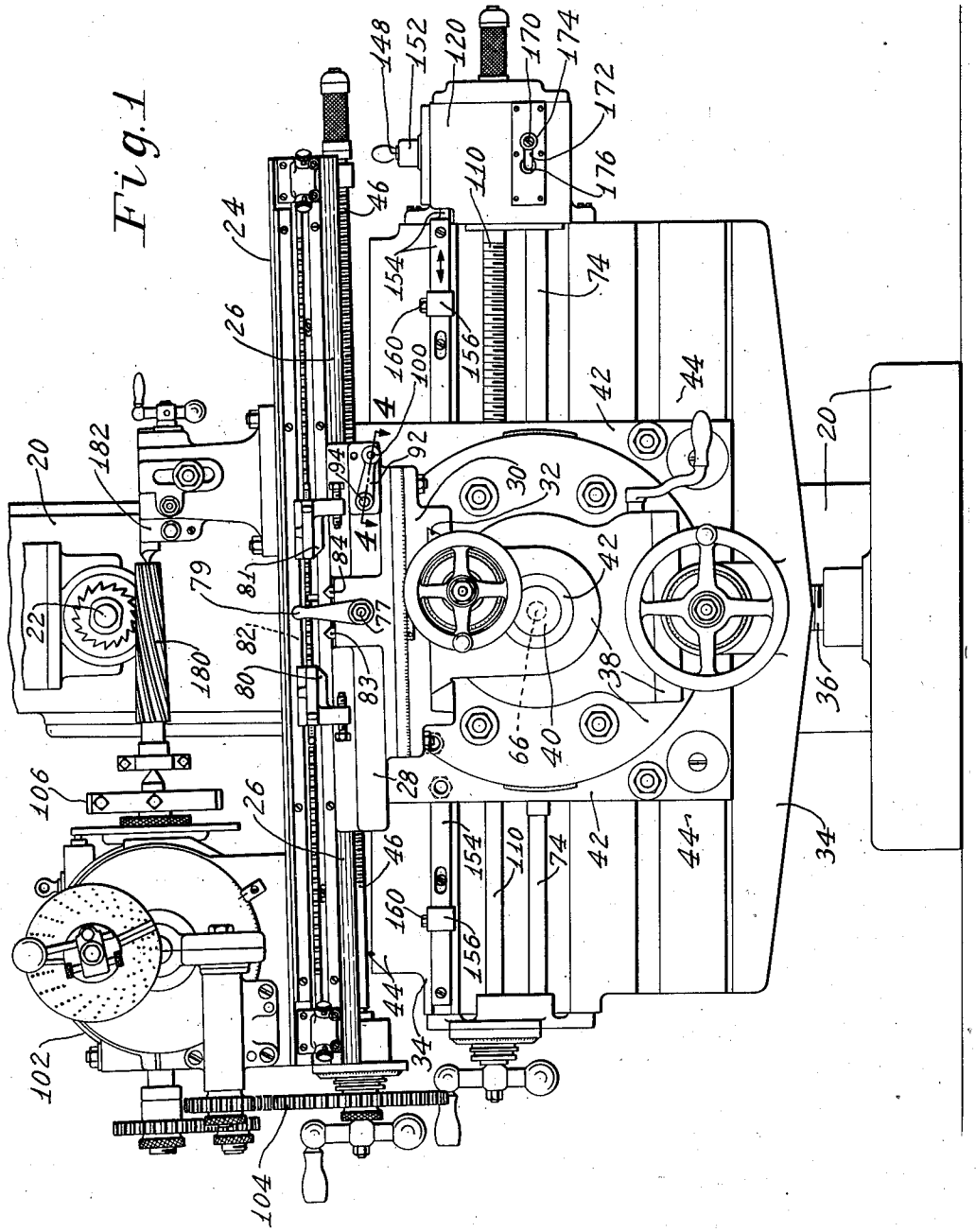
Sept. 28, 1937. A. F. BENNETT 2,094,484

MILLING MACHINE

Filed May 7, 1936 3 Sheets-Sheet 1

Fig. 1



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Filed May 7, 1936 3 Sheets-Sheet 2

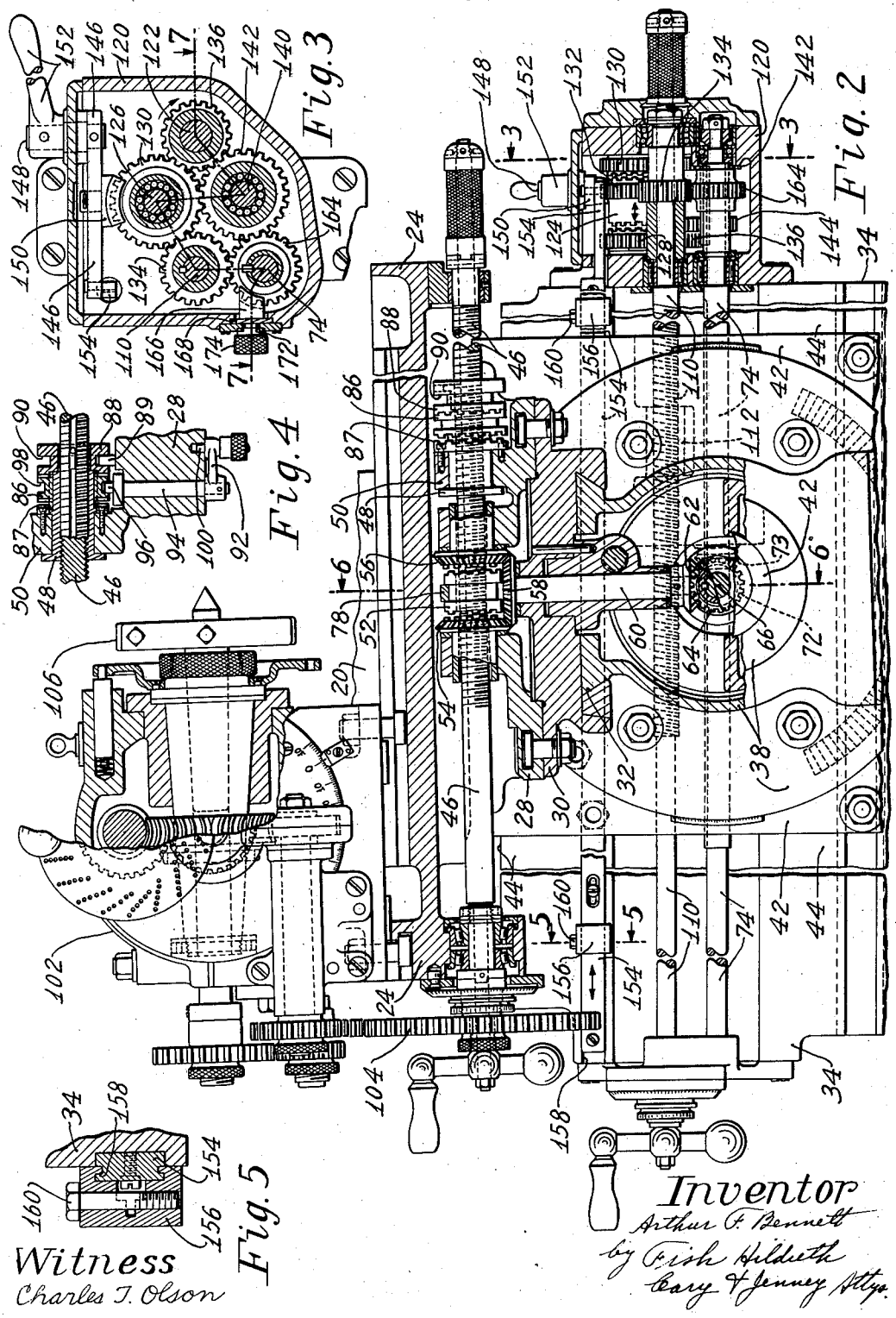

Fig. 2

Fig. 3

Fig. 4

Fig. 5

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Fig. 6

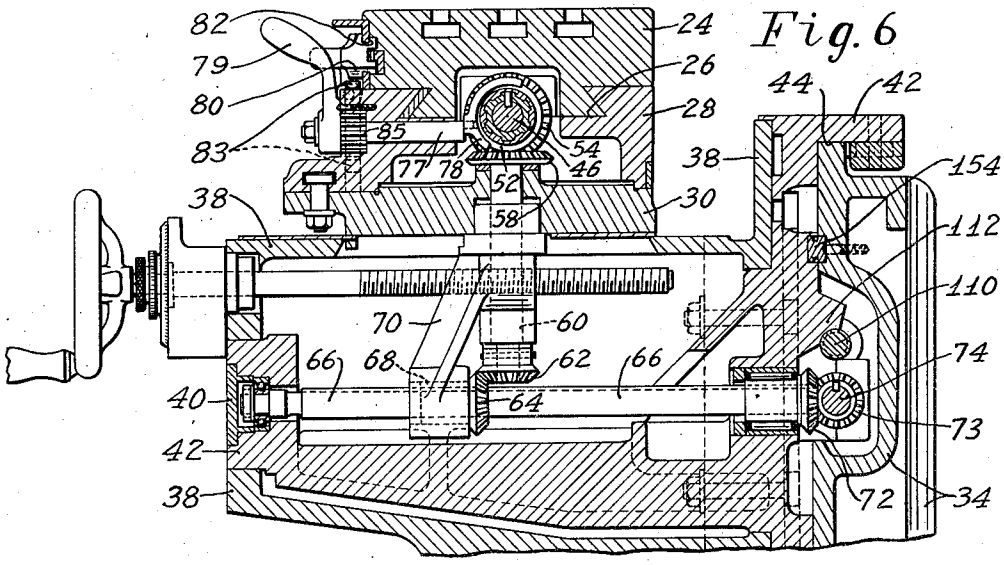


Fig. 7

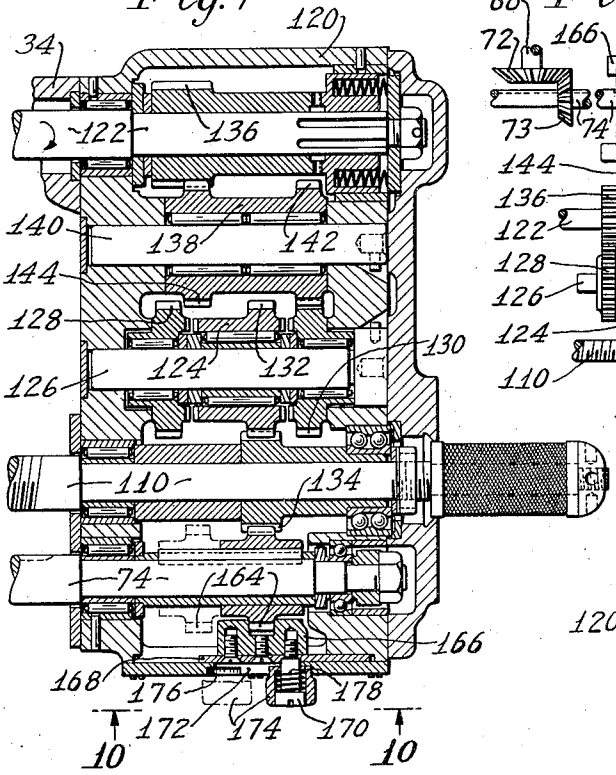


Fig. 8

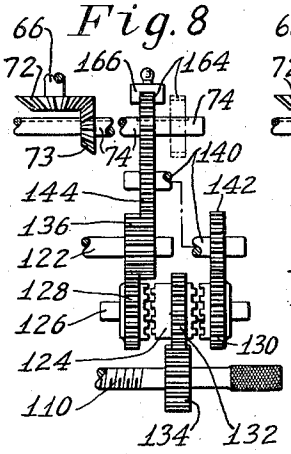


Fig. 9

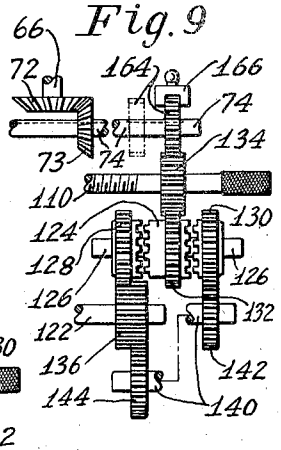
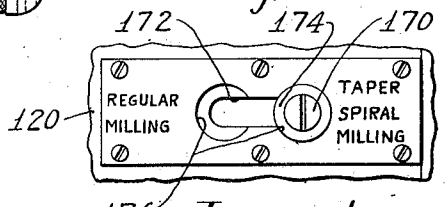


Fig. 10



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Patented Sept. 28, 1937 2,094,484

UNITED STATES PATENT OFFICE

2,094,484

MILLING MACHINE

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Application May 7, 1936, Serial No. 78,391

12 Claims. (Cl. 90—21)

The present invention relates to improvements in milling or similar machines, and more particularly to machines of this general description having a work supporting assembly including a longitudinally movable work table and a number of subsidiary supports movable in a diversity of paths including one such support movable longitudinally or in the direction of table travel.

It is a principal object of the invention to provide in a machine of this general description, a system of power driving connections which may be readily controlled by the operator to secure an automatic or semi-automatic operation of the machine for a wide range of operating conditions, and particularly for the performance of a number of new and useful operations not heretofore performed on machines of this general description.

With this and other objects in view as may hereinafter appear, a principal feature of the invention consists in the provision of driving connections for the machine including a prime mover, a transmission train including a reverser for the table, a transmission train including a separate reverser for the secondary support above referred to, and means for selectively connecting the table transmission train directly to the prime mover or under the control of the reverser for the secondary support, and thereby to secure a direct control of the direction of movement of both supports at a net rate of feed which may be either the sum or the difference of the feeding rates of each support.

Another feature of the invention consists in the combination in a universal milling machine, of a work supporting assembly including a longitudinally reciprocable work table, a secondary slide support movable in substantially the same direction, and a swivel mounting for the work table carried on said secondary support about which the work table may be canted on a horizontal axis, together with driving connections comprising a table transmission train having a reverser, actuating connections controlled thereby for driving a spiral head attachment, driving connections including a separate reverser for the secondary support, and means for connecting the normally independent driving connections above described for the spiral head attachment in series with the transmission train including the reverser for the secondary support above set forth for taper spiral milling and similar operations.

The several features of the invention consist also in the devices, combinations and arrangement of parts hereinafter described and claimed, which together with the advantages to be obtained thereby, will be readily understood by one skilled in the art from the following description taken in connection with the accompanying drawings, in which Fig. 1 is a view in front elevation of a universal milling machine embodying the several features of the invention; Fig. 2 is an enlarged view partly in section of portions of the machine shown in Fig. 1, and with parts broken away or sectioned to illustrate particularly the driving connections for the table and knee rail; Fig. 3 is a detail sectional view taken on the line 3—3 of Fig. 2; Fig. 4 is a detail sectional plan view taken on the line 4—4 of Fig. 1, to illustrate particularly the construction of the table screw locking clutch; Fig. 5 is a detail sectional view taken on the line 5—5 of Fig. 2, to illustrate particularly the construction of the trip bar and limit stop screw thereon for disconnecting the knee rail feed; Fig. 6 is a sectional view taken on the line 6—6 of Fig. 2, to illustrate particularly certain features of construction and certain of the driving connections for the work supporting assembly; Fig. 7 is a developed sectional view of certain of the driving connections including the knee rail reverser and the connections for selectively rendering the table reverser independent of or supplemental to the knee rail reverser; Fig. 8 is a somewhat diagrammatic view illustrating the positions of the gearing connections illustrated in Fig. 7 when set up for the independent operation of the table and knee rail feeds; Fig. 9 is a view similar to Fig. 8, illustrating the gear connections in an alternative position in which the table transmission train is supplemental to and is controlled through the knee rail reverser; and Fig. 10 is an enlarged detail view in front elevation of the manually operable selecting lever for determining the position of the selecting gear connections in the table and knee rail transmission trains above referred to.

The machine disclosed in the drawings as illustrating in a preferred form the several features of the present invention, is a universal milling machine which is similar in many respects to that more fully described and illustrated in the patent to Graves and Gigger No. 1,932,546, dated October 31, 1933.

As best shown in Figs. 1, 2, and 6 of the drawings, the machine comprises a main column or standard 20 on which a cutter spindle 22 is mounted to rotate in stationary bearings of ordinary description. The machine is also provided with a work supporting table 24 mounted to slide on ways 26 formed on a swivel mounting 28

which forms part of a saddle 30 which is mounted for forward and back movements transversely of the table travel on ways 32 carried on the knee. The knee unit of the universal milling machine herein disclosed, is built up of three relatively movable supports comprising a vertically movable knee member 34 arranged to slide in vertical ways formed on the front side of the machine column 20, and adjustably supported by the usual telescoping screw 36, and a swivel knee member 38 which carries the saddle ways 32 and is arranged to swing about an axis generally indicated at 40 to permit longitudinal canting movements of the saddle and table assembly about this point. The swivel knee member 38 is in turn carried on a knee rail 42 which is mounted on longitudinally extending ways 44 formed on the vertically adjustable knee member 34 to provide for longitudinal reciprocating movements of the entire assembly including the table, saddle and knee swivel member 38.

As pointed out in the patent above referred to, the provision for multiple adjustment of the table position to any desired angle with relation to a predetermined plane of movement of the entire work supporting assembly past the cutter spindle, permits of a very rapid and efficient positioning of the work for operation thereon in any desired plane without the necessity of special jigs or time consuming labor in properly setting up the work.

The power driving connections employed to impart the required positioning movements to the work with relation to a rotary cutting tool carried on the spindle 22, comprise a main driving element which may be driven through a conventional rate changing mechanism for imparting the desired feed rate to the work, a power transmission train including a reverser of ordinary description for driving the table, and a similar power transmission train including a reverser for imparting feeding movements to the knee rail 42.

The table driving connections as best shown in Figs. 2 and 6, comprise a table screw 46 rotatably mounted in bearings formed in the under side of the table, and a cooperating nut 48 supported against axial movement in a bushing 50 forming a part of the swivel saddle support 28. Rotational movements are imparted to the screw 46 through connections including a reversing clutch member 52 splined to the screw 46, and arranged for engagement alternatively with cooperating clutch faces formed on two oppositely driven bevel gears 54 and 56, which are supported in external sleeve bearings formed on the swivel saddle member 28 concentrically with the screw 46, and are driven by means of a cooperating bevel gear 58 secured to the upper end of a vertical drive 60 which extends downwardly through the axis of the swivel support 28 and saddle 30. At its lower end the shaft 60 is provided with a bevel gear 62 which is arranged to mesh with a corresponding gear 64 splined to a transversely extending drive shaft 66 supported along the axis of rotation of the swivel knee member 38. In order to maintain the gear 64 in mesh with the gear 62, the gear 64 is provided with a sleeve hub 68 which is externally supported in a bearing formed in a downwardly extending bracket 70 forming part of the saddle 30. The transversely extending drive shaft 66 is in turn driven through connections which include a bevel gear 72 formed in the rearward end of the drive shaft and a cooperating bevel gear 73 splined to turn with and to slide axially with relation to a longitudinally extending shaft 74 mounted in the vertically adjustable knee 34.

The position of the table reverser 52 is controlled through connections (see Figs. 1 and 6) which comprise a forwardly extending clutch shaft 77 which is rotatably supported in bearings formed in the swivel saddle member 28, and is connected at its rear end by means of an eccentric pin to a clutch shoe 78 supported in an annular groove formed in the clutch member 52. At its forward end the control shaft 77 carries an upwardly extending manual clutch lever 79. The machine is also provided with the usual stop dogs which operate when rendered operative to shift the clutch member 52 to neutral position to arrest further movement of the table. These dogs as shown at 80 and 81 are adjustably supported in a track 82 formed in the front side of the table, and cooperating with two vertically extending pins 83 and 84 which have formed thereon rack teeth arranged to mesh with a gear 85 on the clutch shaft 77.

The table driving connections above described, are readily adapted for driving any one of the usual attachments which may be carried on the work table 24 of the machine, as for instance, the usual spiral head illustrated in the drawings. In order that the table screw 46 may be utilized for this purpose without at the same time causing any movement of the table 24, the nut 48 above referred to, has splined to the external periphery thereof, a clutch member 86 which may be engaged alternatively with a stationary clutch member 87 to lock the nut 48 in stationary position, and thereby to cause an axial movement of the table to take place, or may be engaged with a freely rotatable but axially stationary clutch member 88, thereby locking the feed screw 46 against axial movement. As best shown in Figs. 2 and 4, the stationary clutch member 87 is rigidly secured to one face of the bracket bearing 50. The clutch member 88 is freely rotatable on the screw 46, being held against axial movement with relation to the machine by the engagement of a pin 89 formed on an adjacent portion of the swivel saddle support 28 with a peripheral groove 90 in the clutch member 88. The position of the clutch member 86 is controlled (see Fig. 4) by means of a manually operable lever arm 92 secured to the forward end of a rock shaft 94 which at its rear end carries an eccentric pin 96 arranged for engagement with a peripheral groove 98 in the clutch member 80. A spring-pressed detent 100 formed in the lever arm 92, operates to lock the lever 92 and clutch member 80 in either one of two alternative operating positions as best shown in Figs. 1 and 4.

As best shown in Figs. 1 and 2 of the drawings, the machine is fitted with a spiral head 102 of ordinary description, which is bolted in the usual manner to the work supporting table, and is driven from the table feed screw 46 through a gear 104 secured to one end of the feed screw 46 which through the usual change speed and reduction gearing, serves to drive the work arbor 106. Inasmuch as these connections are well known in the art, and do not specifically form any part of the present invention, no further illustration or description thereof is believed necessary.

Longitudinal feeding movements are imparted to the knee rail 42 through connections which comprise a feed screw 110 which is supported at each end in end thrust bearings in the knee mem-

ber 34, and meshes with a cooperating nut 112 formed on the knee rail 42.

In accordance with the present invention, the drive shaft 74 of the table transmission train and the feed screw 110 for imparting feeding movements to the knee rail 42, are driven through gear connections supported in a gear box 120, which are constructed and arranged, in connection with the several adjustable elements of the work supporting assembly above described, to adapt the machine for the performance in a new and more efficient manner, of a number of operations not heretofore considered practicable for machines of this type. The driving connections referred to, comprise a drive shaft 122 which may be driven from any convenient source of power through a conventional rate changing mechanism for imparting the desired rate of feed to the work, and is to be considered as the prime mover in the power driving connections for the several supports comprising the work supporting assembly. As best shown in Figs. 3, 7, 8, and 9, the screw shaft 110 for driving the knee rail 42, is driven from the prime mover 122 through reversing clutch connections including a reversing clutch member 124 loosely mounted on a stub shaft 126 and arranged for axial movement into clutching engagement with corresponding clutch faces formed on each of two reversely driven gears 128 and 130. A gear 132 formed on the periphery of the clutch member 124, meshes with a gear 134 on the screw shaft 110 for driving the knee rail support 42. The gear 128 of the reversing clutch mechanism is driven directly from the prime mover 122 through a meshing gear 136 rigidly secured thereon. The gear 130 of the reversing clutch mechanism is constantly driven in a reverse direction from the prime mover 122 through gear connections comprising a sleeve gear member 138 loosely mounted to turn on a stub shaft 140, and having formed thereon a gear 142 meshing with the reversing gear 130 and a second gear 144 meshing with the driving gear 136 on the prime mover 122.

For controlling the position of the reversing clutch member 124 to disconnect the rail feed or to drive the knee rail member 42 in either direction, a clutch control lever 146 is rigidly secured to a short pivot post 148 extending downwardly into the gear casing 120, and has pivotally mounted thereon a clutch shifting yoke 150, which is arranged to engage the two sides of the gear 132 formed on the periphery of the clutch member 124. A manually operable hand lever 152 secured to the post 148 provides a convenient means for manually shifting the clutch. The clutch may also be controlled automatically to stop further movement of the knee rail support 42 to a limiting position in each direction, through connections comprising a control rod 154 slidably mounted in the knee member 34, and connected at the right hand end as shown in Fig. 2, to a forward extension of the clutch lever arm 146. As best shown in Figs. 2 and 5 of the drawings, stop dogs such as 156, fitted onto a T-shaped track 158 on the control rod 154, and held adjustably in position by means of clamping bolts 160, are arranged for engagement with an abutting portion of the knee rail support 42 upon movement of the rail to the desired limiting position, thus causing the control rod 154 and clutch lever 146 controlled thereby, to be shifted in the corresponding direction to disconnect the clutch member 124.

In accordance with a principal feature of the invention, the table transmission gear train including the shaft 74, is arranged for two alternative modes of operation, namely, to be directly and continuously driven from the prime mover 122, or to be connected for actuation from the knee rail feed reverser 124 and gear 132, in which latter case the movement of the reverser 124 to start and stop and to determine the direction of movement of the knee rail will simultaneously operate to start and stop and to determine the direction of drive of the table transmission train above described. To this end a clutch gear 164 is splined onto the shaft 74, and is arranged to be moved axially to the right to the full line position shown in Fig. 7, and diagrammatically in Fig. 9, thus connecting the shaft 74 of the table transmission train under the control of the knee rail feed reverser 124, or to be moved alternatively to the left to the position shown in dot-and-dash lines in Fig. 7, and diagrammatically in Fig. 8, causing the clutch gear 164 to mesh with gear 144 on the shaft 140, which in turn meshes with the driving gear 136 and the prime mover 132 for the independent operation of the table feed. As shown in the drawings, the position of the clutch gear 164 is conveniently controlled by means of a clutch yoke 166 which engages each side of the clutch gear 164, and forms part of the clutch control slide 168 carried on the inside of the casing 120. The position of the clutch slide 168 and clutch gear 164 is controlled by means of a manually operable detent mechanism which comprises a screw 170 threaded into the slide 168 and arranged to project outwardly through a slot 172 formed in the gear casing 120. A sleeve member 174 is fitted over the head of the screw 170 and held in locking engagement with one of two recesses 176 in the casing 120 by means of a compression spring 178 coiled about the screw 170 between an enlarged head on the screw and the flange or collar forming the inner end of the sleeve detent member 174.

The universal milling machine constructed and arranged as above set forth, is well adapted for the performance of spiral taper milling. The machine as illustrated in Figs. 1 and 2, is set up for such an operation upon a taper spiral cutter generally shown at 180 in Fig. 1, supported at one end in the head stock 186 of the usual spiral head 182, and at its other end in a tail stock 182 bolted to the work table 24. For this operation, the entire work supporting assembly including the table, saddle and the swivel knee member 38 is canted about the axis of the swivel knee member 38, in order to secure the correct positioning of the work with relation to the cutter, the translatory movements of the work then being supplied by imparting the necessary feeding movements to the knee rail support 42, so that the entire work supporting assembly carried on the rail 42 is moved as a unit. For this operation the table clutch member 86 is moved to the right out of engagement with the stationary clutch member 87, thus rendering the table screw 46 inoperative to move the table 24, while at the same time the engagement of the clutch member 86 with the rotatable clutch 88, operates to lock the table against movement in either direction. The clutch gear 164 is moved to the right hand position illustrated in Figs. 2 and 9, so that the table transmission train including the spiral head actuating connections thereto is rendered subsidiary to and directly under the control of the reversing clutch member 124 for controlling the starting

and stopping, and direction of movement of the knee rail **42**. The table reversing clutch **52** is operatively connected to one or the other of the reversing gears **54** or **56**, to fully establish the operating connections to the spiral head under the control of the reversing clutch member **124**. It will readily be seen with this construction and set-up of the operating mechanisms, that the operator has merely to operate the lever **152** to start and stop the feeding operation of the work past the cutter and at the same time to control starting and stopping of the spiral head to maintain at all times the correct operating relation between the feeding and rotational movements imparted to the work.

The universal milling machine herein disclosed is also adapted by reason of the improved coordination of the driving gear trains for the several cooperating supports of the work assembly to secure a greater flexibility and range of operation for the machine in the performance of other milling operations such as ordinary milling. For an extremely rapid, or conversely, an extremely slow operation of the table, the table transmission train is connected in series with the knee rail support clutch **124** as above described and as best shown in Fig. 9 of the drawings, and the clutch member **86** is shifted to the left into engagement with the stationary clutch member **87** to connect the table feed screw **46** to drive the table. The speed of the table when the knee rail clutch **124** is now shifted to either operating position, will be the resultant of either the combined driving rates of the table and rail in the same direction, or their differential if driven in opposite directions depending upon the position of the table reversing clutch **52**.

In order to adapt the machine for the novel and improved mode of operation of the table above described, the gears in the transmission trains have been selected to drive the table and rail respectively at different rates, and thereby to produce a differential movement having a predetermined value for slow speed operation of the table. With the present construction the differential driving rate of the table and knee rail supports is secured by varying the number of teeth in one of the two gears **72** and **73**, the gear **72** having 25 teeth, and the gear **73** having 18 teeth, so that the table is driven at substantially three-fourths of the rate of travel of the knee rail support **42** which is driven from the shaft **122** at the usual driving rate secured by the use of one to one gear driving ratios throughout.

A preferred embodiment of the invention having been described, what is claimed is:—

1. In a milling machine, the combination with a cutter spindle, of a work supporting assembly including a longitudinally movable work table, a plurality of subsidiary supports therefor mounted one on another to move in a diversity of paths and including a support movable longitudinally in the direction of table movement, driving connections for controlling the rate and direction of travel of the work table comprising a prime mover, a transmission train having a predetermined geared driving ratio and including a reverser for moving the work table, a transmission train having a different geared driving ratio and including a separate reverser for moving said longitudinally movable secondary support, and a clutch connection shiftable to connect said work table transmission to be driven from said latter reverser whereby said latter reverser is operative to control simultaneously the starting and stopping and reversal of both the table and longitudinally movable support.

2. In a milling machine, the combination with a cutter spindle, of a work supporting assembly including a longitudinally movable work table, supporting means therefor including a secondary support movable longitudinally in a plane parallel to that of the table movement, and driving connections for controlling the rate and direction of travel of the work table comprising a prime mover, a transmission train having a predetermined geared driving ratio and including a reverser for moving the work table, a transmission train having a different geared driving ratio and including a separate reverser for moving said secondary support, and a clutch connection shiftable to connect said table transmission train to be driven directly from the prime mover, or alternatively from the latter reverser whereby said latter reverser is operative to control simultaneously the table and support.

3. In a milling machine, the combination with a cutter spindle, of a longitudinally movable work table, a transversely movable saddle support for the work table, a vertically adjustable knee having thereon a longitudinally movable rail support for the saddle, driving connections for controlling the rate and direction of travel of the work table comprising a prime mover, a transmission train including a reverser for moving the work table, a transmission train including a separate reverser for driving the rail support, and means operable for connecting said table transmission train to be driven from said prime mover selectively under the control of said rail support reverser or independently thereof.

4. In a milling machine, the combination with a cutter assembly including a cutter spindle and a support for the spindle, a work supporting assembly including a slidable work table, and a plurality of secondary slide supports mounted one on another for translatory movements in a plurality of different paths and including swivel connections interposed between the table and one of said supports for swinging the work support about both transverse and vertical axes, power driving connections for the machine comprising a transmission train for said work support including a reverser, a transmission train including a separate reverser for imparting translatory movements to said last mentioned secondary support, and means for selectively connecting said work support transmission train to be driven directly from the prime mover or from said latter reverser whereby said latter reverser is operative to control simultaneously the operation of the table and said secondary support.

5. In a milling machine, the combination with a rotary cutter spindle, of a work supporting assembly including a longitudinally movable work table and a plurality of secondary slide supports therefor mounted one upon another for translatory movement in diverse paths and including swivel connections interposed between the table and one of said secondary supports for canting the work table about both transverse and vertical axes, power driving connections for the machine including a prime mover, a transmission train for said work support including a reverser, actuating connections for a spiral head attachment on the table, a transmission train including a separate reverser for imparting longitudinal translatory movements to said last mentioned secondary support, means for connecting said table transmission train to drive said actuating con-

nections for the spiral head attachment and for rendering said transmission train inoperative to drive the table, and means for connecting said table transmission train to be driven from the prime mover selectively under the control of said latter reverser or independently thereof.

6. In a milling machine, the combination with a rotary cutter spindle, of a work supporting assembly including a longitudinally movable work table and a plurality of secondary supports therefor mounted one upon the other for translatory movements in diverse paths and including swivel connections interposed between the table and one of said secondary supports for canting the work table about a transverse axis, power driving connections for the machine including a prime mover, a transmission train for said work support including a reverser, actuating connections for a spiral head attachment on the table, a transmission train including a separate reverser for imparting longitudinal translatory movements to said last mentioned secondary support, means for connecting said table transmission to drive said actuating connections for the spiral head attachment and for rendering said transmission train inoperative to drive the table, and a clutch connection shiftable for connecting said table transmission train to be driven from the prime mover selectively under the control of said latter reverser independently thereof.

7. In a milling machine, the combination with a cutter spindle, of a longitudinally movable work table, a plurality of secondary supports for the table mounted one on another including a longitudinally movable slide support and a swivel connection between the table and said slide support on which the table may be canted about a transverse axis, power driving connections for the machine including a prime mover, a transmission train for said work table including a reverser, an attachment actuator, and means for selectively connecting said table transmission train for actuating the table or said attachment actuator, a transmission train including a separate reverser for imparting longitudinal movements to said slide support, and a clutch connection for selectively connecting said work support transmission train to be driven simultaneously with said slide support from said latter reverser or independently thereof.

8. In a milling machine, the combination with a cutter spindle, of a longitudinally movable work table, a plurality of secondary supports for the table mounted one on another including a longitudinally movable slide support and a swivel connection between the table and said slide support on which the table may be canted about a transverse axis, power driving connections for the machine including a prime mover, a transmission train for the work table including a reverser, an attachment actuator operatively connected to said table transmission train, a transmission train including a separate reverser for imparting longitudinal movements to said slide support, and a clutch connection for driving the table transmission train from said latter reverser whereby said latter reverser is operative to control simultaneously the starting and stopping and reversal of the slide support and of the table transmission train and attachment actuator connected thereto.

9. In a milling machine, the combination with a cutter spindle, of a work supporting assembly including a work table and a longitudinally movable supporting member therefor, said table being longitudinally movable relatively to said supporting member, and driving connections for controlling the rate and direction of travel of the work table comprising a prime mover, a transmission train from said prime mover for moving the table relatively to the support, a transmission train from said prime mover for moving the support, means including separate control elements associated with each of said trains for controlling independently starting, stopping and reversal of each of the table and support, and a driving connection including a single control element acting when rendered operative to control simultaneously the starting, stopping and reversal of both of said trains to effect simultaneous movement of the table and support.

10. In a milling machine, the combination with a cutter spindle, of a work supporting assembly including a work table, a longitudinally movable supporting member therefor, said work table being longitudinally movable relatively to said supporting member, and driving connections for controlling the rate and direction of travel of the work table comprising a prime mover, a first transmission train including a reverser for moving the work table, a second transmission train including a separate reverser for moving said supporting member, and means for selectively connecting one of said transmission trains including the reverser associated therewith to be driven from the prime mover exclusive of the other of said reversers, or through said other reverser whereby said other reverser is operative to control simultaneously the operation of the work table and said supporting member.

11. In a milling machine, the combination with a cutter spindle, of a work supporting assembly including a work table, a longitudinally movable supporting member therefore, said work table being longitudinally movable relative to said supporting member, and driving connections for controlling the rate and direction of travel of the work table comprising a prime mover, a first transmission train including a reverser for moving the work table, a second transmission train including a separate reverser for moving said supporting member, and means for selectively connecting said first transmission train to be driven from the prime mover exclusive of said latter reverser, or through said latter reverser whereby said latter reverser is operative to control simultaneously the operation of the work table and said supporting member.

12. In a milling machine, the combination with a cutter spindle, of a work supporting assembly including a work table, a longitudinally movable supporting member therefor, said work table being longitudinally movable relative to said supporting member, and driving connections for controlling the rate and direction of travel of the work table comprising a prime mover, a first transmission train including a reverser for moving the work table, a second transmission train including a separate reverser for moving said supporting member, and a clutch connection shiftable to connect said table transmission train to be driven directly from the prime mover, or alternatively from the latter reverser, whereby said latter reverser is operative to control simultaneously the table and supporting member.

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