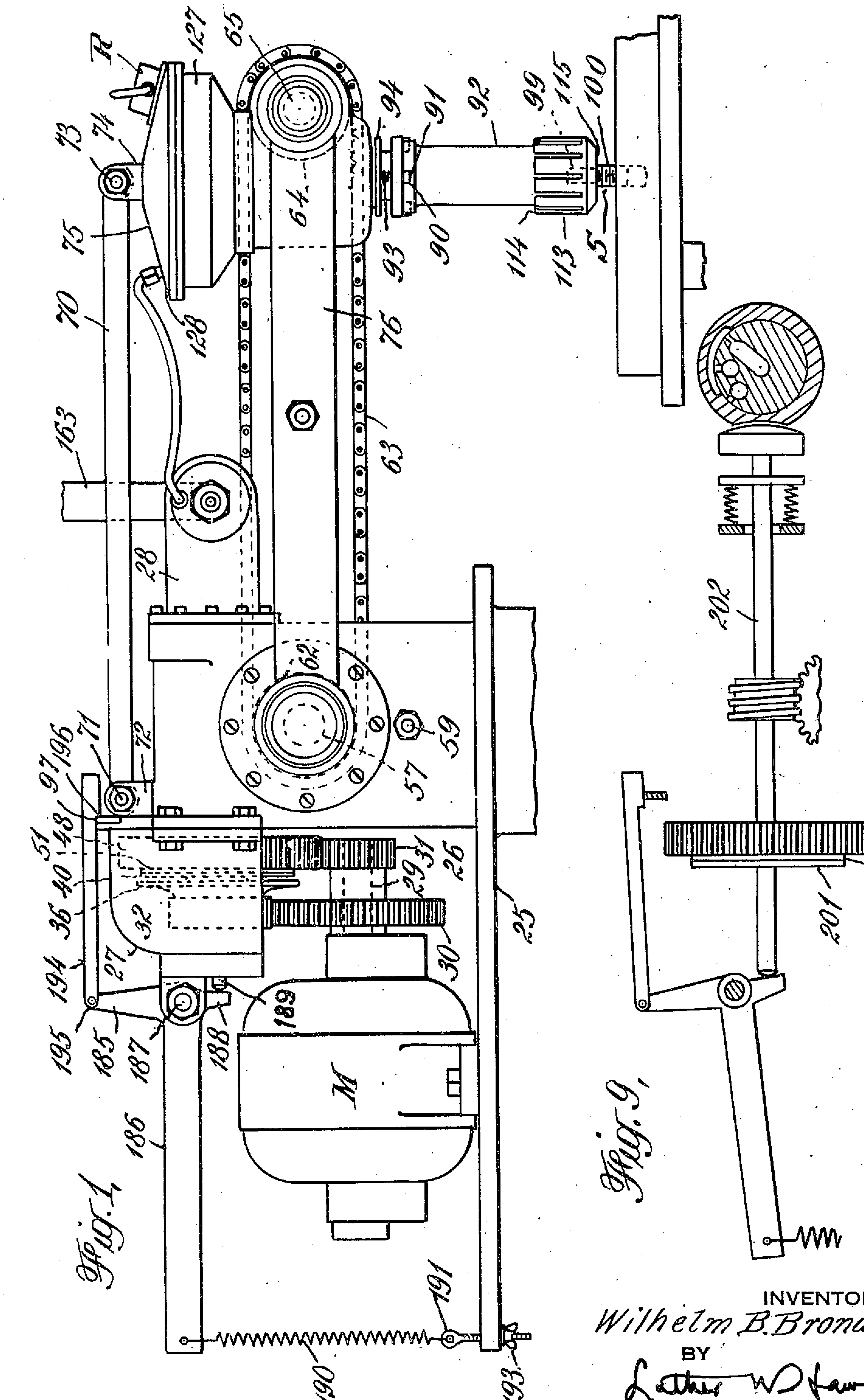
Oct. 4, 1949. W. B. BRONANDER 2,483,751

STUD DRIVING MECHANISM

Filed June 23, 1945 6 Sheets-Sheet 1



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STUD DRIVING MECHANISM

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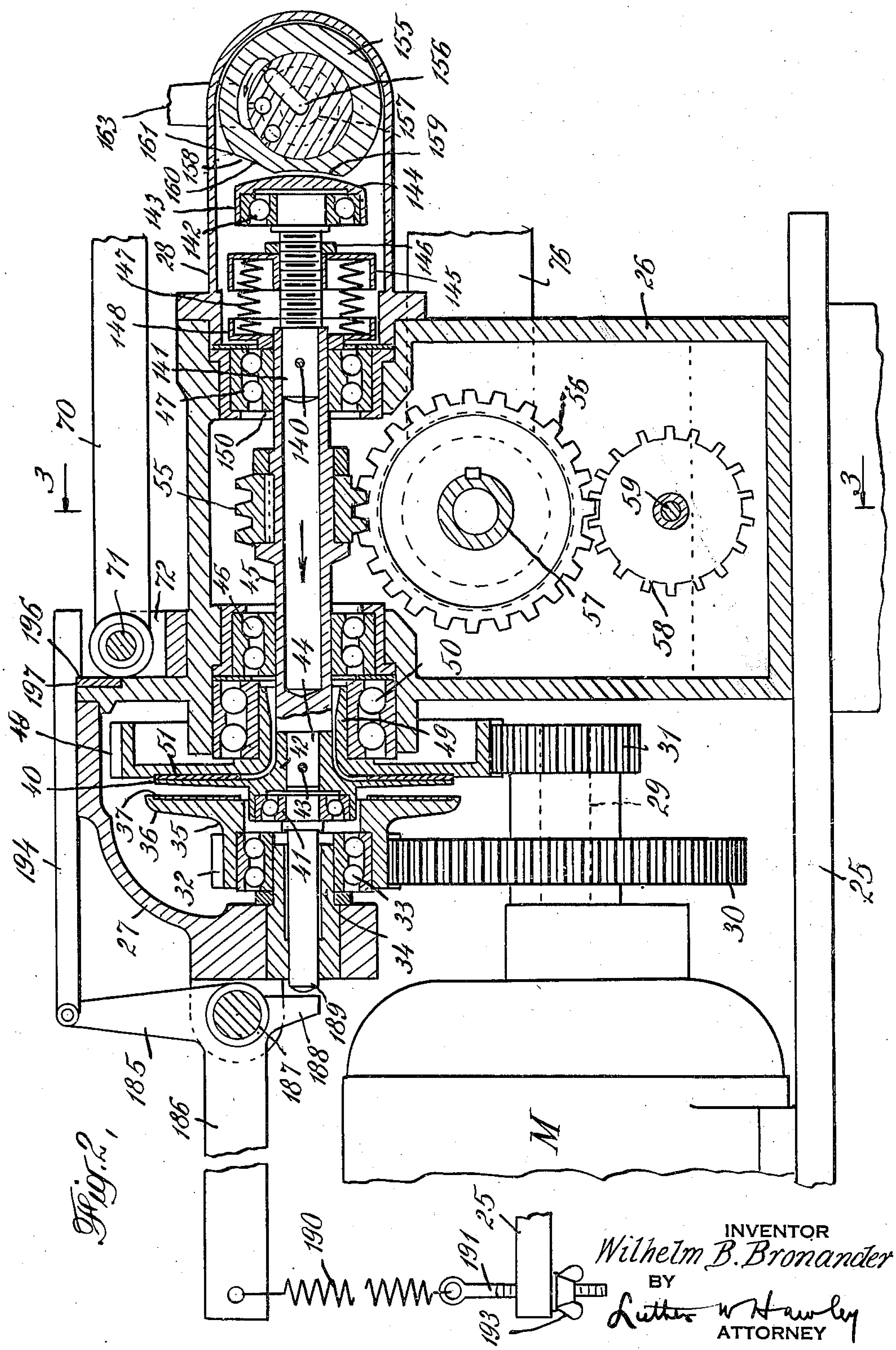

Fig. 2

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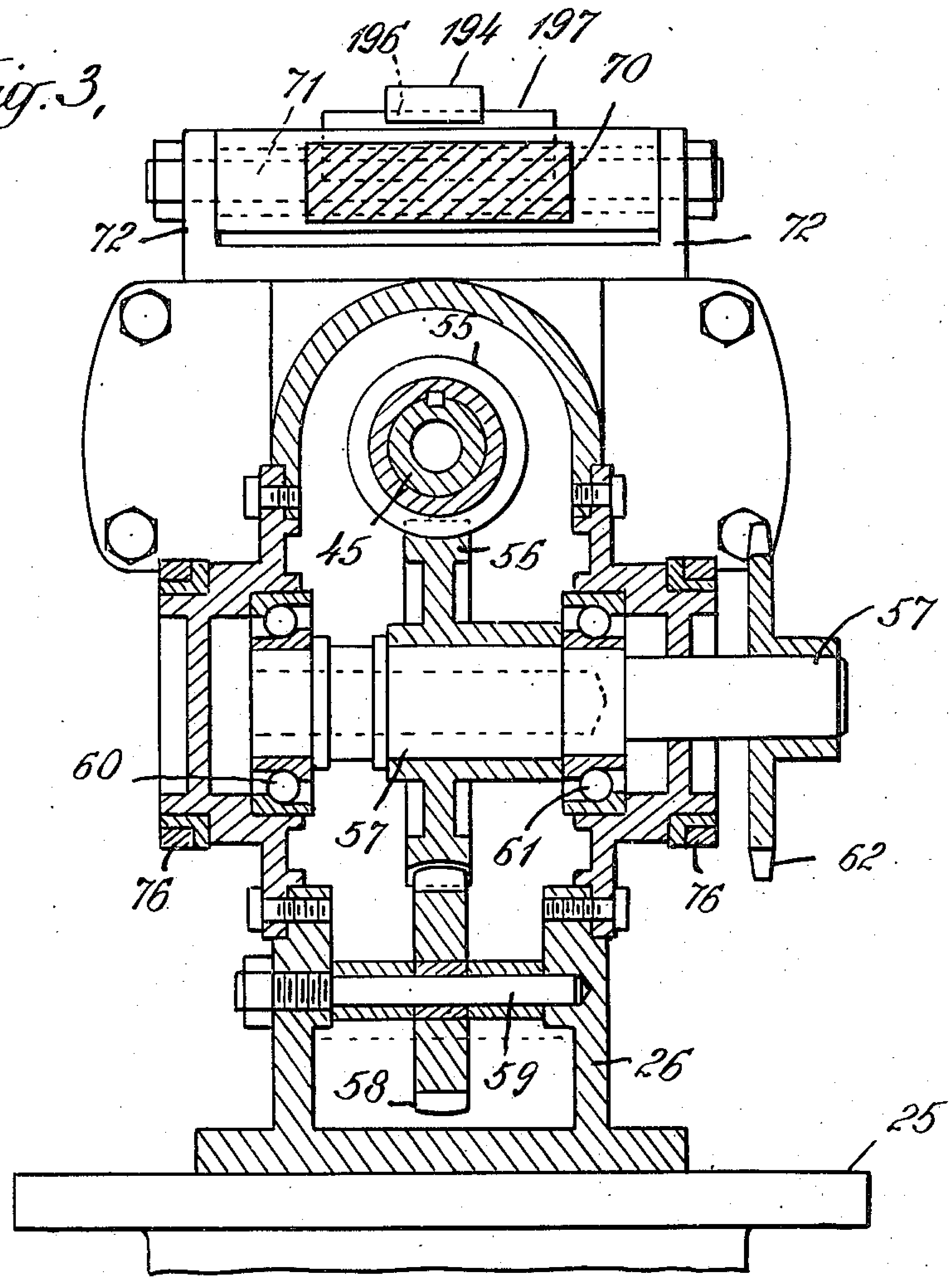
Fig. 3,



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STUD DRIVING MECHANISM

Fig. 4,

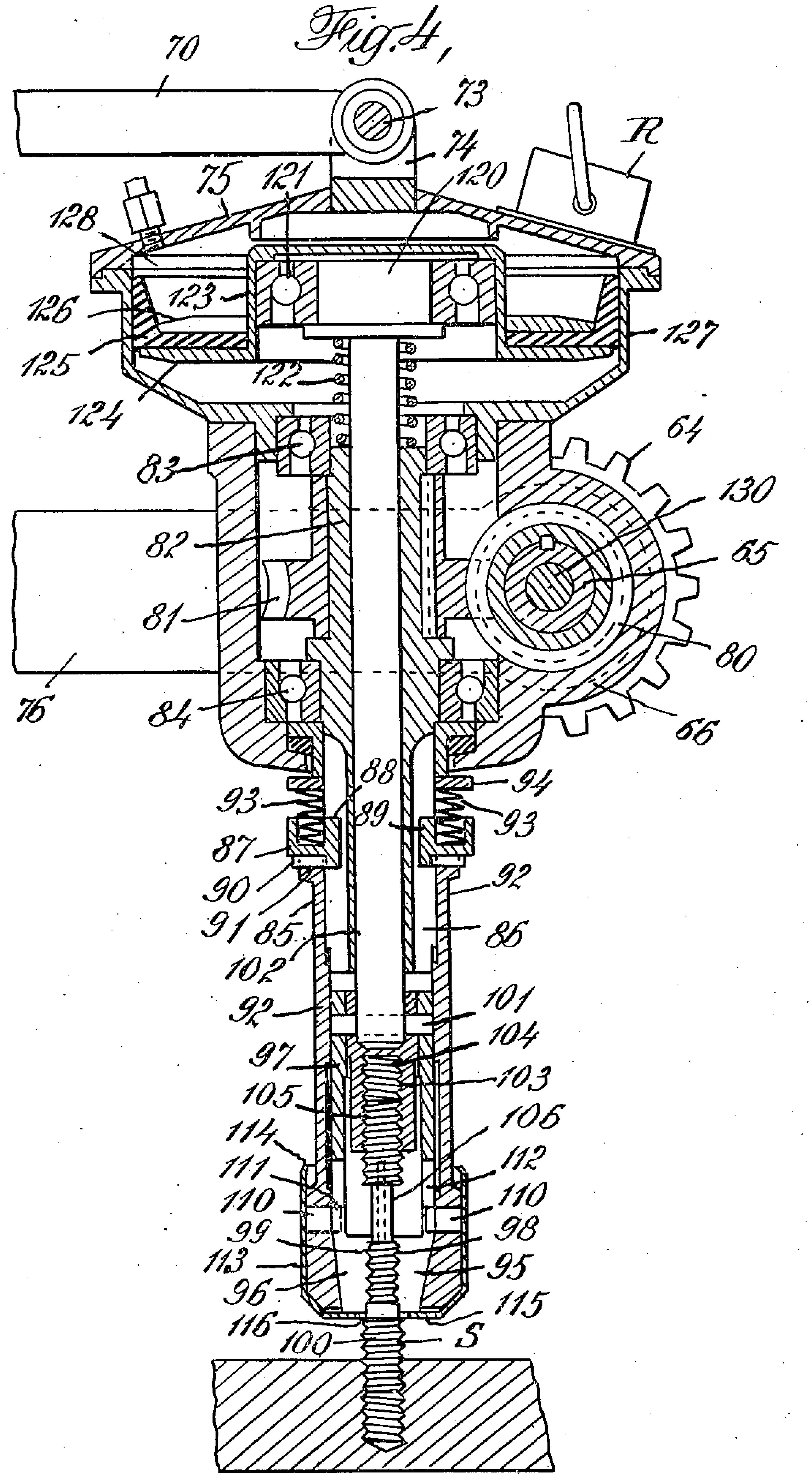

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Fig. 5.

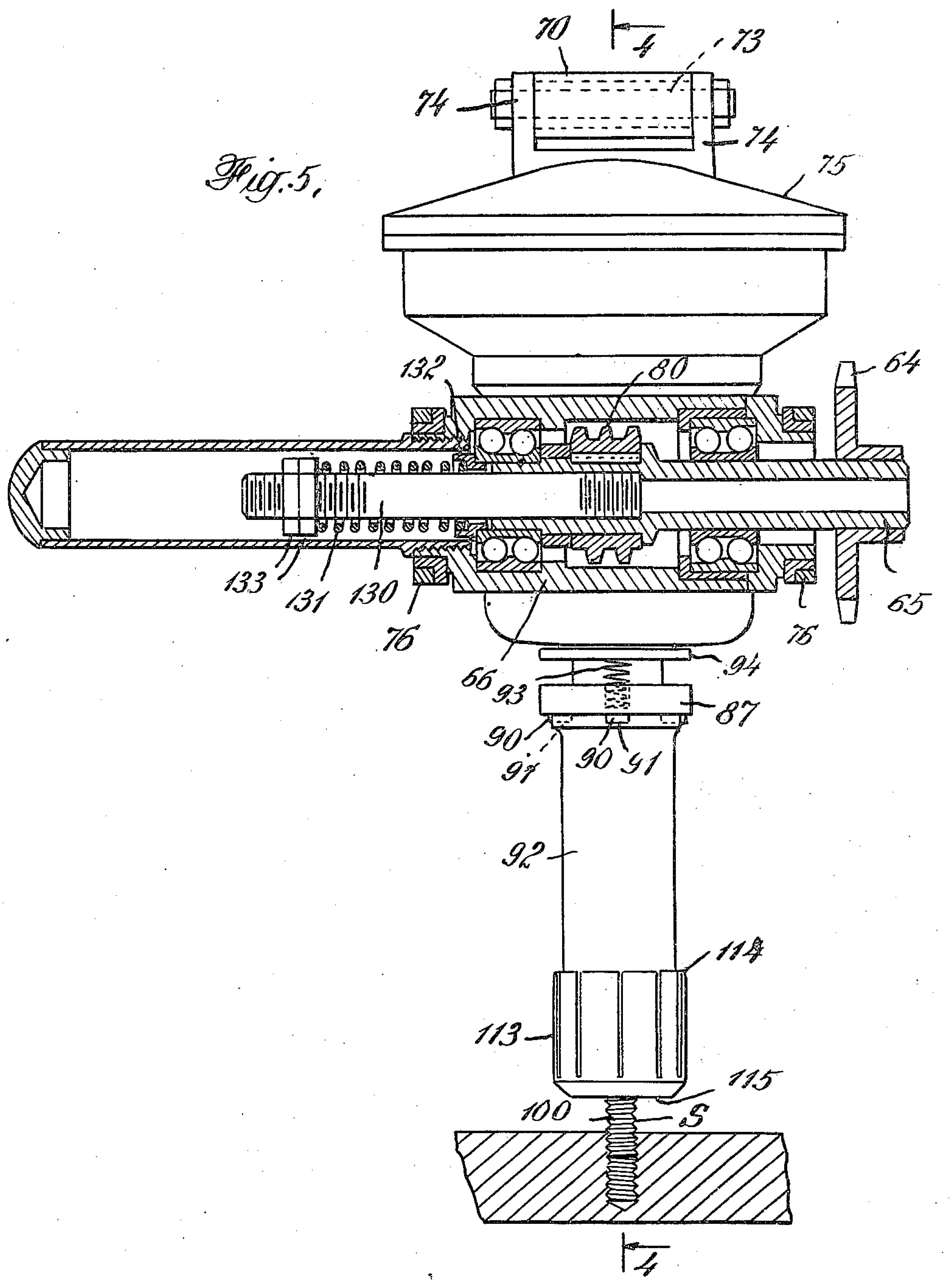

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Fig. 6

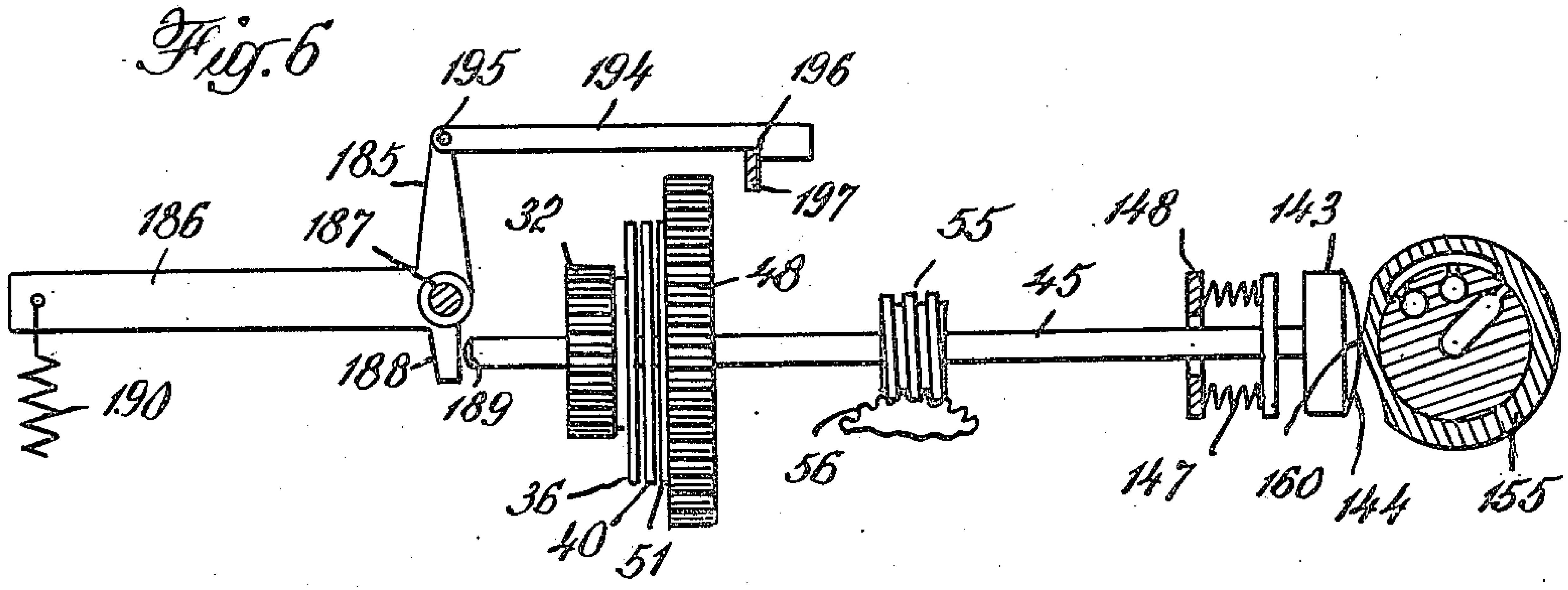


Fig. 7,

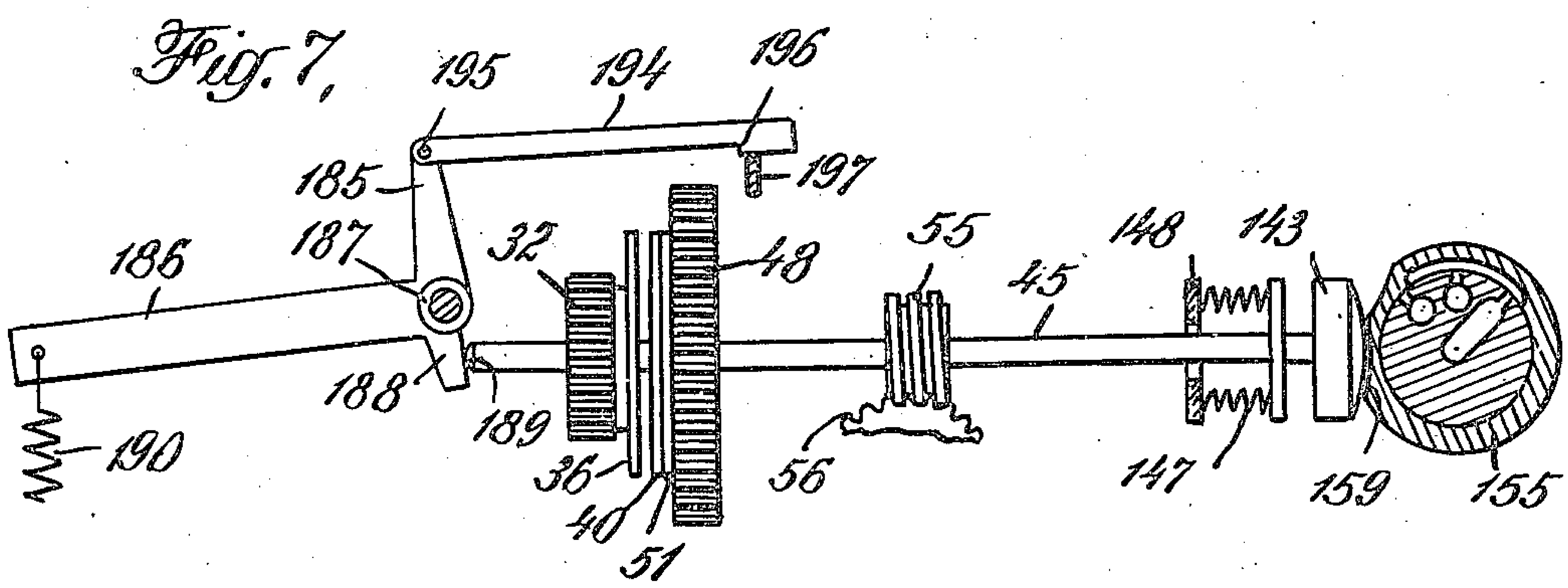
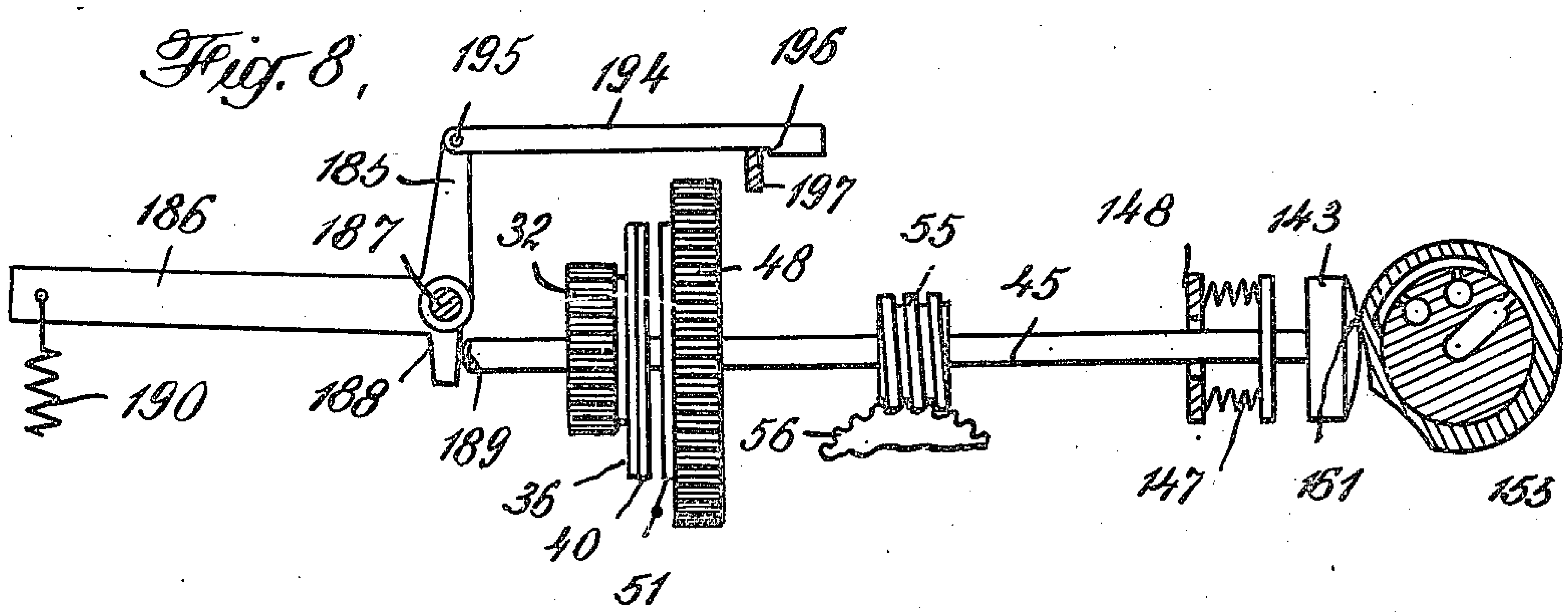


Fig. 8,



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2,483,751

STUD DRIVING MECHANISM

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Original application November 5, 1942, Serial No. 464,626, now Patent No. 2,379,878, dated July 10, 1945. Divided and this application June 23, 1945, Serial No. 601,147

3 Claims. (Cl. 74—411)

This invention relates to stud driving mechanism and this application is a division of my Patent No. 2,379,878 issued July 10, 1945.

Studs are threaded at both ends and screwed into engine casings, cylinders, etc., and parts are secured to the studs by nuts which are screwed on the outer threaded ends of the studs. Such studs are subjected to heavy loads and tremendous pressures and only studs having the proper size or fit can be utilized.

In the aircraft industry in particular, the proper mating of studs and stud holes is most important. It is essential that the studs be driven in under not less than a certain, predetermined torque, or the studs may shake loose. Moreover, it is absolutely essential that the torque drive does not exceed a predetermined limit as it has been found that if this torque is exceeded, after a certain number of hours of actual flight, the studs will fatigue due to strain and will crack.

Government specifications, for this reason, set minimum and maximum torque limits, but all studs are tested by manually operated torque wrenches. Such operations are difficult to control and sabotage is very difficult to detect.

At the present time it is usual to screw the studs in by hand, using large wrenches having sufficient leverage to furnish the necessary torque required to screw the studs in tightly. If the stud is too large it will not screw in to a sufficient extent and must, therefore, be unscrewed and rejected. On the other hand, if the stud is too small, relative to the size of the thread of the opening into which it is screwed, it will not be tight enough and, therefore, must be unscrewed and rejected. Oftentimes over size studs are broken off and must be removed. The removal of studs driven in under a predetermined maximum torque gives rise to a serious problem since much greater torque effort is required to loosen the stud and unscrew it than was expended under the predetermined maximum driving effort.

The procedure above outlined is laborious, time consuming and expensive and, furthermore, is not productive of the required accuracy in sizing or grading the studs relative to the openings in which they are screwed.

This invention has for its salient object to provide efficient stud driving mechanism so constructed that the studs can be driven in at predetermined minimum and predetermined maximum torque and can be unscrewed and removed if the stud has not been driven in far enough under the predetermined maximum torque drive.

Further objects of the invention will appear

from the following specification taken in connection with the drawings which form a part of this application, and in which

Fig. 1 is an elevational view of the machine constructed in accordance with the invention and adapted for use in carrying out the method;

Fig. 2 is an elevational view, partly in longitudinal section, of the driving end of the machine shown in Fig. 1;

Fig. 3 is a vertical sectional elevation taken substantially on line 3—3 of Fig. 2, looking in the direction of the arrows;

Fig. 4 is a vertical sectional elevation through the tool head, this view being taken substantially on line 4—4 of Fig. 5, looking in the direction of the arrows, Fig. 4 being on an enlarged scale;

Fig. 5 is an elevational view, partly in section, taken at right angles to Fig. 4;

Fig. 6 is a diagrammatic view illustrating the neutral position of the clutch and clutch control mechanism;

Fig. 7 is a diagrammatic view similar to Fig. 6 but showing the clutch parts adjusted for low speed maximum torque driving operation;

Fig. 8 is a diagrammatic view similar to Fig. 6 but illustrating the clutch members adjusted for transmitting the drive at high speed and predetermined minimum torque; and

Fig. 9 is a sectional elevation showing a modified form of drive in which the low speed and high speed drives are obtained direct from the motor without the use of two sets of gearing as illustrated in Figs. 1 and 2.

The invention, briefly described, comprises a tool head having a chuck for receiving the stud to be driven, and driving connections between the driving mechanism and the chuck whereby the tool spindle or chuck may be driven in either direction at high speed or low speed. The drive transmitting mechanism between the drive mechanism and the chuck includes drive control means so constructed that minimum torque may be first applied to the chuck and stud carried thereby and if the stud satisfactorily withstands the minimum torque drive, maximum torque may be applied thereto. Suitable testing means is provided whereby the operator can easily and quickly determine whether the stud successfully withstands the minimum and maximum torque drives.

The drive transmitting mechanism includes a driving clutch connection and a worm drive, so arranged that when the stud encounters predetermined resistance on predetermined minimum or predetermined maximum torque forward drive, the clutch will yield and will limit the drive transmitted to said predetermined limits. Moreover, when the stud has been driven in at predetermined maximum torque but has not been driven far enough, then it must be unscrewed and the worm drive reacts on the driving connection to force the clutch members into tight engagement, thus providing for transmission in reverse drive of a higher torque effort than the predetermined maximum torque transmitted on forward drive.

Further details of the invention will appear from the following description.

In the embodiment of the invention illustrated in the drawings, the machine, as shown in Fig. 1, is mounted on a support or base **25** which carries an upwardly extending casing **26** to which are connected supporting brackets or casings **27** and **28**.

The mechanism, as shown in Fig. 2, is driven by a motor M having a shaft **29** on which is mounted a pair of gears **30** and **31**. The gear **30** meshes with a gear **32** which is mounted on a ball bearing **33** carried by a sleeve **34** which is mounted on the bracket **27**. The gear **32** has a hub **35** on which is formed or secured a driving disk **36** having a friction driving surface **37**. The disk **36** forms one-half of a high speed clutch and is adapted to drive a disk **40** mounted on a bearing **41** and having formed thereon a hollow sleeve **42**. The sleeve **42**, as shown at **43**, is pinned to a shaft **44**. The shaft **44** has formed integral therewith a hollow shaft **45** which is mounted in suitable roller bearings **46** and **47**.

The gear **31** meshes with a gear **48** having a hub **49** mounted in a ball bearing **50**. The gear **48** has a disk **51** formed integral therewith having a friction surface **52** adapted to coact with the other face of the intermediate clutch member or disk **40**.

The intermediate clutch member or disk **40** is slidably or longitudinally movable on its axis so that the member **40** may engage the high speed clutch disk **36** or the low speed clutch disk **51**.

Before describing the control mechanism by means of which the drive may be shifted from high speed to low speed or vice versa, the driving connections between the hollow shaft **45** and the tool head will be described.

The hollow shaft **45** has mounted thereon a worm gear **55** which meshes with a worm wheel **56** mounted on a shaft **57**. The worm wheel **56** also meshes with a gear **58** mounted on a stud shaft **59** in the casing **26**. This casing is preferably provided with a suitable lubricant which is picked up by the teeth of the gear **58** and is fed to the worm wheel **56** and worm gear **55**, thereby providing efficient lubrication for these parts.

The shaft **57**, as shown particularly in Fig. 3, is mounted in suitable bearings **60** and **61**. Shaft **57** has secured to one end thereof a sprocket wheel **62** which, as shown in Fig. 1, is connected by a chain **63** to drive a sprocket wheel **64** mounted on a shaft **65** which is carried by the tool head casing **66**.

Tool head

The tool head casing is swung on a parallel link connection from the casing **26** in the following manner. A link **70** is pivoted at **71** to lugs **72** carried by the casing **26** and is pivoted at its opposite end, as shown particularly in Fig. 5 at **73**, to a pair of lugs **74** carried by the cover or casing **75** of the tool head. The other links of the parallel link connection which supports the tool head casing are shown particularly in Figs. 1, 2, 3, 4 and 5. From these figures it will be seen that links **76** are pivoted on the axis of the shaft **57** and at their other ends are pivoted at the axis of the shaft **65**. By means of this parallel link motion the tool head can move downwardly to feed the screw into the work or upwardly away from the work.

The shaft **65**, as shown particularly in Figs. 4 and 5, has mounted thereon a worm gear **80** which meshes with a worm gear **81** mounted on a hollow shaft **82** supported in suitable bearings **83** and **84** in the tool head casing **66**. The hollow shaft **82** has formed therein longitudinal grooves **85** and **86**, as shown in Fig. 4. A cup shaped collar **87** surrounds a portion of the hollow shaft and is provided with inwardly extending lugs **88** and **89** which seat in the grooves **85** and **86**. The cup shaped collar **87** is also provided with diametrically opposite downwardly extending lugs **90** which engage correspondingly located and formed notches **91** formed in the upper surface of a sleeve **92** which surrounds the lower portion of the hollow shaft **82** and extends below said shaft.

The cup shaped collar **87** is held downwardly so that the lugs **90** will engage the depressions **91** by springs **93** which seat at their lower ends in a cup shaped collar and at their upper ends against an abutment **94**.

The sleeve **92** has its lower end inwardly tapered, as shown at **95**, to form a chuck or wedge which coacts under predetermined conditions to force inwardly jaws **96** of a collet **97**. The jaws **96** are provided with internal threads **98** of a suitable pitch to receive one threaded end **99** of a stud S. The other end of the stud is also threaded, as shown at **100**.

The collet **97** consists of a longitudinal sleeve which extends upwardly in the sleeve **92** and is connected by a pin **101** to a plunger **102** slidably mounted in the hollow shaft **82**. The pin **101** also secures within the collet sleeve **97**, a sleeve **103** which extends downwardly in the collet sleeve **97** and is internally threaded at **104**. The threaded opening **104** receives a threaded stud **105** which carries a stop pin **106** which determines the extent to which the threaded end **99** of the stud S is screwed into the collet or chuck. The pin **106** is adjustable by vertically adjusting the threaded stud **105** in the threaded opening **104** in the sleeve **103**.

The collet is driven from the sleeve **92** by means of the structure illustrated in Fig. 4. As shown, four lugs **110** are carried by the lower end of the sleeve **92**. These lugs have reduced extensions **111** which extend inwardly and form vertical ribs which are received in vertical slots or grooves **112** formed in the collet sleeve **97**.

The lower end of the chuck or sleeve **92** has loosely mounted thereon a cylindrical cup or sleeve **113** having a retaining flange **114** at its upper end and having an inwardly extending flange **115** at its lower end, the flange **115** having a central opening **116** and extending beneath the lower ends of the collet jaws **96**. These jaws are formed by upwardly extending slots in the lower end of the collet sleeve **97**. The manner of using the testing sleeve or cup **113** will be hereinafter described.

The plunger **102** is carried by a plunger head **120** mounted in a bearing **121**, the plunger being held in its upward position of movement by a spring **122**. The head **120** and bearing **121** are mounted in an inverted cup **123** having a laterally extending flange **124**. A piston **125** is mounted between a disk **126** and the flange **124** and is positioned in a cylinder 127 formed in the upper end of the tool casing. A suitable fluid is admitted to the cylinder chamber 128 and when this fluid under pressure is admitted to the chamber 128, the piston 125 is depressed in the cylinder 127 carrying with it the plunger 102. As the plunger is depressed, the collet and collet jaws are forced downwardly in the sleeve 92, the chuck 95 causing the jaws to tightly grip the threaded end 99 of the stud S which has been previously inserted in the collet jaws in a manner hereinafter described.

Since the drive between the shaft 65 and the hollow shaft 82 is transmitted through a worm gear drive mechanism, when the torque or resistance encountered as the stud S is screwed into the work exceeds a predetermined amount, the stud S can no longer rotate and the worm gear 80 will tend to move longitudinally on a shaft 65.

In order to prevent this movement, the mechanism shown in Fig. 5 is provided. From this figure it will be seen that the shaft 65, which is hollow, has threaded thereinto a stud or rod 130 on which is mounted a spring 131 which seats in a cup 132 at one end and at its opposite end against adjusting nuts 133 threaded on the stud 130. The spring tension obtained by the use of the spring 131 will tend to prevent the relative movement of the gear 80 to the left and axially of the shaft 65 as indicated by the arrow in Fig. 2.

Drive transmission and control mechanism

This mechanism is particularly shown in Figs. 2, 6 and 7. As shown in Fig. 2, the hollow shaft 45 has pinned thereto at 140, a shaft 141. On the outer end of the shaft 141 is mounted on a ball bearing 142, a cap 143 having an arcuate surface 144. A collar 145, cup shaped in cross section, is mounted on the shaft 141 and is held in the desired position by adjustment by means of a nut 146 which is threaded onto the shaft 141. Springs 147 engage the cup shaped collar 145 and also set in a flanged collar 148 which seats against the inner ball race 150 of the ball bearing 47 and rotates therewith.

The springs 147 are adapted to provide a minimum driving torque in the following manner.

Since the drive between the shaft 45 and the shaft 57 is transmitted through worm driving mechanism, when the stud S encounters a predetermined resistance, the worm gear 56 will be prevented from rotating, thereby causing the worm gear 55, which is still being driven, to move lineally in the direction of the arrow in Fig. 2. Movement of the worm gear 55 in this direction will tend to cause the shaft 45 to move toward the left, viewing Fig. 2, thus moving the intermediate clutch transmitting plate or disk 40 relative to the driving disk or clutch member 51, to a sufficient extent to limit the torque transmission to a predetermined setting. In order to permit the stud to be screwed in to the desired extent or with a minimum torque driving effort, the springs 147 are provided. These springs, as clearly shown in Fig. 2, tend to move the shaft 45 to the right, viewing Fig. 2, thus partially counteracting the tendency of the shaft to move toward the left due to the slowing down or stopping of the worm wheel 56. The springs 147 are so chosen as to accomplish the foregoing result to the desired extent.

This torque yielding or torque limiting action takes place on forward drive only. However, when the drive is in reverse the worm gear 55 will tend to move the shaft 45 to the right, viewing Fig. 2. Thus, the thrust reaction clamps the clutch disk 40 to the driving disk 51, giving practically a positive reverse drive. This is particularly important under a condition encountered when the stud has been driven in under maximum torque but has not been driven far enough into the work. It has been found that after a stud has been driven in under predetermined torque a much greater torque is required to loosen and unscrew the stud. By thus forcing the clutch disk 40 into tight engagement with the driving disk 51 the necessary additional torque effort required to loosen and remove the stud is provided.

The position of the shaft 45 and the intermediate clutch member 40 carried thereby is determined by a cam 155 carried by a spindle or stud shaft 156 rotatably mounted in a bearing 157 formed in the bracket or casing 28.

The cam 155 has formed thereon two concave cam surfaces 158 and 159 which are separated by a ridge 160. Furthermore, the outer edges of the concave surfaces 158 and 159 are bordered by ridges 161 and 162.

The cam 155 is manually controlled by a handle 163. When the cam is positioned as shown in Fig. 2, the cap 143 is disposed opposite the concave surface 159 which is so formed that the shaft 45 is positioned to permit the intermediate clutch member 40 to engage the clutch member 51 and thereby transmit the drive from the shaft 29 to the shaft 45 at low speed.

When the handle is moved to shift the cam 155 to the position shown in Fig. 6 in which the ridge 160 engages the cap 143, the shaft 45 will be so positioned as to dispose the intermediate clutch member or driven plate 40 between the clutch members 36 and 51 and thus no drive will be transmitted to the shaft 45.

When the handle and cam 155 have been shifted to the position shown in Fig. 8 in which the cap 143 is disposed opposite the ridge 161, the shaft 45 will be shifted to the left, thus engaging the intermediate clutch member 40 with the clutch driving member 36, thus transmitting the drive at high speed to the shaft 45. High speed is also transmitted when the cam is shifted to the position shown in Fig. 8 and the cap 143 is disposed in engagement with the ridge 161.

In addition to controlling the position of the driven disk 40 with reference to the driving disks 36 and 51, the cam and handle also control the passage of pressure fluid to the tool head cylinder chamber 128. This fluid control is fully shown in my Patent No. 2,379,878 above mentioned and forms no part of the present invention and, therefore, need not be further described.

After the minimum torque drive has been transmitted to the tool and the stud has not been driven in too far thereby, as will be hereinafter explained, further torque or a maximum torque is applied in the following manner. A bell crank lever comprising arms 185 and 186 is pivotally mounted, as shown at 187, on the bracket 27. This lever has a downwardly extending lug 188 which is disposed opposite the outer end of a slidable stub shaft 189 positioned in axial alinement with the shaft 45. A spring 190 engages the outer end of the arm 186 and is adjustable by an eye bolt 191 which extends through the base member 25 and is engaged by a wing nut 193.

The spring 190 tends to rotate the bell crank lever in an anti-clockwise direction about the axis 187 and this rotation is normally prevented by means of a latch bar 194 which is pivoted at

195 to the outer end of the arm 185 and has at its opposite end a hook 196 which is adapted to engage a latch bar 197.

When the bar 194 is lifted, the spring 190 will rotate the bell crank lever in an anti-clockwise direction, causing the lug 188 to engage the outer end of the shaft 189 and to push this shaft inwardly against the outer end of the shaft 45, thus further resisting the tendency of this shaft to shift to the left and discontinue the drive between the intermediate clutch member 40 and low speed clutch disk 51. In this manner a maximum driving torque is permitted in driving the stud into the work before the drive is disconnected.

In order to unscrew the stud from the work in case the stud is not the proper size, a reversing switch R is provided for the motor M. This switch operates in the usual well known manner to reverse the motor and thereby to reverse the drive. As hereinbefore explained, upon reverse drive the additional torque required to loosen the stud is available due to the action of the worm drive which causes the clutch members to be tightly clamped together, giving practically a positive drive.

If desired, instead of having two driving disks, driven at low and high speeds through two sets of gears, as shown in the preceding figures, the high and low speeds can be taken directly from the motor shaft, as shown in Fig. 9. In this case the motor will be provided with low and high speed windings. One driving disk 200 is used and the driven disk 201 is shifted into and out of driving relation thereto.

It will be understood that the control cam for shifting the shaft 202 will be simplified since the disk 201 need not be shifted to the left to engage the high speed disk as in the other embodiment of the invention.

The operation of the driving mechanism should be clear from the foregoing specification but the action of the worm driving connection between the driven shaft and the tool shaft on forward and reverse drive may be briefly summarized as follows. When the stud S on forward drive encounters a predetermined resistance, the worm gear 56 will be prevented from rotating, thereby causing the worm gear 55 which is still being driven to move lineally in the direction of the arrow in Fig. 2. This will tend to cause the shaft 45 to move to the left, viewing Fig. 2, thus moving the intermediate clutch transmitting plate or disk 40 relative to the driving disk or clutch member 51 to a sufficient extent to limit the torque transmission to a predetermined setting. If the stud is driven in under minimum torque drive to a satisfactory extent and not too far, the arm 194 is raised, thereby permitting the spring 190 through the bell crank lever 186 to exert pressure on the shaft 45 toward the right, viewing Fig. 2, and provide a maximum torque driving connection. In case the stud under maximum torque drive has not been driven far enough into the work, it must be removed and on reverse drive the worm driving connection reacts on the friction drive to clamp the clutch disk 40 to the driving disk 51, effecting practically a positive reverse drive. As hereinbefore explained, this is important since a much greater torque effort is required to loosen and unscrew the stud than the predetermined maximum torque effort which was utilized to screw the stud.

Although certain specific embodiments of the invention have been particularly shown and described, it will be understood that the invention is capable of modification and that changes in the construction and in the arrangement of the various cooperating parts may be made without departing from the spirit or scope of the invention, as expressed in the following claims.

What I claim is:

1. In a machine of the character described, a reversible friction driving member, means for driving said friction driving member in opposite directions a shaft mounted for axial movement, coaxial with the axis of the friction driving member, a friction driven member mounted on said axially movable shaft and movable into and out of driving engagement with two degrees of torque transfer with said friction driving element as the shaft is moved axially, a tool driving shaft, means including a worm driving connection between said axially movable shaft and said tool driving shaft, said worm driving connection limiting the torque transmitted by the friction driving and driven members and operating to clamp said members in tight driving relation on reverse drive, and means coacting with the driving connection between the driving and driven friction members for increasing the torque load limit to effect the second degree of torque transfer to which the drive will be limited on forward drive.

2. In a machine of the character described, a reversible drive shaft, means for driving said shaft in opposite directions, a friction clutch member driven thereby, a driven shaft mounted for axial movement, a second clutch member on said shaft and movable into and out of engagement with said first clutch member with two degrees of torque transfer as said shaft is moved axially, a tool shaft, operative driving connections including a worm driving connection between said driven shaft and said tool shaft, said worm driving connection reacting on said clutch members to limit the torque transmitted therethrough to a constant predetermined minimum torque, when the load on the tool shaft on forward drive reaches said predetermined limit, and manually controlled means associated with said clutch members on forward drive for increasing the torque driving effort to a predetermined maximum torque limit to effect the second degree of torque therefor, said worm drive reacting on said clutch members to limit the torque transmitted therethrough to said predetermined maximum torque limit when the resistance on the tool shaft reaches said predetermined limit, and said worm driving connection on reverse, automatically forcing said clutch members into tight driving relation, thereby increasing the torque transmitted to a limit higher than said predetermined maximum.

3. In a machine of the character described, a reversible drive shaft, means for driving said shaft in opposite directions, a friction clutch member driven thereby, a driven shaft mounted for axial movement, a second clutch member on said shaft and movable into and out of engagement with said first clutch member with two degrees of torque transfer as said shaft is moved axially, a tool shaft, operative driving connections including a worm driving connection between said driven shaft and said tool shaft, said worm driving connection reacting on said clutch members to limit the torque transmitted therethrough to a constant predetermined minimum torque, when the load on the tool shaft on forward drive reaches said predetermined limit, and means associated with said clutch members on forward

drive for increasing the torque driving effort to a predetermined maximum torque limit to effect the second degree of torque therefor, said worm driving connection reacting on said clutch members to limit the torque transmitted therethrough to said predetermined maximum torque limit when the resistance on the tool shaft reaches said predetermined limit, and said worm driving connection on reverse, automatically forcing said clutch members into tight driving relation, thereby increasing the torque transmitted to a limit higher than said predetermined maximum.

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