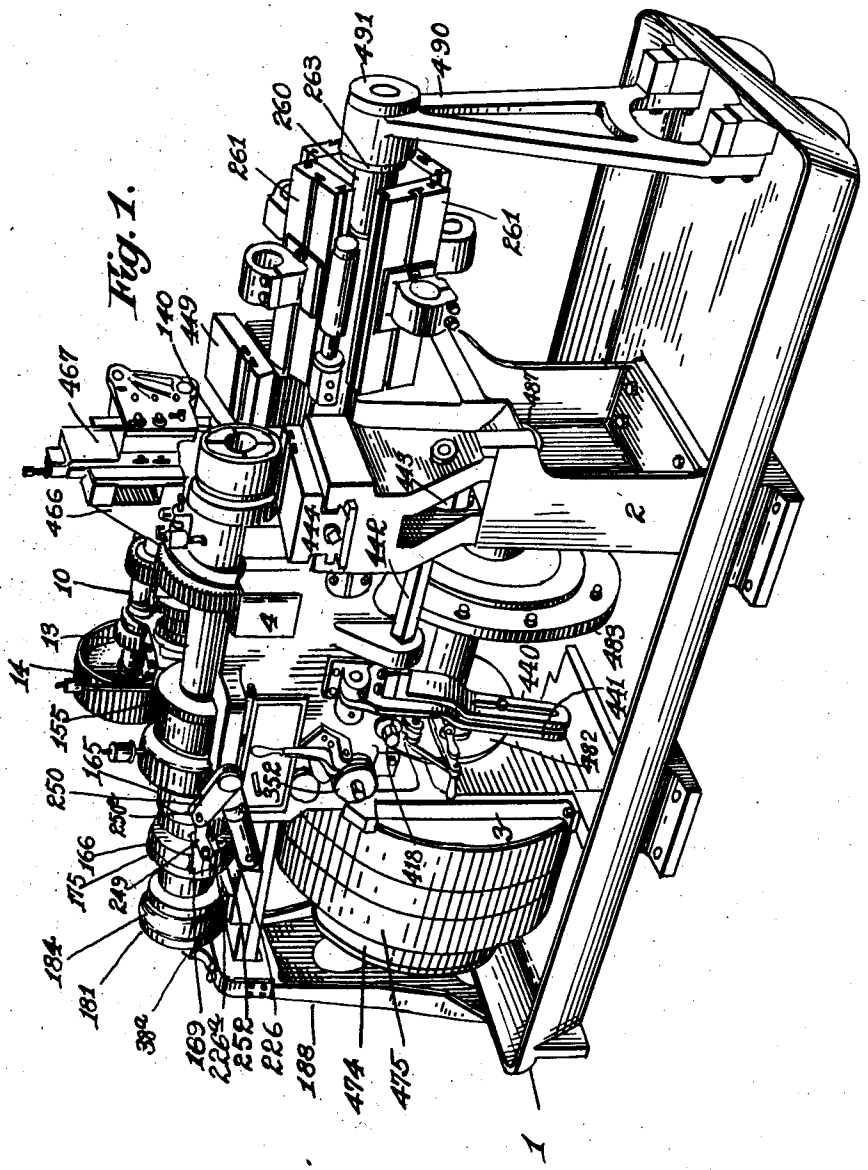
Dec. 29, 1925. 1,567,790

A. E. DRISSNER

AUTOMATIC SINGLE SPINDLE OR TURRET LATHE MACHINE

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Fig. 1.



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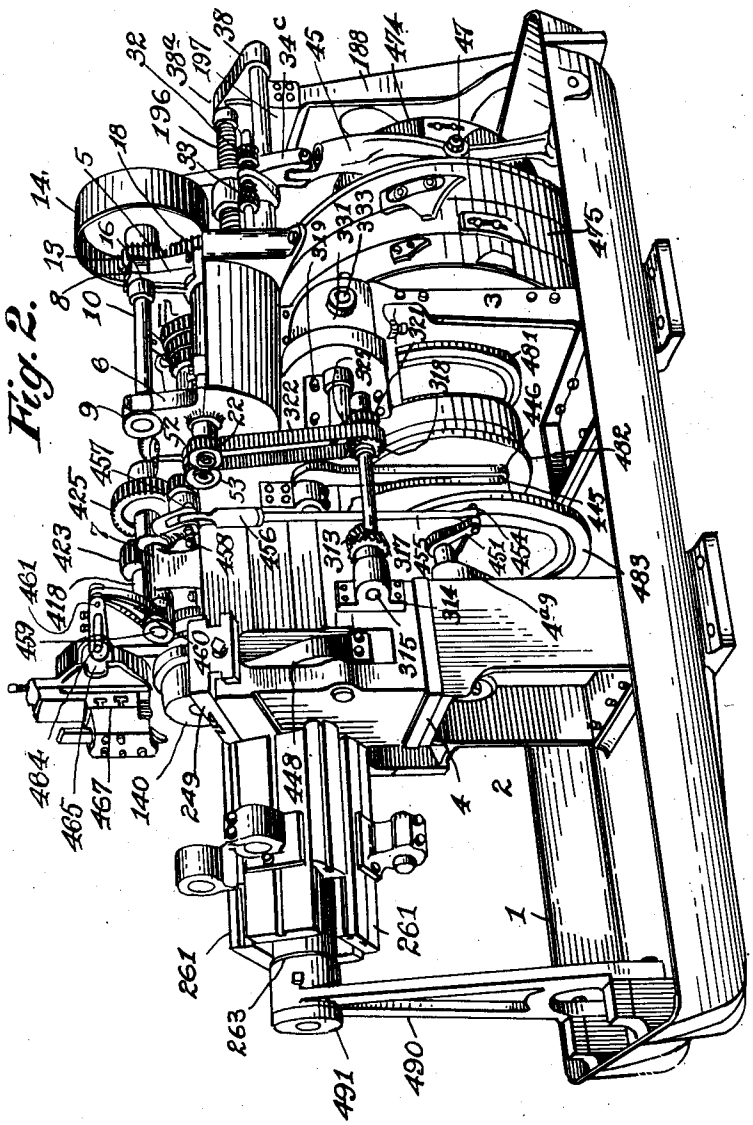
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AUTOMATIC SINGLE SPINDLE OR TURRET LATHE MACHINE

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Fig. 2.



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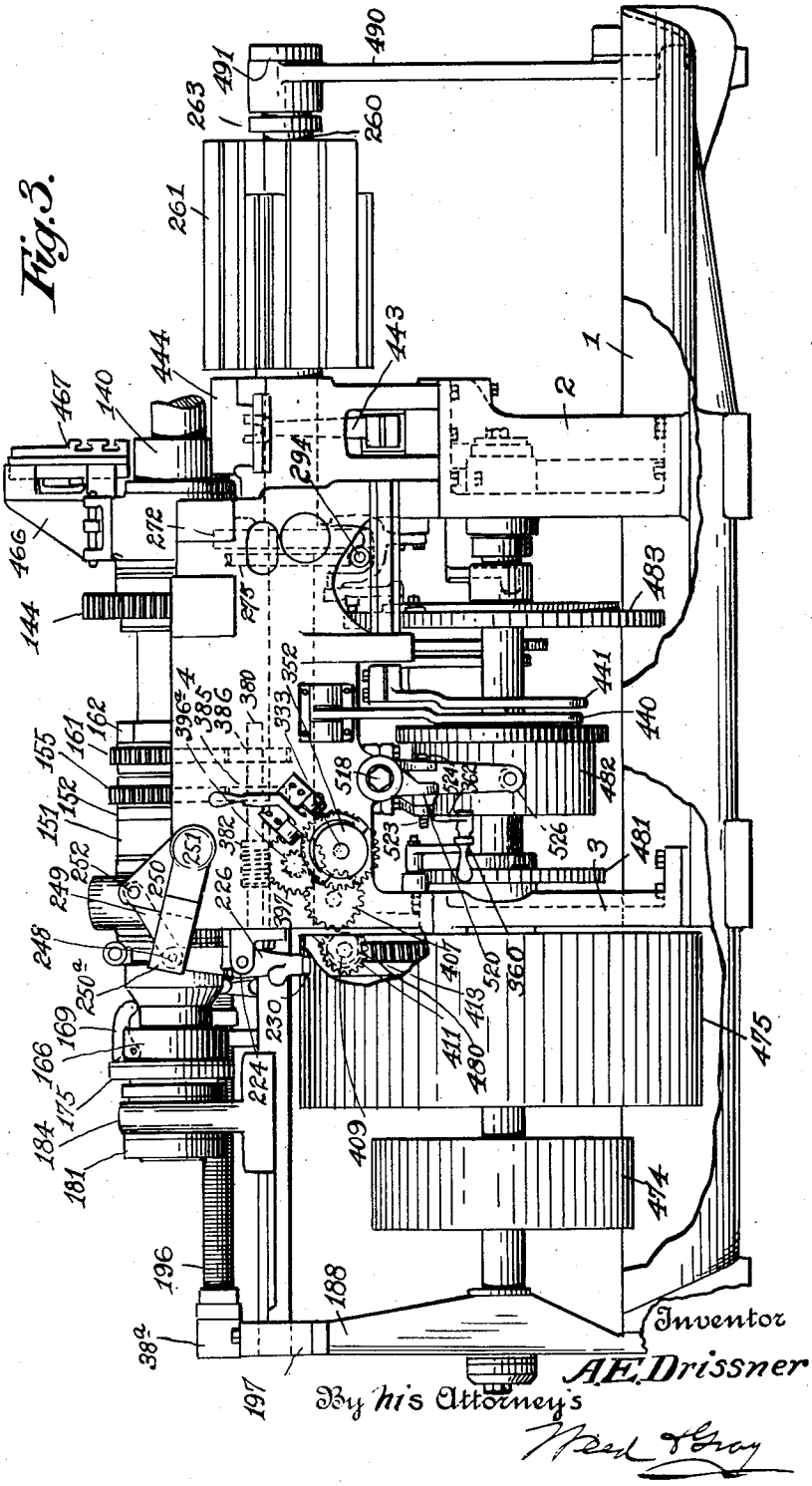
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AUTOMATIC SINGLE SPINDLE OR TURRET LATHE MACHINE

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Fig. 3.



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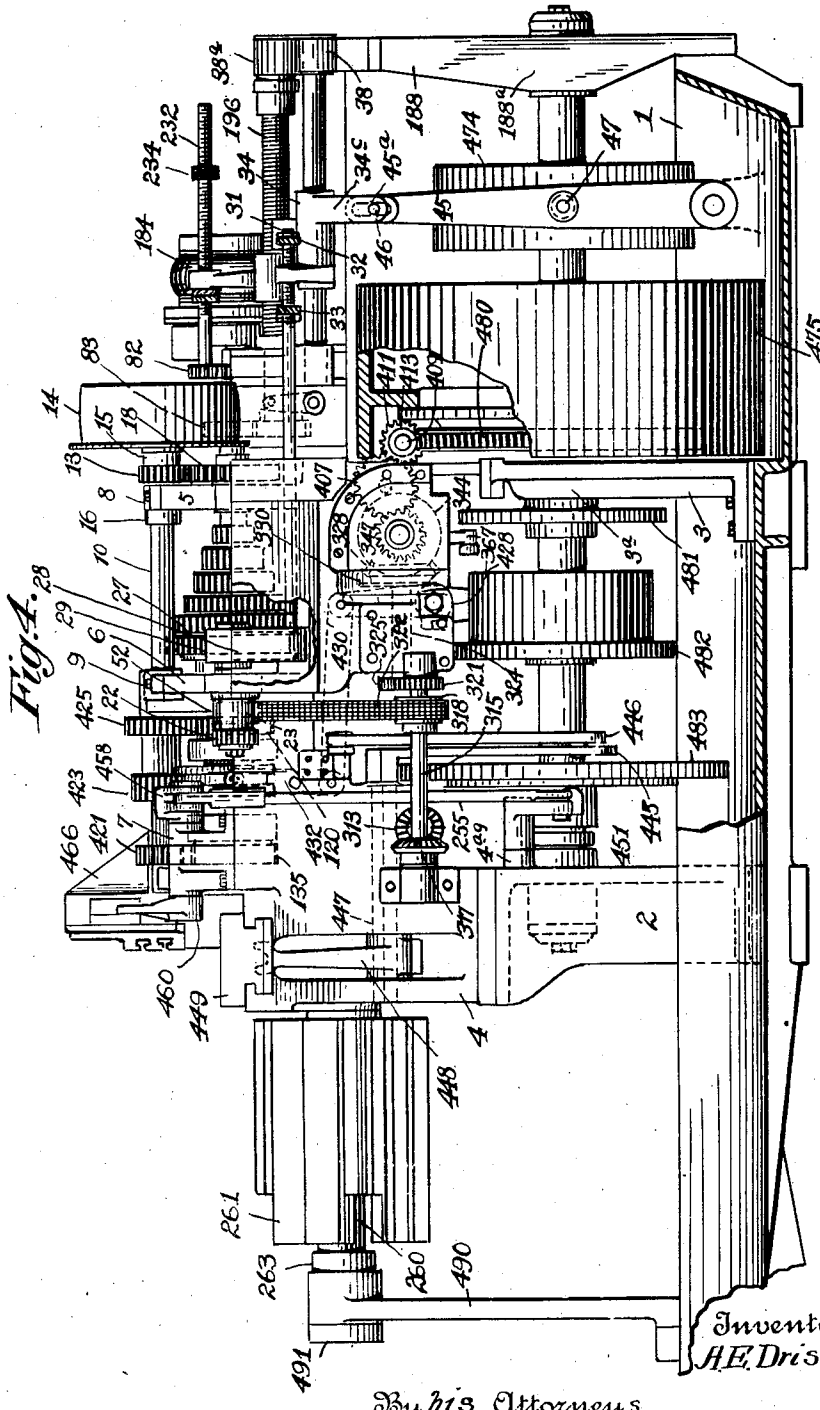
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AUTOMATIC SINGLE SPINDLE OR TURRET LATHE MACHINE

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Fig. 4.



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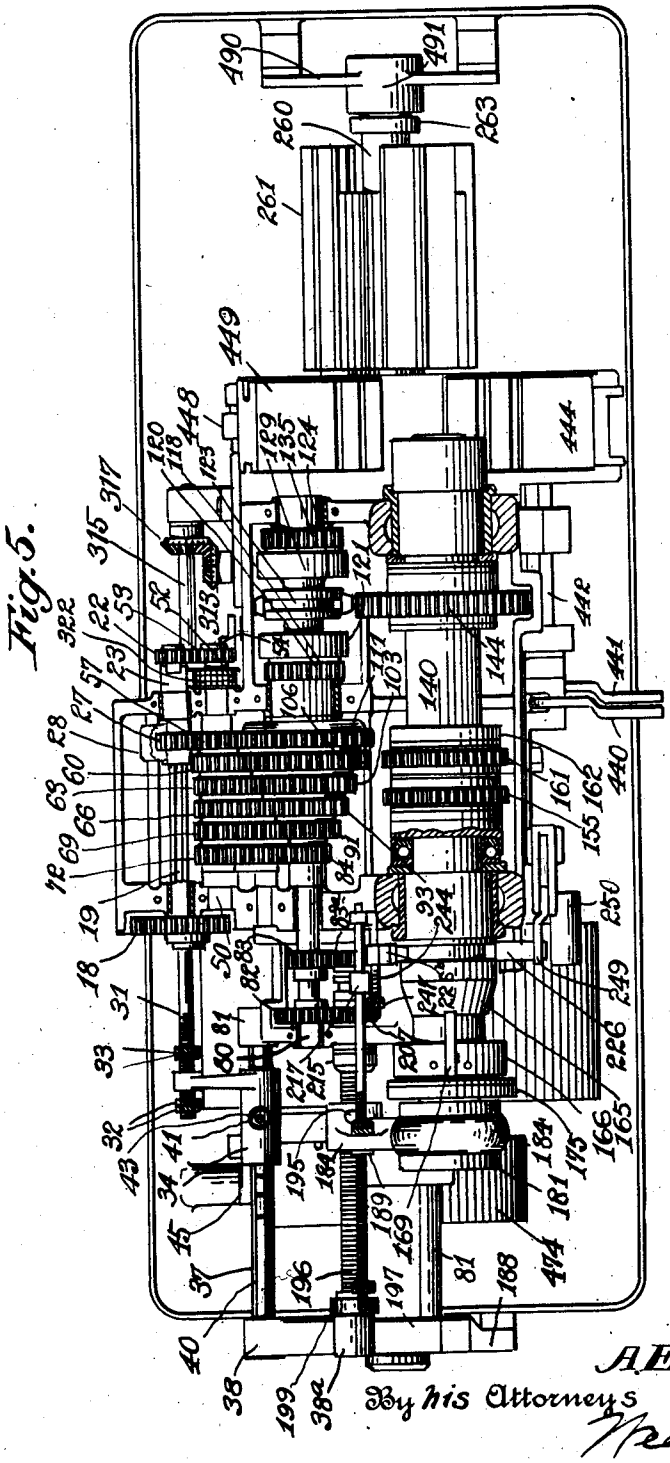
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AUTOMATIC SINGLE SPINDLE OR TURRET LATHE MACHINE

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Fig. 5.



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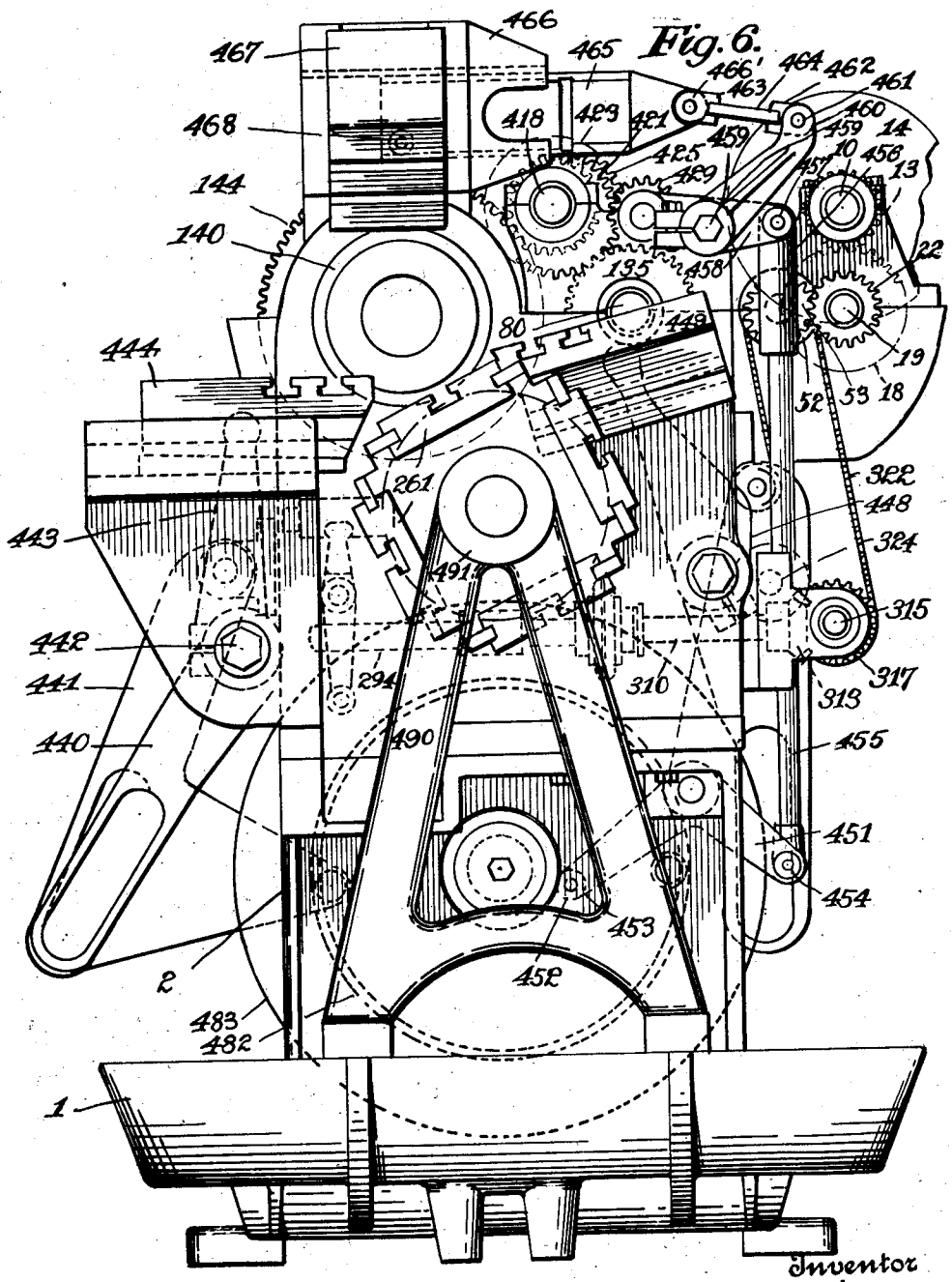
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AUTOMATIC SINGLE SPINDLE OR TURRET LATHE MACHINE

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Fig. 6.



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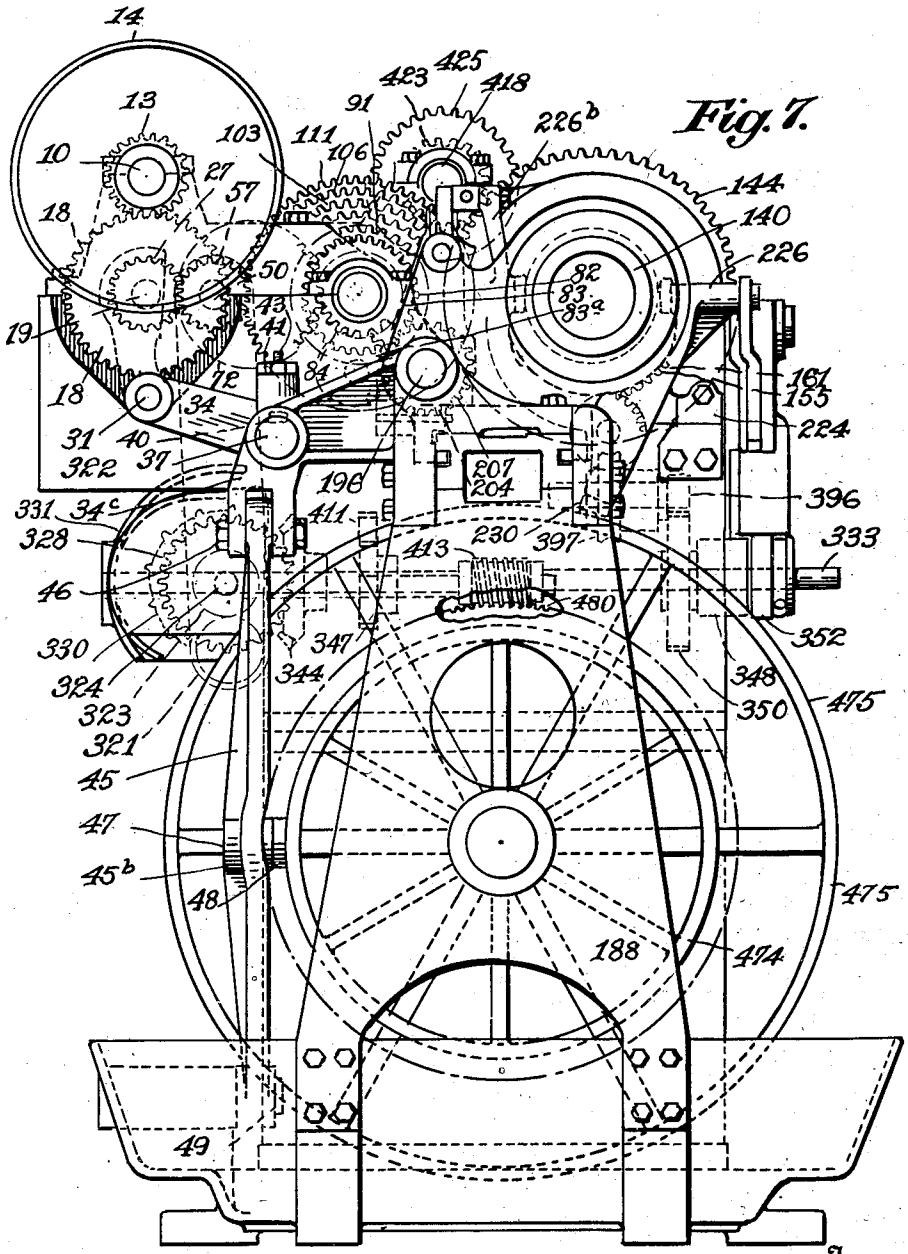


Fig. 7.

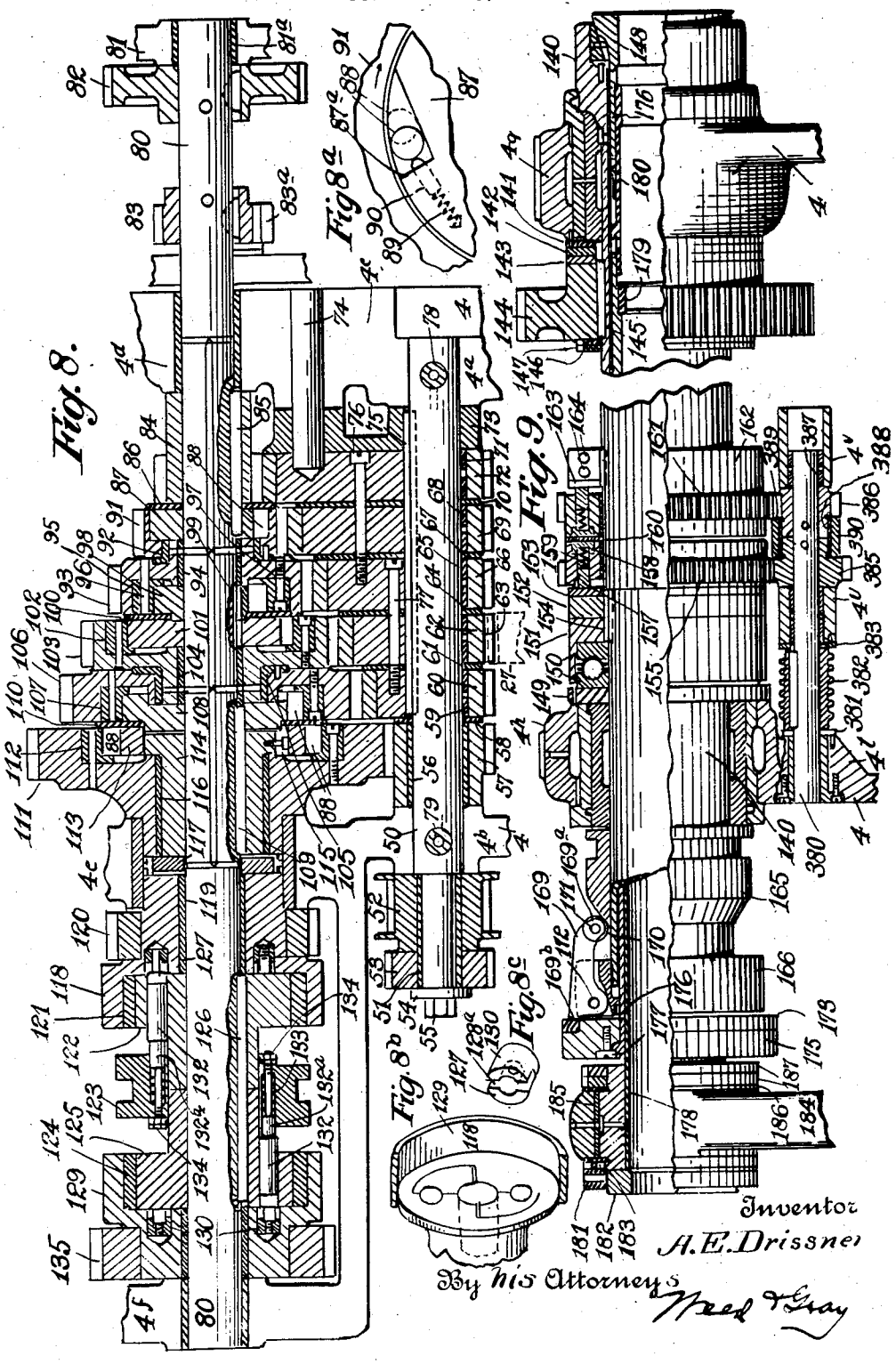
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AUTOMATIC SINGLE SPINDLE OR TURRET LATHE MACHINE

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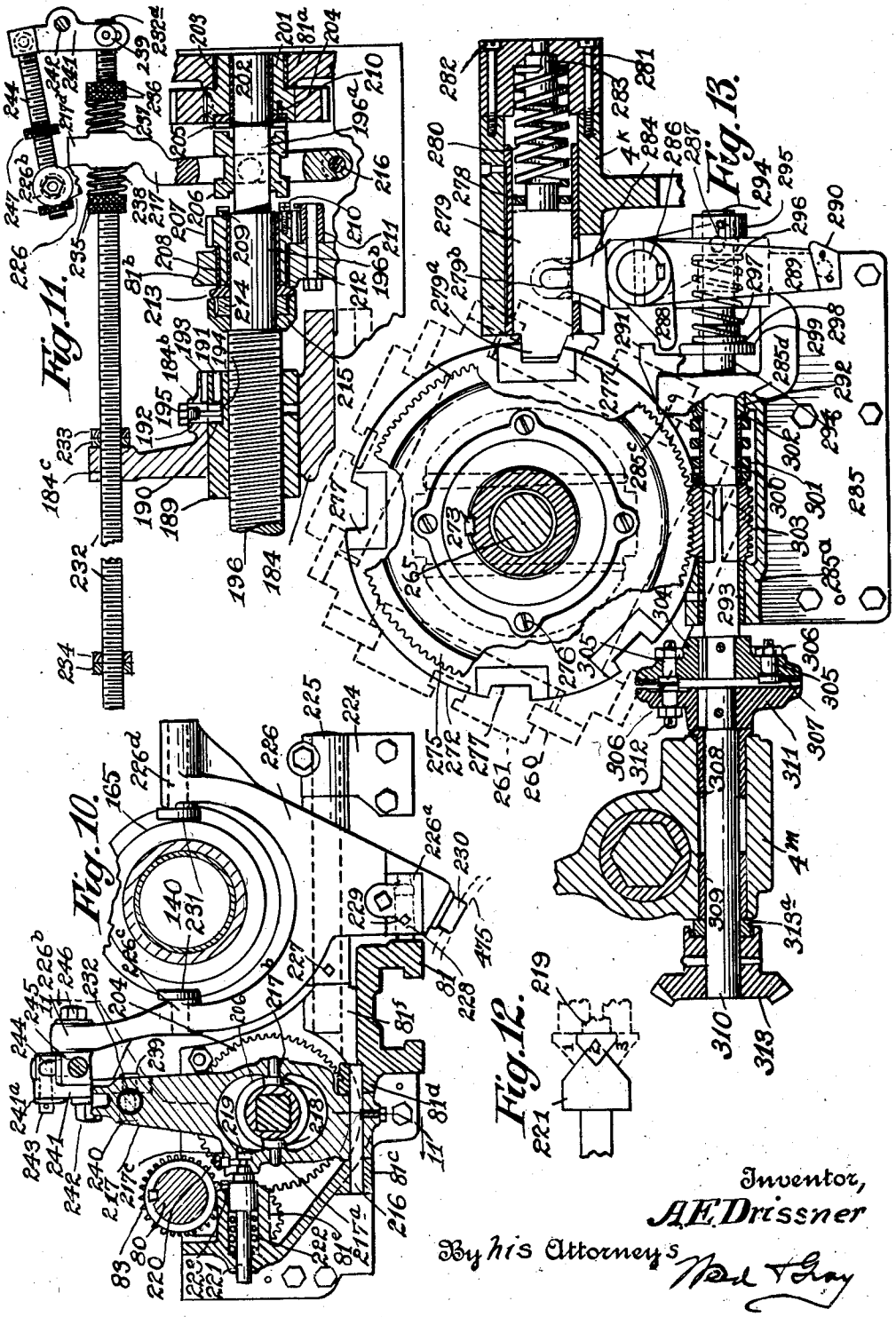


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AUTOMATIC SINGLE SPINDLE OR TURRET LATHE MACHINE

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AUTOMATIC SINGLE SPINDLE OR TURRET LATHE MACHINE

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Fig. 15.

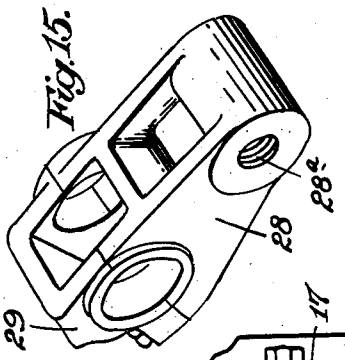


Fig. 14.

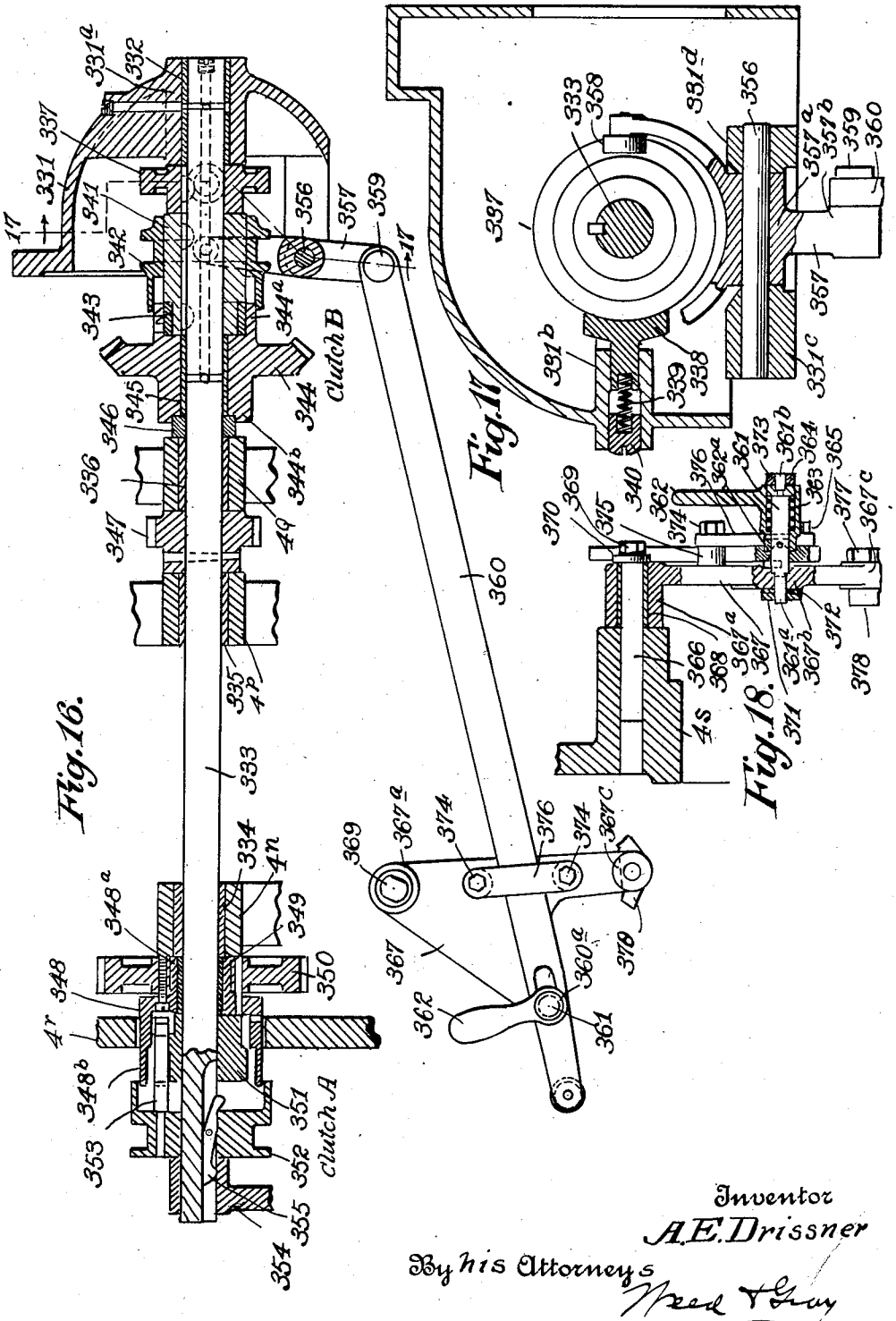
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AUTOMATIC SINGLE SPINDLE OR TURRET LATHE MACHINE

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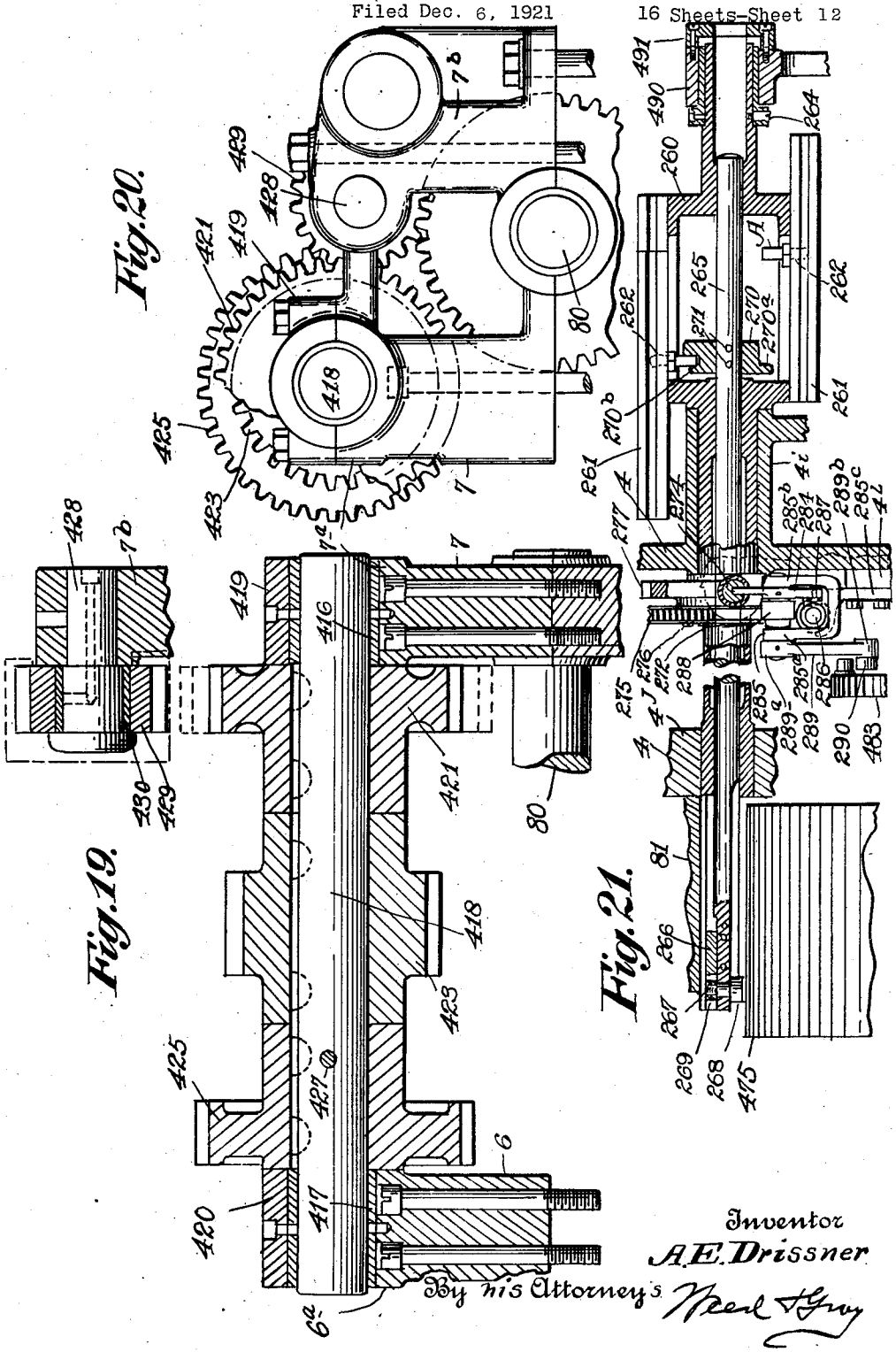


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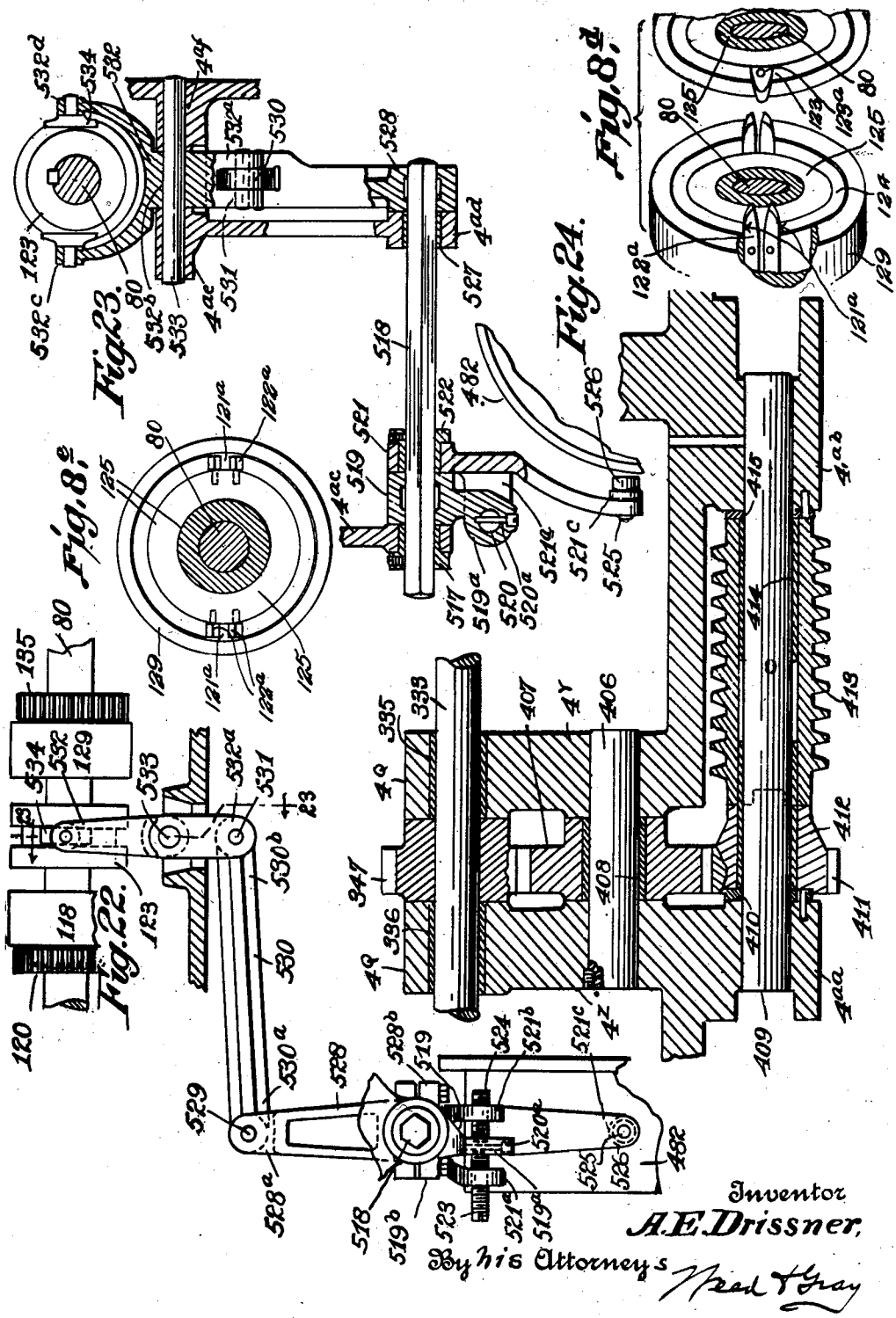


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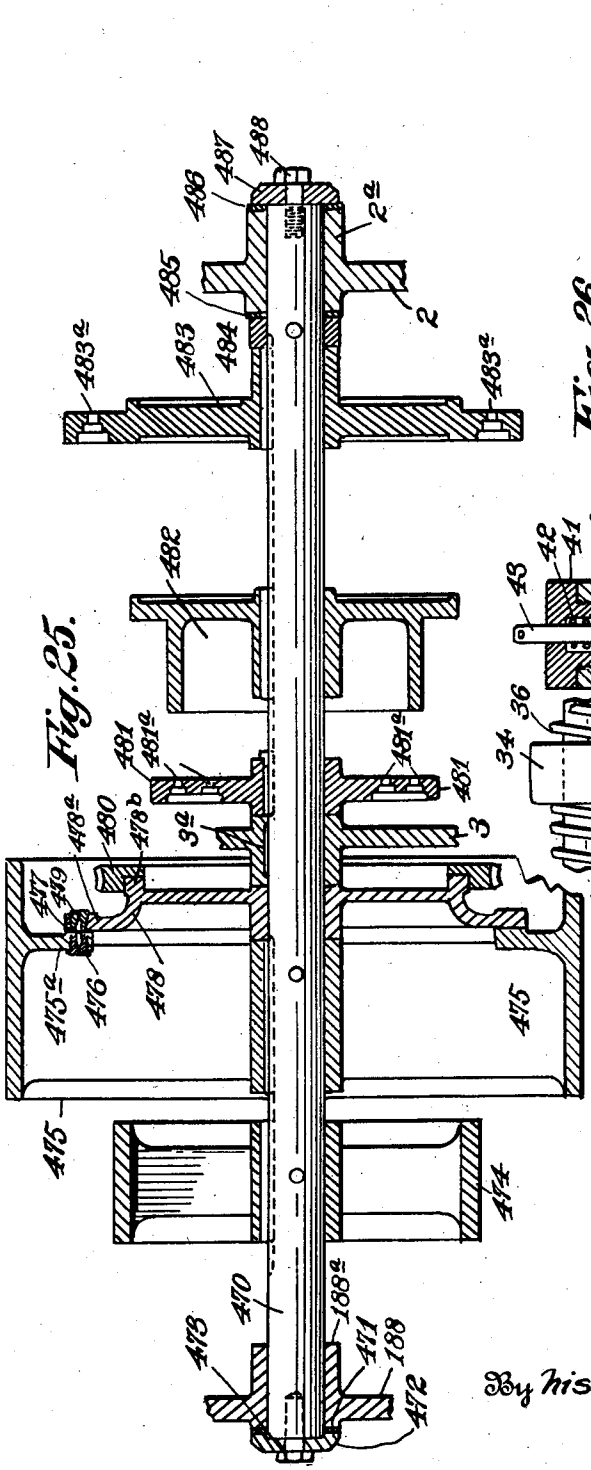


Fig. 25.

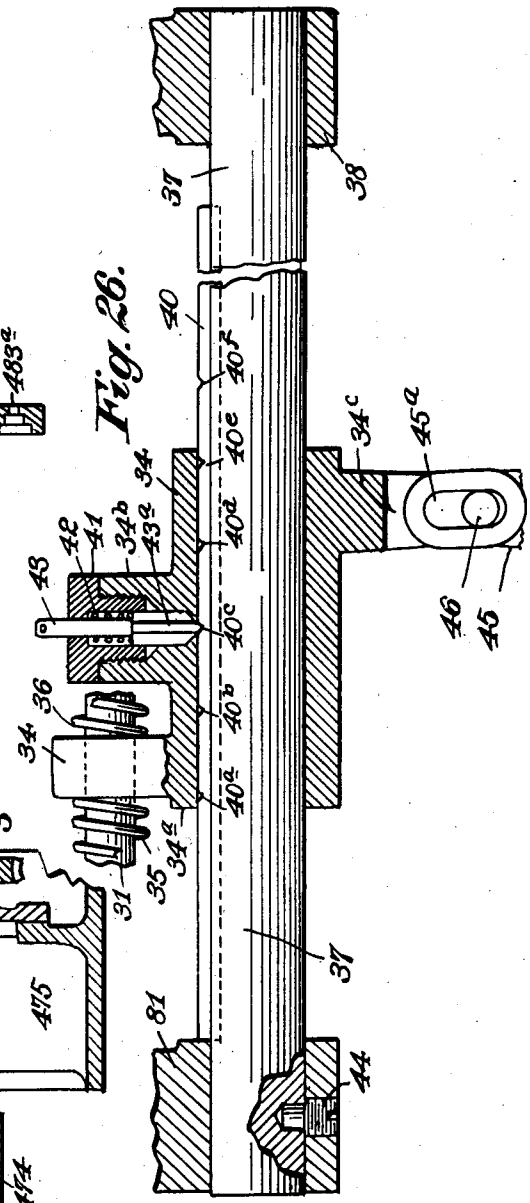


Fig. 26.

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Fig. 27.

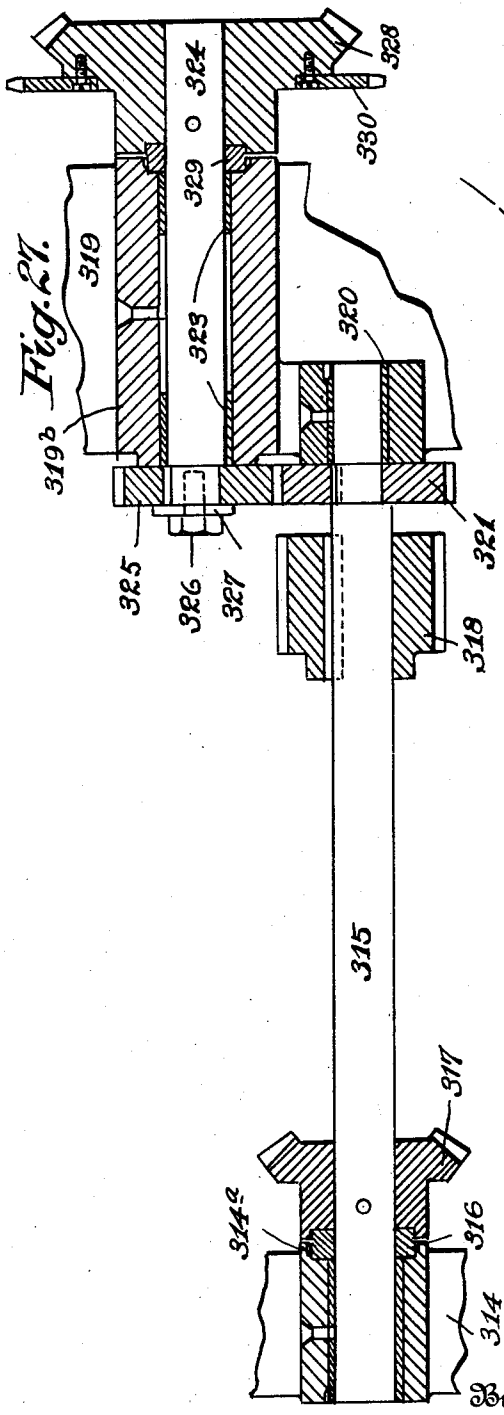


Fig. 29.

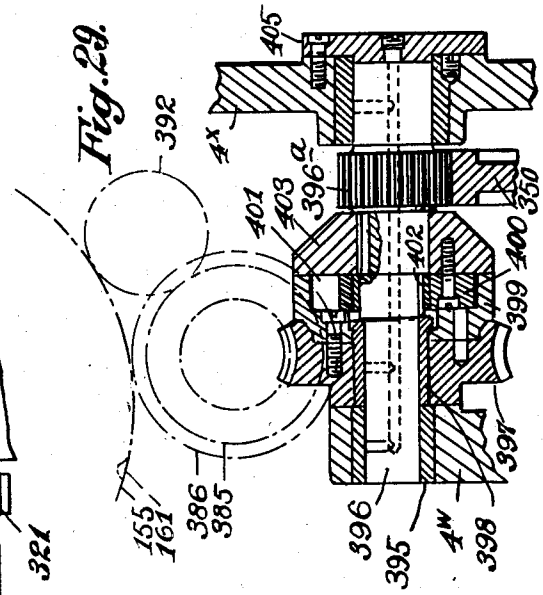
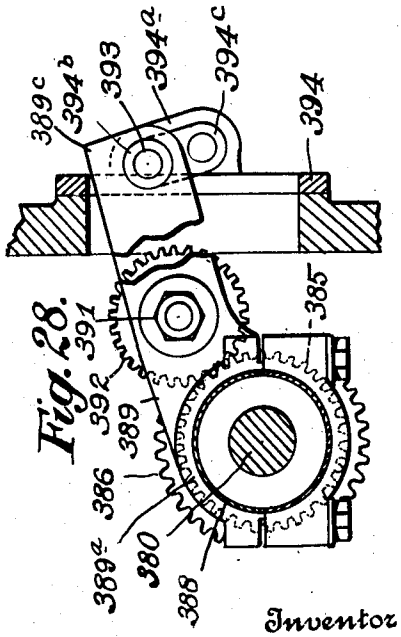


Fig. 28.



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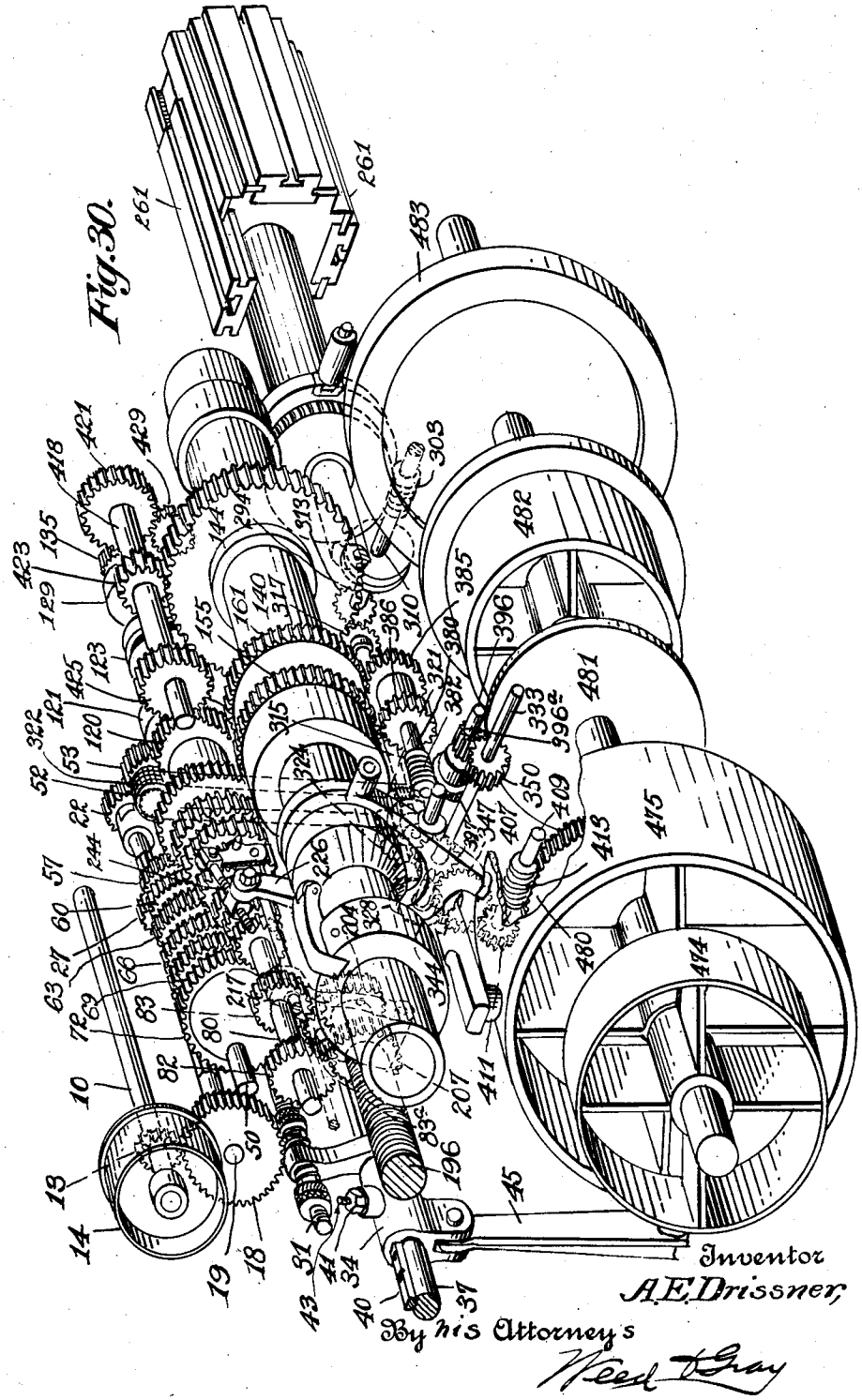
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AUTOMATIC SINGLE SPINDLE OR TURRET LATHE MACHINE

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Fig. 30.



Patented Dec. 29, 1925. 1,567,790

UNITED STATES PATENT OFFICE.

ALFRED E. DRISSNER, OF CLEVELAND, OHIO, ASSIGNOR TO THE NATIONAL ACME COMPANY, OF CLEVELAND, OHIO, A CORPORATION OF OHIO.

AUTOMATIC SINGLE-SPINDLE OR TURRET-LATHE MACHINE.

Application filed December 6, 1921. Serial No. 520,287.

To all whom it may concern:

Be it known that I, ALFRED E. DRISSNER, a citizen of the United States, residing at Cleveland, in the county of Cuyahoga and State of Ohio, have invented certain new and useful Improvements in Automatic Single-Spindle or Turret-Lathe Machines, of which the following is a specification.

This invention relates to metal working machines of that kind generally designated as automatic single spindle or turret lathes, in which the work upon which the various operations are to be performed is held in a rotatable work spindle and is operated upon by tools supported and held by a rotatable turret, so mounted and indexed as to advance the tools successively into working position, and which machine is adapted for the production of metal parts used in practically all metal working industries from bar stock or forgings, the object of the invention being to provide an improved machine of this class.

One of the principal objects of this invention is the provision of an improved machine, in which the entire mechanism is driven by a single belt or motor thereby doing away with a number of belts or two or more motors.

Another object of great importance is an improved gear transmission, by means of which the work spindle may be driven at a number of different speeds in either direction, and in which the change of speed at any time desired is automatically obtained, and in which the speed of the cam drum and parts operated thereby is also changed each time the speed of the spindle is changed.

In machines of this general class it has heretofore been usually necessary to stop the machine and replace gears to change the speed thereby lowering production but in the present improvement the change of speed is automatically obtained at any time desired, and this change of speed is positive and accurate. This improved gear transmission enables some classes of work to be done at high spindle speed and other classes of work to be done at low spindle speed, whereas in the general type of machine of this kind there is only one speed for the spindle when once in operation. As a result of the present improvement the output of the machine is very materially increased.

In the present improved machine, as illustrated, the work spindle can be driven both right-handed and left-handed at six different speeds, or when driven only right-handed it can be driven at twelve different speeds.

Another important object of this invention is the provision of an improved means for feeding the stock or bar thereby doing away with the old style weight or gravity feed.

In the present improvement one of the important advantages obtained is that the cam drum can be speeded up whenever desired without affecting the speed of the spindle, which is a great advantage in the indexing of the turret, as very little time is thus lost in this operation.

Another object of this invention is the provision of an improved top tool or cut-off slide operating mechanism.

The present improved organization and construction of machine permits the use of improved safety mechanisms at several points whereby injury to the mechanism is prevented in case of accident, and these important advantages and objects as well as many others will appear throughout the specification.

In the drawings accompanying and forming a part of this specification, Fig. 1 is a perspective view of what may be considered the front side of this machine; Fig. 2 is a perspective view of what may be considered the rear side of this machine; Fig. 3 is a side elevation of the machine at the same side shown in Fig. 1 and therefore what may be considered as the front side; Fig. 4 is a side elevation of the machine at the same side shown in Fig. 2, and therefore what may be considered as the rear side; Fig. 5 is a top or plan view of this improved machine partly in section, but with the tool forming and top slides removed; Fig. 6 is a right-hand end view of the machine as illustrated in Fig. 1; Fig. 7 is a left-hand end view of the machine as illustrated in Fig. 1; Fig. 8 is a top sectional view of this improved gear transmission for the main spindle; Fig. 8^a is a detail view of the roller clutch used in connection with the gear transmission mechanism; Fig. 8^b is a detail view of the positive clutch cup used in connection with the gear transmission mechanism; Fig. 8^c is a detail view of the dog used in connection with this positive clutch

cup shown in Fig. 8[b]; Fig. 8[d] is a fragmentary perspective view partly in section illustrating the friction parts of the double friction clutch mechanism; Fig. 8[e] is a cross section illustrating one of the members of the double friction clutch mechanism; Fig. 9 is a sectional view of the main spindle and a part of the power feed; Fig. 10 is a cross sectional view of the improved stock feeding mechanism; Fig. 11 is a sectional view of the stock feeding mechanism taken on line 11—11 Fig. 10; Fig. 12 is a detail view of the locking device shown in Fig. 10 for the shifting lever of the stock feeding mechanism; Fig. 13 is a cross sectional view of the turret indexing and locking mechanism; Fig. 14 is a sectional view of the main pulley drive and automatically shiftable gear for automatically changing the speed of the main spindle; Fig. 15 is a perspective detail view of the automatic change speed actuator or gear housing shown in Fig. 14; Fig. 16 is a sectional view of the clutch shaft mechanism; Fig. 17 is a sectional view taken on line 17—17 Fig. 16; Fig. 18 is a detail sectional view of the clutch operating means shown in Fig. 16; Fig. 19 is a sectional view of part of the main spindle driving mechanism; Fig. 20 is a right-hand end view of the mechanism illustrated in section in Fig. 19; Fig. 21 is a longitudinal sectional view of the tool turret and its indexing means; Fig. 22 is a view of the lever mechanism operating the friction and positive clutch mechanism, this view being a left-hand end view of that mechanism which is illustrated in section in Fig. 23, and is the means which controls the clutch mechanism on the shaft 80 of the power transmission mechanism; Fig. 23 is a cross-sectional view taken on lines 23—23 Fig. 22; Fig. 24 is a cross-sectional view of the cam shaft driving means; Fig. 25 is a longitudinal view of the cam shaft illustrating the cams thereon in section; Fig. 26 is a partly sectional view of the means for operating the shiftable gear in the power transmission mechanism whereby the speeds of the spindle may be changed; Fig. 27 is a sectional view of the driving means for the fast feeding and indexing mechanism; Fig. 28 is a view illustrating the reverse spindle drive control illustrated in Fig. 9; Fig. 29 is a partly sectional view of a part of the power feed mechanism connected with cross shaft 333 for driving the cam shaft; and Fig. 30 is a perspective view in diagrammatic form illustrating the assemblage of the various gears.

Similar characters of reference indicate corresponding parts in the several figures of the drawings.

The present machine is an improvement in many very material respects upon that shown and described in the Cone Patent No. 1,303,216 dated May 6, 1919, owned by the National Acme Company of Cleveland, Ohio, also the assignee of the present invention.

Before proceeding to a detailed description of the machine illustrated in the drawings, it should be understood that the invention is not limited to the particular embodiment herein described, that the drawings are more or less conventional, many of the cams being omitted or shown conventionally, and that the phraseology herein described is for the purpose of description and not for limitation. For instance, in other words, such cams as are herein shown will be adapted for certain kinds of work, but for other kinds of work different cams would of course have to be used.

Referring to the accompanying drawings, which illustrate the present preferred embodiment of this improved machine, the machine consists of an oil pan 1, upon which are secured two columns 2 and 3. On top of these two columns a headstock or frame 4 is securely mounted. This frame is of such design as to provide a very rigid base for the majority of the operating mechanisms. Upon frame 4 three brackets 5, 6 and 7 (see Figs. 2, 4, and 14) are securely mounted. These brackets are of such design that in connection with the frame 4 they form, at suitable locations, split bearings. These bearings, along with other similar as well as suitable bearings support the operating mechanisms hereinafter described.

The main driving mechanism and sliding gear.

On the top of the two brackets 5 and 6 caps 8 and 9 (see Figs. 2, 4 and 14) are securely mounted and are of such a design in connection with the brackets that they form split bearings. Bushings 11 and 12 are pressed into these split bearings and freely running in these bushings is the main pulley shaft 10. This pulley shaft projects to the rear of bearing 8, and on this shaft is mounted the back gear 13 and main driving pulley 14, both being keyed to shaft 10 by a key 15. The collar 16, fitted and pinned to shaft 10 and washer 17, secured to end of shaft 10 by a suitable screw, hold in place the pulley 14, back gear 13, and shaft 10.

All the movements of this improved machine are obtained from this main driving pulley 14. This is an important feature in the present organization of machine, and motor power may be used in place of pulley, belt, and countershaft, in which case the pinion of the motor would be fitted on the pulley shaft 10 in place of the pulley 14 and the motor secured to the bracket which in turn would be secured to frame 4.

The split bearings at 5 and 6 (see Fig. 14) are also bored and in these are pressed bush-

ings 25 and 26. Bushing 25 is bored to receive a rotatable shaft 19. Bushing 26 is bored to receive a turned down end of this shaft 19. The back gear 18 fits one end of shaft 19, being keyed thereon by key 20, and is held in place by a washer 21 and screw. Gear 18 meshes with gear 13 forming the back gears of the machine and in place of these gears just mentioned other sets of different sizes may be used in place of those shown, and thus a wide range of speed for shaft 19 is obtained. Shaft 19 between bearings 5 and 6 is machined hexagon and a gear 27 is broached so as to freely slide thereon. This gear could be bored instead of broached and fit on shaft 19, which would then be round with a long key instead of hexagon; but this is undesirable owing to the fact that the gear would always have a tendency to bind on the key when operating. This difficulty is overcome by the use of a hexagon shaft.

The turned down end of shaft 19 projects beyond bearing 6 and on this is mounted and keyed a driving sleeve 23. This sleeve at one end is drilled and counterbored so as to receive part of two safety pins. Adjacent this sleeve is a gear 22 bored to receive a bushing, which in turn is bored to fit shaft 19 and freely runs thereon. Gear 22 is counterbored to receive the other part of the two safety pins mentioned above. Gear 22 and sleeve 23 are held in place by means of washer 24 and a screw. A cap 29 is secured to a bracket 28 (see also Fig. 15) and forms a housing for gear 27, thus forming an actuator to control the sliding gear. This bracket 28 is bored to receive a stationary shaft 30, on which it freely slides. This shaft is supported by the frame 4 under bearings at 5 and 6. The bracket 28 at 28^a is tapped to receive one end of rod 31, which is partly supported and freely slides thru a hole in frame 4 under bearing at 5. The other end of this rod 31 is threaded a suitable distance. On the threaded end of rod 31 two sets of adjustable lock nuts 32 and 33 and two springs 35 and 36 are mounted. Between these springs is the boss of a lever 34 (see also Fig. 26) bored to fit rod 31 so that it may slide thereon. This lever at 34^a (see Fig. 26) is bored so as to freely slide on a stationary shaft 37. A keyway is cut in the hub of this lever so that it may slide on key 40, which fits in shaft 37 and has notches 40^a, 40^b, 40^c, 40^d, 40^e and 40^f suitably spaced and located across the top thereof. The shaft 37 is supported by bracket 81 and bracket 38. A dog point screw 44 in bracket 81 keeps the shaft 37 in place and from turning. The lever 34 at 34^b is bossed and bored to receive the large end of a plunger 43, which may freely slide therein. The boss is counterbored and tapped so as to receive the screw 41, and this screw is counterbored to receive the plunger 43, which may freely slide up and down therein. A spring 42 is placed in this counterbore and fits around small end of plunger 43. A pin in the projecting end of plunger 43 keeps the plunger in place. The large end of plunger 43 is machined to fit the notches 40^a to 40^f cut in key 40. A groove 43^a is cut in plunger and a pin (not shown) fits this groove and keeps the plunger from turning while allowing it to move up and down. The lever 34 at 34^c is fork shaped, and is machined so as to receive one end of lever 45 (see Figs. 2 and 4) and this lever 45 at this end has an elongated hole milled therein and this receives the shank of a stud 46, which fits holes in lever 34 and is secured therein by a nut. This lever 45 at 45^b (see Figs. 2 and 7) is bored to receive stud 47, which holds roll 48 in place, allowing same to turn freely. The lower end of this lever 45 is pivoted to a boss on pan 1 by a stud 49. The lever 45 is actuated by suitable cams on the cam drum 474.

The link belt 322 driving mechanism.

In connection with the shiftable gear mechanism just described is a stationary shaft 50 (see Figs. 5 and 8) supported in the split bearings 4^a and 4^b. This shaft is held in place and kept from turning by means of pins 78 and 79 in said bearings (see Fig. 8). One end of this shaft is turned down. A link belt gear 52 is bored to receive one end of a bushing 51. A gear 53, which meshes with the gear 22 (see Fig. 14) is bored so as to securely receive the other end of bushing 51. These gears 52 and 53 are connected so as to rotate together, the gear 53 driving chain gear 52. The bushing 51 is bored to fit shaft 50 and freely run thereon. Gears 52 and 53 are held in place by a washer 54 secured to the end of shaft 50 by a screw 55.

The transmission or spindle driving mechanism.

On this fixed shaft 50 and next to bearing 4^b on the inside is gear 57 (see Figs. 5, 8 and 30), which is bored so as to securely receive the bushing 56, and this bushing freely runs on shaft 50. Next to this is a spacer 58 bored to fit shaft 50. Besides this is gear 60 bored to fit bushing 59 and freely runs on said bushing. This bushing is eccentrically bored to fit shaft 50 and is keyed thereon. This eccentric bushing is tapped to receive a screw 77. Next to gear 60 is spacer 61 bored to fit shaft 50 and also drilled to receive screw 77. Besides this is gear 63 (shown in mesh with sliding or shifting gear 27 hereinbefore described, see Fig. 14), which gear 63 is bored to fit the eccentric bushing 62 and freely runs thereon. This bushing 62 is bored eccentrically to fit shaft 50 and is keyed thereon. This bushing is also drilled

to receive the screw 77. Next to this is spacer 64 which is bored to fit shaft 50 and is drilled to receive screw 77. Beside this is gear 66 which is bored to fit the bushing 65 and freely runs thereon. This bushing 65 is eccentrically bored so as to fit shaft 50 and is keyed thereon. Bushing 65 is drilled and counterbored so as to receive part of screw 77. This screw thus holds the bushings 59, 62 and 65 and spacers 61 and 64 together in one unit. Bushing 65 is tapped to receive part of screw 76. Next to bushing 65 is spacer 67, which is bored to fit shaft 50 and also drilled to receive part of screw 76. Beside this is gear 69, which is bored to fit eccentric bushing 68 and freely runs thereon. Bushing 68 is eccentrically bored to fit shaft 50 and is keyed thereon. Bushing 68 is drilled so as to receive part of screw 76. Next to this bushing 68 is spacer 70 which is bored to fit shaft 50 and drilled to receive part of screw 76. Beside this is gear 72,—the last of the six gears,—which is bored so as to fit eccentric bushing 71 and freely runs thereon. Bushing 71 is eccentrically bored to fit shaft 50 and is keyed thereon. Bushing 71 is drilled and counterbored to receive part of screw 76. This screw 76 thus holds the first unit mentioned above and the spacers 67 and 70 along with bushings 68 and 71 together in one large unit. Bushing 71 is drilled to receive part of pin 74. On inside of bearing at 4^a is spacer 73 which is bored to fit shaft 50, and is keyed thereon. This spacer is also drilled to receive a part of pin 74. Key 75 is the means of keying all the eccentric bushings and spacers except 58 to shaft 50, so that all of said eccentric bushings are fixed to the fixed shaft 50 and the ring gears 60, 63, 66, 69 and 72 are rotatable thereon, while the first gear 57 of the set of six also rotates on the shaft 50 but is not eccentrically supported. The frame at 4^e is drilled to receive part of pin 74. This pin holds spacer 73 in place and also the large unit referred to above consisting of all eccentric bushings and the spacers between same. The gears 72, 69, 66, 63, 60 and 57 are idler gears and any nay be meshed with gear 27 when desired, by shifting the latter as hereinbefore described.

Shaft 80 cooperates in the following manner with the gears on shaft 50. Suitable bushings are mounted in the split bearings 81^a, 4^d, 4^e and 4^f (see Fig. 8) and form bearings for the revolving shaft 80. Gear 82 is keyed and pinned on shaft 80, and is located next to bearing 81^a. Gear 83 is also keyed and pinned on shaft 80, and is located between gear 82 and frame 4. Next to split bearing 4^d and in mesh with idler gear 72 is gear 84 keyed to shaft 80. Next comes spacer 86 also keyed to shaft 80. Beside this in mesh with idler gear 69 is gear 91 fitting shank of bushing 92 and pinned thereto. Gear 91 is counterbored to receive a roller clutch mechanism consisting mainly of plate 87 (see Fig. 8^a). This plate is bored so as to fit shaft 80 and is keyed thereon. Key 85 is the means of keying gear 84, spacer 86, and plate 87 to shaft 80. Plate 87 has a suitable number of notches milled therein equally spaced (see Fig. 8^a). Each of these notches receives a roll 88, and in the straight side of each notch is drilled a hole which receives a spring 89 and a plunger 90. This plunger forces roll 88 away from the straight side of each notch. The flange of bushing 92 acts as a spacer between gear 91 and gear 93, which is in mesh with idler gear 66. This gear 93 fits bushing 94 and is pinned thereto and bushing 94 is bored to fit shaft 80 and freely run thereon. Bushing 92 is bored so as to fit shank of gear 93 and freely runs thereon. This gear 93 is counterbored to receive the cup 95, which is secured by pin 96 and screw 97. This cup is bored to clear boss of gear 93 and is counterbored to receive roll clutch mechanism consisting mainly of plate 98. This plate is milled the same as plate 87 and each of these roll clutch mechanisms is similar to that mentioned above. This roll clutch plate 98 is bored to fit shaft 80 and is keyed thereon. Beside gear 93 is spacer 100, which securely fits shank of plate 98. Next to this is gear 103 bored to fit bushing 104 and pinned thereto, and bushing 104 is bored to fit shaft 80 and freely runs thereon. Gear 103 is counterbored to receive cup 102, which receives roller clutch mechanism (the plate of which is 101) which is similar to that shown in Fig. 8^a. Cup 102 is similar in design to cup 95. Roll plate 101 is bored so as to fit shaft 80 and is keyed thereon. Key 99 is the means of keying the roll plates 98 and 101 to shaft 80. The flange of bushing 105 acts as a spacer between gear 103 and gear 106 in mesh with idler gear 60. Bushing 105 is bored to fit the shank of gear 103 and freely runs thereon. Gear 106 is bored to fit shank of bushing 105 and is pinned thereto. Gear 106 is counterbored so as to receive cup 107 which receives roll clutch mechanism (the plate of which is 108) similar to roller clutch mechanisms already described. Cup 107 is similar in design to cup 95. Plate 108 is bored so as to fit shaft 80 and is keyed thereon. Plate 108 is counterbored to allow clearance of boss of gear 106, shank of bushing 105, shank of gear 103, and bushing 104. Spacer 110 is bored so as to securely fit shank of plate 108. Next to this is the last gear 111 in mesh with idler gear 57. Gear 111 is bored to receive bushing 116 and is pinned thereto. Gear 111 is also counterbored to receive the cup 112, which receives the roller clutch mechanism (the plate of which is 113), this machine being similar to those

described. Cup 112 is similar in design to cup 95. Roll plate 113 is bored to fit bushing 114 and is keyed thereon, by key 115. Bushing 114 is bored to fit shaft 80 and is keyed thereon. Bushing 116 is bored to fit shank of bushing 114 and freely runs thereon. The shank of gear 111 is turned down to fit in bore of bushing (mounted in split bearing 4^e and freely runs therein. A gear 120 on other side of bearing 4^e fits the shank of a clutch cup 118 and is keyed thereon. Clutch cup 118 is bored to receive a bushing 119 and is pinned thereto. Bushing 119 fits shaft 80 and freely runs thereon. The ends of shanks of gear 111 and clutch cup 118 are counterbored and in the space formed thereby an end thrust washer 117 is placed, which freely fits shaft 80. Next to bearing 4^f is gear 135 which is bored to fit shank of clutch cup 129 and is keyed thereon. Clutch cup 129 (see Fig. 8^b) is bored to receive a bushing which in turn is bored to fit shaft 80 and freely runs thereon. The large ends of the clutch cups 118 and 129 are counterbored to receive the double friction clutch mechanism, the parts shown of which are rings 121 and 124, sleeves 122 and 125, clutch sleeve 123, fingers 122^a, and wedges 123^a. Sleeves 122 and 125 are bored to fit shaft 80 and are both keyed thereon by key 126. The flanges of sleeves 122 and 125 are broached so as to receive plungers 132, which freely slide therein. Clutch sleeve 123 is bored to fit shanks of sleeves 122 and 125 and freely slides thereon. Clutch sleeve 123 is tapped from both sides to receive threaded ends of plungers 132. These tapped holes are counterbored and receive the larger shanks 132^a of plungers 132. In front of these and in same counterbores are the springs 133 thru which the smaller shanks of plungers 132 pass. The nuts 134 are for adjusting and keeping in place the plungers 132. The faces of both the counterbores of cups 118 and 129 are suitably milled (see Fig. 8^b), and in these milled places are drilled holes which receive the dogs 130 (see Fig. 8^c). There is a tapped hole and counterbore in these dogs for use in taking them out after being pressed in. The center line of plungers 132 and dogs 130 is the same distance from center of shaft 80 and therefore when these different parts meet as will be described later, their center lines will be in line with each other.

As shown in Figs. 8^d and 8^e each clutch ring or sleeve 122 and 124 is split at 121^a and within these splits or openings are inserted a pair of fingers 122^a pivoted to each sleeve 122 and 125. A wedge 123^a is secured to opposite faces of the clutch sleeve 123, and in operation when the member 123 is shifted toward the clutch ring 124 or 121, as the case may be, the wedge 123 will be driven between the fingers 122^a, thus spreading the fingers and expanding the ring 124 or 121 into frictional engagement with clutch cup 129 and the sleeve 125, or clutch cup 118 and sleeve 122, as the case may be.

In mesh with gears 120 and 135 are a pair of gears carried on a shaft 418 (see Figs. 19 and 20 and 30) and by means of which shaft 418 the work spindle is driven as now to be described. Caps 419 and 420 (see same Figs. 19 and 20) are securely mounted on brackets 7 and 6 respectively and are of such design in connection with these brackets as to form split bearings. These bearings are bored to receive bushings 416 and 417, which are pinned thereto. These bushings are bored to fit shaft 418, which freely runs therein. Next to bearing 7^a is a gear 421, which is keyed to shaft 418. Next to this is gear 423, which is also keyed to shaft 418. Between gear 423 and bearing 6^a is gear 425, which is likewise keyed to shaft 418. The bracket 7 at 7^b is bored to receive stud 428, which is held therein by a set screw. Gear 429 (mounted only when reverse speed is desired and referred to hereinafter) is bored to securely receive bushing 430, which in turn is bored to fit stud 428 and freely rotates thereon. The flange of stud 428 maintains gear 429 in place. Gear 425 meshes with gear 120 on shaft 80 (see Fig. 8) while gear 421 meshes with gear 135 on shaft 80. When the idler gear 429 is desired gear 421 is replaced by a similar gear but with less teeth. In that case (with gear 429 mounted) the substituted gear with less teeth, meshes with said gear 429, which in turn meshes with gear 135 on shaft 80. Gear 423 on said shaft 80 meshes with gear 144 on main spindle hereinafter described (see Fig. 30).

Operation of the spindle driving mechanism.

The mechanism so far described operates as follows, and many advantages and improvements will be observed:

The source of power coming thru pulley 14, Fig. 14 (or when a motor is used, a gear in place of pulley 14) to driving shaft 10 drives gear 13, and thus gear 18 which drives shaft 19. The angular drive shaft 19 thus rotates shiftable gear 27, which is shifted by bracket 28 by means of rod 31, shaft 30 merely acting as a guide for bracket 28 to travel on. The shifting rod 31 is shifted longitudinally by means of slide member 34 (see Fig. 26). The springs 35 and 36 act as cushions in case the teeth of gears should clash when lever moves one way or the other against the lock nuts 32 and 33 (Fig. 14). The travel of shifting rod 31 is adjustable thru these lock nuts 32 and 33. The lever 34 is moved by lever 45 and cams on cam drum 474 on the cam shaft. The cams are suitably machined and timed to give the correct position at the de-

sired time. After these cams have through lever 45 shifted slide 34, this slide 34 is suitably held in position (and hence gear 27) by plunger 43 (see Fig. 26) falling in one of the notches in the key 40. These notches are machined at suitable locations so that shifting rod 31 and hence gear 27 is held in the desired position at all times. When the plunger 43 is in, say, notch 40[a] the gear 27 is in mesh with gear 57; when in notch 40[b] with gear 60, etc. When the shifting gear 27 is in mesh with the idler gear 72, it drives gear 84 (see Fig. 8), which in turn drives shaft 80 by means of key 85. When the gear 27 is in the foregoing position it is driving shaft 80 at its maximum speed. The key 85 also drives roller plate 87 and spacer 86. By means of this roller clutch, the plate 87 is not connected with gear 91 when gear 27 is in above position. When shifting gear 27 is in mesh with idler gear 69, which in turn is in mesh with gear 91, the roller plate 87 is connected with gear 91 by means of roller clutch. Therefore the gear 27 in this position drives shaft 80 at a slower speed than thru 84. When gear 27 is not in mesh with gear 72 the gear 84 runs idle. When gear 27 is in mesh with idler gear 66, it drives gear 93. This in turn drives roller plate 98 by means of roller clutch mechanism. The roller plate 98 drives shaft 80 by means of key 99. With gear 27 in mesh with 66 the shaft 80 runs at a slower speed than thru gear 69. When gear 27 is in mesh with idler 63, which is in mesh with gear 103, it drives roller plate 101 by means of roller clutch mechanism and this in turn drives shaft 80 by means of key 99. When in this position the roller plate 98 is not connected in any way with the gear 93. When in this position the rate of speed of the shaft 80 is still slower. When the gear 27 is in mesh with idler gear 60, which meshes with gear 106, this gear 106 drives roller plate 108 by means of roller clutch mechanism, which drives shaft 80 by means of key 109 at a slower speed than the one just before mentioned. When the gear 27 is in mesh with the idler gear 57, which is in mesh with gear 111, this gear 111 drives roller plate 113 by means of roller clutch mechanism. This plate 113 drives the sleeve 114 by means of key 115 and this in turn drives the shaft 80 by means of key 109; the roller plate 108 now is in no way connected with gear 106. When gear 27 is in this last position mentioned the shaft 80 is, thru this gear transmission, at its lowest speed.

By the phrase "roller or roll clutch mechanism" in the above operation is meant the following:

When roll plate 87 is being driven in direction of arrow (see Fig. 8[a]) by shaft 80 at a greater rate of speed than that at which gear 91 is going, the roll 88 is forced by centrifugal force against plunger 90 and towards side of notch 87[a] and roll 88 is not in any way in contact with gear 91; now when gear 91 is driven at a greater speed in direction of arrow than roll plate 87 is being driven, the wall of counterbore in gear 91 catches the roll 88 (with help of spring 89 and plunger 90) and wedges same and hence driving roll plate 87 and in turn driving shaft 80. The above description describes just one of these rolls in action whereas any suitable number may be used and in the case of the gears 93, 103, 106 and 111 instead of using the walls of counterbores (which must be hardened and of special steel) for driving rolls, a steel ring as described hereinbefore is used for this purpose.

The above transmission of speed by means of the operation above described is one of the most important features of this improved machine, and it is automatic in operation thruout. When a slow or fast spindle speed and tool feed is desired, all that is necessary is a suitable cam on drum 474. An important advantage of this transmission is the fact that, when this sliding gear 27 is automatically shifted from one idler to another and at times may be in mesh with two, the idler that drives shaft 80 the faster, runs away from the other. This of course all happens when this improved machine is in operation and is very rapid. In the above description we have just two sets of six gears each in operation, but of course many different changes of gears (reverse or forward) as desired, may be used.

The shaft 80, thru gears 120 and 135 and key 126 and friction clutches (see Fig. 8) drives gears 421 and 425 on shaft 418 (see Figs. 19 and 30), which drives shaft 418 so that gear 423, located midway thereon, drives gear 144 on main spindle 140, thus driving the main spindle. The spindle 140 can be driven either right or left handed at any time desired by means of suitable cams on drum 482 and levers hereinafter described for shifting the clutch sleeve 123 (see Fig. 8). When spindle runs right handed the clutch sleeve 123 (Fig. 8) is in connection with clutch 121 and gear 120 is driving shaft 418 through gear 425. When reverse drive is desired, the sleeve 123 is shifted into connection with clutch 124 to drive gear 135 and this gear being in mesh with idler gear 429 (Figs. 19 and 20) drives it and thereby gear 421 on shaft 418 is driven and thereby the spindle thru gear 423 on said shaft 418 and gear 144 on the spindle.

In this invention the improved double friction clutch just described above is a very important feature. In driving the spindle or any heavy load a friction clutch will always tend to slip, but this friction clutch is in the form of a combination friction and

positive clutch. When the sliding clutch sleeve 123 for instance is in connection with gear 135, thru the clutch sleeve 125, the plunger 132 in case the friction clutch tends to slip, will only slip until the plunger 132, forced by spring 133, strikes seat 130 (Fig. 8c) at 128a, thus making it a positive clutch. When the gear 120 is driving, the same operation takes place. The thrust ring 117 (Fig. 8) is the end thrust bearing for clutch when sleeve 123 is shifted toward the gear 120.

The clutch sleeve 123 shifting mechanism.

The frame, (see Figs. 22 and 23) at 4ac is bored to receive the shank of bushing 517, which in turn is broached to fit a hexagon shaft 518, and this bushing 517 is secured to the hex shaft by means of a set screw in the flange of said bushing. On the inside of the frame is a lever 519, which is broached to fit hex shaft 518. This lever at 519a is bored to receive a thrust pin 520, which is secured therein by a screw 520a. The lever 519 at 519b and 528b (see Fig. 22) is slit and then drilled, tapped and counterbored at right angles to the slit and a screw is fitted therein so as to provide a suitable means by which the lever may be tightened on hex shaft 518. Next to lever 519 is a lever 521, which is bored so as to receive the shank of bushing 522. This bushing is broached so as to fit shaft 518 and is secured thereon by means of set screw in the flange of said bushing. Lever 521 at 521a and 521b (see Fig. 22) is tapped so as to receive the adjusting screws 523 and 524 respectively. The ends of these adjusting screws fit in concave ends of thrust pin 520. Lever 521 at 521c carries a stud 525, which holds roll 526 in place. The frame at 4ad is bored so as to receive bushing 527 which is broached to receive other end of hex shaft 518. Next to bearing 4ad is the lever 528, which is broached to receive the hex shaft 518. This lever 528 at 528a is drilled to receive pin 529. The link 530 at 530a is also drilled to receive pin 529. This link at 530b is drilled to receive pin 531, and the lever 532 is drilled at 532a to receive said pin 531. The frame at 4ae and at 4af (see Fig. 23) is bored to receive shaft 533. The lever 532 at 532b fits this shaft 533 and is pinned thereon, thus forming a fulcrum for said lever. This lever at 532c and 532d is drilled to receive the shanks of shoes 534. These shoes fit in recess of sliding clutch sleeve (see Fig. 8) 123 of the clutches on transmission gear shaft 80.

The roll 526 (see Figs. 22 and 23) is shifted by means of a suitable cam on cam drum 482, thus swinging lever 521. The arm 521a and 521b of this lever, thru adjusting screws 523 and 524 shift lever 519 in the same direction as lever 521. This in turn rocks the hex shaft 518, which thus shifts lever 528, and this lever 528 thus pulls or pushes as the case may be, the link 530, which in turn acts upon the lever 532 and thru the shoes 534 shifts the clutch sleeve 123 and so operates one or the other of the friction clutches on shaft 80.

Construction of the work spindle.

In the frame 4 (see Fig. 9) are the high speed spindle bearings 4g and 4h, (a description of which is not deemed necessary herein since they are described and claimed in my co-pending application Serial No. 480,270, filed June 25, 1921). Mounted to run freely in these bearings is the main spindle 140. An end thrust bearing 141 is mounted on the spindle and is pinned to frame 4 at 4g and next to this is a floating ring 142 and next to this is a ring 143. Next to ring 143 is mounted main spindle drive gear 144, which meshes with gear 423 on shaft 418 (see Fig. 19), and which shaft 418 is operated from transmission gear shaft 80 as just described. This gear 144 is keyed to the spindle 140 by the key 145, and is held in position by lock nuts 146 and 147 screwed on the spindle 140. The front or nose of the spindle 140 is so constructed as to receive a regular Acme draw or pull back chuck 148. On inside face of the bearing 4h, a thrust ring 149 is mounted on the spindle. Against this ring is placed the end thrust bearing 150. Against the end thrust bearing 150 is housing 151. Next to the housing 151 is placed spacer 152 and suitably held to this is ratchet ring 153. The housing 151, spacer 152 and ratchet ring 153 are keyed to the spindle 140 by the key 154. Next to the ratchet ring 153 is mounted gear 155, bushed with a suitable bushing, which runs freely on spindle 140. The gear 155 is suitably counterbored to receive teeth on ratchet ring 153. The gear 155 is also drilled, broached, counterbored, and tapped at suitable locations. The broached hole receives the square plunger 157 and the tapped hole receives the special screw 158. The plunger 157 and screw 158 are drilled to receive spring 159. The ratchet ring 153, the plunger 157, the screw 158 and spring 159 form a ratchet clutch. Next to gear 155 is end thrust spacer 160. Next to this is gear 161. This gear 161 is of similar design as gear 155 having the same clutch mechanism as gear 155. The spindle 140 is suitably recessed to receive the split collar 162 and split ratchet ring 163, which is similar to ratchet 153 with the exception that 153 is not split, and the split ratchet ring 163 is suitably held to the split collar 162. The split collar is held together by screws 164. A wedge spool 165 is mounted in the spindle 140 in the rear of bearing 4h and slides freely thereon. The rear end of the spindle 140 is threaded to receive the finger holder 166. This finger holder is adjustable

to control the grip of chuck 148 on the work and when adjusted is held securely by a brass shoe and set screw. There are three suitable slots milled on the outer face of finger holder 166 to receive three wedge fingers 169. Each of these fingers 169 at 169[a] is drilled and slotted to receive a roll 170 held by stud 171, while fingers 169 are held and pivoted in finger holder 166 by a stud 172. The fingers at 169[b] bear against a hardened ring 173. A thrust ring 175 is machined so as to receive ring 173, and this thrust ring 175 is pressed on to shoulder on rear end of pull tube 176, the screws 177 holding it thereon. The pull tube 176 is machined so as to pass freely into the spindle 140. The front end of the pull tube 176 is tapped to receive Acme chuck 148. The pull tube 176 is bored so as to receive feed tube 178, the front end of which is counterbored to receive stock support ring 179, and is tapped to receive an Acme feed collet 180. A steel bushing 181 is mounted and riveted on feed tube 178, and this bushing 181 is counterbored to receive bushing 182. In front of the flange of bushing 181 is mounted end thrust bearing 183. This bearing receives the pressure of stock feed collet 180 in backward motion over the stock. Next to the bearing 183 is the boss of a bracket 184[a], which is suitably bored to receive bushing 185. This bushing 185 forms a free running surface for steel bushing 181. On the inside of the boss of bracket 184[a] is a steel washer 186 and next to this are adjusting lock nuts 187 screwed on to bracket 184[a].

The stock feeding mechanism.

Rigidly mounted on the frame 4 and supported by end bracket 188 is bracket 81 (see Figs. 5, 10 and 11). The bracket 188 is machined to receive bracket 38 (see Figs. 2 and 5) and a side plate 197. These two parts help to support the bracket 81. Mounted on the bracket 81 and machined to slide freely thereon is feed slide 184 (see Fig. 11). This slide 184 is suitably bored to receive driving bushing 189. The slide 184 is drilled at 184[b], and the bushing 189 is also drilled and counterbored in line with hole drilled at 184[b]. A plug 190 is placed in counterbore in bushing 189 and held therein by screw 191. A plug 192 is placed in hole drilled at 184[b] and held therein by screw 193. The plug 190 is drilled and counterbored to receive safety pin 194. The plug 192 is also drilled and counterbored and tapped. In the drilled hole of plug 192 is the other end of the safety pin 194. A screw 195 keeps pin 194 from freeing itself. The driving bushing 189 is threaded to receive threaded shaft 196 and this shaft 196 is turned to a suitable smaller diameter at its rear end to run freely in a bushing 38[a] pressed into bracket 38, and a housing which receives an end thrust bearing is located at this end of the shaft. A sleeve 201 suitably bushed with bushing 202 runs freely on the other end of this shaft 196, and the shank of the sleeve 201 runs freely in bushing 203, which is pressed into bracket 81 at 81[a], thus forming a support for this end of shaft 196. A gear 204 is mounted on sleeve 201 and keyed thereon. The sleeve 201 is counterbored to receive ratchet ring 205 held therein by screws 210. The shaft 196 is machined so as to be square at 196[a], and mounted thereon is a sliding sleeve 206 with suitable clutch teeth machined on each end. On shaft 196 at 196[b] is mounted a gear 207, suitably bushed, and runs freely thereon. The shank of gear 207 fits into bushing 208 and freely runs therein, while this bushing 208 is forced into bore of bracket 81 at 81[b]. To the gear 207 is secured by means of screws 210 a ratchet ring 209. A guide bracket 211 holds gear 207 in place and is held to bracket 81 at 81[b] by screw 212. At 81[b] an end thrust washer 213 is mounted, against which is end thrust bearing 214, and housing this bearing is housing 215, which is pinned to shaft 196. The slide 184 at 81[c] and 81[d] (see Fig. 10) carries pin 216 on which pivots, between 81[c] and 81[d], the shifting lever 217. At 217[a] and 217[b] the lever 217 is drilled to receive the brass shoes 218. These shoes 218 are so located as to fit into a recess or groove in sliding sleeve 206. The lever 217 is drilled at 217[c] to receive wedge stud 219 (see Figs. 10 and 12), which is held in position by screw 220, the end of which fits into recess or groove in stud 219. On the center line of drilled hole at 217[c], the bracket 81 is drilled and counterbored to receive plunger 221. The shank of this plunger 221 passes thru small hole and acts as a guide for the plunger. A spring 222 is placed in counterbore and forces plunger 221 to press against wedge 219. A pin 223 acts as a guide for the plunger 221 so that it will not turn. The construction and operation of wedge 219 and plunger 221 is shown in Fig. 12. The shifting lever 217 is drilled at 217[d] and the slide 184 is also drilled at 184[c] and in these two holes is located screw rod 232, which passes freely therethru. The lock or adjusting nuts 233 and 234 are located as shown, and these nuts 233 and 234 are adjusted after the machine is assembled and when in their proper places the nut 233 is pinned to rod 232 and a pin is placed thru rod 232 just in back of nut 234. When in this position the maximum length of feed is obtained. The lock or adjusting nuts 235 and 236 are also placed in position and between each of these nuts and shifting lever 217 are placed springs 237 and 238. The rod 232 at 232[a] is drilled to receive stud 239 (see Fig. 10) which is locked in position by a nut 240. A link 241

has a suitable elongated hole which receives stud 239, thus connecting rod 232 with the link 241. The link 241 is drilled to receive screws 242, which holds said link to frame 4, and this screw 242 acts as the fulcrum for said link 241. The link at 241[a] (see Fig. 10) is drilled to receive a stud 243 and the square end of screw 244 is also drilled to receive said stud 243, thus connecting the link 241 and screw 244. A cotter pin thru end of stud 243 holds it in position. The lever 226 at 226[b] (see Fig. 10) is drilled to receive the shank of the square headed stud 245, and is held by nut 246. The square head of stud 245 is drilled to receive screw 244 and rocks on same. Nuts 247 (see Fig. 11) are placed in position on screw 244 and when located at proper adjusted positions are secured thereon by pins. A bracket 224 is located on frame 4. This bracket 224 and bracket 81 at 81[f] are drilled to receive shaft 225 which also passes thru hole drilled in shifting fork or chucking lever 226, holding same in position. At the lower end of lever 226 are holes in boss at 226[a] and in counterbore thereof is placed an adjusting stud 228, which is adjustable by means of tapped hole. A screw 229 locks stud 228 when desired adjusted position is obtained. The large end of stud 228 bears with suitable pressure against bracket 81, thus supporting lever 226 against side pressure. A roller 230 is held in position on extreme lower end of lever 226, and this roller 230 comes in contact with cams on cam drum 475. The lever 226 is provided at 226[c] and 226[d] with shoes 231 which fit into a recess on groove in wedge spool 165 (see Fig. 5) and operates the same. The chucking lever 226 at 226[d] carries a stud (see Fig. 1) for a connecting link 249 and a hand chucking lever 250 pivoted to frame 4 by a suitable stud 251, and is secured to this link 249 at 250[a].

Operation of stock feed mechanism.

This stock feeding mechanism is a great improvement over the old style feeding mechanisms. This feeding on this improved machine is especially efficient when feeding large stock. On the general type of feeding mechanism where weight or gravity feeding is used and even when feeding directly with cams, a great amount of momentum is created and hence the stock hits the stock with great force, in time causing damage thereto. This momentum is eliminated on this improved machine, and also there are adjusting facilities which stop this stock feed at the desired time so as not to cause any damage to stock stop. The feeding mechanism of this improved machine is positive and powerful, yet if anything should go wrong in operation there is the improved safety device 194, which stops the operation and hence saves mechanism from any damage. This mechanism is efficient in the feeding of small stock when desired. Another advantage of this feeding mechanism is that it is impossible for feeding to take place without stock being unchucked, or for feed slide to travel back for feeding again without stock being chucked.

The roll 230 is acted on by a suitable cam secured to cam drum 475, and hence swings the yoke lever 226 and thus the wedge spool 165, (Figs. 5 and 9) is moved by shoes 231, and this unchucks the stock, that is to say, draw chuck 148 releases its grip on the stock. When this yoke lever 226 is shifted, the extension 226[b] thereof strikes one of the nuts 247 (see Fig. 11) and hence moves screw 244 a suitable distance, and this screw 244 swings link 241, which shifts rod 232 to the rear, and this causes lock nuts 236 to compress spring 237 against lever 217 and hence shifts the same with the rod 232. This spring 237 thus acts as a cushion in case teeth hereinafter described clash. Sliding sleeve 206 is thus shifted by lever 217 thru the shoes 218, so that the teeth on this sleeve will mesh with the teeth cut on ratchet ring 209, which is being driven at a suitable rate of speed by gear 207. This gear 207 is driven continually by gear 82 on gear transmission shaft 80 (see Figs. 5, 8 and 30). When lever 217 is shifted wedge stud 219 (see Fig. 12) is forced in the same direction, and this pushes plunger 221 in against its spring 222, which snaps it back when wedge comes into position 3 (see Fig. 12), thus holding lever 217 in place. When sleeve 206 is being driven thru clutch 207 it rotates the threaded shaft 196, which thus shifts the bushing 189 forward thereon, and thereby the slide 184, whereupon the feeding of the stock takes place, that is, feed tube 178 and feed collet which grips stock are forced forward by slide 184. This feeding is automatically stopped at the right time when slide arm or extension 184[c] strikes lock nuts 233, which are set after being once adjusted on machine. This moves rod 232 just enough so that lock nuts 235 thru spring 238 shift lever 217. Thus sleeve 206 is disconnected from gear 207 and wedge 219 forced forward into position 2 (Fig. 12). The disconnection of ratchet clutch causes threaded shaft 196 to stop rotating and in turn stops slide 184 from moving forward.

The stock is now ready to be chucked. This is done when desired by a suitable cam on drum 475 acting on roll 230 in just the opposite way than when unchucking stock. This causes lever 226 to shift wedge spool 165 (see Figs. 5 and 9) to the rear and hence chucking stock, that is fingers 169 are spread open and draw-tube 176 and collet 148 are drawn to the rear, which causes collet to grip stock securely. While lever 226 is acting on spool 165 the arm or extension 226[b]

thereof strikes the other nut 247 and so pulls screw 244 in the opposite direction. This causes rod 232 thru link 241 to move and hence lock nuts 235 compress spring 238 and move lever 217. This action causes teeth on sleeve 206 to engage with teeth on ring 205. The spring 238 thus also acts as a cushion should the teeth clash. Ring 205 is driven continually by means of gear 83 on shaft 80 (see Fig. 8) and since gear 83 drives idler 83[a] below it (see Fig. 30) which thus drives gear 204 keyed to bushing 201 (Fig. 11), bushing 201 is directly connected with ring 205 and drives the same. Thus ring 205 is driven in an opposite direction to that which ring 209 is driven and hence when sleeve 206 is engaged with ring 205, the threaded shaft 196 is rotated in an opposite direction to that when sleeve 206 is engaged with ring 209. When sleeve 206 is engaged with ring 205 the wedge 219 is in position 1 (see Fig. 12) and bushing 189 is traveling to the rear with the slide 184. Due to the construction of the gears, slide 184 travels to the rear much slower than when traveling to the front or feeding. The reason for this is that no time should be lost in feeding whereas there is ample time for the slide to travel back into position to feed again. When the slide extension or arm 184[c] strikes adjustable lock nuts 234 it pulls rod 232 to the rear and lock nuts 236 and spring 237 shift lever 217 backward just enough to disengage sleeve 206 from ring 205, thus stopping rotation of shaft 196 and backward travel of slide 184. The wedge 217 is now in position 2, Fig. 12. Lock nuts 234 are adjustable and thus the desired length of feed is obtained.

Tool turret and its indexing mechanism.

The tool turret 260 (see Figs. 1, 2, 13 and 21) is mounted in the frame 4 by suitable bearings at 4[i] and 4[j], and in bracket 490, and which bracket 490 is securely mounted in oil pan, and cap 491 thereof is suitably secured in position. The turret 260 is constructed with four tool slides 261 and one stop position. A stud 262 is screwed into each of these four slides. A suitable bushing is pressed into a bore of bracket 490 and is itself bored to receive the front end of the turret 260 and suitably held to same by screw 264. A draw bar shaft 265 passes thru the turret 260 and extends thru the long shaft of the turret and over the lead cam drum 475. On this end of draw bar shaft is mounted draw bar slide 266. This slide 266 fits into a way in the bracket 81 and being suitably secured to the draw bar shaft holds the same in a positive position so that the bar shaft will not turn. A stud 267 holding a roll 268 is placed into this end of the draw bar, and this stud 267 is held by lock nuts 269. On the front end of draw bar shaft and within the housing of the turret is mounted a tool slide actuator 270. This actuator 270 is fixed to the draw bar by pins 271. The flange of the actuator at 270[a] acts as a safety in that it keeps all of the studs 262 in position A during the indexing of turret and therefore there is no danger of a stud not rotating properly into position 270[b]. Without this flange 270[a] the slides 261, which were not working, could move forward by vibration and then when the indexing took place the stud 262 did not fall into proper position and hence would cause a lot of trouble.

Turret locking mechanism.

Against the inside wall of the frame 4 on the turret shaft is mounted lock bolt seat disc 272 (see Figs. 13 and 21), which is held to turret shaft by a key 273 (see Fig. 13) and taper pins. A worm gear 275 is located on the hub of this disc 272 and suitably held in place by screws 276. The lock bolt seat disc 272 has five slots milled in its periphery, and four of these slots are at right angles to one another, while the other slot is half way between two of the other equally spaced slots. In each of these slots is secured a lock bolt seat 277. When one position is not used a filler block can be in any of these lock bolt seats and the turret will not therefore stop at this position. The frame 4 (see Fig. 13) is drilled at 4[k] and in this hole is pressed a steel bushing 278 and this bushing 278 is suitably bored to receive lock bolt 279, which slides in its bushing 278. The lock bolt at 279[a] is machined to fit the bolt seats 277. The top of lock bolt at 279[a] is straight to receive pressure of the cutting tools while the bottom is tapered to press the lock bolt into its seat in the forward position. At the other end of lock bolt it is turned down to smaller diameter to act as a guide for lock bolt spring 280. A cap 281 is placed on end of boss at 4[k] and suitably held thereon by screws 282. The inside of cap 281 is drilled and counterbored to two diameters. In the smaller counterbore is pressed plug 283. This plug also helps to guide spring 280 as it compresses and expands. The spring 280 fits the larger counterbore of cap 281. At 279[b] the lock bolt is suitably machined to receive lock bolt lever 284. The bushing 278 and the frame at 4[k] is cut away so that lock bolt lever may freely operate. U-shaped bracket 285 is rigidly secured to frame at 4[l] (see Fig. 21). This bracket at 285[a] and 285[b] is drilled to receive a short shaft 286 (see Fig. 13). The lock bolt lever 284 at its fulcrum is drilled to fit this shaft 286 and is pinned and keyed thereon against face of bearing 285[b]. The lower end of lock bolt lever is drilled to receive the shank of a shoe 287. A latch lever 288 is drilled to

fit and is suitably located and secured on this shaft 286 (see Fig. 13). A lever 289 at 289[a] (see Fig. 21) fits shaft 286 and is secured thereon. At 289[b] this lever 289 receives shank of a cam 290. This cam is kept from turning by suitable pins, and the cam 290 is operated by suitable cams on cam drum 483. The bracket 285 is provided with a bearing 285[c] (see Fig. 13) which is constructed to receive a latch 291. This latch 291 is pivoted by a suitable pin and may be easily moved up and down in a slot in bearing 285[c]. At 285[d] the boss on bracket 285 is suitably bored to receive shank of bushing 292. The flange of this bushing 292 faces against boss at 285[d]. The bearing 285[c] is bored to securely receive bushing 293. The bushings 292 and 293 are bored to receive indexing shaft 294. At the small end of this shaft 294 a collar 295 is located and secured. A suitable distance from this collar 295 is a sliding sleeve 296, which is bored to slide on shaft 294. Between sleeve 296 and collar 295 is located the above mentioned shoe 287. The shank of sleeve 296 fits into spring 297 and one end of this spring 297 bears against the flange of said sleeve 296. Near this a collar 298 is located and is securely fitted and pinned to shaft 294. This collar 298 is turned down on one side and fits into spring 297, the end of which bears against the flange of said collar. On opposite side of this collar 298, which is turned down, a collar 299 is securely mounted.

On small end of shaft 294 between bearings at 285[d] and 285[c] is mounted a bushing 300. Between spring 301 and against a flange of the bushing is a washer 302 which fits on shaft 294. On this bushing 300 is mounted the spring 301. One end of spring bears against washer 302 and the other end against worm 303. This worm 303 which is in mesh with worm gear 275 of the tool turret, fits on the square part of shaft 294. Near this the end of shaft 294 is turned down to receive clutch plate 304, which is securely held to shaft 294 by a key and pin. The flange of this plate 304 is drilled to receive clutch pins 305, which are secured in position by nuts 306. Outside of these pins on the face of the plate 304 a leather cushion disc 307 is securely held.

The frame 4 at 4[m] (see Fig. 13) carries the bushings 308 and 309, which are bored to receive a short shaft 310 which freely runs therein. This shaft 310 is turned down on its inner end opposite inner end of shaft 294, and receives a clutch plate 311, which is secured to said shaft 310. The flange of plate 311 is likewise drilled to receive a clutch pin 312, threaded on one end to receive a nut 306. The flange of bushing 308 acts as a spacer between boss 4[m] and clutch plate 311. On the other end of short shaft 310 is secured a bevel gear 313. There is an end thrust bearing 313[a] between this gear 313 and boss 4[m].

A bracket 314 (see Figs. 2 and 27) is rigidly secured to the frame 4 and in the boss of which is a bushing bored to receive a shaft 315 and freely runs therein. This bearing at 314[a] is counterbored to receive an end thrust bearing 316. Next to this is a bevel gear 317, which is pinned to said shaft 315, and this gear 317 meshes with gear 313 of short shaft 310 (see Fig. 13). Near the other end of shaft 315 there is keyed and pinned a link belt gear 318, which is connected with link belt gear 52 of stationary gear transmission shaft (see Fig. 8) by a link belt 322 (see Fig. 2) and this gear 318 is driven thru the link belt by gear 52, which is fixed to gear 53 (see Fig. 8) and both of which rotate on the end of gear transmission shaft 50, and are driven by the gear 22 (see Fig. 14) as hereinbefore explained. A bracket 319 is also rigidly secured to frame 4, the boss of which at 319[a] is bored to securely receive a bushing 320. This bushing is bored to receive the turned down end of shaft 315, which freely runs therein. A gear 321 is mounted on this turned down part of shaft 315 and is also keyed thereon, the purpose of which will be hereinafter described.

Operation of the turret indexing and bolt mechanism.

The shaft 315 (see Figs. 2 and 27) thru its bevel gear 317 drives bevel gear 313 on shaft 310 (Fig. 13). The shaft 315, as before stated, is driven by means of chain gear 52 (see Fig. 8) connected with chain gear 318 on shaft 315 by means of link belt chain 322. The gear 52 is driven by gear 53 on said shaft 315 and gear 53 is in mesh with gear 22 (see Fig. 14) of said shaft 19, and this shaft carries the shiftable gear 27 and receives its power from the main pulley 14. Thus the shaft 310 is driven steadily at all times during the operation of the machine. When the lock bolt (see Fig. 13) is in a lock bolt seat 277 there is no connection between the shaft 310 and the shaft 294. To index the turret the lock bolt is first disengaged but at the same time shaft 294 has to be driven by shaft 310. Therefore when the cam 290 is shifted by the cam drum 483 and moves the lever 289 a suitable distance, this partly turns shaft 286 whereupon the lock bolt lever 284 is shifted and the lock bolt 279 is moved against spring 280 and disengages the lock bolt from its seat 277. At the same time that the upper part of lever 284 is acting on lock bolt 279 the lower part of this lever by means of shoe 287 and sleeve 296 is compressing spring 297

against collar 298, which in turn presses washer 299 against lower part of latch 291 When lock bolt is clear of its seat, the lever 288 lifts latch 291 so as to free washer 299, whereupon the spring 297 forces washer 299, collar 298 and shaft 294 toward shaft 310, so that clutch plate 304 strikes clutch plate 311. The leather washer 307 acts as a cushion to absorb the shock when the two plates engage. When these clutch plates engage lug pin 312 in plate 311 which is being continuously driven turns until it strikes one of the lug pins 305 and thereby the clutch plate 311 drives the clutch plate 304. This drives shaft 294 and hence worm 303, and this drives the worm gear 275, which thus indexes the turret. The next position of the turret is determined by the position of the next open lock bolt seat. When the cam disc 483 stops acting on cam 290 the turret has moved toward its next position, and when the roll of the cam disc 483 has stopped acting on cam 290 the lock bolt lever 284 ceases to hold lock bolt 279, but nevertheless the lock bolt 279 is held against the periphery of turret disc 272, between the lock bolt seats and the spring 280 is pressing the lock bolt 279 against such periphery. When the next lock bolt seat arrives in line with lock bolt 279, the bolt is forced forward into its seat and thereby locks the turret. This brings lock bolt lever back into original position, and this by means of shoe 287 and the lower part of lock bolt lever forces collar 295 back and this in turn forces shaft 294 back away from shaft 310 and at the same time disengages clutch pins 312 and 305, whereupon shaft 294 stops turning, as does also worm 303 and worm wheel 275. By this action the washer 299 comes back to its original position and the latch 291 falls back into its original position. Thus, when the lock bolt 279 drops in a lock bolt seat 277 the disc 272 and hence worm gear 275 stop revolving. The shaft 294 continues to turn until mechanism above mentioned disengages clutch. Between the time that the lock bolt 279 drops into its seat and clutch 311 is disengaged, the worm 303 tends to drive worm gear 275, but as just mentioned gear 275 is held stationary by the lock bolt. Therefore the worm 303 will travel along square part of shaft 294 against end thrust spring 301 until clutch is disengaged. This spring 301 not only acts as safety but it tends to force the straight part of lock bolt seat of disc 272 securely against straight part of lock bolt 279 at 279^a.

The power feed or cam shaft driving means.

Now, returning to Figs. 2 and 27, the bracket 319 at 319^b is bored to securely receive bushing 323, which receives shaft 324 running freely therein. This shaft 324 has gear 325 keyed thereto and it is in mesh with gear 321. Screw 326 and washer 327 keep gear 325 in place.

The opposite end of shaft 324 carries a bevel 328 pinned thereto. Between gear 328 and boss 319^b of bracket 319 is located an end thrust bearing 329, and the bracket 319 and gear 328 are counterbored to receive this end thrust bearing 329. The bevel gear 328 back of its teeth carries sprocket 330 fixed thereto. The shaft 324 thru its bevel gear 328 rotates the cross shaft 333 (see Fig. 16) as now to be explained.

A housing 331 (see Figs. 2, 16, 17 and 18) is rigidly secured to frame 4. This housing at 331^a securely receives bushing 332, which receives shaft 333 freely running therein. The main frame at 4^n, 4^p and 4^q (Fig. 16) are all bored to securely receive bushings 334, 335 and 336 respectively and these bushings receive the shaft 333, which freely runs therein. Next to boss 331^a is a friction disc 337, which fits and is keyed to shaft 333 at 331^b. The bracket 331 is drilled to receive the shank of shoe 338 (see Fig. 17). The concave part of this shoe 338 fits the periphery of friction disc 337 and at the end of its shank receives spring 339. A set screw 340 in the bracket receives the other end of this spring 339. Next to friction disc 337 is clutch sleeve 341 keyed to shaft 333. A sliding grooved sleeve 342 fits on sleeve 341 and shoes 358 hereinafter described fit therein. One end of this sliding sleeve 342 is constructed to house boss 344^a of bevel gear 344, which as hereinafter described, meshes with bevel gear 328 (see Fig. 27). The sliding sleeve 342, the clutch sleeve 341 and the boss 344^a of bevel gear 344 are so constructed as to receive the friction clutch mechanism, of which ring 343 is a part. This forms "clutch B". The bevel gear 344, which as just stated, is in mesh with bevel gear 328, is bored to securely receive the bushing 345, which fits on shaft 333. Gear 344 is counterbored at 344^b so as to receive the end thrust bearing 346, which fits shaft 333. Another gear 347 is pinned to shaft 333, being located between bearings 4^p and 4^q. A clutch sleeve 348 is bored to receive bushing 349 and this bushing 349 is bored to fit shaft 333. This clutch sleeve 348 at 348^a is turned down and gear 350 is fixed thereto. The clutch sleeve at 348^b is counterbored and houses friction clutch mechanism. A clutch sleeve 351 fits on shaft 333. The outside of this sleeve 351 is machined so as to receive parts of the friction clutch mechanism. A grooved wedge ring 352 is bored to fit shaft 333, and this ring 352 is counterbored at one end so as to partly house the clutch mechanism. In the groove of this ring fits a shoe hereinafter described. The ring 352 is drilled to receive shank of wedge 353. Next to this ring 352 is a crank 354 adapted to fit end of shaft 333. The shaft 333 at this end is

milled and receives pivoted latch lever 355. The frame 4 at 4^r is bored so as to allow clearance for sleeve 348.

The bracket 331 at 331^e (see Fig. 17) and at 331^d is drilled to receive shaft 356, on which clutch lever 357 is mounted the lever being bored at 357^a to fit this shaft 356, and it is pinned thereon. The forks of this lever 357 receive the shanks of shoes 358 (one of which is shown). These shoes 358 fit the groove of sleeve 342 hereinbefore described. The lever 357 at 357^b (see Fig. 17) receives the shank of stud 359. One end of a rod 360 also fits on shank of this stud 359. Near the other end of rod 360 there is an elongated slot which receives stud 361. Rod 360 at one end of this elongated hole is counterbored and receives the end of a releasing lever 362, which fits on stud 361. This lever 362 is counterbored and receives a spring 363 (see Fig. 18) and also a washer 364. This lever at 362^a is suitably cut away so as to receive a pin 365 secured in stud 361. The frame 4 at 4^s (see Fig. 18) receives stud 366 securely held therein. The bracket 367 at 367^a is also bored so as to receive a bushing 368 and this bushing 368 fits on shaft 366, which is tapped at one end to receive screw 369, which holds washer 370 in place. The bracket 367 at 367^b is drilled and counterbored to receive stud 361. This stud 361 is threaded at each end and at end 361^a receives a nut 371 which holds washer 372 in place. At the other end 361^b the stud 361 receives nut 373. In bracket 367 on each side of rod 360 there is a screw 374. Bushings 375 and a plate 367 fit on these screws 374, and form a suitable housing for rod 360. The bracket 367 at 367^c receives screw 377, the threaded part of which receives a cam 378 kept from turning by a suitable pin.

The frame at 4^t (see Figs. 3, 9, 28 and 29) is bored and counterbored to securely receive a bushing, which receives a shaft 380. A washer 381 (see Fig. 9) fits on shaft 380 and is kept from turning by means of a pin. Next to this washer 381 is a worm 382 keyed to shaft 380. Next to worm 382 is a washer 383, kept from turning by a pin. The frame 4 at 4^u is also bored to securely receive a bushing 384. Next to bearing 4^u is gear 385 pinned to shaft 380. This gear 385 is in mesh with gear 155 on main spindle. Next to gear 385 is gear 386, which is pinned to shaft 380. This gear 386 is in mesh with idler gear 392 (see Fig. 28) hereinafter described. The frame 4 at 4^v is bored so as to receive bushing 387, which receives end of shaft 380. A bushing 388 fits on bosses of gears 385 and 386. This bushing is split for assembling purposes. A swinging arm 389 (see Fig. 28) is at 389^a of such construction as to form with a cap 390 a split bearing, and this split bearing fits on bushing 388. This arm at 389^b receives a stud 391, which carries idler gear 392 in mesh with gear 386 of shaft 380 and gear 161 of main spindle (see Fig. 29). The arm 389 at 389^c receives a pin 393. A bracket 394 is rigidly secured to the bed and this bracket at 394^a has two holes at a suitable distance apart and at equal distance from center of shaft 380. Either one of these holes receives the pin 393. The frame 4 at 4^w (see Fig. 29) is bored to receive bushing 395, and this bushing receives the turned down end of shaft 396. Next to frame 4^w is a worm gear 397 on shaft 396 and is in mesh with worm 382 of shaft 380 (see Figs. 9 and 28). The worm gear 397 is counterbored and chamfered so as to receive a clutch ring 399 securely held therein. This ring 399 is counterbored so as to form a shoulder and housing for flange of bushing 398. Clutch ring 399 is counterbored a second time so as to suitably receive a roller plate 400. This plate has three notches cut on its periphery at equal distance from each other. These notches receive rolls 401 and the notches are each drilled to receive a plunger and spring, such as 90 and 89, hereinbefore described in connection with Fig. 8. The ring 399, the plate 400, rolls 401 and plungers and springs together form a roller clutch the same as used in gear transmission on shaft 80. The plate 400 is bored to securely receive a bushing 402 and this in turn is bored to receive the shaft 396 which freely runs therein. Next to plate 400 and rigidly held by means of screws and pins is a collar 403. This collar is bored to fit shaft 396 and is held thereon by a key. Next to collar 403 the shaft 396 is so machined as to form a gear 396^a which meshes with gear 350 hereinbefore described on shaft 333 (see Fig. 16 and also Fig. 30). The opposite end of shaft 396 is carried by the frame 4 at 4^x bored to receive a bushing, which receives the end of this shaft 396 and a washer 405 is held to frame 4^x by screws.

The frame at 4^z and 4^y (see Fig. 24) is bored to receive a short shaft 406 running parallel with shaft 333 of Fig. 16, and is secured by screws. A gear 407 securely receives bushing 408, which in turn is bored to fit shaft 406. This gear 407 is located between the bearings 4^y and 4^z and meshes with gear 347 on shaft 333 (see Figs. 3 and 30, also Fig. 16). The frame 4 at 4^{aa} and at 4^{ab} is bored to receive stationary worm shaft 409. Next to bearing 4^{aa} is end thrust washer 410 which fits shaft 409. Next to this is gear 411, in which is bushing 412 which is bored to fit this stationary worm shaft 409. Gear 411 is counterbored a little and receives bushing 410. This gear 411 is in mesh with gear 407, and one end is machined to couple with end of worm 413, which worm is bored to securely receive a part of bushing 412 and all of bushing 414,

which latter fits on shaft 409. Next to worm 413 is an end thrust washer 415, which fits on shaft 409.

The operation of the power feed and cam shaft.

The driving of the main spindle 140 in either direction has hereinbefore been described. Hence the ratchet plate 153 (see Fig. 9) drives the gear 155 thru plungers 157. When the spindle is revolving right handed the gear 161 remains idle (the plungers passing over teeth of ratchet plate 163). The gear 155 drives the gear 385 (see also Figs. 28 and 29), which in turn drives shaft 380. When spindle 140 is driven left handed the above operation reverses itself, the gear 161 becomes the driver and gear 155 is idle. The gear 161 drives the idler gear 392 which drives the gear 386 that in turn drives shaft 380. By means of this idler gear 392 the shaft 380 is driven in same direction at all times regardless of which way the spindle is driven. In case spindle 140 only runs in the one direction (right hand) the idler gear 392 may be disengaged from gear on spindle 161 by taking out pin 393 (see Fig. 28) from position 394[b], and swinging arm 389 away from spindle and inserting the pin 393 in position 394[c]. The point is to keep gear 161 from acting on ratchet plate 163 and plungers 157 and hence wearing them out. The worm 382 keyed to shaft 380, drives the worm gear 397 (see Fig. 29), which in turn drives the roller clutch cup 399. This cup drives roller plate 400 thru the rollers 401. This is the same mechanism as explained in gear transmission (Fig. 8[a]). The roller plate drives the collar 403 which drives the shaft 396. The gear 396[a] cut in shaft 396 drives gear 350 on shaft (see Fig. 16) 333. This gear 350 drives the clutch cup 348 which drives the shaft 333 when desired thru the clutch "A", consisting of ring, fingers, and clutch sleeve 351 keyed to shaft 333. The gear 347 is driven by shaft 333. Coming back now to shaft 315, which is driven by the chain 322, this shaft 315 drives gear 321 which in turn drives gear 325. This gear drives shaft 324, and this shaft 324 drives bevel gear 328, which bevel gear drives bevel gear 344 on shaft 333 (see Fig. 16), which in turn drives said shaft 333 thru the clutch "B" consisting of ring 343, fingers, and clutch sleeve 341 (keyed to shaft) when engaged. When shaft 333 is driven thru clutch "A" (the sleeve of which is 351) it is on its slow feed. This slow feed is controlled by main spindle 140 and hence changes speed with same. The gear 347 on this shaft 333 is driven by this slow feed mechanism only when clutch "A" is engaged and the clutch "B" is disengaged. When clutch "B" is engaged the shaft 333 is driven much faster than when same is disengaged. When clutch "B" is engaged the clutch "A" can be either engaged or disengaged. This is made possible by means of roller clutch on shaft 396 (see Fig. 29). The action of this roller clutch is the same as the one shown at Fig. 8[a] used on gear transmission shaft 80. This action in short is—when worm gear 397 (Fig. 29) is driving cup 399 and roller plate 400 is either stopped or going at a slower rate of speed than cup 399, this cup 399 locks with rolls 401 and hence drives shaft 396 thru collar 403. When roller plate 400 is driven at a higher rate of speed (when both clutches "A" and "B" are engaged) than cup 399 then the rolls 401 unlock and hence there is no connection between roller plate 400 and cup 399. The clutch "A" is operated when desired by hand, while the clutch "B" is also operated by hand when desired but it also may be operated automatically by suitable dogs. These dogs act on cam 378 (see Fig. 16) and by means of lever 367 and hand lever 362 operate the rod 360 back and forth, thus in turn thru yoke lever 357 and shoes 358 engaging or disengaging clutch "B". By pulling handle 362 (see Fig. 16) down 90° the end 362[a] acts on a pin in stud 361 (see Fig. 18) and handle disengages itself from counterbore in rod 360. This causes stud 361 to act freely in elongated slot at 360[a] (see Fig. 17) and hence lever 367 has no connection with rod 360 which is desirable at times for setting-up purposes. When handle 362 is pushed back the spring 363 being compressed acts on handle and forces it back into counterbore of rod 360 when same is in position. This makes the connection between lever 367 and rod 360. This handle is a new improvement on the machine.

The gear 347 (see Fig. 16; also Fig. 24) which is driven by the shaft 333, drives the idler gear 407 on stationary shaft 406. This idler gear in turn drives the gear 411 on stationary shaft 409, and this gear 411 is coupled to and drives the worm 413 which is also on shaft 409, and this worm 413 in turn drives the cam shaft thru worm wheel 480 of cam drum 475. For the general assemblage of these several shafts just described, see Fig. 30.

The cam shaft and cam drums.

The bracket 188 (see Figs. 3 and 25) at 188[a] and the column 3 and 3[a] and column 2 and 2[a] are bored to receive the cam drum cam shaft 470. Next to bearing 188[a] is a fiber washer 471 (see Fig. 25), which fits drum shaft 470. Next to this is a collar 472 drilled to receive screw 473 and counterbored to fit end of drum shaft 470. This end of drum shaft is tapped to receive the screw

473, which holds collar 472 in place. A cam drum 474 is keyed and pinned to cam shaft 470 and on the periphery of this drum there are tapped holes at convenient places to receive screws which in turn secure suitable cams to the drum. Next to this is the main cam drum 475, which is also keyed and pinned to cam shaft 470. On the periphery of this main cam drum there are also tapped holes at convenient places to receive screws that secure suitable cams to the drum. This main cam drum at 475[a] is drilled and tapped to receive a special screw 476 which is drilled and counterbored. The counterbore receives one-half of a safety pin 477. Facing against main cam drum 475 is worm gear drum 478 centrally bored to fit drum shaft 470. The flange of this worm gear drum at 478[a] is drilled and tapped to receive special screw 479, which is in line with special screw 476. Special screw 479 is drilled and counterbored, the counterbore receiving the other half of the safety pin 477. The worm gear drum at 478[b] is machined to receive worm gear 480, which is secured thereto by means of suitable screws, and this worm gear 480 is in mesh with worm 413 of shaft 409 (see Fig. 24) and which, as hereinbefore stated, is driven from shaft 333. On the cam shaft is also a disc 481, which is centrally bored and keyed to said shaft. This disc at 481[a] has two identical slots machined around the same, the center lines of which are coincident with the axis of drum shaft, and these slots receive shanks of screws that hold suitable cams in place. Next to this disc 481 is cam drum 482, which is centrally bored to receive the drum shaft 470 and keyed and pinned thereon, and the periphery of this cam drum is tapped at convenient places for screws to securely hold suitable cams in place. Next to this is disc 483 centrally bored to fit cam shaft 470 and it is also keyed and pinned thereon. This disc at 483[a] has slot machined around the same, the center line of which is at the same distance from the center of the cam shaft. This slot receives at any place the shank of screws to hold suitable cams in place. Next to cam disc 483 is collar 484. Next to this is a fiber washer 485, which faces against boss 2[a]. On the opposite side of boss 2[a] is another fiber washer 486. Next to this is washer 487 which is drilled to receive screw 488. This screw fits in tapped hole in end of drum shaft and securely holds washer thereto.

Referring to Fig. 25, the worm gear 480 drives the drum 475 direct (at 475[a]) and in turn this drum 475 drives the cam shaft 470. The point of connection between worm gear drum 478 and drum 475 is at a more advantageous point than when the worm wheel drives the cam shaft 470, and this in turn drives the cam drum 475, which has heretofore been the case in machines having a cam shaft. This point of connection makes it also very convenient for a safety device.

The cam drum 482 on face toward cam disc 483 is machined to receive the cams for the forming slide 444 and the cam disc 483 is machined on face toward cam drum 482 to receive the cams for tool slide 449 while the other face is machined to receive cams for operating the top slide 467.

Cross tool slides.

The cross or forming slides of this improved machine (see Figs. 1, 2 and 6) are of the same general principle in construction and operation as those shown in National Acme Patent No. 1,320,609 dated January 18, 1918. On the forming side of this improved machine the lever 441 is operated by a cam on drum 482. This lever 441 is pivoted at its upper end to a suitable bracket and in turn operates lever 440 fastened to hex shaft 442 and so rocks this shaft and thereby the lever 443 on other end of said shaft 442, which shifts the forming tool slide 444 back or forward. On the opposite side of the machine the tool slide 449 is also shifted by a suitable cam on cam disc 483 cooperating with suitable levers 445, 446 and 448 (see Fig. 2) and hex shaft, all of which may be generally similar to that described for tool slide 444.

Top tool or cut-off slide.

A lever 451 is suitably pivoted to the frame 4[as] (see Figs. 2 and 6). One arm of this lever 451 carries stud 452, which carries a suitable roller 453. The other arm of lever 451 carries stud 454, which secures upright rod 455 to lever arm 451. The other end of the rod 455 is threaded to receive rod end 456. One end of this rod end 456 carries pin 457, which passes thru a forked lever (see Fig. 2) 458, thus holding rod end 456 in fork of lever 458. The other end of fork lever 458 fits on a hexagon shaft 459, which is mounted in bracket 7 and is suitably bushed so as to be free to turn therein. The other end of shaft 459 has lever 460 fitted thereon. Both levers 458 and 460 are securely held to shaft 459. The small end of lever 460 carries stud 461, which connects lever 460 with a knuckle joint 462, and this knuckle joint 462 is connected with a knuckle joint 463 by knuckle joint link 464. Knuckle joint 463 is connected to a cam slide 465 by a stud 466'. This cam slide 465 travels in a way machined in a bracket 466. This bracket is held to frame 4 by screws, and is located directly over main spindle 140, and the holes that the screws pass thru to hold bracket 466 in place may be elongated to permit a backward and for-

ward adjustment when necessary. A suitable fine adjusting stop (not shown) is located on side of bracket so that the desired location can be maintained at all times. Suitable cams can be fastened to cam slide 465 to meet the desired length of travel of the cut-off tool. A way is also machined to receive tool slide 467 and this tool slide is of the same principle in construction as the cross slides. This tool slide 467 has T-slots machined therein so that a cut-off tool holder can be fastened and securely held thereon. A roll 468 is suitably fastened to tool slide 467 and thru this roll the slide is forced to travel up and down along cams screwed to cam slide 465.

Operation of top tool slide.

When the cam on disc 485 contacts with roll of lever 451, it operates rod 455 pushing the same in an upward direction. This rod turns shaft 459, rocks lever 460, which forces cam slide thru connecting link 464, toward bracket 466. The cam on cam slide 465 comes in contact with roll 468 on cut-off slide and forces same to travel down to cut-off piece of completed work. When work is cut-off, a suitable take-back cam on disc pulls cut-off slide up and away from work thru the same operation as described above, only reverse. There is also a take-back cam on cam slide 465. This cut-off operation is positive and has all adjustments necessary. The rod end 456 screwed onto rod 455 affords a very important adjustment.

In this improved machine it will be observed that there is no working mechanism under the turret and working section of this machine, which makes it very desirable as it leaves a large space for chips.

The above improved machine has an automatic oiling system, chain driven by sprocket gear 330 (see Fig. 27) which freely lubricates all working parts and also provides steady streams of oil on work when tools are operating thereon.

For the purpose of briefly following the several mechanisms operated from the main power pulley 14, the following brief description is given:

Main spindle drive.

Pulley 14 on shaft 10 (see Fig. 14) through gear 13 and gear 18 of hex shaft 19, rotates shiftable gear 27, which, according to its position rotates any one of the six idler gears on shaft 50 (Fig. 8) and thereby any one of the six gears carried by shaft 80.

Shaft 80, through gears 120 and 135 and the friction clutches (Fig. 8) drives gears 425 and 421 of intermediate shaft 418 (see Fig. 19) and gear 423 of this shaft 418 drives the gear 144 and thereby main spindle 140, the spindle being run either right or left handed, according to whichever friction clutch gear 120—135 is used. When spindle runs right handed, clutch gear 120 is driving gear 425 of intermediate shaft 418, the gear 423 of which is in mesh with gear 144 of the main spindle. When the reverse drive is used, the opposite clutch drives gear 135, which in mesh with an idler gear 429 (Fig. 20) drives it and thereby gear 421 on said shaft 418, and thus gear 144 of the main spindle.

The friction clutch sleeve 123 (Fig. 8) is shifted through the mechanism shown in Figs. 22 and 23 through the cam drum 482 on the cam shaft.

The shiftable gear 27 is shifted by rod 31 (Fig. 14) and rod 31 is shifted by lever 34 (Fig. 26), which is shifted by lever 45 and suitable cams on cam drum 474.

Chain drive.

Going back to sliding gear 27 and its shaft 19 (Fig. 14), gear 22 thereon meshes with loose gear 53 on stationary gear transmisison shaft 50 (see Fig. 5). Fixed to gear 53 is chain gear 52 also loose on shaft 50. Chain 322 is thus driven by loose gear 53 from main source of power, and this chain drives chain gear 318 on shaft 315 (see Fig. 27).

Slow and fast feed.

The main spindle 140 runs in either direction and drives shaft 380 (see Fig. 9) through gears 155 and 161 always in the same direction.

Slow feed.

Worm 382 on shaft 380 (see Fig. 9) drives worm gear 397 of short shaft 396 (see Figs. 29 and 30). Gear 396[a] of short shaft 396 drives gear 350 through clutch "A" and this gear 350 drives gear 347 of said shaft 333, which drives gear 407 of short shaft 406 (Fig. 24) and this gear 407 drives worm 413, which drives main cam shaft thru drum 475.

High speed

Chain 322 to shaft 315 (Fig. 27) drives shaft 324 by gears 321 and 325. Shaft 324 drives bevel gear 328 which drives bevel gear 344 of shaft 333, which thru clutch "B" drives said shaft 333.

Turret indexing mechanism.

The shaft 315 also drives thru bevel gears 317 and 313 the shafts 310 and 324, and turret and bolt mechanism, (see Fig. 13).

Stock feeding mechanism.

Gear 82 on gear transmission shaft 80 (Figs. 5 and 11) continually drives gear 207 on threaded feed shaft 196. Gear 83 on

transmission shaft 80 drives idler gear 83ª below it, which drives gear 204 on threaded feed, and these gears control the rotation of the shaft 196 in one or the other direction. Thus ring 205 is driven in an opposite direction to ring 209, so that when sliding clutch sleeve 206 is engaged with ring 205 the shaft 196 is rotated in an opposite direction to that when sleeve 206 is engaged with ring 209, and this shifts the slide 184 in opposite directions. The sliding clutch sleeve 206 is shifted by lever 217 and the co-related mechanisms shown in Figs. 10 and 11, which in turn is controlled by lever 226 thru cams on cam drum 475.

From the foregoing, it will be seen that the work spindle by the mechanism illustrated herein can be run in either direction at six different speeds. When however, it is desired only to run the spindle right-handed instead of both right-handed and left-handed, the idler gear 392 (Figs. 28 and 29) and the idler gear 429 (Figs. 19 and 20) are not used. When the idler gear 392 is omitted of course gear 161 may also be omitted from the work spindle. A larger diameter of gear than that shown on shaft 80 (Fig. 20) is then used to mesh with its gear 421 on shaft 418. The clutch gears 120—135 however (Fig. 8) are still used with the result that when these idler gears are dispensed with the spindle may be run right-handed with twelve different speeds, that is to say, six speeds in proportion to the clutch gear 120 and six speeds in proportion to the clutch gear 135, whereas in the Cone patent hereinbefore referred to, No. 1,303,216, only two speeds in either direction of the spindle is possible.

Moreover, in that machine the feeding of the stock is by weight and gravity and in that machine the cam disc for operating the cross slides is in front of the frame, and under the tool turret, and therefore the chips very materially interfered with the proper operation of the parts, whereas in the present machine it will be observed (see Fig. 2, for instance), there are no cams or cam drums in front of the frame 4, and that also in the present improvement the cut-off tool slide is at the top of the spindle instead of at the side thereof, as has heretofore been the practice.

I claim as my invention:

1. In a metal working machine, the combination of a drive shaft, a rotatable work holder, a tool carrier, means for rotating the work holder at different speeds and comprising a pair of shafts, one thereof rotatable and the other fixed against rotation, sets of variable speed gears carried by said pair of shafts and means for connecting the drive shaft with any of said sets of gears, and including a rotatable gear located between said drive shaft and said sets of gears and shiftable on an axis parallel with said fixed shaft into mesh with the gears thereon.

2. In a metal working machine, the combination of a drive shaft, a rotatable work holder, a tool carrier, means for rotating the work holder at different speeds and comprising a pair of shafts, one thereof rotatable and the other fixed against rotation, sets of variable speed gearing carried by said pair of shafts and including a plurality of gears eccentrically mounted on said fixed shaft, and means for connecting the drive shaft with any of said sets of gearing.

3. In a metal working machine, the combination of a drive shaft, a rotary work holder, a tool carrier, means for rotating the work holder at different speeds and comprising a pair of shafts, sets of variable speed gearing mounted on said pair of shafts, a cam shaft, and a sliding gear shifted from the cam shaft for connecting the drive shaft with any of said sets of gearing.

4. In a metal working machine the combination of a drive shaft, a cam shaft, a rotary work holder, a tool carrier, means for shifting said tool carrier and work holder one relatively to the other, four or more sets of variable speed gearing connecting said drive shaft and work spindle, and means controlled by said cam shaft for operating said gearing thereby to drive the work spindle at any one of four or more speeds, said means including a shaft and a shiftable gear carried thereby and shiftable into position to cooperate with any of said sets of gearing.

5. In a metal working machine the combination of a drive shaft, a rotary work holder, a tool carrier, means for shifting said work holder and tool carrier one toward and from the other, means for rotating the work holder at any one of four or more speeds, and comprising a pair of parallel shafts having cooperating sets of variable speed gearing, and means for automatically connecting said drive shaft to any of said sets of gearing for rotating the work spindle.

6. In a metal working machine the combination of a pair of shafts, a rotary work spindle driven therefrom, a cam shaft, an indexible tool turret, tool holders carried thereby, means for indexing the turret, means for shifting said tool holders and work spindle one toward and from the other, means for rotating the work holder at more than two speeds in one direction and comprising a plurality of sets of variable speed gearing carried by said pair of shafts, and means controlled by the cam shaft for connecting any one of said sets to the work spindle.

7. In a metal working machine, the combination of a drive shaft, a rotary work spindle, a cam shaft, a tool carrier, means for shifting said tool carrier and work spindle one toward and from the other, means for rotating said work spindle at different speeds, means directly connected to said work spindle for driving said cam shaft from the work spindle at different speeds, clutch mechanism for disconnecting the cam shaft from the work spindle, and means for independently driving the cam shaft from said drive shaft.

8. In a metal working machine, the combination of a drive shaft, a rotary work spindle, a cam shaft, a tool carrier, means for shifting the tool carrier and spindle one toward and from the other, a pair of shafts, sets of variable speed gearing carried by said shafts, means for connecting the drive shaft with any of said sets of gearing to operate the work spindle at different speeds, means for driving the cam shaft from the work spindle at different speeds, clutch mechanism for disconnecting said last means and means for driving the cam shaft from the drive shaft independently of the work spindle.

9. In a metal working machine the combination of a pair of shafts, a cam shaft, a rotary work holder, a tool carrier, means for shifting said tool carrier and work holder one relatively to the other, means for rotating said work holder at more than two speeds in one direction, and comprising a plurality of sets of transmission gearing carried by said pair of shafts, means operated by the cam shaft for connecting together any one of said sets of gearing, and means for connecting said work holder to said gearing for rotation in either direction.

10. In a metal working machine, the combination of a drive shaft, a rotary work spindle, a cam shaft, a tool carrier, means for shifting the tool carrier and spindle one toward and from the other, a pair of shafts, sets of variable speed gearing carried by said shafts, means for connecting the drive shaft with any of said sets of gearing, clutch mechanism for connecting any of said sets of gearing with the work spindle to rotate the same at different speeds in different directions, means for driving the cam shaft from the work spindle at different speeds in a constant direction, and means for driving the cam shaft from the drive shaft independently of the work spindle.

11. In a metal working machine, the combination of a pair of shafts, a rotary work holder, a cam shaft, a tool slide, means controlled by the cam shaft for reciprocating said tool slide relatively to said work holder, sets of variable speed gearing carried by said pair of shafts and connected to said work holder, a shiftable gear adapted to be connected to any of said sets of gearing, and means for automatically shifting said gear from the cam shaft thereby to rotate said work holder at more than two speeds in one direction.

12. In a metal working machine, the combination of a drive shaft, a rotary work holder, a tool carrier, variable speed mechanism for connecting said drive shaft with the work holder and including a shaft, a set of gears mounted thereon and having the teeth thereof in alinement at one side of the shaft, and a gear driven by said drive shaft and shiftable on an axis parallel to said second shaft into mesh with the gears of said set.

13. In a metal working machine, the combination of a drive shaft, a rotary work holder, a cam shaft, a tool carrier, means for shifting said tool carrier and work holder one relatively to the other, variable speed gearing for operating said work holder at different speeds from the drive shaft, means for driving said cam shaft from said work holder independently of the drive shaft, and means for driving said cam shaft from said drive shaft independently of the work holder.

14. In a metal working machine, the combination of a drive shaft, a rotary work holder, a tool carrier, variable speed mechanism for connecting said drive shaft with the work holder, and including a shaft, a set of gears eccentrically mounted thereon to have the teeth thereof in alinement at one side of the shaft, and a gear shiftable on an axis parallel with said last shaft into mesh with the gears of said set, said gear being driven from the drive shaft.

15. In a metal working machine, the combination of a rotatable work spindle, means for rotating it at different speeds in one or two directions, a cam shaft, means for feeding the stock through the work spindle and comprising a feed slide, a rotatable screw for shifting said slide, means for rotating the screw in either of two directions and including a pair of clutches, and means connected with the cam shaft mechanism for controlling said clutches.

16. In a metal working machine, the combination of a rotatable work spindle, means for rotating it at different speeds in one or two directions, a cam shaft, means for feeding the stock through the work spindle and comprising a feed slide, a rotatable screw for shifting said slide, means for rotating the screw in either of two directions and including a pair of clutches, and means connected with the cam shaft mechanism for controlling said clutches, and a safety mechanism between the screw and slide.

17. In a metal working machine, the com-

bination of a rotatable work spindle, means for rotating it at different speeds in one or two directions, a cam shaft, means for feeding the stock through the work spindle and comprising a feed slide, a rotatable screw for shifting said slide, means for rotating the screw in either of two directions and including a pair of clutches, and means connected with the cam shaft mechanism for controlling said clutches, and a safety mechanism between the screw and slide and comprising a shearable pin.

18. In a metal working machine, the combination of a rotatable work spindle, means for rotating it at different speeds in one or two directions, a cam shaft, means for feeding the stock through the work spindle and comprising a feed slide, an interiorly threaded bushing carried by said slide, a safety pin connecting said bushing and slide, a rotatable screw cooperating with the threads of said bushing for shifting the slide, means for rotating the screw in either of two directions and including a pair of clutches, and means connected with the cam shaft mechanism for controlling said clutches.

19. In a metal working machine, the combination of a rotatable work spindle, means for rotating it at different speeds in either of two directions and comprising two sets of meshing gears, a rotatable shaft rotatable by one of said sets of gears, a pair of gears fixed to said rotatable shaft, a cam shaft, means for feeding the stock through the work spindle and comprising a feed slide, a rotatable screw for shifting said slide, means connected with said pair of gears of the rotatable shaft for rotating the screw in either of two directions and including a pair of clutches, and means connected with the cam shaft mechanism for controlling the operation of said clutches.

20. In a metal working machine, the combination of a rotatable work spindle, a cam shaft, means for rotating said spindle, means for feeding the stock through the work spindle and comprising a feed slide, a rotatable screw for shifting said slide, means for rotating the screw in either of two directions, and means operated by the cam shaft for controlling the direction of rotation of said screw.

21. In a metal working machine, the combination of a rotatable work spindle, means for rotating it at different speeds in either of two directions, means for feeding the stock through the work spindle and comprising a feed slide, a rotatable screw for shifting said slide, clutch mechanism and gearing for rotating the screw in either of two directions, and means connected with the cam shaft mechanism for controlling the rotation of the screw.

22. In a metal working machine, the combination of a rotatable work spindle, means for rotating it at different speeds in either of two directions, means for feeding the stock through the work spindle and comprising a feed slide, a rotatable screw for shifting said slide, means including a pair of gears for rotating the screw in either of two directions, a shiftable clutch sleeve adapted to cooperate with one or the other of said gears, a cam shaft, and means connected with the cam shaft for controlling said clutch sleeve and comprising a lever, means for shifting said lever, and means for holding said lever in its shifted position.

23. In a metal working machine, the combination of a rotatable work spindle, means for rotating it at different speeds in either of two directions, means for feeding the stock through the work spindle and comprising a feed slide, a rotatable screw for shifting said slide, means including a pair of gears for rotating the screw in either of two directions, a shiftable clutch sleeve adapted to cooperate with one or the other of said gears, a cam shaft, and means connected with the cam shaft for controlling said clutch sleeve and comprising a lever, means for shifting said lever, and a spring pressed plunger for holding said lever in its shifted position.

24. In a metal working machine, the combination of a shiftable work spindle, means for rotating it at different speeds in either of two directions, a cam shaft, means for feeding the stock through the work spindle and comprising a feed slide, a rotatable screw for shifting said slide, means for rotating the screw in either of two directions and comprising a pair of gears loosely mounted on said rotatable screw, each of said gears having a clutch member connected therewith, a duplex clutch sleeve keyed to said screw, a pivoted lever for shifting said clutch sleeve, means connected with the cam shaft for operating said clutch lever in either of two directions, and means connected with the slide for disconnecting the clutches.

25. In a metal working machine, the combination of a work spindle, means for feeding stock therethrough and comprising a feed slide, a rotatable screw for shifting said slide, means for rotating the screw in either of two directions and including a pair of gears loosely mounted on said screw, each having a clutch member, a sliding clutch sleeve keyed to said screw and shiftable relatively thereto, and means for shifting said clutch sleeve independently of said screw.

26. In a metal working machine, the combination of a work spindle, means for feeding stock therethrough and comprising a feed slide, a rotatable screw for shifting said slide, means for rotating the screw in either of two directions and including a pair of gears loosely mounted on said screw, each

having a clutch member, a sliding clutch sleeve keyed to said screw, and means for shifting said clutch sleeve, and means connected with the slide for disconnecting the clutch sleeve.

27. In a metal working machine, the combination of a work spindle, means for feeding stock therethrough and comprising a feed slide, a rotatable screw for shifting said slide, means for rotating the screw in either of two directions and including a pair of gears loosely mounted on said screw, each having a clutch member, a sliding clutch sleeve keyed to said screw, means for shifting said clutch sleeve, and means connected with the slide for disconnecting the clutch sleeve through its shifting means.

28. In a metal working machine, the combination of a work spindle, means for feeding stock therethrough and comprising a feed slide, a rotatable screw for shifting said slide, means for rotating the screw in either of two directions and including a pair of gears loosely mounted on said screw, each having a clutch member, a sliding clutch sleeve keyed to said screw, means for shifting said clutch sleeve, means connected with the slide for disconnecting the clutch sleeve, and means for holding the clutch sleeve shifting means in a predetermined position.

29. In a metal working machine, the combination of a work spindle, means for feeding stock therethrough and comprising a feed slide, a rotatable screw for shifting said slide, means for rotating the screw in either of two directions and including a pair of gears loosely mounted on said screw, each having a clutch member, a sliding clutch sleeve keyed to said screw, means for shifting said clutch sleeve, means connected with the slide for disconnecting the clutch sleeve, means for holding the clutch sleeve shifting means in a predetermined position, and cam shaft operated means for operating the clutch sleeve shifting means.

30. In a metal working machine, the combination of a rotatable work spindle, means for rotating it at different speeds in either of two directions, means for feeding the stock through the work spindle and comprising a feed slide, a rotatable screw for shifting said slide, a pair of loosely mounted driven gears on said screw, each having a clutch member, a sliding clutch sleeve keyed to said screw and adapted to cooperate with either one of the two clutch members thereby to connect either one of the two gears with the screw, a lever for shifting said clutch sleeve, means for holding said lever and its clutch sleeve in cooperation with either of said gears, a cam shaft, means connected therewith for operating said clutch shifting lever and comprising a threaded member having a pair of adjustable stops, a swinging link, and a threaded rod connected with said slide and with said link and also with said clutch sleeve shifting lever and operative through the slide to disconnect the clutch sleeve from the clutch members.

31. In a metal working machine, the combination of a rotatable work spindle, means for rotating it at different speeds in either of two directions, means for feeding the stock through the work spindle and comprising a feed slide, a rotatable screw for shifting said slide, a pair of loosely mounted driven gears on said screw, each having a clutch member, a sliding clutch sleeve keyed to said screw and adapted to cooperate with either one of the two clutch members thereby to connect either one of the two gears with the screw, a lever for shifting said clutch sleeve, means for holding said lever and its clutch sleeve in cooperation with either of said gears, a cam shaft, means connected therewith for operating said clutch shifting lever and comprising a threaded member having a pair of adjustable stops, a swinging link, a threaded rod connected with said slide and with said link and also with said clutch sleeve shifting lever and operative through the slide to disconnect the clutch sleeve from the clutch members, and buffing means carried by said last threaded rod for absorbing the shock of the clutches.

32. In a metal working machine of the class described, the combination of a single power driving means, a rotatable work spindle, gear transmission mechanism for rotating the spindle at different speeds in either of two directions, means for operating said mechanism, means for feeding the stock through the spindle, a rotatable tool turret, means for indexing it, a plurality of sliding tool carriers carried by the turret, and means for shifting said tool carriers.

33. In a metal working machine, of the class described, the combination of a single drive shaft, a cam shaft, a rotatable work spindle, gear transmission mechanism for rotating the spindle at different speeds in either of two directions, means for driving said cam shaft at different speeds, means for feeding the stock through the spindle, a rotatable tool turret, means for indexing it, a plurality of sliding tool carriers carried by the turret, and means for shifting said tool carriers.

34. In a metal working machine the combination of a rotatable work spindle, gear transmission means for rotating the same at different speeds, a cam shaft, means for rotating the cam shaft at different speeds, stock feeding means, a tool turret, means for indexing and locking said turret, a plurality of tool slides, means for shifting the same relatively to said work spindle, a single drive shaft, and a single shaft connected to said drive shaft for operating all of said means.

35. In a metal working machine the combination of a rotatable work spindle, a pair of shafts having gear transmission means for rotating the same at different speeds, a cam shaft, means for rotating the cam shaft at one or more speeds, stock feeding means, a tool turret, means for indexing and locking said turret, a tool slide, means for shifting the same, a single drive shaft, and a single shaft connected to said drive shaft for operating all of said means.

36. In a metal working machine, the combination of a tool carrier, means for operating the tool carrier, a rotatable work spindle, means for rotating the work spindle at different speeds in either of two directions, means for feeding the stock through the spindle and including a feed slide and a rotatable screw, safety mechanism connecting the screw with the slide, a cam shaft, means for rotating the cam shaft and comprising a drum mounted thereon, a gear, and safety mechanism connecting said gear and drum.

37. In a metal working machine, the combination of a tool carrier, means for operating the tool carrier, a rotatable work spindle, means for rotating the work spindle at different speeds in either of two directions, means for feeding the stock through the spindle and including a feed slide and a rotatable screw, safety mechanism connecting the screw with the slide, a cam shaft, means for rotating the cam shaft and comprising a drum mounted thereon, a gear, and safety mechanism connecting said gear and drum, each of said safety mechanisms comprising a shearable pin.

38. In a metal working machine, the combination of a tool carrier, means for operating the tool carrier, safety mechanism for positioning the tools carried by said carrier, a rotatable work spindle, means for rotating the work spindle at different speeds in either of two directions, means for feeding the stock through the spindle and including a feed slide and a rotatable screw, safety mechanism connecting the screw with the slide, a cam shaft, means for rotating the cam shaft and comprising a drum mounted thereon, a gear, and safety mechanism connecting said gear and drum.

39. In a metal working machine, the combination of a tool carrier, means for operating the tool carrier, safety mechanism for positioning the tools carried by said carrier, a rotatable work spindle, means for rotating the work spindle at different speeds in either of two directions, means for feeding the stock through the spindle and including a feed slide and a rotatable screw, safety mechanism connecting the screw with the slide, a cam shaft, means for rotating the cam shaft and comprising a drum mounted thereon, a gear, safety mechanism connecting said gear and drum, means for indexing the carrier, and means for locking it in its indexed position, said indexing means also including a safety device.

40. In a metal working machine the combination of a drive shaft, a cam shaft, a rotary work holder, gear transmission mechanism for rotating said work holder at different speeds from said drive shaft, and mechanism connected to said work holder for driving said cam shaft from said work holder, independently of the drive shaft, and means for driving said cam shaft from the drive shaft independently of the work holder.

41. In a metal working machine, the combination of a rotary spindle, a rotary cam shaft, a top tool slide located above said spindle and shiftable toward and from the spindle, a cross tool slide shiftable toward and from the spindle, means for shifting said cross slide from the cam shaft, a cam slide located entirely above the spindle for operating said top slide, and means operated from the cam shaft for independently shifting said cam slide.

42. In a metal working machine, the combination of a rotary spindle, a top tool slide located above said spindle and shiftable toward and from the spindle, a cam slide supported to move in a straight path transversely to the path of movement of said tool slide for shifting the same, a rotary cam shaft, and means operated from the cam shaft for shifting said cam slide.

43. In a metal working machine, the combination of a rotary spindle, a top tool slide located above said spindle and shiftable toward and from the spindle, a cam slide supported to move in a straight path transversely to the path of movement of said tool slide for shifting the same, a rotary cam shaft, means operated from the cam shaft for shifting said cam slide and including a swinging lever, and means for connecting said lever to the cam slide to permit relative movement of the lever and slide.

44. In a metal working machine, the combination of a rotatable work spindle, means for rotating it at different speeds, a cam shaft, means for rotating the cam shaft at different speeds from the work spindle, a tool carrier, means for operating it, a top tool slide, and means for operating it from said cam shaft.

45. In a metal working machine, the combination of a rotary cam shaft, a rotary spindle, a support located above said spindle and having a vertical slideway and a horizontal slideway, a top tool slide shiftable in said vertical slideway, a cam slide shiftable in said horizontal slideway for shifting said tool slide, and means for operating said cam slide from the cam shaft.

46. In a metal working machine, the combination of a rotary cam shaft, a rotary spindle, a support located above said spindle and having a slideway, a top tool slide shiftable in said slideway in a straight path toward and from the spindle, said support also having a slideway extending transversely to said first slideway, and a cam slide operated from the cam shaft and shiftable in said second slideway in a straight path to shift said top tool slide.

47. In a metal working machine, the combination of a rotatable work spindle, means for rotating it, a tool carrier, means for operating it, a top-cut off tool slide located above the spindle, means for operating it and including a cam slide, and a cam shaft connected with said cam slide and including an adjustable rod.

48. In a metal working machine, the combination of a tool carrier, means for operating it, a rotatable work spindle, means for rotating it at different speeds, a cam shaft, means for operating said cam shaft at different speeds and comprising a cross shaft, a pair of gears loose thereon, a pair of clutch mechanisms for connecting said gears with said shaft, means connecting the rotary spindle with one of said clutch gears, means for driving said shaft through the other of said clutch gears, means for engaging either of said clutch mechanisms, and means for driving the cam shaft from said cross shaft.

49. In a metal working machine, the combination of a tool carrier, means for operating it, a rotatable work spindle, means for rotating it at different speeds, a cam shaft, means for operating said cam shaft at different speeds and comprising a cross shaft, a pair of gears loose thereon, a pair of clutch mechanisms for connecting said gears with said shaft, means connecting the rotary spindle with one of said clutch gears, means for driving said shaft through the other of said clutch gears, means for engaging either of said clutch mechanisms, one thereof from the cam shaft, and means for driving the cam shaft from said cross shaft.

50. In a metal working machine, the combination of a tool carrier, means for operating it, a rotatable work spindle, means for rotating it at different speeds, a cam shaft, means for operating said cam shafts at different speeds and comprising a cross shaft, a pair of gears loose thereon, a pair of clutch mechanisms for connecting said gears with said shaft, means connecting the rotary spindle with one of said clutch gears, means for driving said shaft through the other of said clutch gears, means for engaging either of said clutch mechanisms, one thereof both manually and also automatically from the cam shaft, and means for driving the cam shaft from said cross shaft.

51. In a metal working machine, the combination of a tool carrier, means for operating it, a rotatable work spindle, means for rotating it at different speeds, a cam shaft, means for operating said cam shaft at different speeds and comprising a cross shaft, a pair of gears loose thereon, a pair of clutch mechanisms for connecting said gears with said cross shaft, means connecting said cross shaft with said cam shaft, means connecting the rotary spindle with one of said clutch gears whereby the cam shaft will be operated at different speeds co-related to the speed of the spindle, means for driving said cross shaft through the other of said clutch gears whereby the cam shaft will be operated at a high speed, and means for engaging either of said clutch mechanisms.

52. In a metal working machine, the combination of a tool carrier, means for operating it, a rotatable work spindle, means for rotating it at different speeds, a cam shaft, means for operating said cam shaft at different speeds and comprising a cross shaft, a pair of gears loose thereon, a pair of clutch mechanisms for connecting said gears with said cross shaft, means connecting said cross shaft with said cam shaft, means connecting the rotary spindle with one of said clutch gears whereby the cam shaft will be operated at different speeds co-related to the speed of the spindle, means for driving said cross shaft through the other of said clutch gears whereby the cam shaft will be operated at a high speed, and means for engaging either of said clutch mechanisms, one of said clutch mechanisms being also operative from the cam shaft.

53. In a metal working machine, the combination of a tool carrier, means for operating it, a rotatable work spindle, means for rotating it at different speeds, a cam shaft, means for operating said cam shaft at different speeds and comprising a cross shaft, a pair of gears loose thereon, a pair of clutch mechanisms for connecting said gears with said cross shaft, means connecting said cross shaft with said cam shaft, means connecting the rotary spindle with one of said clutch gears whereby the cam shaft will be operated at different speeds co-related to the speed of the spindle, means for driving said cross shaft through the other of said clutch gears whereby the cam shaft will be operated at a high speed, and means for engaging either of said clutch mechanisms, said high speed clutch mechanism being also operative from the cam shaft.

54. In a metal working machine, the combination of a tool carrier, means for operating it, a rotatable work spindle, means for operating said cam shaft at different speeds and comprising a cross shaft, a pair of gears loose thereon, a pair of clutch mechanisms for connecting said gears with said cross shaft, means connecting said cross shaft with

said cam shaft, means connecting the rotary spindle with one of said clutch gears whereby the cam shaft will be operated at different speeds co-related to the speed of the spindle, means for driving said cross shaft through the other of said clutch gears whereby the cam shaft will be operated at a high speed, means for engaging either of said clutch mechanisms, said high speed clutch mechanism being also operative from the cam shaft, and means effective to permit the high speed clutch mechanism to operate during the engagement of the other clutch mechanism.

55. In a metal working machine, the combination of a tool carrier, means for operating it, a rotatable work spindle, means for rotating it at different speeds, a cam shaft, means for operating said cam shaft at different speeds and comprising a cross shaft, a pair of gears loose thereon, a pair of clutch mechanisms for connecting said gears with said cross shaft, means connecting said cross shaft with said cam shaft, means connecting the rotary spindle with one of said clutch gears whereby the cam shaft will be operated at different speeds co-related to the speed of the spindle, means for driving said cross shaft through the other of said clutch gears whereby the cam shaft will be operated at a high speed, means for engaging either of said clutch mechanisms, said high speed clutch mechanism being also operative from the cam shaft, and including a roller clutch effective to permit the high speed clutch mechanism to operate during the engagement of the other clutch mechanism.

56. In a metal working machine the combination of a drive shaft tool carrier, means for operating it, a rotatable work spindle, means for operating it, a cam shaft, mechanism connected to said work spindle for driving said cam shaft from the work spindle, and means for independently driving the cam shaft from the drive shaft.

57. In a metal working machine the combination of a tool carrier, means for operating it, a rotatable work spindle, means for operating it, a cam shaft, and mechanism connected to said work spindle for driving said cam shaft from the work spindle, said mechanism comprising a shaft having clutch mechanism adapted to be connected to and disconnected from said spindle, and means for operating said clutch mechanism, from said cam shaft.

58. In a metal working machine the combination of a drive shaft, a tool carrier, means for operating it, a rotatable work spindle, means for operating it, a cam shaft, a cross shaft, means connected to said cross shaft for driving the cam shaft, a pair of clutch mechanisms connected to said cross shaft, means for connecting one of said clutch mechanisms to the work spindle, and means for connecting the other clutch mechanism to the drive shaft.

59. In a metal working machine, the combination of a tool carrier, means for operating it, a rotary spindle, means for rotating it, a cam shaft, means connected to said spindle for driving said cam shaft from the spindle and comprising a drum secured thereto, a driving gear, and safety mechanism connecting said driving gear with the drum.

60. In a metal working machine, the combination of a tool carrier, means for operating it, a rotary spindle, means for rotating it at different speeds, a cam shaft, means connected to said spindle for driving said cam shaft from the spindle and comprising a drum secured thereto, a driving gear, and safety mechanism connecting said driving gear with the drum and comprising a shearable pin.

61. In an automatic single spindle lathe, the combination of a single power driving means, a rotatable work spindle adapted to be driven either right or left handed, gear transmission mechanism for rotating the spindle at a plurality of different speeds in either of two directions, a tool carrier, means for operating it, a cam shaft, and means for operating it and comprising a drum secured to said shaft, a gear and shearable safety pin mechanism connecting said gear with said drum, and means connecting the cam shaft through said gear with the rotary spindle whereby the speed of the cam shaft is co-related to the speed of the spindle.

62. In a metal working machine the combination of a rotatable work spindle, means for rotating it, means for feeding stock through the spindle and comprising a rotatable feed screw, means for rotating said screw in opposite directions and including clutch mechanism, and means for operating said clutch mechanism independently of said feed screw.

63. In a metal working machine the combination of a rotary shaft, a sliding gear carried thereby, a pair of shafts, a plurality of cooperating variable speed gears carried by each shaft, a rotatable work holder, a tool holder, means for shifting said work holder and tool holder one relatively to the other, and means for shifting said sliding gear into mesh with the gears of one of said pair of shafts thereby to operate the work holder at different speeds.

64. In a metal working machine the combination of a rotary shaft, a sliding gear carried thereby, a pair of shafts, a plurality of cooperating variable speed gears carried by each shaft, a rotatable work holder, a tool holder, means for shifting said work holder and tool holder one relatively to the other, means for shifting said sliding gear into mesh with the gears of one of said pair

of shafts thereby to operate the work holder at different speeds, and clutch mechanism carried by the other one of said pair of shafts for controlling the direction of rotation of said work holder.

65. In a metal working machine the combination of a rotary shaft, a cam shaft, a sliding gear carried by said first shaft, a pair of shafts, a plurality of cooperating variable speed gears carried by each shaft, a rotatable work holder, a tool holder, means for shifting the work holder and tool holder one relatively to the other, and means operated by the cam shaft for shifting said sliding gear into mesh with the gears of one of said pair of shafts thereby to operate the work holder at different speeds.

66. In a metal working machine, the combination of a drive shaft, a pair of rotary shafts, a rotary work holder driven therefrom, a tool carrier, means for shifting the work holder and tool carrier one relatively to the other, means for rotating the work holder at any one of four or more speeds, and comprising four or more sets of variable speed gearing carried by said rotary shafts, and means for connecting said drive shaft to any of said sets of gearing.

67. In a metal working machine, the combination of a drive shaft, a pair of rotary shafts, a rotary work holder driven therefrom, a tool carrier, means for shifting the work holder and tool carrier one relatively to the other, means for rotating the work holder at any one of four or more speeds and comprising four or more sets of variable speed gearing carried by said rotary shafts, a cam shaft, and means controlled from said cam shaft for connecting said drive shaft to any of said sets of gearing.

68. In a metal working machine, the combination of a drive shaft, a rotary work holder, a tool carrier, means for shifting the tool carrier and work holder one relatively to the other, three parallel shafts between said work holder and drive shaft, variable speed gearing carried by a pair of said parallel shafts, a sliding gear carried by the third, and means for shifting said gear into mesh with said gearing.

69. In a metal working machine, the combination of a drive shaft, a rotatable work holder, a tool carrier, means for shifting the tool carrier and work holder one relatively to the other, a pair of shafts, a plurality of sets of variable speed gearing carried thereby, a shiftable gear, means for supporting said gear for shiftable movement into cooperation with any of said sets of gearing, and means for shifting said gear.

Signed at 1822 Park Row Building, New York, New York, this 29th day of November, 1921.

ALFRED E. DRISSNER.