Jan. 25, 1955 O. E. STAPLES ET AL 2,700,324

METHOD OF HOBBING

Filed April 12, 1949 8 Sheets-Sheet 1

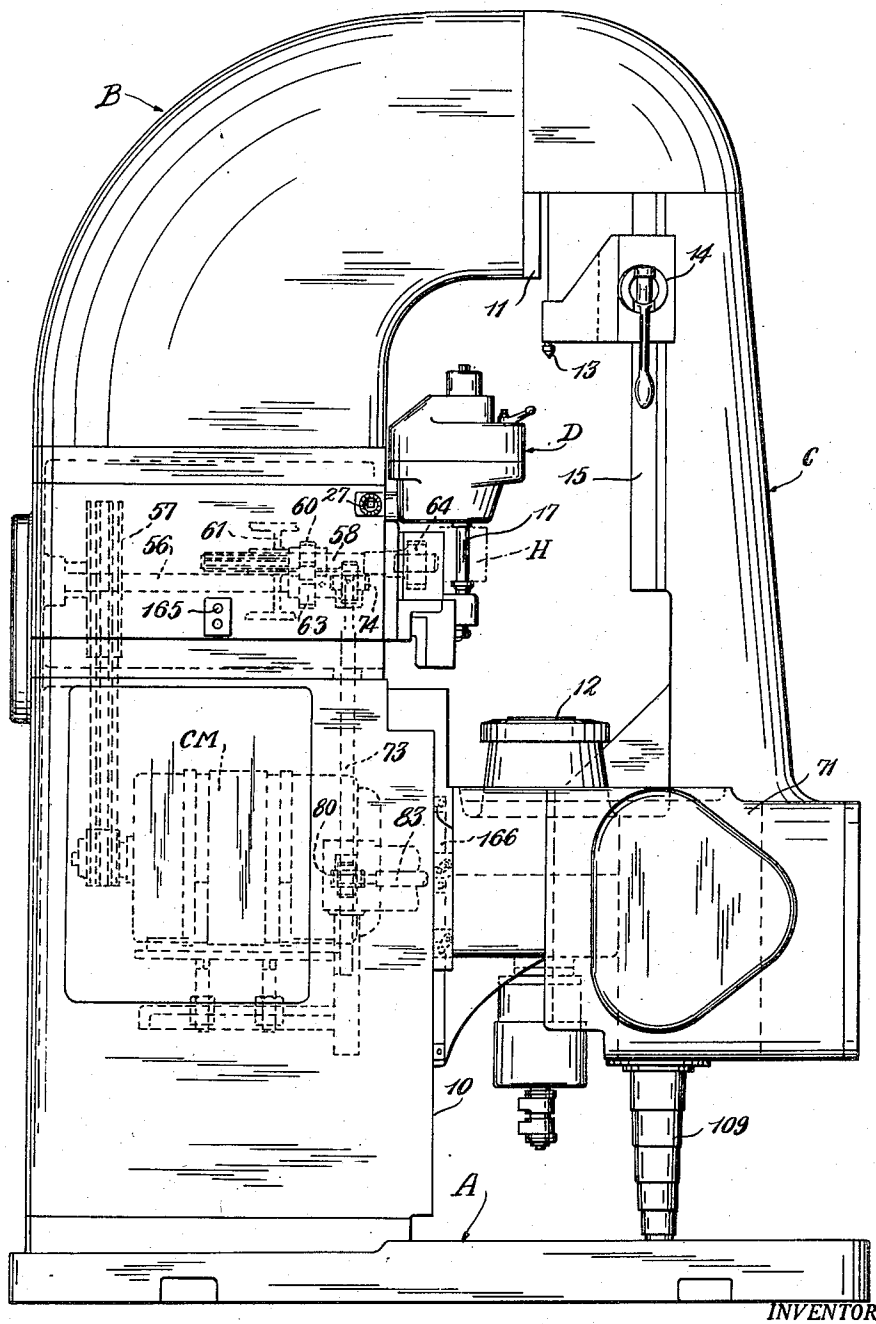


FIG. 1

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METHOD OF HOBBING

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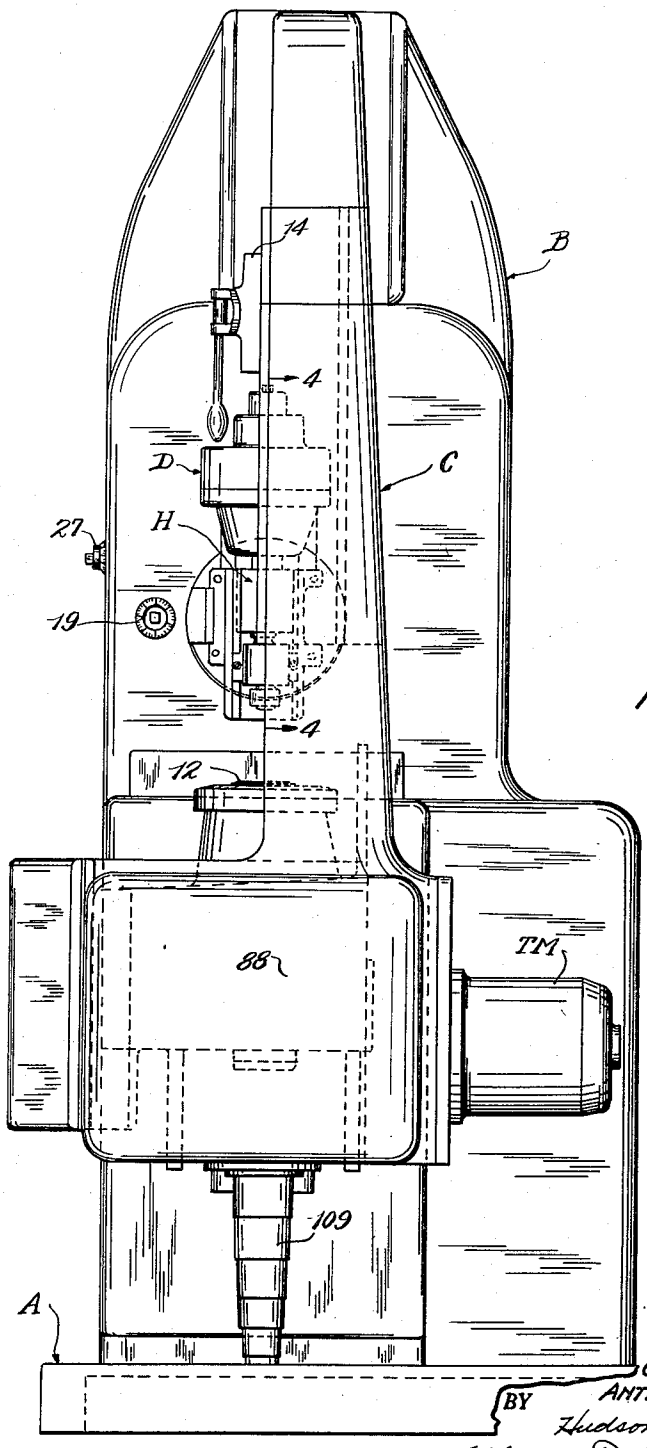


FIG. 2

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METHOD OF HOBBING

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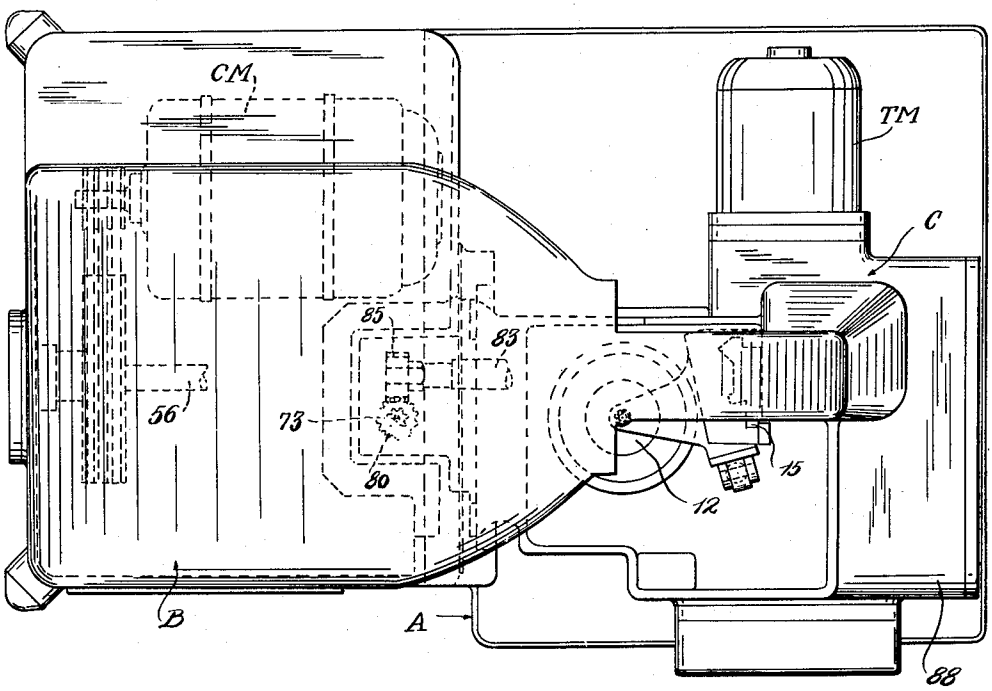


FIG. 3

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METHOD OF HOBBING

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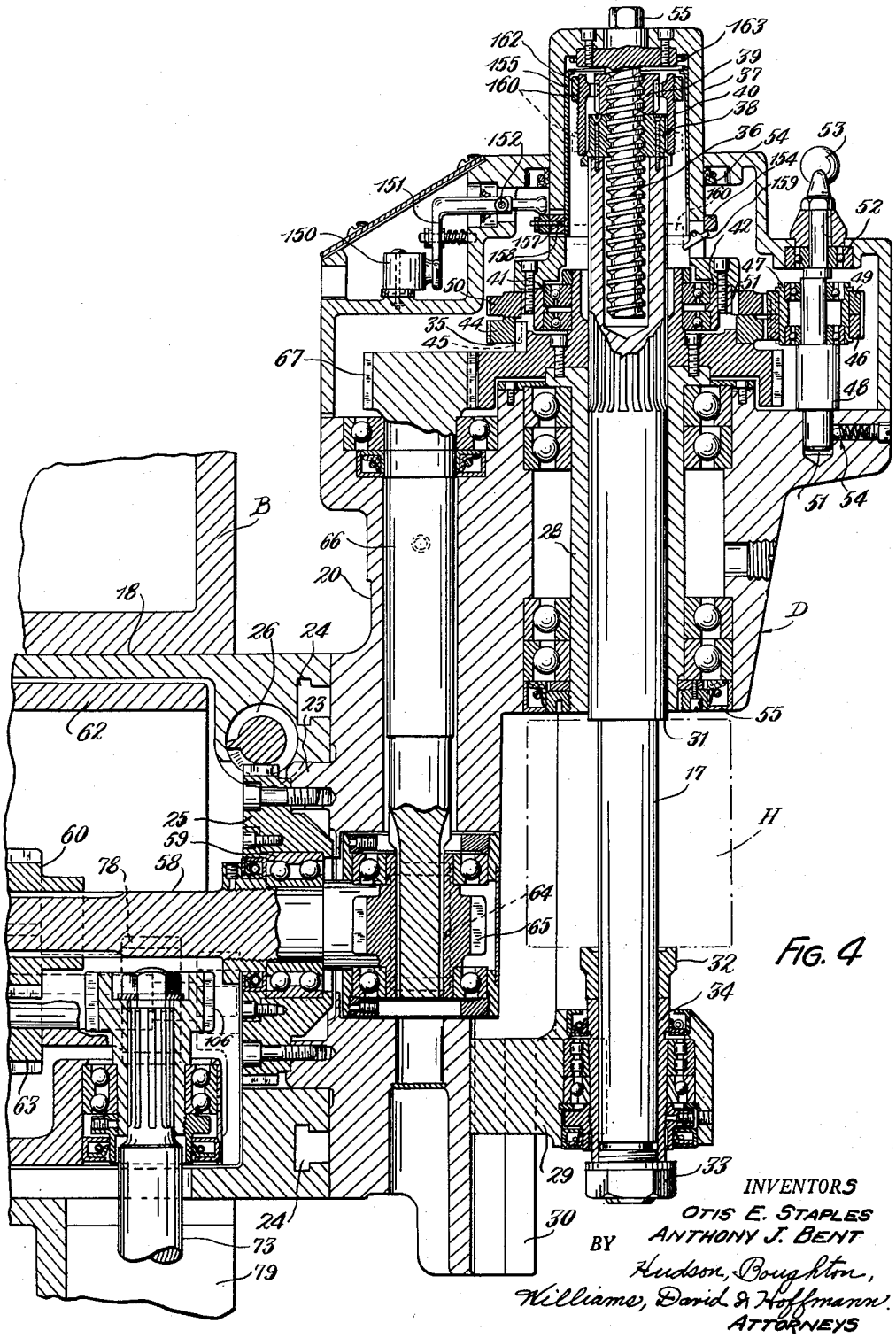


FIG. 4

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METHOD OF HOBBING

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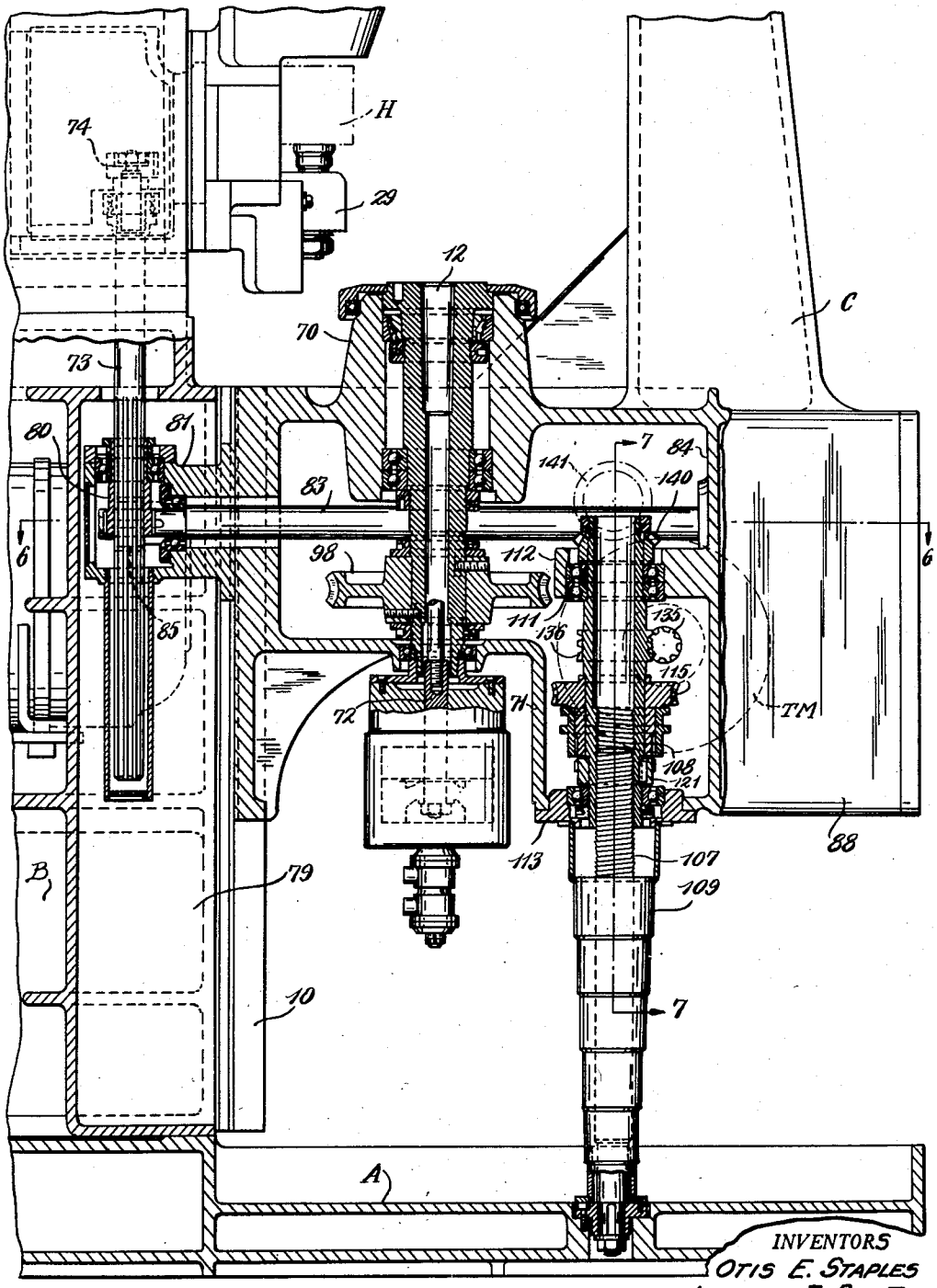


FIG. 5

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METHOD OF HOBBING

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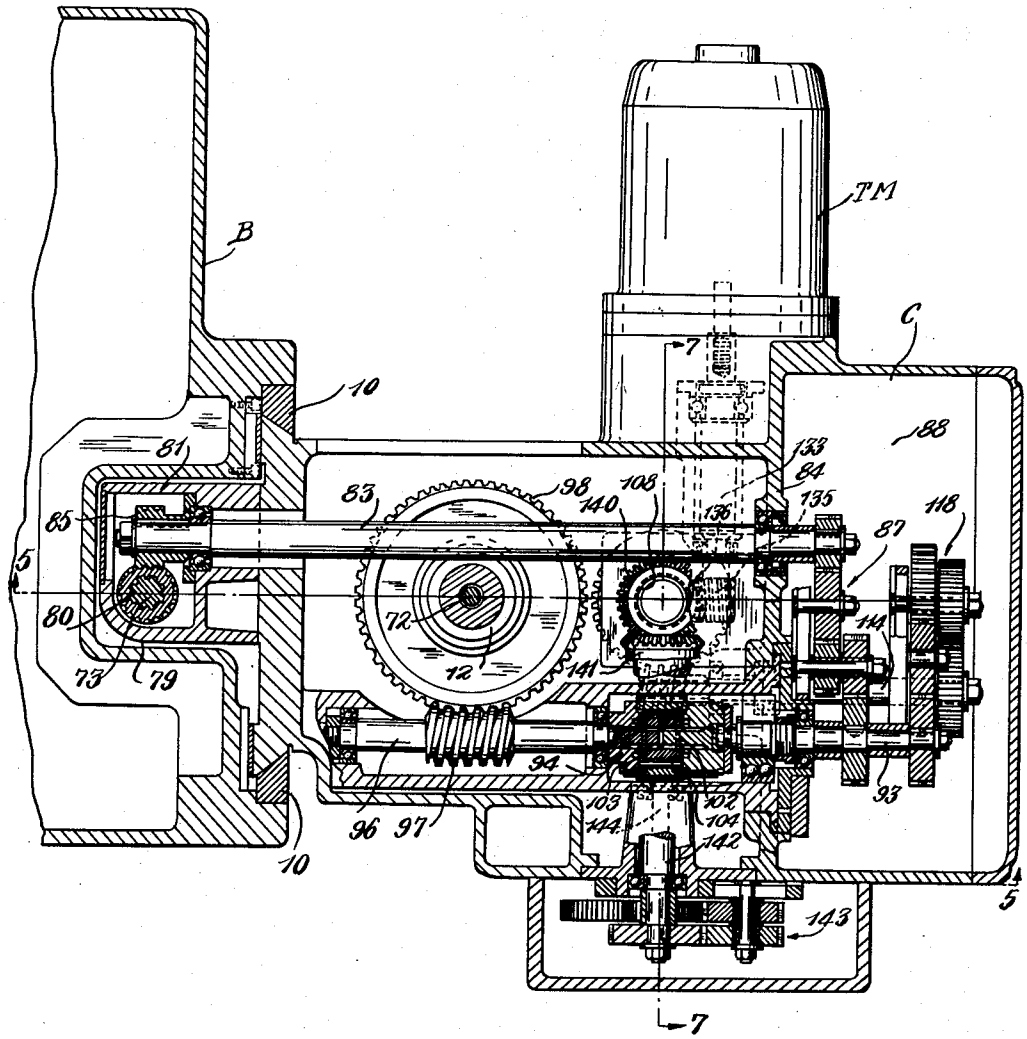


FIG. 6

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METHOD OF HOBBING

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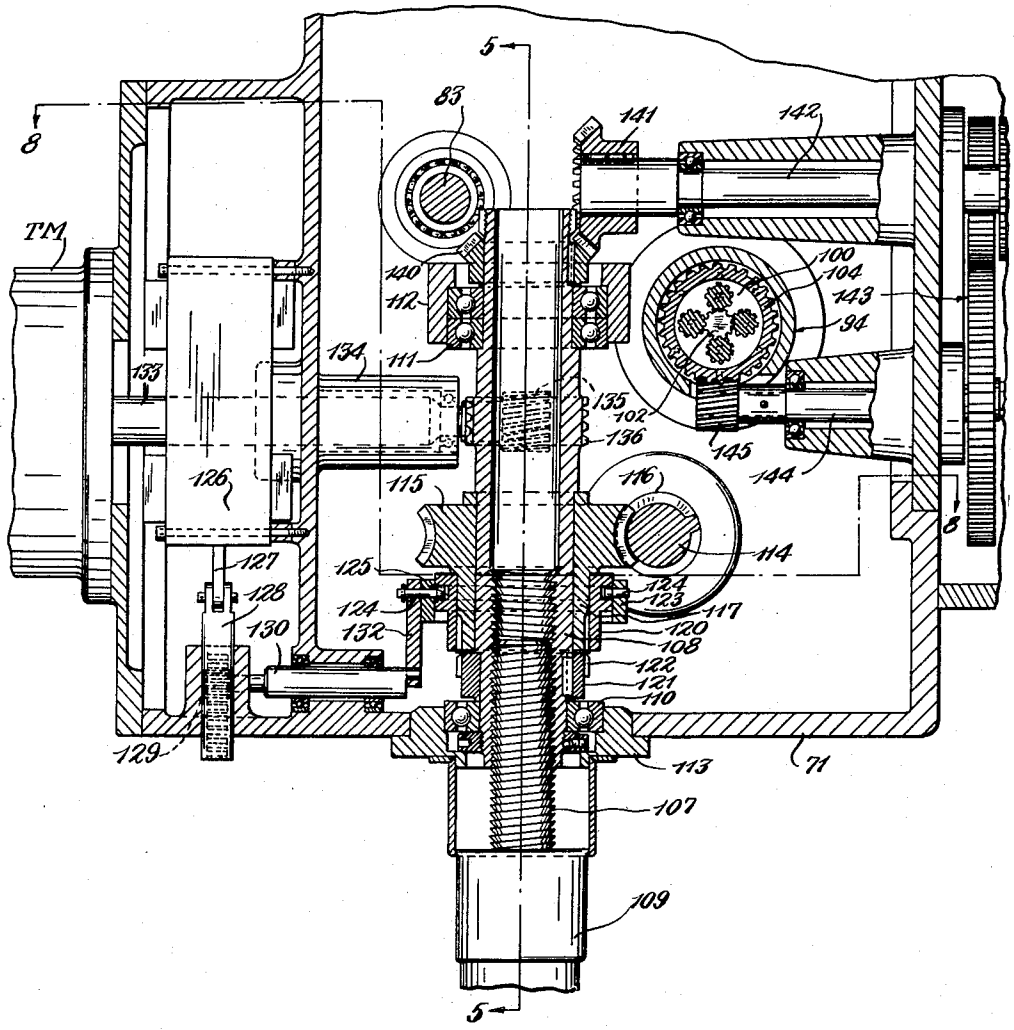


FIG. 7

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METHOD OF HOBBING

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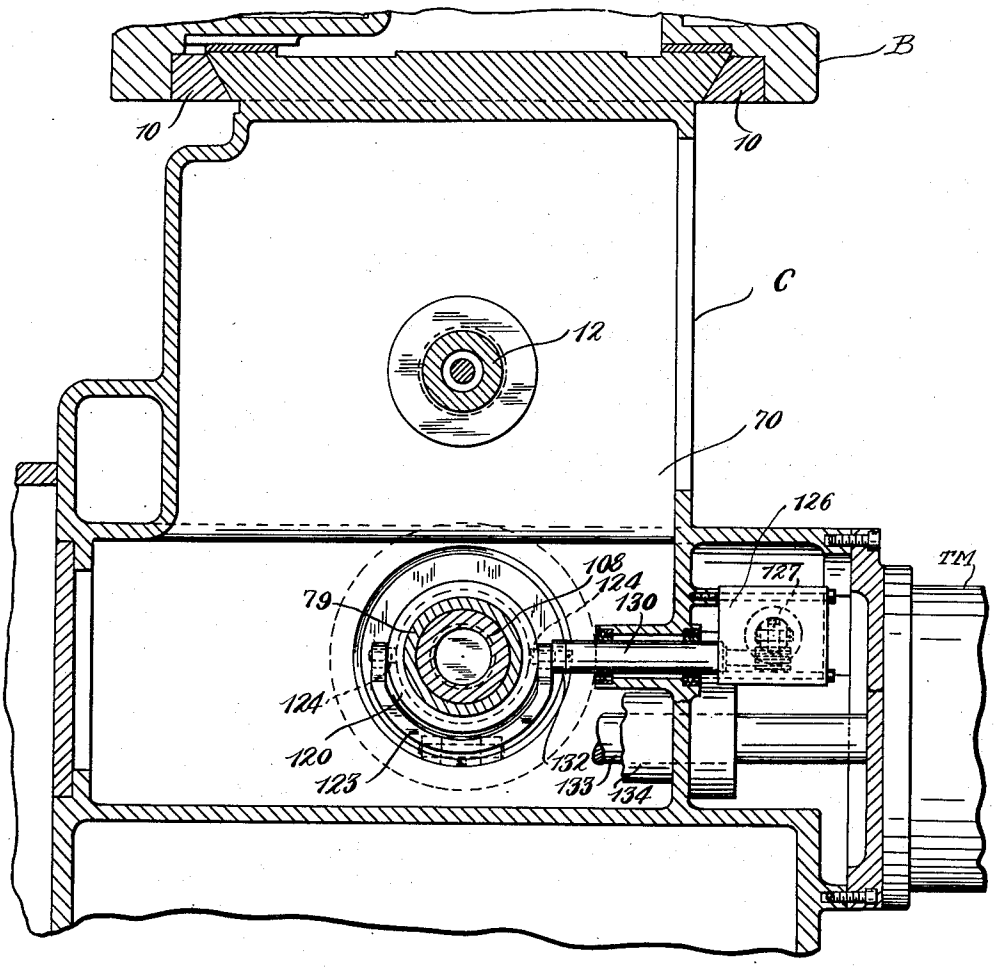


FIG. 8

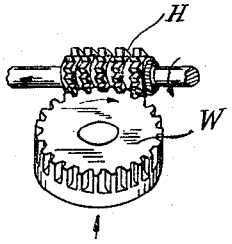


FIG. 9

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United States Patent Office 2,700,324
Patented Jan. 25, 1955

2,700,324

METHOD OF HOBBING

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Application April 12, 1949, Serial No. 86,952

3 Claims. (Cl. 90—4)

The present invention relates to machine tools and more particularly to machines for and methods of hobbing gears and the like and, particularly, to hobbing machines of the axial feed type as distinguished from tangential feed type hobbing machines.

In the operation of hobbing machines of the axial feed type, it is customary to periodically advance the hob axially, that is, move the hob tangentially of the work spindle after a number of gears have been cut and a portion of the hob dulled, so as to bring an unused section of the hob into cutting position. This practice does not make full use of the hob since the portions thereof intermediate successive settings perform very little, if any, cutting; in other words, the wear, etc., is not uniformly distributed over the entire usable or effective length of the hob.

The principal object of the invention is the provision of a novel and improved method of hobbing gears and the like, which method comprises, rotating a hob and work blank in cutting relation and in timed relation producing a relative feed movement therebetween axially of the axis of rotation of the work blank, and continuously advancing the hob at a very slow rate along its axis and in a direction opposite to the direction of movement of the engaged periphery of the work piece so that, in general, the initial cut in the blank is made by a used portion of the hob and unused portions of the hob initially engage previously cut portions of the blank.

The invention resides in certain steps of procedure and further objects and advantages will be apparent from the following description of the preferred embodiment described with reference to the accompanying drawings forming a part of this specification, in which similar reference characters designate corresponding parts, and in which

Fig. 1 is a side elevational view of a hobbing machine designed to operate according to the present invention;

Fig. 2 is a front view of the hobbing machine shown in Fig. 1;

Fig. 3 is a plan view of the hobbing machine shown in Fig. 1;

Fig. 4 is a sectional view taken substantially along line 4—4 of Fig. 2;

Fig. 5 is a fragmentary enlarged view, partly in section, of the hobbing machine of Fig. 1, showing the work spindle and elevation mechanism for the work head, the section being taken substantially on line 5—5 of Figs. 6 and 7;

Fig. 6 is a sectional view taken substantially on line 6—6 of Fig. 5;

Fig. 7 is an enlarged sectional view taken substantially along line 7—7 of Fig. 6;

Fig. 8 is a sectional view taken substantially along line 8—8 of Fig. 7; and

Fig. 9 is a diagrammatic showing of a hob cutting teeth in a gear blank according to the invention.

Although the invention is susceptible of being performed on various types of hobbing machines, it is herein shown and described with reference a hobbing machine generally of the type shown in United States Patent No. 2,307,428, issued January 5, 1943, except that, among other things, the shape of the machine is slightly different, for example, the hob head is carried by a member slidably supported in a cylindrical aperture in the vertical column or frame rather than being supported on horizontal ways, and the mechanism for moving the work head vertically is of a different arrangement.

Generally speaking, the machine is of vertical construction and comprises a base A, a vertical column or gooseneck B supported upon the base A, a work head C vertically movable upon vertically spaced pairs of ways 10, 11 on the column B, and a tool or hob head D carried by a cylindrical member slidably supported in the column B and adjustable therein horizontally toward and from the work head. The work piece to be hobbed, which may be a gear blank, a shaft to be splined, or the like, is adapted to be rotatably supported by a work spindle 12, forming a part of the work head C, and a tail center 13 carried by a tail slide 14 supported for movement toward and from the work spindle upon ways 15, 16 on the work head. A hob arbor 17 is rotatably supported in the hob head D, and during operation of the machine is rotated in timed relation to the rotation of the work spindle 12 by a cut motor CM located in the lower part of the column B and operatively connected to the arbor and spindle. The work piece is moved vertically past the hob during the cutting operation to effect the normal feeding operation, by vertical movement of the work head C, which movement is synchronized with the rotation of the hob arbor. Simultaneously with the other movements and in synchronism therewith, the arbor is moved axially to advance the unused portions of the hob, which is indicated at H by broken lines in Fig. 4, into cutting relation with the work piece, which work piece is rotated in a direction such that the peripheral portion engaged at any instant by the hob moves in a direction opposite to that of the axial movement of the hob. Rapid traverse means, including a reversible rapid traverse motor TM, is provided to cause relatively rapid movement of the work head to carry the work piece from a work loading position to the cutting position and to return the work head to the loading position after the cutting operation has been performed.

The hob head D, see Fig. 4, is attached to an end wall of a cylindrical member 18, which member is supported in a horizontal cylindrical aperture in the column B. The member 18 is mounted for horizontal movement and suitable means, such as a key and keyway, not shown, is provided to prevent rotation of the member, and adjusting means, such as a screw device, not shown, is provided for accurately positioning the member 18 horizontally in the cylindrical aperture by rotation of a dial 19 on column B. The housing 20 of the head D is connected to the member 18 so that it can be angularly positioned relative to the latter, and for this purpose it includes a boss 23 extending in a circular opening in the end wall of the member 18. The housing 20 is held to the member 18 by suitable bolts, not shown, the heads of which are disposed in a circular groove 24 in the end wall of member 20, which groove is T shape in cross section.

The angular position of the head D relative to the cylindrical member 18 may be adjusted by a worm gear 25 bolted to the neck 23 and engaged by a worm 26 journalled in member 20, which worm is rotatable by a member 27. By this arrangement, the hob axis may be disposed at any desired angle relative to the axis of the work piece.

The hob arbor 17 is mounted in a spindle sleeve 28 which is journalled in a tubular opening in the housing 20 by suitable antifriction bearings. The end of the arbor extending from the housing 20 is journalled in a bearing assembly 29 which is slidingly mounted on ways 30. The hob H is attached to the arbor between a shoulder 31 and a washer 32 by a nut 33 threaded on the arbor and pressing on a bearing sleeve 34 of an antifriction bearing in the bearing head 29.

The upper portion of the arbor 17, as viewed in Fig. 4, is splined and a drive gear 35, which is bolted to the upper end of sleeve 28, is slidingly keyed into the splines so that the arbor may be rotated as it moves axially relative to the drive gear. The upper end portion of the arbor has a bore therein, and a screw 36, which is bolted to a cap 37, depends into the bore. A nut 38 is bolted to the upper end of the arbor and threadingly receives the screw 36, whereby relative rotation between the arbor and the screw causes axial movement of the arbor relative to the screw. Any possible backlash between the threads of the screw and nut is obviated by a second nut 39 which

is threaded on the screw and which may be rotated and drawn against nut **38** and locked from rotation relative to the latter by a sleeve **40** having longitudinally extending internal teeth engageable in serrations on the exteriors of nuts **37**, **38**. The cap **37** is rotatively supported on the hub of the driving gear **35** for arbor **17** by a thrust bearing structure **41**, the cap being provided with a flange which is bolted to the outer race **42** of the bearing structure. The cap **37**, and consequently the screw **36**, may rotate relative to the arbor **17**, but the cap or screw cannot move axially.

The cap **37** is adapted to be rotated relative to the arbor to advance the latter on the screw by differential gearing driven by the drive gear **35**. The differential drive comprises a gear **44** mounted on the gear **35** and keyed thereto as at **45**. The gear **44** is adapted to mesh with a gear **46** mounted on a bushing **47** journalled on a shaft **48** by antifriction bearings. The gear **46** is keyed to a gear **49** which is also mounted on the bushing **47** and which meshes with a ring gear **50** mounted on the outer race member **42** of the bearing structure **41** and keyed thereto as at **51**. The gears **46**, **49** may be moved into and out of engagement with gears **44**, **50** by rotation of the shaft **48** so that the drive for the cap **37** may be selectively connected and disconnected. For this purpose the shaft **48** has the lower end thereof journalled in a bore **51**, and the opposite end is journalled in a bearing **52** axially aligned with the bore. The portion of the shaft **48** on which the gears **46**, **49** are journalled is eccentric to the axis of the bore and bearing, and the gears are moved into and out of engagement with gears **44**, **50** by the eccentric movement of the shaft portion on which they are mounted. A crank handle **53** is provided for rotation of the shaft **48** and a detent structure **54** is provided for releasably retaining the shaft in the gear engaging and disengaging positions.

The gears **44** and **50** are of the same diameter, and gears **46** and **49** are of the same diameter, but the number of teeth on the gears of corresponding diameters vary slightly so that the gear **50**, and hence cap **37** and screw **36**, will lose one revolution for approximately every 10,000 revolutions of the arbor and cause the screw to advance the arbor approximately one screw thread for each 10,000 revolutions of the arbor. For example, the number of teeth on gears **44**, **46**, **49**, and **50** may be 244, 81, 83 and 250, respectively, to produce this speed reduction. If the screw **36** has ten threads to the inch, the resultant axial movement imparted to the arbor **17** will be approximately one ten millionths of an inch per revolution of the arbor. The direction of axial movement of the arbor depends upon the ratios of the teeth on the gears **44**, **46**, **49** and **50** and the direction of pitch of the threads on the screw, and as brought out hereinbefore, the direction of movement of the arbor should be opposite to the direction of movement of the portion of the work piece tangentially engaged by the hob at any given instant.

After the arbor **17** has advanced to the extent desired i. e., until all of the available cutting portions of the hob has been use, it may be retracted onto the screw **36** for a succeeding period of operation with a new hob by rotating the cap **37** relative to the arbor. This is accomplished by disengaging gears **46**, **49** from gears **44**, **50**, respectively, and turning the cap by a wrench engaging a polygonal head **55** on the screw **36**, which head projects through an opening in the cap.

The arbor drive gear **35** is driven by the cut motor CM through a main drive shaft **56** journalled in the column B and which has a pulley **57** mounted thereon which is driven by the cut motor through a belt. The main drive shaft **55** is adapted to drive a parallel, splined shaft **58** which is journalled at one end in a bearing **59** located in the worm gear **25** and the opposite end is supported in a gear **60** journalled in a web **61** of a cylindrical boss structure **62** which projects from the rear wall of column B. The gear **60** is driven by a gear **63** mounted on the drive shaft **55**, and gear **60** is splined to the shaft **58** so that the latter may be driven throughout the horizontal adjustments of the hob head. The forward end of the shaft **58** which extends into the hob head housing **20** has a helical gear **64** thereon which drives a helical gear **65** mounted to one end of a shaft **66** journalled in suitable antifriction bearings, and the opposite end of which shaft **66** has a gear **67** which drives the arbor driving gear **35**. It will be seen that the hob arbor **17** is driven

by the cut motor and as the arbor rotates it is simultaneously and continuously moved axially. The hob head C may be positioned so that the axis of arbor **17** may be at any desired angle relative to the axis of the work spindle **12** and the hob may be adjusted to and from the axis of the work spindle **12**, as desired.

The work spindle **12**, which is tubular in construction, has its upper end journalled by suitable antifriction bearings in a cylindrical boss formation **70** on the work head C, and its lower end is journalled in an antifriction bearing in an opening through the bottom wall of the work head housing **71**. Preferably, the work spindle **12** is provided with a pneumatically operated chuck for holding the work pieces. The chuck is not shown as such chucks are well known, however, a portion of the pneumatic mechanism **72** for operating the chuck is shown attached to the lower end of the spindle. The spindle **12** is driven in synchronism with the hob arbor **17** by the cut motor CM, through a drive mechanism which includes a vertical shaft **73** the upper end of which is journalled in the column B and is provided with a helical gear **74** driven by a helical gear **78** on shaft **56**. The shaft **73** projects downwardly into a channel **79** formed in the column B and is splined throughout a substantial portion of its length. The splined portion of the shaft **73** is slidably engaged by a helical gear **80** splined thereto. The gear **80** is journalled in a projection **81** integral with the housing **71** and which extends into the channel **79**. A cross shaft **83** having one end journalled in the projection **81** and the opposite end journalled in a partition wall **84** of the work head housing, is driven by gear **80** through a gear **85** mounted on the end of the shaft journalled in the projection. It will be seen that the drive between gears **80** and **85** will be maintained throughout the vertical range of movement of the work head C by reason of the spline connection between shaft **73** and gear **80**.

The shaft **83** drives a speed change gear train, indicated generally at **87**, which is located within the front compartment **88** formed in the work head housing **71**. The gear train drives a shaft **93**, which comprises one input element of a differential **94** in the drive for the work spindle **12**. The output of the differential **94**, comprises a shaft **96** having a worm **97** which drives a worm gear **98** integral with the spindle **12**.

The differential **94** comprises a cage **100** carrying four planetary gears **101** which gears mesh with two axially aligned sun gears **102**, **103** formed on the adjoining ends of the aligned input and output shaft **93**, **96**, respectively. The cage **100** has a helical gear **104** by which rotation of the cage is controlled. When the cage is stationary and shaft **93** rotates, shaft **96** will be driven directly. If the cage is rotated, the shaft **96** is driven at a speed which is the algebraic sum of the speeds of the cage and input shaft **93**. When it is desirable to cut spur teeth on gear blanks, for example, the cage is locked to prevent rotation thereof and the work piece will be moved past the hob to effect the cutting of straight gear teeth. In the event it is desired to cut spiral teeeh, the cage is rotated to change the speed of rotation of the work spindle **12** relative to the movement of the work head C and cause spiral teeth to be formed, as is well understood by those familiar with the art.

The work head C, see Figs. 5 and 6, is supported by a screw **107**, the lower end of which is non-rotatively attached to the base A and the upper end of which has a tubular nut **108** threaded thereon. Preferably, the screw shaft **107** is enclosed in a telescoping guard **109**, for shielding the screw from chips and other foreign particles which might otherwise collect on the threads thereof. The nut **108** is journalled at its lower end in an antifriction combination thrust bearing **110** mounted in the lower walls of the work head housing and its upper end is journalled in bearings **111** mounted in a bracket **112** integral with the partition **84** in the work head housing **71**. When the nut **108** is rotated, by means described hereinafter, the head C is moved vertically in a direction depending on the direction of rotation of the nut. The screw **107** extends through a flanged ring **113** which is mounted in an opening in the lower wall of the work head housing and bearing **110** is secured in the ring. The inner race of the bearing **110** is attached to the nut **108**.

The nut **108** is adapted to be rotated by either the cut motor CM or the traverse motor TM, and automatically controlled means is provided for rendering one or the

other of the motors effective to drive the nut at the proper times and in the proper direction. The cut motor drive mechanism for the nut **108** includes a worm gear **115** in mesh with and driven by, a worm **116** formed on a shaft **114** rotatably supported in the work head housing **71** and operatively connected to the shaft **93** by a speed change gear train **118**, see Fig. 6. The worm gear **115** is rotatively mounted on the nut **108** and is provided with a downwardly extending hub **117**, the lower portion of which is externally splined. A clutch collar **120** surrounds the hub **117** and has teeth slidingly engaged with the hub splines for connecting the work gear **115** with the collar **120** throughout a range of sliding movement of the collar on the hub. A sleeve **121** keyed to the nut **108** immediately below the lower splined end of the hub **117** of the worm gear **115**, has its upper portion splined as at **122** to receive the internal teeth of the collar **120** when the collar is lowered over the upper portion of the sleeve. Thus, by sliding the clutch collar **120** downwardly and upwardly, as viewed in Fig. 7, the worm **115** is drivingly connected and disconnected, respectively, with the nut **108**.

The clutch collar **120** is moved vertically by a yoke **123** which has pins **124** extending into a peripheral groove **125** formed in the collar. The yoke is moved by an electrical solenoid **126** which has an armature **127** associated therewith and which is connected with a rack member **128** which cooperates with pinion **129** formed on a rocker shaft **130** to rotate the latter shaft when the armature is attracted and released from the solenoid. An arm **132** on the rocker shaft is connected to the clutch yoke **123**, and when the solenoid is energized, the yoke is lowered, as viewed in Fig. 7, for connecting gear **115** with the nut **108**. When the solenoid is deenergized, the armature drops and the yoke is raised to disconnect the gear **115** and nut **108**. The solenoid **126** is controlled by a suitable control circuit, not shown, according to the vertical position of the work head C relative to the hob head.

The traverse motor TM is mounted on the exterior of the left hand wall of housing **71**, as viewed in Fig. 7, and it is drivingly connected with the nut **108** by a shaft **133** connected to the motor armature shaft and journalled in a bearing housing **134**. A helical gear **135** connected to the end of shaft **133** opposite the motor, is continuously in mesh with a helical gear **136** formed integral with the nut **108**. The traverse motor is connected in driving relation with the nut **108** at all times, and it is adapted to rotate the nut at a rapid rate, relative to that at which the nut is driven by the cut motor, for moving the work head C vertically to cutting position and to return the work head to loading position. The control system for the hobbing machine is arranged such that when the nut **108** is driven by gear **115**, the traverse motor is deenergized and it may be driven through the gears **135**, **136**.

When the hobbing machine is used to cut spiral gear teeth, or the like, the cage **100** of the differential **94** is driven in timed relation to the rotation of the nut **108**, as shown, the cage **100** is operatively connected to the nut **108** by drive mechanism which includes miter gears **140**, **141** on the upper end of the nut **108** and a horizontally extending shaft **142**, respectively, seen in Fig. 7. The shaft **142** is adapted to drive a speed change gear train **143** located in a compartment formed in the side of the work head housing **71** and opposite the rapid traverse motor. The gear train **143** drives a shaft **144** having a helical gear **145** thereon which drives the gear **104** connected to the cage **100**. The rotation of the cage **100** imposes a differential in speed between the input shaft **93** and the drive shaft **96** for the spindle **12** according to the speed of the nut **108**. If it is desired to cut straight gear teeth, or the like, the gear train **143** is disconnected and the cage **100** held against rotation with the result that a direct drive is had through the differential.

It will be seen that as the work piece is fed vertically past the hob, the piece is rotated on its axis at a certain speed relative to the speed of the hob, and the rate of vertical feed of the work piece has a definite relationship to the hob speed. The hob will also be continuously fed axially during the cutting operation and the rate of axial movement of the hob preferably is such that it will require a number of hours to use all of the available cutting portions thereof. It is desirable to have an automatic indicating mechanism for signalling the termination of the hob movement, and for this purpose, a limit switch **150**, which may be seen in Fig. 4, is provided in a recess in the hob head housing **20**. This switch is connected in a signal circuit, not shown, such as a light and/or bell circuit, so that when the switch is closed the signal circuit will be energized. The switch is movable to its closed position by a crank lever **151** pivoted at **152** in an opening through a wall of the hob head structure, and one end of the lever is positioned adjacent the side of cap **37**. The lever **151** is adapted to be moved counterclockwise, as viewed in Fig. 4, by upward movement of a ring **154** attached to a sleeve **155**, positioned within cap **37**, by a plurality of spacers **157** and bolts **158**, one each of which are shown in the drawings. It will be understood that the cap **37** has appropriate openings for receiving the spacers and bolts. The ring **154** is adapted to be moved upwardly by three fingers **159**, only one of which appears in the drawings, which fingers are pivoted in slots in the sides of the cap **37** and spaced equally thereabout. The outer ends of the fingers **159** are adapted to engage the underside of the ring and the inner ends of the fingers are adapted to be engaged by a ring **160** threaded on the exterior of the sleeve **40** as the end portion of the arbor **17** travels toward the lower end of the cap **37**. The fingers **159** are adapted to be tilted by the travel of ring **160** to raise the ring **154** for rotating switch arm **151** to close the signal circuit. This condition is illustrated in Fig. 4, wherein the position of the ring **160** at the end of the axial movement of the hob is shown in dotted lines. The point of travel of the arbor **17** at which the switch **150** is operated may be adjusted by varying the position of the ring **160** on the sleeve **40**, as is indicated in dotted lines in Fig. 4. The ring **160** may be locked in the proper position by a lock nut **162**. When the screw **36** is rotated to draw the arbor **17** into the cap **37**, as when the new hob is to be placed in operation, the ring **160** is removed from fingers **159**. A coil spring **163** is interposed between the end wall of the cap **37** and the outer end of the sleeve **155** to urge the sleeve toward the base of the cap to release the switch lever **151** when the arbor **17** is initially positioned for operation with a new hob.

In operation of the machine, a new or sharp hob is mounted on the arbor **17** and the latter is drawn upwardly on the screw **36**, as viewed in Fig. 4, so that the end of the hob will initially engage a work piece mounted in the spindle **12**. The work piece is chucked in the spindle **12** and secured therein by the tail stock member **13** and the hob head D is adjusted horizontally so that when it engages the work piece it will cut to the proper depth. It is to be understood, of course, that the hob head D will be rotated or positioned approximately 90° from the position shown in Figs. 1 and 2 so that the axis of the hob will extend transverse with respect to the axis of the work piece. For purpose of explanation, it will be assumed that the machine is set for conventional hobbing and that the work pieces are loaded when the work head is in its lowest position. The automatic control of the cut motor, the rapid traverse motor and the solenoid **126** may be effected by a control system, parts of which are shown at **165** and **166**, and which may be similar to that described in the aforementioned patent and in which case the solenoid **126** would be connected in the control circuit in such a manner that it would be energized and deenergized simultaneously with the energization and deenergization of the rapid traverse motor. The cycle of operation is initiated by actuation of the start push button switch **165** which causes the traverse motor to rapidly elevate the work head C to a point at which the work piece closely approaches the hob. The traverse motor is then automatically deenergized and the clutch solenoid **126** is energized to connect gear **115** with the nut **108** so that the work head C will continue to move vertically but at a relatively slow rate past the hob H while the hob and work piece both rotate in timed relation. After the work piece is moved past the hob, the clutch solenoid and the cut motor are automatically deenergized and the finished work is removed from the spindle **12**, after which the start push button switch **165** is again depressed thereby causing the traverse motor to operate in a reverse direction from its initial direction to rapidly lower the work head C to the loading position, at which point the traverse motor is automatically deenergized. A new work piece is mounted to the work head and the cycle of operation is repeated as described.

During the cutting operation the hob H is continuously advanced in the direction which is counter to the

direction of movement of the periphery of the work piece at its point of engagement with the hob so that unused portions of the hob will be continuously fed into tangential engagement with the work pieces and the initial engagement of the unused portions with the work pieces will be with portions of the work which have been cut by used portions of the hob. In other words, the used portions of the hob will rough out the cuts and the less used portions will perform the finished cuts so that greater accuracy is achieved in the finished work piece and at the same time a maximum useful life of the hob is attained.

The relative movements of the hob and work piece in one example of carrying out the method of the invention is illustrated in Fig. 9. In this particular instance, the work piece W, which is a gear blank, is rotated clockwise in cutting relation with the hob and it is moved upwardly on its axis for feeding to the hob. The hob is rotated for conventional hobbing and at the same time it is slowly advanced axially in a direction counter to that of the portion of the periphery of the work piece engaged thereby. The rate of axial advance of the hob is relatively slow and this movement does not enter into the feed considerations. Throughout a considerable number of cycles of hobbing operations, however, the hob will be advanced from one end to the other of its effective cutting portions. As explained hereinbefore, this movement continually and gradually presents a new portion of the hob into cutting engagement with portions of the work previously cut by used portions of the hob. It may, in some cases, be desirable to move the hob vertically and parallel to the axis of the work piece to effect axial feeding, rather than move the work piece, and such arrangement falls within the contemplation of the invention.

It will be apparent by those familiar with the art that the directions of movement of the hob and the work piece may be reversed and the relative speeds thereof may be altered, if desired, by appropriate substitution of or by the addition of gears in either of the gear trains **87**, **91** or **143**, and for this purpose it may be desirable to provide interchangeable gear structures. Regardless of the change in direction of rotation of the hob and the work piece, it is essential to the present method that the direction of axial movement of the hob with respect to the direction of rotation of the work piece be retained which causes the direction of advance of the hob to be in the opposite direction to the movement of the peripheral position of the work piece tangentially engaged by the hob.

It should be noted that the screw **107** on which the work head C is moved vertically is located on an axis which is substantially at the center of mass of the work head C so that a minimum of stress is applied to the guides **10**, **11**, **15** and **16**, which increases the accuracy and durability of the machine. This arrangement also permits the work spindle **12** to be located adjacent to the column B which provides a minimum of overhang of the work head and provides greater stability for the spindle. In addition, the structural arrangement shown provides a relatively compact driving mechanism for rotating the work spindle **12**, the hob arbor **17** and the elevating nut **108**.

Suitable means may be provided for lubricating the various gears and bearings and a suitable coolant may be fed to the hob and work pieces, but since such means are commonly used, they have not been shown in the embodiment of the invention described.

While the preferred form of the invention has been described in considerable detail, it is to be understood that this is by way of example only and that the invention is not limited to the particular details shown and described.

Having thus described our invention, we claim:

1. The method of hobbing which comprises, rotating a hob in cutting relation with a work piece rotated in timed relation therewith, producing relative movement therebetween longitudinally of the axis of rotation of the work piece to produce a feeding movement between the hob and work piece, and simultaneously and continuously slowly moving said hob axially in a direction opposite to the direction of movement of the portion of the periphery of the work piece engaged by the hob at any given time to gradually advance the hob relative to the work piece and thereby bring successive portions of the hob into cutting position.

2. The method of hobbing which comprises, successively rotating work pieces in cutting relation with a rotating hob, producing relative movement between the work pieces and hob longitudinally of the axis of rotation of the workpieces to produce a feeding movement between the hob and the work pieces being cut, and simultaneously and continuously slowly moving said hob axially in a direction opposite to the direction of movement of the portion of the periphery of the work piece engaged by the hob at any given time to gradually advance the hob relative to the workpiece and thereby bring successive portions of the hob into cutting relation with successive workpieces.

3. The method of hobbing a number of workpieces which comprises bringing successive workpieces rotated about a common axis in a given direction into hobbing engagement with a rotating hob having an appreciable longitudinal cutting surface, producing relative movement therebetween longitudinally of the axis of rotation of the workpieces to produce a feeding movement between the hob and workpieces, and producing a continuous slow unidirectional relative movement between the workpieces and hob axially of the hob during hobbing of the workpieces and in a direction opposite to the direction of movement of the portions of the workpieces engaged by the hob whereby the segment of the hob engaging the workpieces is gradually moved lengthwise of the hob during cutting of the workpieces and causing roughing cuts in the workpieces to be made by used portions of the hob and finishing cuts therein to be made by continually advanced unused portions of the hob.

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