pick-off gears. The shaft 79 has a worm 84 fixed thereon meshing with a worm gear 85 while the shaft 81 has a worm 86 thereon meshing with a worm gear 87. The slower rate of feed derived through the gears 74 and 78 is also attributable to the fact that the worm 84 has a low pitched single lead thread, whereas the worm 86 operating in connec-

tion with the gears 75 and 80 for the higher rate of feeding used in tapping operations has a higher pitched double lead thread. The two worm gears 85 and 87 driven by the worms 84 and 86 are keyed to the driving elements of the two clutches 88 and 89 respectively, mounted for rotation on a driven element 90 common to the two clutches. The latter is splined, as at 91, on a shaft 92 received in bearings in the end walls of the feed box. The driven element 90 of the two clutches has a collar 93 splined thereon and provided with clutch jaws on the opposite ends thereof arranged to engage complementary clutch jaws provided on the driving elements 88 and 89 whereby to communicate drive to the driven element 90 from either of the gears 85 and 87. A shifting yoke 94, mounted to oscillate with a shaft 95, is provided for shifting the collar 93. The shaft 95 is oscillated by a lever 96 through a link connection 97 with the hand lever 98. When either one of the two clutches 88 and 89 is engaged a gear 99 keyed on the driven element 90 common to the two clutches is driven and transmits the drive through an intermediate idler gear 100 to the gear 101 keyed on the driven element 57 common to the two clutches 55 and 56 previously referred to. Thus the shifting of the hand lever 66, previously referred to, engages either a rapid traverse or a rapid return feed for the carriages 12 whereas the shifting of the lever 98 engages either a slow feed for boring and reaming or a faster feed for tapping but under any circumstances only one of the clutches will be engaged at a time. The shifting of the clutch collar 61 instead of being accomplished by the use of a hand lever 66 may obviously be secured by the use of engaging and releasing dogs and the same is true of the clutch collar 93 which, as herein described, has connection with the hand lever 98. No limitation, therefore, should be imposed on the application of the invention by reason of the particular form of means herein illustrated. As a matter of fact, the mechanism in the feed box is particularly designed and intended for automatic operation.

In addition to providing for the different feeds above described, I have also provided a hand wheel 102 to be used in feeding the carriages by hand as, for example, in performing a facing operation. This wheel is fixed on a shaft 103 bearing a bevel gear 104 meshing with a bevel 105 splined on the feed screw shaft 42, the gear 105 being held against endwise movement in a suitable yoke provided on the inside wall of the bed 10. If desired, the hand wheel may be detachably clutched in connection with the shaft 103 or the gear 104 may be unmeshed from engagement with the gear 105 until such time as hand operation of the ma-

chine is desired. Making this provision would obviate the necessity for the hand wheel rotating when the carriages were being fed by power. The carriages are arranged to be fed by hand in this way in order to accommodate practically any facing operation which may be encountered. Hand feeding is practically necessitated since the rate of feed is usually considerably slower than that for boring or reaming and will vary considerably for different jobs.

In conclusion, attention may be called to the tool heads 106 mounted on the ends of the spindles 16. In the present case, each of these heads is arranged for operation through a pilot bearing 107 provided on the fixture 14 and suitable tools are provided thereon to perform the boring, tapping, and facing operations; the two surfaces designated *a* and *b* require a boring operation while the latter also requires a tapping operation. The proper tools for all of these operations are provided on the head 106 in accordance with the usual practice. The use of inserted cutting teeth or the like for jobs of this kind is so well known as to require no description and the same is true of the teeth used in the facing off of the surface designated *c*. Where the character of the work requires the use of a cluster of tools the proper multiple tool heads will, of course, be employed, these being provided of special forms to suit special requirements.

It is believed that the foregoing description conveys a full understanding of my invention and of the many advantages and increased range of utility which is afforded in a machine constructed in accordance therewith as compared with machines of a similar type provided in the past. It is further believed that a disclosure of this embodiment of my invention will naturally suggest other possible embodiments as well as variations in the design, construction, or arrangement of the parts, especially in the case of those skilled in the art to which the invention relates. It is, therefore, to be understood that no limitation is placed on the invention by reason of the particular embodiment illustrated but it is the endeavor in the appended claims to cover all changes within the spirit and scope of the invention.

I claim:

1. In a machine of the character described adapted for performing tapping operations, a bed providing ways thereon, a carriage movable on said ways, a feed screw rotatably mounted in said bed for feeding said carriage, a spindle arranged to carry a tap rotatably mounted in said carriage and arranged to be fed therewith, a driving element in said bed having connection with a source of power to be driven in either direction, transmission gears between said driving element and said feed screw for driving

the latter, and other transmission gears between said feed screw and said spindle for driving the latter whereby the driven gear for the spindle is more remote from the driving element than the driven gear for the feed screw, for the purposes described.

2. In a machine as set forth in claim 1, the provision of a single set of changeable pick-off gears in the transmission between the driving element and the feed screw whereby a change in the ratio of said pick-off gears serves to speed up or slow down the operation of both the feed screw and spindle without affecting the predetermined relationship between the driving of the spindle and the driving of the feed screw.

3. In a machine of the character described, a bed providing ways thereon, a carriage movably mounted on said ways, a spindle rotatably mounted in said carriage and arranged to move therewith, a feed screw shaft rotatably mounted in said bed and arranged in the turning thereof to communicate movement to the carriage, said feed screw shaft extending into a feed box, a drive shaft also extending into said feed box, a gearing connection between the latter shaft and the spindle including a gear loosely mounted on the feed screw shaft and arranged when clutched thereto to drive the same, and other gearing in said feed box between said drive shaft and said feed screw shaft arranged when clutched to the latter to communicate another drive or drives thereto.

4. In a machine of the character described, a bed providing ways thereon, a carriage movably mounted on said ways, a spindle rotatably mounted in said carriage and arranged to move therewith, a feed screw shaft rotatably mounted in said bed and arranged in the turning thereof to communicate movement to the carriage, said feed screw shaft extending into a feed box, a drive shaft also extending into said feed box and having a gear thereon constantly turning therewith in the operation thereof, a gear meshing therewith and mounted freely on the feed screw shaft to turn constantly with the drive shaft, a train of gears extended from said last mentioned gear to the spindle for driving the latter, another gear freely mounted on the feed screw shaft but driven in the reverse direction from its companion gear by gearing between the same and the drive shaft, and means for selectively clutching either of said gears with said feed screw shaft.

5. In a machine as set forth in claim 4 wherein the companion gears on said feed screw shaft provide for rapid traverse and rapid return driving of the feed screw shaft, the provision of a third gear constantly connected with said feed screw shaft to communicate a feed drive to the latter, and

auxiliary gearing between said drive shaft and said feed gear providing a speed reduction for the feed drive, said gearing including a clutch arranged to be engaged to communicate feed drive to the feed screw shaft, said clutch being engaged when neither of the companion gears on the feed screw shaft are clutched therewith. 70

6. In a machine of the character described, a bed providing ways thereon, a carriage movably mounted on said ways, a spindle rotatably mounted in said carriage and arranged to move therewith, a feed screw shaft rotatably mounted in said bed and arranged in the turning thereof to communicate feed movement to the carriage, said feed screw shaft extending into a feed box, a drive shaft also extending into said feed box, a gear fixed on said drive shaft to turn constantly therewith in its operation, a pair of companion gears mounted freely on said feed screw shaft, one of said companion gears being driven from said first mentioned gear and the other of said companion gears being also driven therefrom but in the reverse direction, means for selectively clutching either of said gears with said feed screw shaft whereby to communicate a rapid return or rapid traverse drive thereto, another gear to communicate a feed drive to said screw feed shaft in the same direction as the rapid traverse drive, reduction gearing connected with said feed gear and driven from the drive shaft gear, and a clutch for throwing said feed gear into operation to transmit the feed drive to said screw feed shaft from said reduction gearing, said clutch being engaged when neither of the companion gears is clutched with the feed screw shaft. 75 80 85 90 95 100 105

7. In a structure as set forth in claim 6, the provision in connection with said reduction gearing of changeable pick-off gears whereby to change the driving ratio between the drive shaft gear and the feed gear. 110

8. In a machine of the character described, a bed providing ways thereon, a carriage movably mounted on said ways, a spindle rotatably mounted in said carriage and arranged to move therewith, a feed screw shaft rotatably mounted in said bed and arranged in the turning thereof to communicate feed movement to the carriage, said feed screw shaft extending into a feed box, a drive shaft also extending into said feed box, a gear fixed on said drive shaft to turn constantly therewith in its operation, a pair of companion gears mounted freely on said feed screw shaft, one of said companion gears being driven from said first mentioned gear and the other of said companion gears being also driven therefrom but in the reverse direction, means for selectively clutching either of said gears with said feed screw shaft whereby to communicate a rapid return or rapid traverse drive thereto, another 115 120 125 130

gear in constant driving relation with said feed screw shaft and arranged to transmit any one of a plurality of feed drives to said shaft in the same direction as the rapid traverse drive, and a plurality of reduction gear trains driven from the drive shaft gear having the terminal gears thereof all turning in the same direction but at different speeds and arranged to be clutched selectively into driving connection with said feed gear whereby to communicate feed drives to said feed screw shaft through whichever train of reduction gearing is clutched into action.

9. In a structure as set forth in claim 8, the provision in connection with certain of the reduction gear trains of changeable pick-off gears individual to the particular trains arranged when changed to vary the rate of feed for the particular trains associated therewith whereby to increase the range of feed drives available.

10. In a machine of the character described, a bed providing ways thereon, a carriage movably mounted on said ways, a spindle rotatably mounted in said carriage and arranged to move therewith, a feed screw shaft rotatably mounted in said bed and arranged in the turning thereof to communicate feed movement to the carriage, said feed screw shaft extending into a feed box, a drive shaft also extending into said feed box, a gear fixed on said drive shaft to turn constantly therewith in its operation, a pair of companion gears mounted freely on said feed screw shaft, one of said companion gears being driven from said first mentioned gear and the other of said companion gears being also driven therefrom but in the reverse direction, means for selectively clutching either of said gears with said feed screw shaft whereby to communicate a rapid return or rapid traverse drive thereto, another gear in constant driving relation to said feed screw shaft for transmitting feed drives thereto, a cross shaft having a driving connection with said drive shaft, a pair of parallel cross shafts driven from the first cross shaft, each shaft of said pair having a worm thereon, worm gears meshing with said worms and arranged to be driven in the same direction but at different speeds according to the difference in the drive ratios between the worms and gears, and means for selectively clutching either of said worm gears in driving relation with said feed gear to communicate feed drives to the feed screw shaft.

11. In a structure as set forth in claim 10 wherein the driving connection between the first mentioned cross shaft and one of the other cross shafts comprises a pair of changeable pick-off gears arranged when changed to vary the rate of feed.

12. In a structure as set forth in claim 10

wherein the driving connection between the first mentioned cross shaft and each of the other cross shafts comprises a pair of changeable pick-off gears whereby to vary the rate of drive for either of the two worm gears and accordingly vary the rate of feed transmitted therefrom.

13. In a machine of the character described, a bed providing ways thereon at opposite ends, carriages movable on said ways, rotary spindles carried thereby and arranged to move therewith, a feed screw shaft having right and left handed threads on the two ends thereof to feed the carriages respectively in opposite directions either toward or away from one another, end housings on said bed and supporting the free ends of said spindles, gear trains in each of said housings having splined connection with said spindles, a driving element in said bed having connection with a power source, a gear driven thereby in each of said end housings and transmitting the drive to said spindles through the gear trains in said housings, a shaft extending lengthwise of said bed to provide a driving connection between said gears, couplings between the opposite ends of said shaft and said gears providing for detachability of said end housings from said bed and also serving as frangible elements arranged to fracture under overload, and means providing a variable driving connection between said feed screw shaft and said driving element.

14. In a structure as set forth in claim 13 wherein the means providing for a variable driving connection between said feed screw shaft and the driving element in said bed comprises gearing in a feed box mounted on the one end of said bed adjacent the end of said feed screw shaft, the provision of another drive coupling between the end of said feed screw shaft and the gearing in said feed box providing detachability for the feed box with the gearing therein from the end of the bed while at the same time providing for fracture in the event of an overload.

15. In a machine of the character described, a plural-way bed, carriages movable on said ways, spindles rotatably mounted in said carriages and movable therewith, feed screw means for moving said carriages, a single driving element having connection with a source of power, separate trains of gears between said element and each of the spindles for driving the same, there being a gearing connection between said element and said feed screw means for operation of the latter and a single pair of changeable pick-off gears between the driving element and all of the aforesaid gears and the gearing connection whereby a change in the ratio of said pick-off gears speeds up or slows down the operation of the spindles and the

feed screw means while maintaining a predetermined relationship between the driving of the spindles and the driving of the feed screw means.

5 16. In a machine of the character described, a bed providing ways at opposite ends thereof, carriages mounted on said ways for operation toward and away from one another, spindles rotatably mounted in
10 said carriages and arranged to move therewith toward and away from work set therebetween, a feed screw rotatably mounted in said bed and providing right and left handed threads at opposite ends thereof for
15 feeding the carriages in opposite directions toward and away from one another, a driving element in said base having connection with a source of power to be driven in either direction, transmission gears between said
20 driving element and said feed screw for driving the latter, and other transmission gears between the latter gears and said spindles for driving the latter.

17. In a machine as set forth in claim 16,
25 the provision of a single set of changeable pick-off gears in the transmission between the driving element and the transmission gears for driving the feed screw whereby a
30 change in the ratio of said pick-off gears serves to speed up or slow down the operation of the spindles with the feed screw while maintaining a predetermined relationship between the driving of the spindles
35 and the driving of the feed screw.

18. In a machine of the character described, a bed providing ways thereon, a carriage movably mounted on said ways, a spindle rotatably mounted in said carriage
40 and arranged to move therewith, a feed screw shaft rotatably mounted in said bed and arranged in the turning thereof to communicate feed movement to the carriage, said feed screw shaft extending into a feed
45 box, a drive shaft also extending into said feed box, a gear fixed on said drive shaft to turn constantly therewith in its operation, a pair of companion gears mounted freely
50 on said feed screw shaft, one of said companion gears being driven from said first mentioned gear and the other of said companion gears being also driven therefrom but in the reverse direction, means for selectively clutching either of said gears with
55 said feed screw shaft whereby to communicate a rapid return or rapid traverse drive thereto, another gear in constant driving relation with said feed screw shaft and arranged to transmit any one of a plurality
60 of feed drives to said shaft, and one or more reduction gear trains driven from the drive shaft gear having the terminal gears thereof all turning at different speeds and arranged to be clutched selectively into driving connection with said feed gear.

65 19. In a structure as set forth in claim 18,

the provision in connection with one or more of the reduction gear trains of changeable pick-off gears individual to the particular train or trains arranged when changed to vary the rate of feed whereby to increase the
70 range of feed drives available.

20. In a machine of the character described, a bed providing ways thereon, a carriage movably mounted on said ways, a spindle rotatably mounted in said carriage
75 and arranged to move therewith, a feed screw rotatably mounted in said bed and arranged in the turning thereof to communicate feed movement to the carriage, an end housing on said bed supporting the free
80 end of said spindle, a gear train in said housing having splined connection with said spindle, a driving element in said bed having connection with a power source, the gear
85 train having a driving connection with said element, and a drive coupling between one end of said feed screw shaft and one of the gears of said train, said coupling enabling detachability of the end housing from the
90 bed and also serving as a frangible element arranged to fracture under overload.

21. In a structure as set forth in claim 20 wherein the end housing has a feed box on the lower end thereof having gearing
95 therein providing for a variable driving connection between the feed screw shaft and the driving element in said bed, another drive coupling between the driving element and the gearing in said
100 feed box likewise enabling detachability of the feed box with the end housing from the end of the bed while at the same time providing for fracture in the event of an overload.

22. In a machine of the character described, the combination of a bed having
105 ways thereon, a carriage movably mounted on said ways, a rotary spindle carried thereby and movable therewith and arranged to operate a tapping tool, a drive
110 shaft, means for communicating positive movement to the carriage to give the correct lead to the tap comprising a feed screw and positive gearing between the drive shaft and the feed screw for communicating a feed
115 drive to the latter, and positive gearing interconnecting the feed screw and spindle whereby the same operate in a definite predetermined relation.

23. A machine as set forth in claim 22
120 wherein the drive shaft is reversible so as to reverse the direction of operation of both the feed screw and the spindle, and wherein the feed screw and spindle are in close-
125 coupled relation to obviate any back-lash effect when a reversal in the direction of drive occurs, the drive being from the drive shaft to the feed screw and from thence to the spindle whereby to avoid the possibility
130

of a reversal in the direction of operation of the spindle ahead of the feed screw.

24. In a machine of the character described, a bed providing ways thereon, a movable carriage on said ways, a feed screw for communicating movement to said carriage, a spindle rotatably mounted on said carriage and arranged to be fed therewith, a drive shaft, positive gearing between the drive shaft and the feed screw for driving the latter, and positive gearing providing a close-coupled connection between the feed screw and the spindle for driving the latter in a predetermined relation with the feed screw.

25. A machine as set forth in claim 24 wherein the drive shaft is reversible so as to reverse the direction of drive for the feed screw and spindle, the close-coupled connection between the feed screw and spindle serving to minimize any back-lash effect in the reversal in the direction of drive.

26. In a machine of the character described, a bed providing ways thereon, a carriage movable on said ways, a feed screw rotatably mounted in said bed for feeding said carriage, a spindle rotatably mounted in the carriage and arranged to move therewith, an end housing on said bed supporting the free end of said spindle, a gear train in said housing having splined connection with said spindle, a driving element in said bed having connection with the gear train in the housing for transmitting the drive to the spindle, and means providing a variable drive connection between the feed screw shaft and the driving element.

27. In a machine of the character described, a bed providing ways thereon at opposite ends, carriages movable on said ways, rotary spindles carried thereby and arranged to move therewith, a feed screw shaft having right and left handed threads on the two ends thereof to feed the carriages respectively in opposite directions either toward or away from one another, and housings on said bed supporting the free ends of said spindles, gear trains in each of said housings having splined connection with said spindles, a driving element having driving connection with said gear trains in said housings for transmitting the drive to the spindles, means providing a variable driving connection between said feed screw shaft and said driving element, and clutches in said end housings arranged to disconnect the spindles from driving relation with the gear trains in said housings without interrupting the driving of the feed screw shaft.

28. A machine as set forth in claim 26 including a clutch in the end housing for disconnecting the spindle from driving relation with the gear train in said housing without interrupting the drive for the feed screw shaft.

29. In a machine of the character described, a bed providing ways thereon, a carriage movably mounted on said ways, a spindle rotatably mounted on the carriage for movement therewith and arranged to operate both boring and tapping tools, a feed screw for communicating movement to the carriage, a drive shaft, positive gearing providing a definite driving connection between the drive shaft and the spindle, positive transmission gears between the drive shaft and the feed screw arranged when clutched therewith to communicate a positive feed drive thereto suitable for the performance of the boring operation, and still other positive transmission gearing between the drive shaft and the feed screw arranged when clutched therewith to communicate still another feed drive thereto suitable for the tapping operation to be performed, the driving of the feed screw during the tapping feed bearing a definite predetermined relation to the driving of the spindle.

In witness of the foregoing I affix my signature.

JOHN S. BARNES.