March 7, 1944. J. E. POORMAN 2,343,577

GRINDING MACHINE

Filed Aug. 10, 1942 4 Sheets-Sheet 1

Fig. 1.

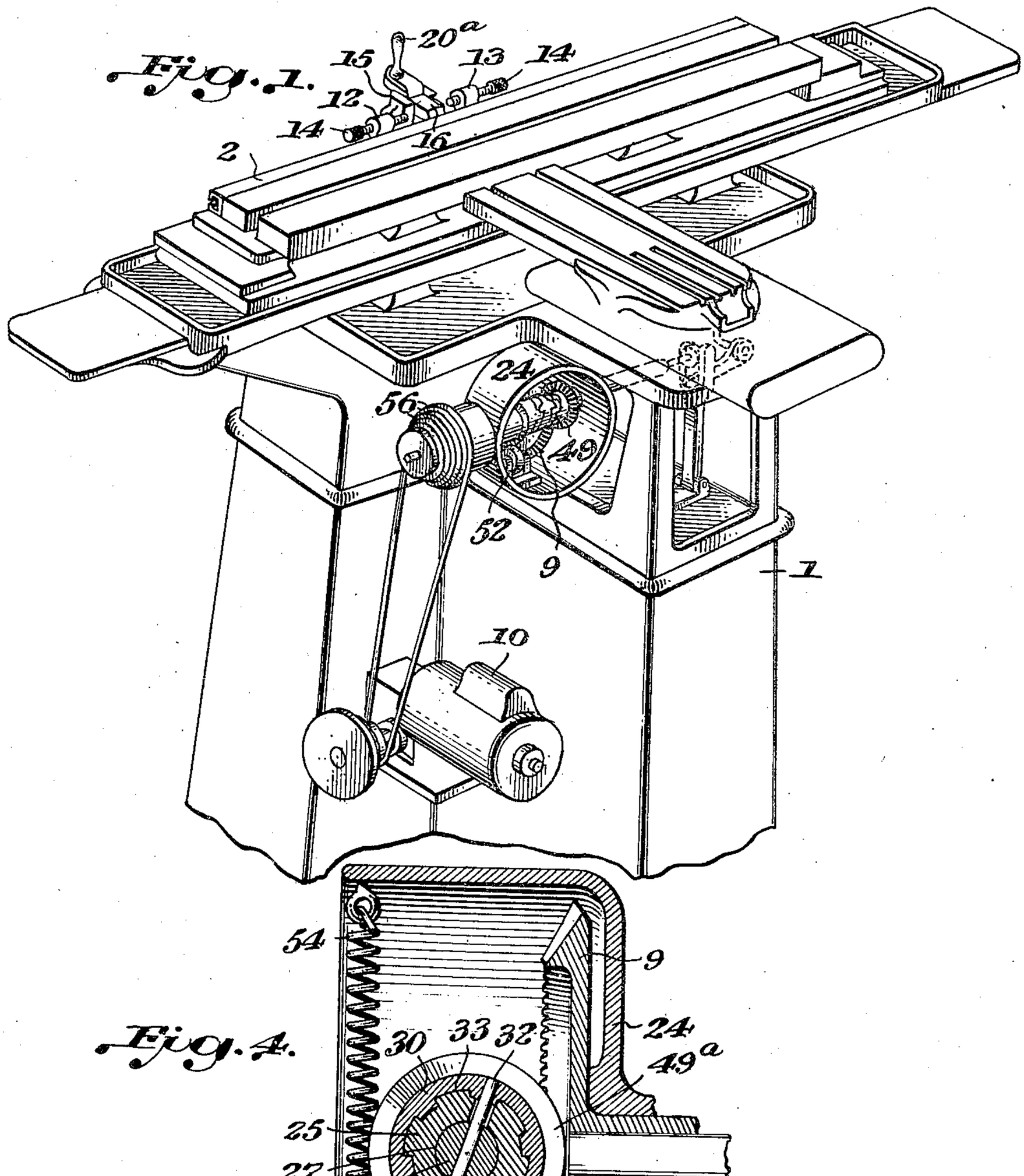

Fig. 4.

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GRINDING MACHINE

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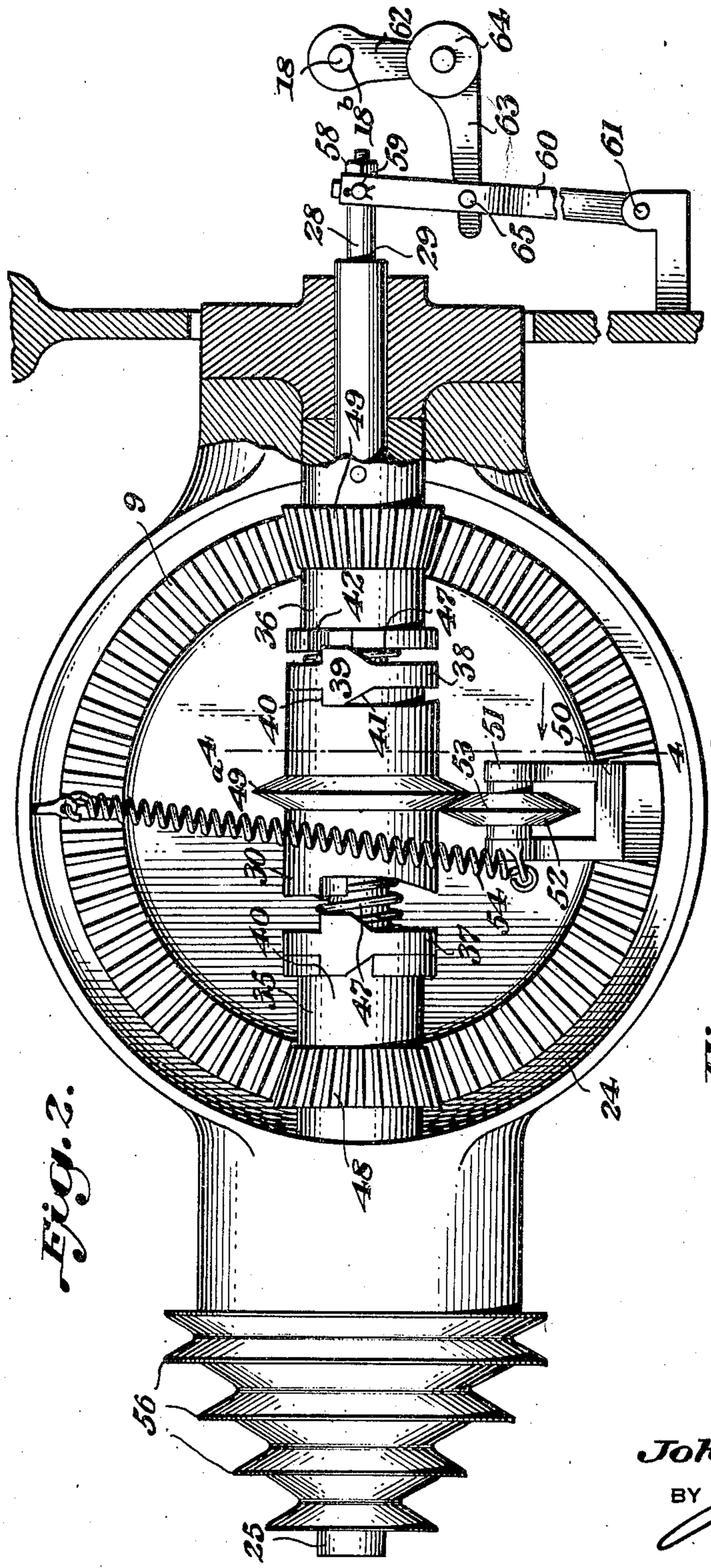

Fig. 2.

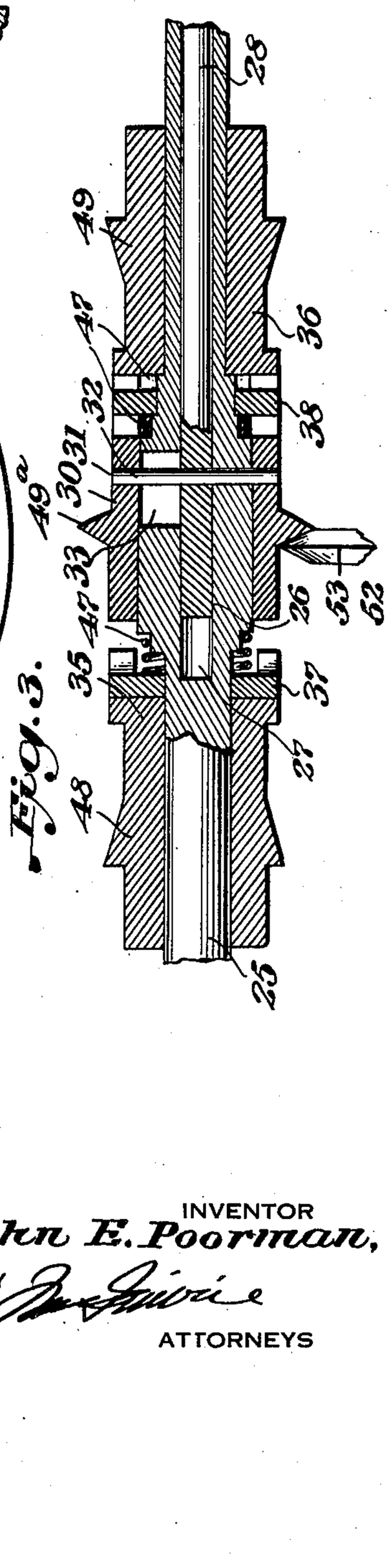

Fig. 3.

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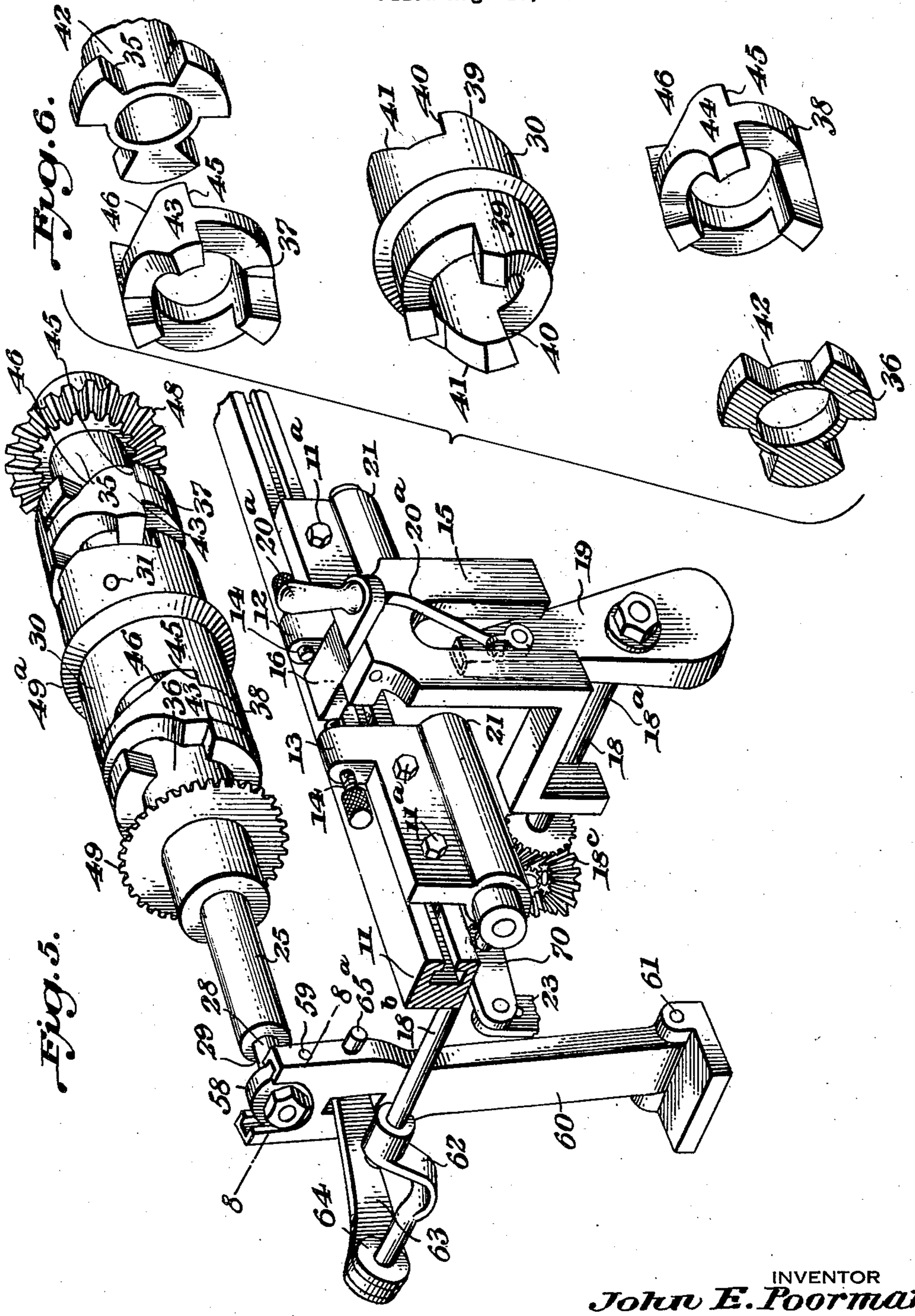

Fig. 5.

Fig. 6.

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Fig. 8.

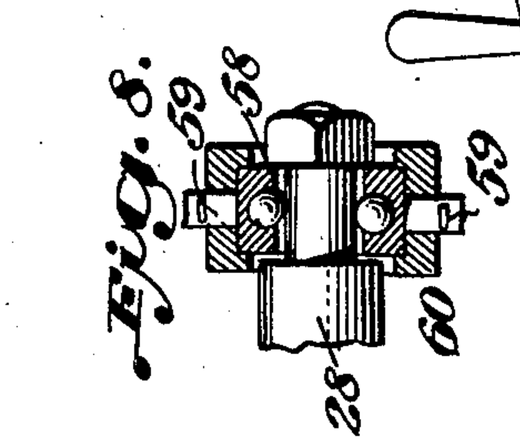


Fig. 7.

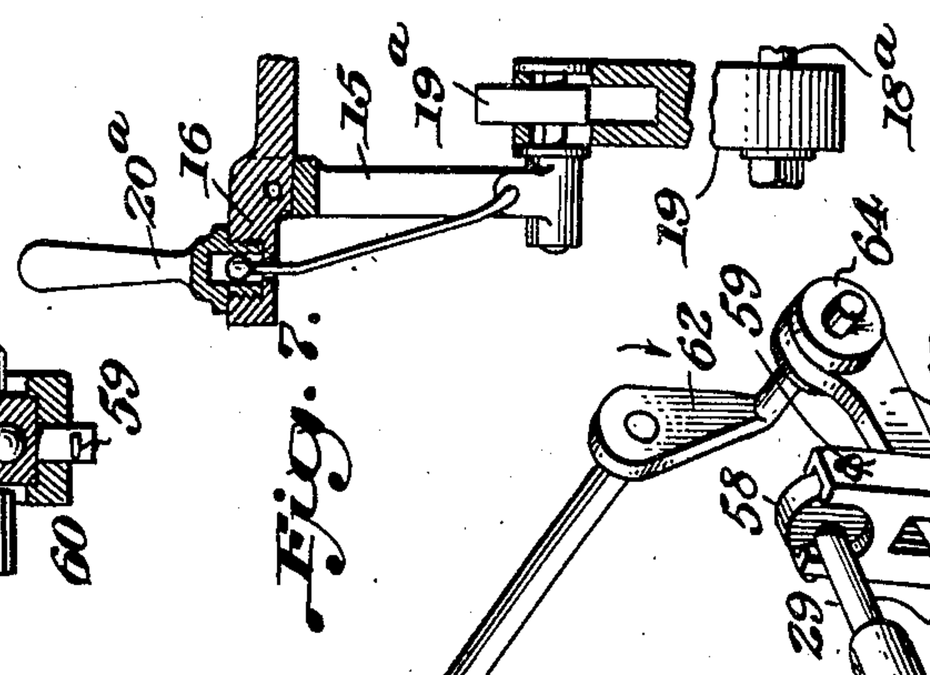
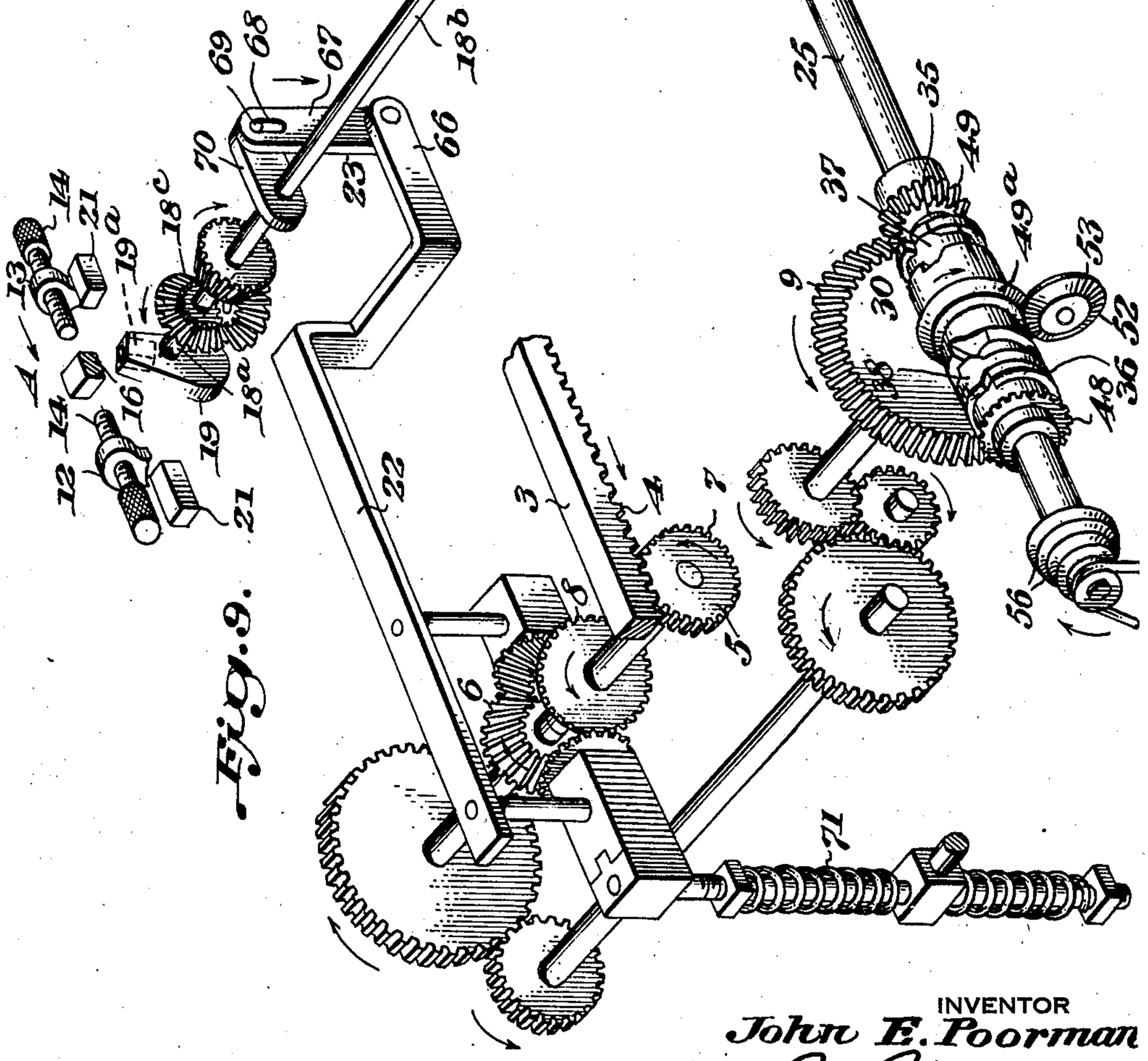


Fig. 9.



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Patented Mar. 7, 1944

2,343,577

UNITED STATES PATENT OFFICE

2,343,577

GRINDING MACHINE

John E. Poorman, Philadelphia, Pa.

Application August 10, 1942, Serial No. 454,309

8 Claims. (Cl. 74—324)

This invention is directed to an improvement in grinding machines, wherein provision is made for so controlling the mechanism to insure absolute precision in grinding, and is more particularly concerned with means for reversing the operation of the grinding machine following a predetermined and precise limit of grinding movement, to permit absolute precision grinding and machine reversal following such precision grinding limit.

In conventional grinding machines, it is customary to provide for automatic operation after the setting of the machine for the desired grinding. Thus, in such conventional machines, the table or other material base is set for a predetermined limited movement for the desired grinding, and during the final step of this movement, mechanism is set in motion to reverse the operation of the drive for the return of the table, and if desired, a further grinding during such return. It not infrequently happens that there is a variation in motion between the time the automatic reversing mechanism commences to operate and the completion of that operation, which variation is not infrequently due to inaccurate timing, wear of parts, or momentum overrun. Any such variation is of course highly undesirable in any grinding operation and absolutely fatal in precision grinding.

In an application filed by me in the United States Patent Office November 10, 1941, Serial No. 418,569, I have described and claimed an improvement in grinding machines, wherein the table of the grinding machine is brought to a complete stop at the exactly determined limit of the grinding operation, to thus insure absolute precision grinding, and wherein means are provided to inaugurate reversal of table movement for reverse grinding following complete cessation of table movement and while such table is at complete rest, whereby the table movement and therefore any grinding operation is completely interrupted during the time-period necessary to operate the reversal of table drive.

The primary object of the present invention is to improve the reversing control and operation of the type of machine described in the above-identified application, whereby to insure a simplified construction of relatively few parts, with such parts constructed for effective cooperation with the minimum of shock and wear, with the result of repeated uniformity of operation without variation and thus insure longer life.

A further object of the present invention is to provide mechanically operated means for initially shifting the reversing mechanism, and auxiliary means cooperating with the initial means to insure movement of the interlocking clutch means and lock the parts in clutched relation.

A further object of the invention is to provide automatic means forming a part of the former means for initially shifting the reversing mechanism to lock the parts in reversing position, while permitting the automatic means to assume normal position once the reversal movement is started.

The improved reversing mechanism forming the primary detail of the present invention includes the provision of two relatively movable shafts having a common axis, of which one is power driven continuously in one direction, and the other of which is axially shifted under a particular control mechanism, together with interlocking elements mounted on one of the shafts to selectively control the direction of machine-table movement in accordance with the direction of movement of the axially-shiftable shaft under the control mechanism.

For convenience and a more definite understanding of the present invention, the improved reversing mechanism will be shown in connection with the machine details described in the above-identified application, though it will be understood that the present invention is in nowise limited thereto, it being further noted that in the accompanying drawings, certain details of the mechanism of the above-identified application will be shown diagrammatically or in dotted outline in sufficient particularity for a complete understanding of the present invention, but without intention of thereby limiting the application of the present invention.

In the accompanying drawings:

Figure 1 is a perspective view showing the application of the invention to a grinding machine.

Figure 2 is a rear view of the reversing mechanism.

Figure 3 is a central vertical section of the same.

Figure 4 is a transverse section on the line 4—4 of Figure 2.

Figure 5 is a detailed perspective view of the reversing mechanism and the table-stop arrangement viewed from the front of the machine.

Figure 6 is a perspective of clutch details.

Figure 7 is a detailed sectional view of the stopping-controlling element.

Figure 8 is a detail section on the line 8—8 of Figure 5.

Figure 9 is a diagrammatic view of the reversing mechanism and its control elements.

The general details of the machine described in the above-identified application, and to which the present invention is shown as applied for convenience, without, however, thereby restricting the application of the present invention, may be briefly described as follows:

It will be evident the improvement is applicable in any type of machine employing a reversing element.

The machine includes a main frame 1, on which is slidably guided a table 2, to receive the material to be operated on by a grinding or like mechanism. The table has a central depending rib 3, on which is secured or formed a rack 4, to be driven by a train of gear from the motor or other source of power, for reciprocating the table and supported material or work.

The train of gear, indicated generally at 5, includes details with which the present invention is concerned, and such includes two gears 6 and 7, with an interposed differential 8 between the gears 6 and 7, the latter cooperating with the rack 4. The gear train also includes what may be termed a primary gear 9, the initial gear in the train responsive, through the reversing mechanism of this invention, to the motor 10.

The more or less conventional machine being described for a better understanding of the present invention includes means whereby the cessation of movement of the table at the predetermined exact limit of the grinding operation is provided, together with a means for inaugurating the reversal of table travel, and a means for controlling the reversing mechanism of the present invention.

Such controlling means, which is in accord with the construction of the above-identified application, may be briefly described as follows: A hollow guide bar 11 is secured to one edge of the table 2, and independent heads 12 and 13 slidably cooperate with such guide bar 11. Set screws 11*a*, carried by the heads and cooperating with the guide bar 11, permit the heads to be independently fixed with relation to the guide bar in any desired relative spacing. A two-armed bracket 15 is secured to the frame 1, on which is pivotally mounted a stop 16, which, when in operative position, is in the path of movement of the ends of set screws 14, adjustably mounted, one in each of the heads 12 and 13. As the stop, except for its pivotal movement, is fixed relative to the frame, it will be obvious that the movement of the table 2 in either direction will be stopped on contact of the set screw 14 of the particular head with the stop 16. As the heads 12 and 13 are adjustable in the guide bar 11, and the set screws further adjustable in the heads, it is apparent that the table may be brought to rest in travel in either direction, and the grinding effect on the work on the table completely stopped at any selected point in table travel, to thus provide for exact precision grinding.

A shaft 18, hereinafter termed the reversing shaft, is rotatably mounted in the frame 1, and is divided into two sections 18*a* and 18*b*, connected by a reversing bevel gear set 18*c*, so that movement of one section of the shaft will reversely affect the other shaft section. The shaft section 18*a* is terminally provided with a lever 19 extending upwardly between the arms of bracket 15. The lever 19 is provided with a slidably mounted stop 19*a*, which when in operative position, is in the path of movement of the stops or lower projections 21 on the heads 12 and 13.

It will be apparent from the hereinafter description of the operation of the machine, that the cooperation of the stop 16 and the particular set screw 14 functions to stop the table movement and thereafter inaugurates the reversing mechanism. As it is also contemplated that if and when it is desired to inaugurate the reversing mechanism during and incident to the final increment of and before stopping the table movement or grinding operation, means must be provided to selectively permit such operation, and to this end, the stop 19*a* and projections 21 are arranged as described.

It is also evident that the two radically different controls of the reversing mechanism, one after the table is completely stopped, and one while the table is moving, can not function at the same time. In order that the respective functions may be completely and simply selective, the lever 19 is provided with a manually-controlled member 20*a*, connected to the stop 16 and to the stop 19*a* to selectively swing the stop 16 into or out of operative position or slide the stop 19*a* into or out of operative position. Thus, either stop may be made to function, and if desired, both stops may be simultaneously moved out of operative position by appropriate operation of the member 20*a*, to provide for hand movement of the table, as provided in the aforementioned application and unnecessary to describe herein.

It will of course be apparent that the machines of the type with which the present invention is concerned must additionally, and for more effective service, present the possibility of the more conventional operation of such machines, namely, that of operating the reversing mechanism during and substantially coincident with the final movement of the table during grinding operation. This operation is effective in conventional grinding where exact precision limits are not so vital, and the control of the table movement and simultaneous control of the reversing mechanism during the table movement is governed by the stop 19*a* in cooperation with the projections 21, as will later appear.

The gear train, as stated, includes a differential 8 between the gears 6 and 7, the latter cooperating with the rack 4 and moving the table. When the table 2 is stopped by engagement of one or the other of set screws 14 of heads 12 and 13 with the stop 16, the table 2 and therefore gear 7 stop. Gear 6, however, is still power-driven and this acts through the differential 8 to compel a tilting movement of the differential 8 and rock a bar 22 carried by the differential 8 and cause such bar through linkage 23 connected to the reversing shaft 18 to turn said reversing shaft to a degree to operate the reversing mechanism. The gear or power train, as defined in the claims, thus includes the gears from the initial drive element on one side of the differential 8, with the addition of a gear section on the opposite side of the differential and directly engaging the rack 4.

This reversing mechanism, which forms the primary subject matter of the present invention, will now be specifically described. The reversing mechanism includes an annular open-ended housing 24, arranged adjacent, in the present disclosure, to the primary gear 9 of the gear train. A shaft 25 extends substantially diametrical of

the housing and mounted in appropriate bearings carried by the housing. The shaft **25** is diametrically enlarged for a portion of its length, as at **26**, and axially bored at **27** throughout the enlarged portion. A secondary shaft **28** is slidably fitted in the bore **27** and extends at one end beyond the enlarged end of shaft **25**, as at **29**.

A sleeve **30** is keyed at **31** against independent rotative movement on the enlarged portion **26** of shaft **25**, the sleeve being free for sliding movement on shaft **25**. A pin **32** is passed through sleeve **30**, through somewhat elongated slots **33** in the shaft **25**, said pin passing through and being fixed relative to secondary shaft **28**. Thus in any sliding movement of shaft **28**, relative to shaft **25**, the sleeve **30** will be moved within the limit of the slots **33**.

Mounted on shaft **25**, on opposite sides of the sleeve **30**, are pinion-collars **35** and **36** respectively, each collar being held against independent longitudinal movement on the shaft, but freely rotatable thereon. A clutch ring is mounted for free rotative and longitudinal movement on shaft **25**, between the sleeve **30** and each pinion-collar, such clutch rings, indicated at **37** and **38**, providing a means for clutching cooperation between the sleeve **30** and the respective pinion collars **35** or **36**.

To provide the clutch relation, the opposing ends of the sleeve **30** are formed with clutch projections or teeth **39**, each presenting an abrupt face **40** and a sloping face **41**. The pinion collars **35** and **36** on their ends toward the sleeve **30** are formed with clutch recesses **42**, and rings **37** and **38** are formed on their opposite faces with clutch teeth **43** and **44**, each having abrupt faces **45** and inclined faces **46**, respectively, teeth **43** cooperating for clutching function with the teeth **39** on the adjacent face of the sleeve **30**, and teeth **44** cooperating with the recesses **42** in the end face of the particular pinion-collar **35** or **36**. A spring **47** encircling shaft **25** is interposed between each ring and the adjacent end of sleeve **30**, to normally force the ring in clutching cooperation with the adjacent pinion-collar, and at the same time move it away from possible contact with the teeth of the sleeve **30**.

A pinion is formed as a fixed part of each pinion-collar, pinion **48** being on collar **35**, and pinion **49** on collar **36**. The reversing assembly is mounted so that the pinions are in constant driving interfit with diametrically opposite portions of the primary gear **9** of the gear train previously described, and as the pinions **48** and **49** are driven in the same direction, as will later appear, driving influence of one pinion will drive primary gear **9** in one direction, while similar influence of the other pinion will drive the primary gear **9** in the opposite direction.

The various clutch teeth on the sleeve **30**, rings **37** and **38**, and recesses in the pinion-collars **35** and **36**, face in the same direction on each element as concerns their abrupt faces. This provides an important detail of the reversing assembly, for when a ring is engaged by the adjacent end of sleeve **30** for clutching action, the inclined faces **46** of the teeth ride into contact with the inclined faces of the recesses **42** of the pinion-collar, and under the pressure of the sleeve, such inclined faces are forced into a frictional engagement which will start movement of the engaged collar before the full force and effect of the abrupt driving faces of the ring and collar come into engagement.

In order to insure that the sleeve **30** will be given a limit movement in each operation, and avoid possibility of the teeth out of mesh contacting, the sleeve is provided with an annular inverted V-shaped rib **49***a*. Mounted on the frame, adjacent the reversing assembly, is a support **50**, to which a bar **51** is terminally pivoted. The bar **51** carries a free disc **52**, peripherally shaped at **53** to complement rib **49***a*. A spring **54**, secured to the frame **1** and to the bar **50**, holds a particular face of the periphery **52** in contact with the appropriate face of the rib **49***a*. As the sleeve **30** is moved to a point where all teeth are out of contact relation, the bar **51** yields to permit the peripheral edge **53** to ride over the rib **49***a*, and under the strain of spring **54**, snap down on the opposite side of the rib **49***a* to insure uniform and complete movement of sleeve **30**.

Thus, the automatic cooperation of the rib **49***a* on the sleeve **30** and the complementary element **53** on the disk **52** serves two important functions. First, it absolutely and positively insures an invariable position of the sleeve **30** in clutching function to avoid any, even slight, deviation from this position which might otherwise be incident to some wear of parts or other mechanical detail, and second, it positively holds the operative parts of the clutch in a fixed positive cooperation when functioning, and at the same time compels and insures positive separation of the clutch parts not functioning at the moment to prevent obvious mechanical difficulty.

In connection with the detail immediately above described, it is to be borne in mind that the time interval during which the reversing mechanism is inaugurated and completed is extremely limited, occurring while the table is at complete rest, and that necessarily the movement of the clutch parts will therefore be very restricted in order to start and complete the reversal during the extremely limited period at which the table is at rest. Therefore, recognizing the mechanical elements as subject to wear and as practically impossible to construct without some tolerance of variation, it will be apparent that the provision and function of the rib **49***a* and element **52** play a particularly important part in the correct, substantially instantaneous, uniformly positive, and substantially invariable operation of the reversing clutch mechanism.

A motor **10** is mounted on the frame **1** and has a belt drive to any one of a speed-differential set of pulleys **56**, secured on one end of shaft **25**. The secondary shaft **28** extends beyond shaft **25** at the end opposite the motor drive, and such extended end, indicated at **29**, is provided with a bearing **58** having diametric pins **59** cooperating with the forked end of a lever **60**, swinging at its lower end on a bracket **61**, fixed to frame **1**. Thus movement of the lever **60** will compel longitudinal movement of the auxiliary shaft **28** and of sleeve **30** without interfering with the necessary rotation of such shaft and sleeve.

The movement of the lever is directly controlled by the movement of the reversing shaft **18**, and for this purpose, the reversing shaft is provided with a relatively fixed crank-formed member **62**, to which is connected a bar **63**, mounted for free rotation on, but held against relative longitudinal movement on, the crank end, as by crank-carried discs **64** on opposite sides of the bar **63**. The end of the bar **63** has

a transverse pin 65 freely engaging the forks of lever 60.

Thus on turning movement of the reversing shaft 18, the crank member 62 will move the bar 63 and thereby the lever 60 in one direction or the other, and thus shift auxiliary shaft 28 and thereby the sleeve 30 in the proper direction.

It will of course be understood that the movement of the reversing shaft after the table has been stopped is completed solely through the differential 8, and that the movement of the reversing shaft before the table has been stopped is through cooperation of the stop 19*a* and the projections 21, and that the latter operation must not affect the differential parts. For this result, the linkage 23 hereinbefore noted is made up of an angled extension 66 from the differential bar 22, underlying the section 18*b* of the reversing shaft 18 and having a terminal upstanding link 67 formed with a slot 68 to receive a pin 69 projecting from an arm 70 extending from and rigid with the section 18*b* of the reversing shaft.

The operation will first be described with particular reference to the details of the illustrated machine, and providing for a complete stopping of the table and the operation of the reversing of table movement after the table has stopped, which is the primary purpose of the present construction. The adjustable heads 12 and 13 are manually set on or in the guide bar 11 at the exact points in table travel at which the grinding influence on the work must stop. When the set screw 14 of the particular head engages the stop 16, the table is brought to a complete stop. Of course, the gear 7 is also stopped, but as the power is continuous, the gear 6 continues to turn. Thus, it will be apparent that through the differential 8, which through bar 22 and link 23 turns the reversing shaft 18 to swing crank 62, and through bar 63 move lever 60 and thereby move secondary shaft 28, the sleeve 30 will be moved to clutch the particular pinion-collar 35 or 36 not then in driving coaction with primary gear 9 and free the previously active pinion-collar. This reverses the gear train and the table is driven in the opposite direction.

In the operative movement of the bar 22 of the differential to move the reversing shaft, the appropriate wall or end of slot 68 in 67 is engaged by the pin 69, and after the gear train following reversal again moves the table, the differential 8, or more particularly the bar 22, returns to a normal position through spring 71 connected thereto. This return of the differential to normal position does not affect the reversing shaft 18 for the pin 69 simply moves idly in the slot 68.

With particular reference to Figure 9 for a detailed explanation of one operation, the parts are in one operation, the right hand clutch being operative, and the table moving in the direction of arrow A. The adjacent set screw 14 (at the right) engages the stop 16 and the table is stopped. Gear 7 is stopped, but as the gear train is still operating, gear 6 is moving. Differential is rocked to move the end of bar 22 connected to the reversing shaft downwardly against the tension of spring 71. As the slot 68 has its upper wall in contact with pin 69 of arm 70, the reversing shaft is turned in a clockwise direction, moving the crank member 62 and shifting secondary shaft 28 of the clutch mechanism toward the left, and moving sleeve 30 to release the right-hand clutch and couple the left-hand clutch, reversing the drive of primary gear 9, and thus reversing the table movement. In the movement of the sleeve 30, the rib 49*a* shifts disk 52 against tension of spring 54, causing the projection 53 on the disk to ride over the rib 49*a* and down the opposite side. This insures full movement of clutch parts and further holds or locks such parts in set position until the next reversal. As the table starts, the hold on the differential is released, and the spring 71 restores the bar 22 to normal position. As this is opposite the operative movement, the slot link 67 moves relative to pin 69, and the set position of the reversing shaft is not altered.

When the reversing shaft 18 is moved by the differential bar 22, the section 18*a* of that shaft, owing to the reversing gear set 18*c*, moves anti-clockwise, as will be apparent. Thus in the normal position of the parts, shown in Figure 9, if the control of the reversing mechanism is to be accomplished without stopping the table, as before referred to, the stop 16 is moved out of the path of set screws 14, as by hand-operated member 20*a*, so that as the table moves still in the direction of the arrow A, Figure 9, the right-hand projection 21, moving with the table, contacts stop 19*a* and swings lever 19 in an anti-clockwise direction, which through gear set 18*c* will swing section 18*a* of reversing shaft 18 in a clockwise direction, identical with its movement through the differential control and performing of course the identical reversing mechanical operation. It will be seen that in this control by lever 19, the reversing shaft arm 70 moves downwardly, and owing to slot 69, does not influence the differential bar 22.

Of course, movement of the table in the opposite direction is similarly controlled, the position of the pin 69 being normally in this table direction at the bottom of slot 68, the differentially-controlled bar moving up in control, while in the use of the lever 19 for reverse control, the left-hand projection 21 turns such lever and reversing shaft section 18*a* clockwise and reversing shaft section counter-clockwise.

What I claim is:

1. In a machine including a reciprocating member, a power train for operating the member and having its inauguration in a continuously driven unidirectional power means, said power train including a gear section directly operating the member, means for interrupting the effective influence of the power train on the member at any selected point in the travel of the member in either direction, said interruption completely stopping member movement without interfering with continued power-train operation other than such gear section, means for reversing movement of the power train, and means actuated by the continued operation of the power train following complete stopping of member movement to operate the reversing means.

2. A machine including a continuous undirectional power means, a power train operated by the power means, said power train including a gear section serving as the final drive element, means for reversing the driving effect of the power means on the power train, a member operated by the power train in a direction determined by the particular direction of power-train movement, means for selectively and completely stopping member movement in any one particular direction, the power train other than such gear section continuing in operation following complete stopping of the member, and means responsive to such continued operation of the power train to automatically operate the reversing means to

change direction of power train and its driving effect on the member.

3. In a metal-treating machine, including a reciprocating material-supporting element, power means for operating the element, selectively-adjustable means for completely stopping the element movement at a predetermined point, a reversing shaft, mechanism governed by the power means following complete stopping of the element to actuate the reversing shaft, and a reversing assembly forming part of said power means and directly coupled to the reversing shaft for operation in the movement of such shaft.

4. In a metal-treating machine, including a reciprocating material-supporting element, power means for operating the element, selectively-adjustable means for completely stopping the element movement at a predetermined point, a reversing shaft, mechanism governed by the power means following complete stopping of the element to actuate the reversing shaft, and a reversing assembly forming part of said power means and including a primary shaft, interlocking elements of the assembly carried solely by the primary shaft, and a secondary shaft movable relative to the primary shaft for controlling the interlocking elements, said secondary shaft being directly coupled to the reversing shaft.

5. A reversing mechanism for use in a machine of the type including means for completely stopping the machine at a selected point, power means for operating the machine and in part continuing in operation for a period following complete stopping of the machine, said reversing mechanism including a primary shaft, clutch parts carried solely by said primary shaft, a secondary shaft slidable in the primary shaft and controlling said clutch parts, and means for operating the secondary shaft in the continued operation of the power means after completing stopping of the machine.

6. A construction as defined in claim 5, wherein the clutch parts include a clutch sleeve on the primary shaft, and a connection between such sleeve and the secondary shaft for moving the sleeve for clutching function in the movement of the secondary shaft.

7. A construction as defined in claim 5, wherein the clutch parts include pinions rotatably free while fixed against axial movement on the primary shaft, a clutch sleeve non-rotatable while slidable on the primary shaft, a cooperating clutch element rotatable and slidable on the primary shaft between the clutch sleeve and each pinion, and means on the secondary shaft for controlling the clutch sleeve to clutch a pinion to the primary shaft through the interposed clutch element.

8. A construction as defined in claim 5, wherein the operating means for the secondary shaft includes a reversing shaft operated in the said continued operation of the power means, a crank on the reversing shaft, and a connection between the crank and secondary shaft.

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