No. 686,116. Patented Nov. 5, 1901.

H. McC. NORRIS.

DRILL.

(Application filed May 27, 1901.)

(No Model.) 3 Sheets—Sheet 1.

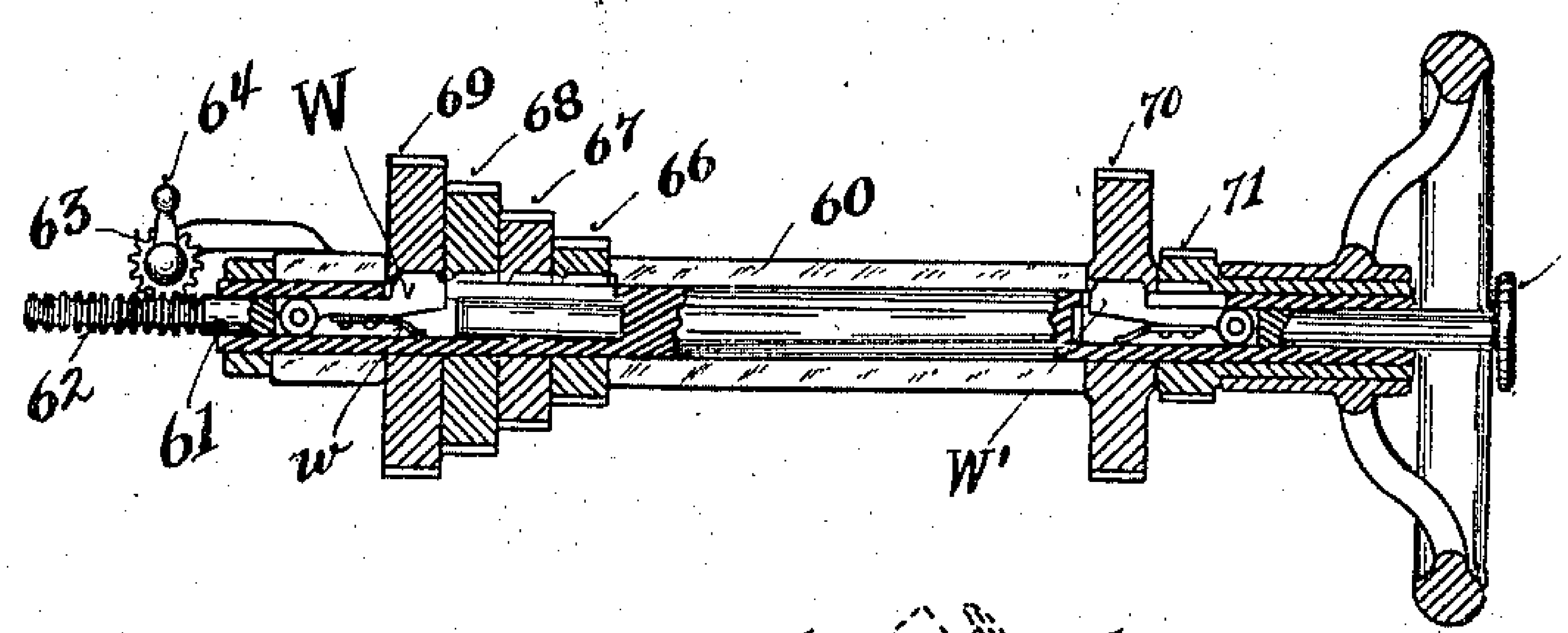

Fig. 14.

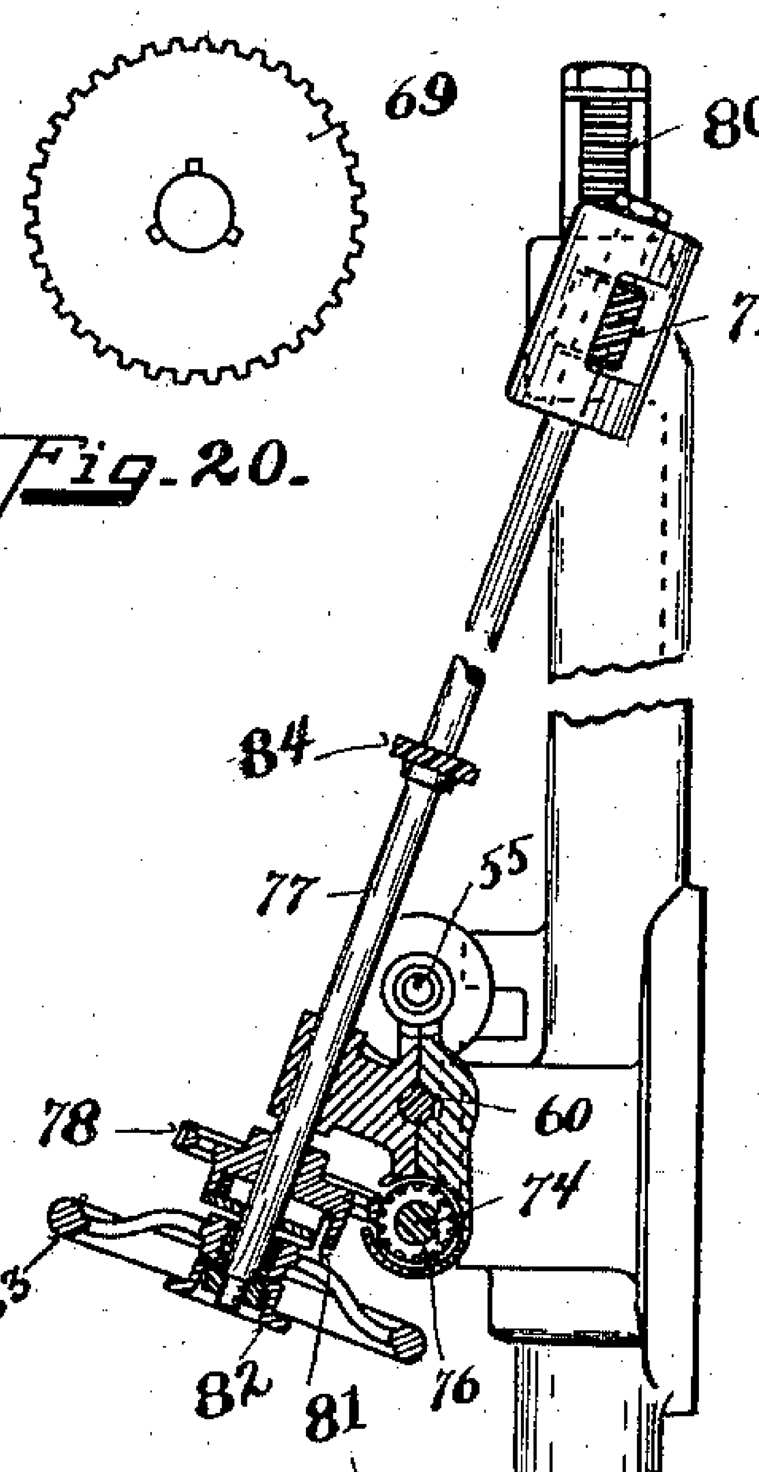

Fig. 20.

Fig. 13.

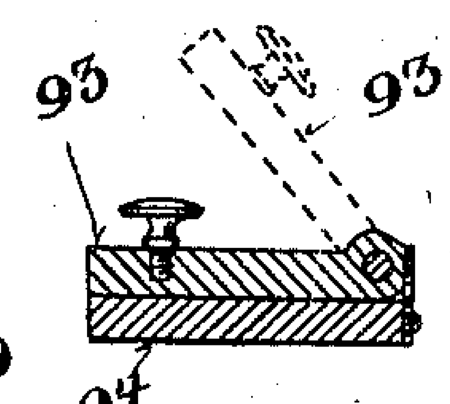

Fig. 17.

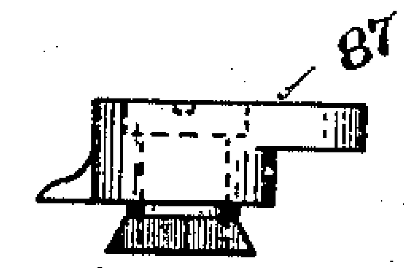

Fig. 18.

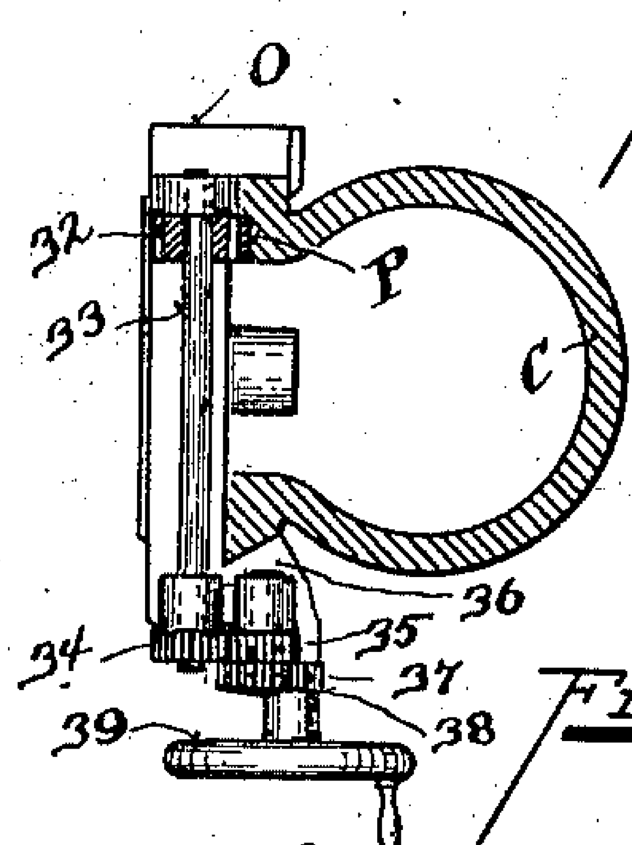

Fig. 15.

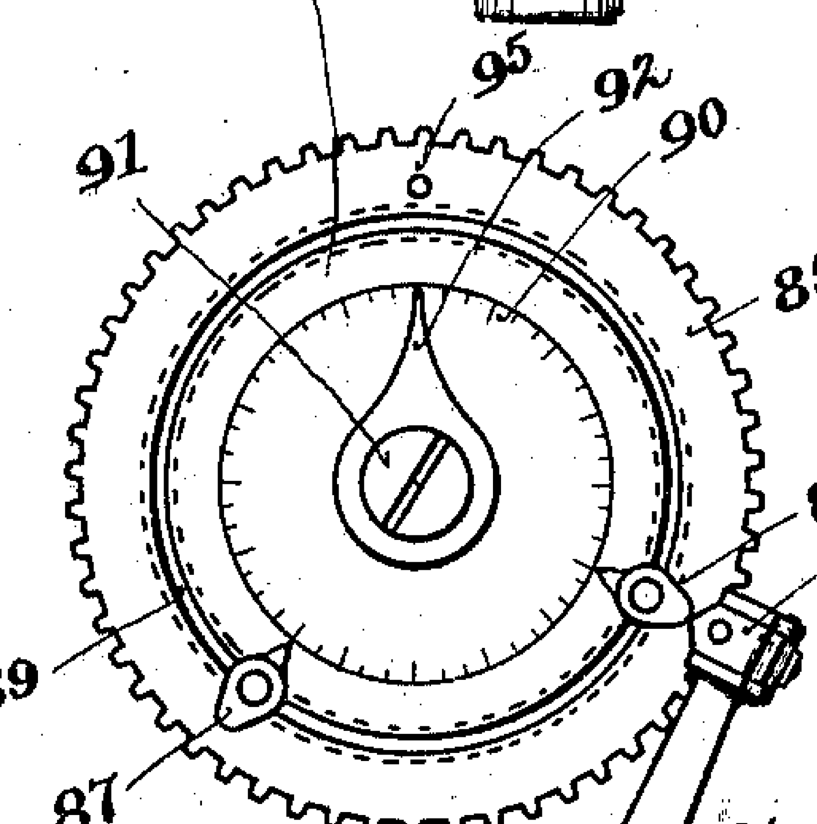

Fig. 16.

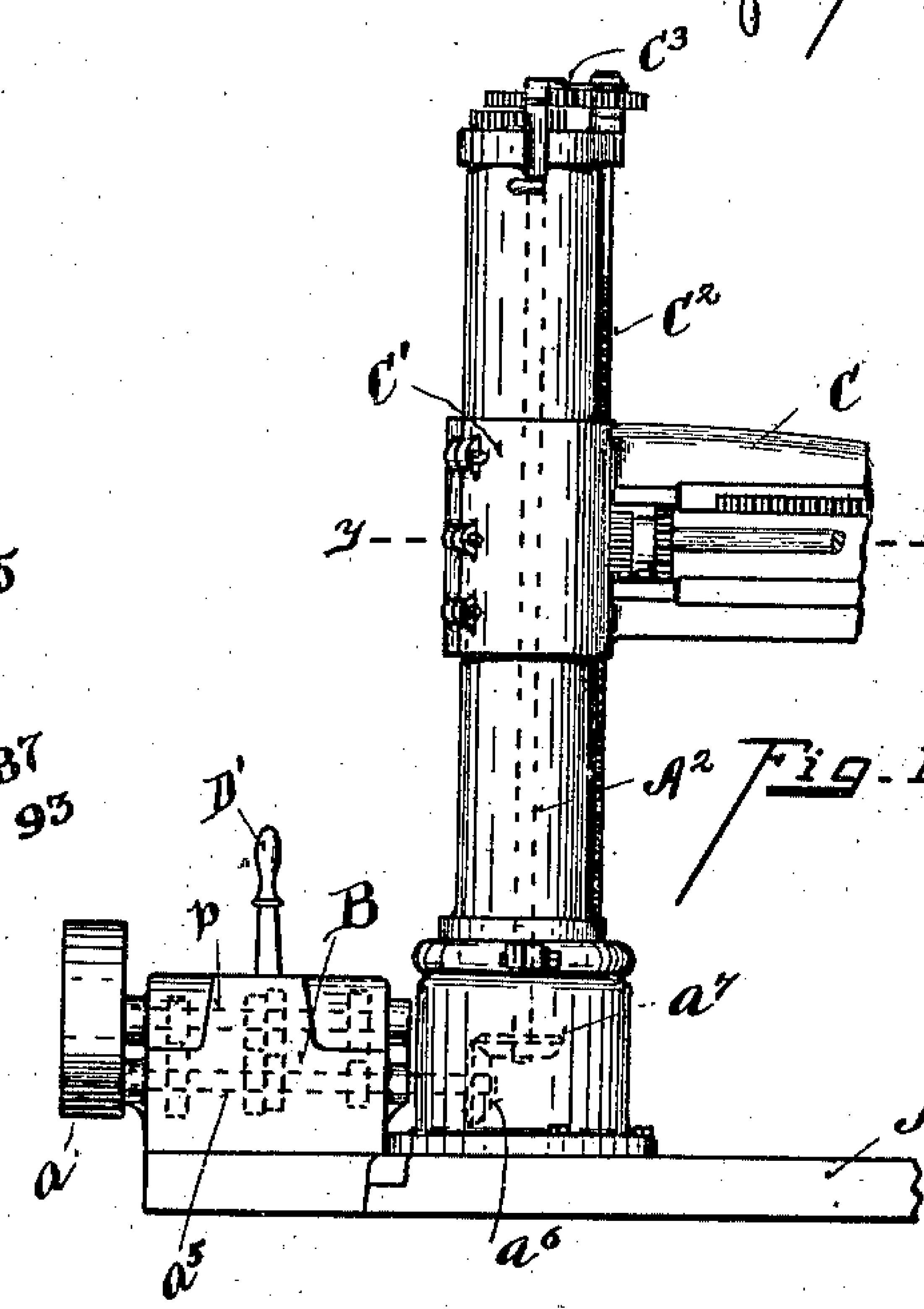

Fig. 1.

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3 Sheets—Sheet 2.

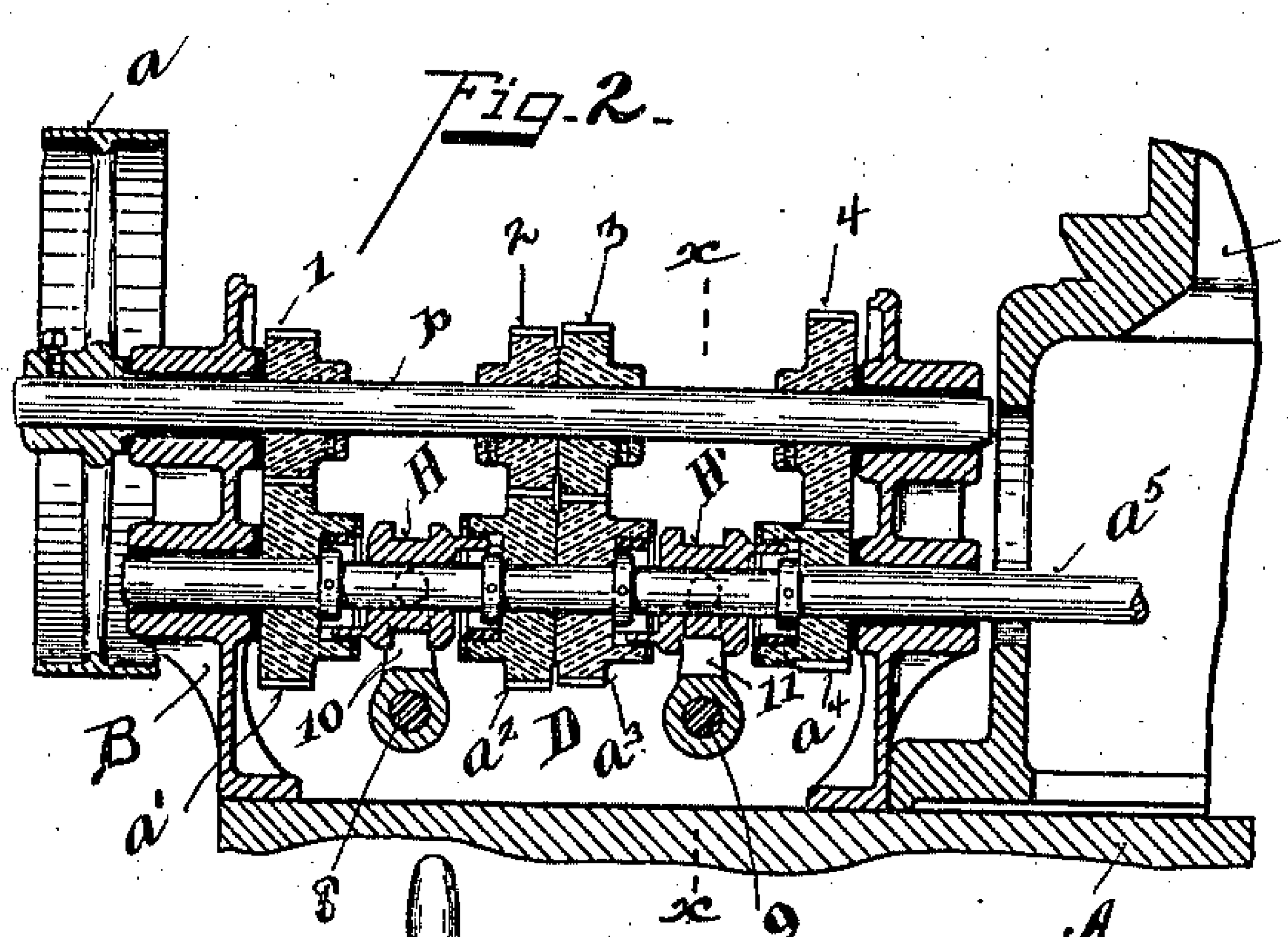


Fig. 2.

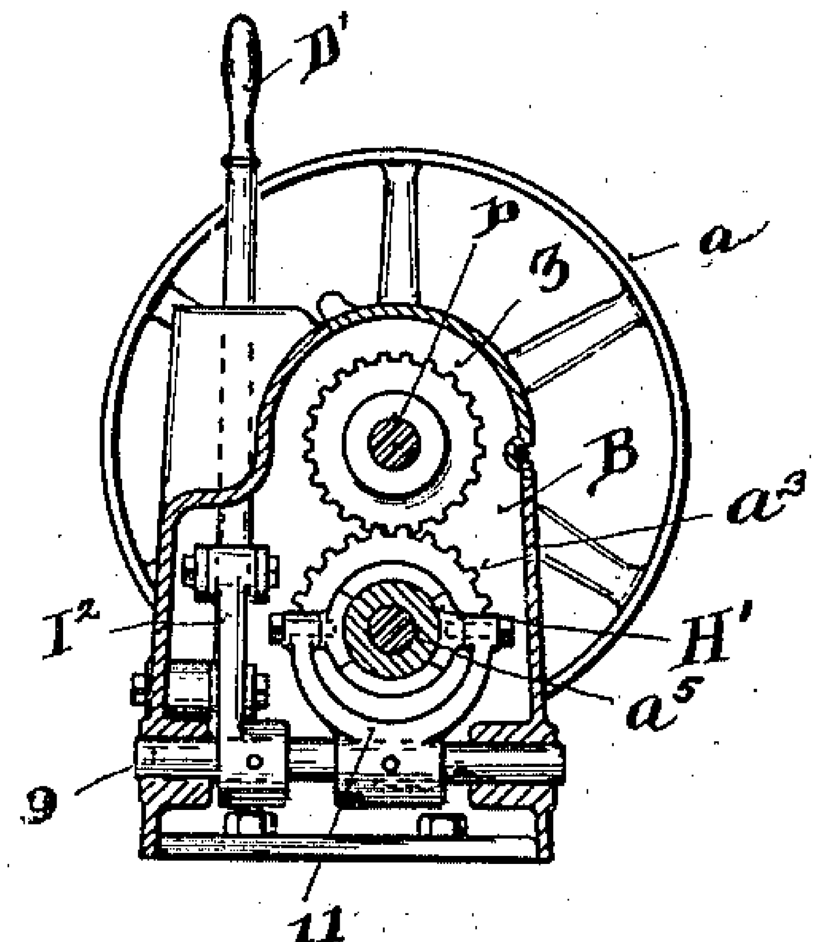
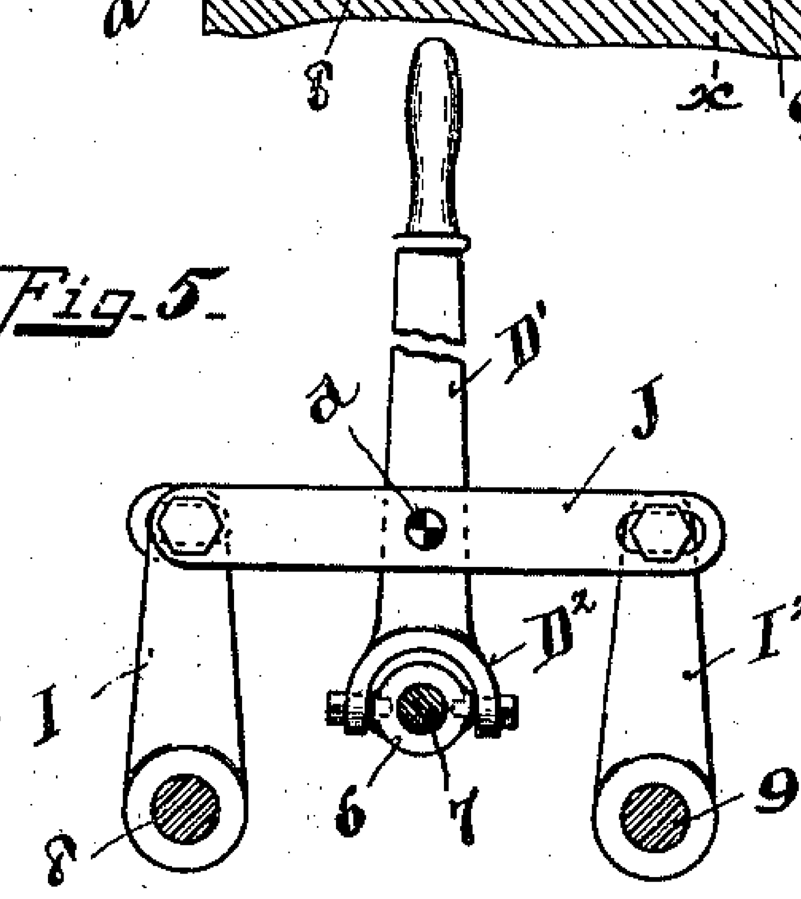


Fig. 3.



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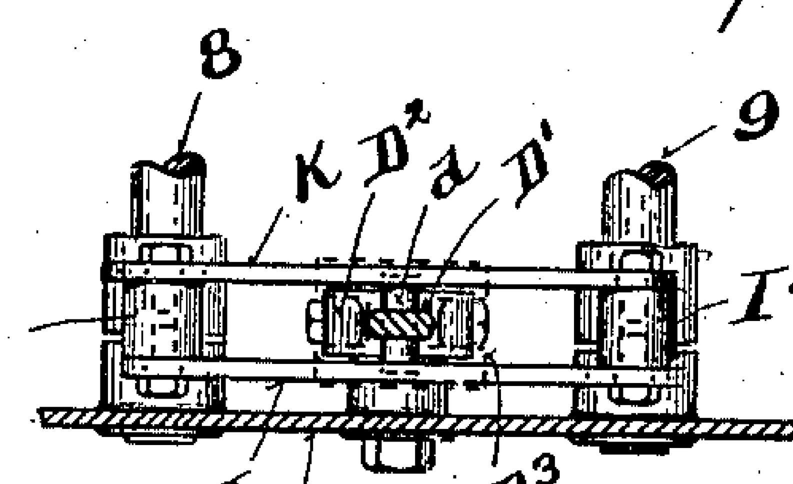

Fig. 4.

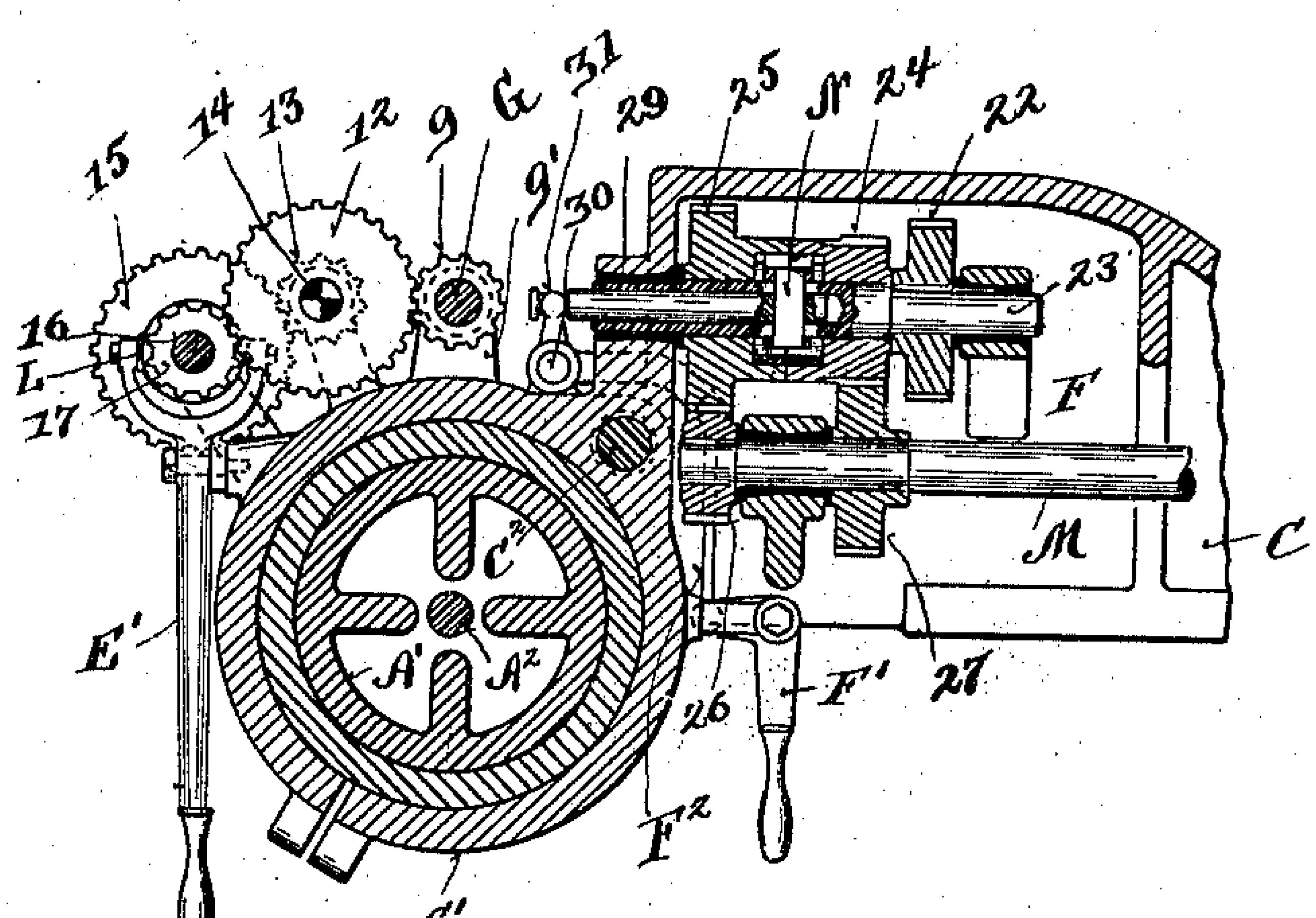

Fig. 6.

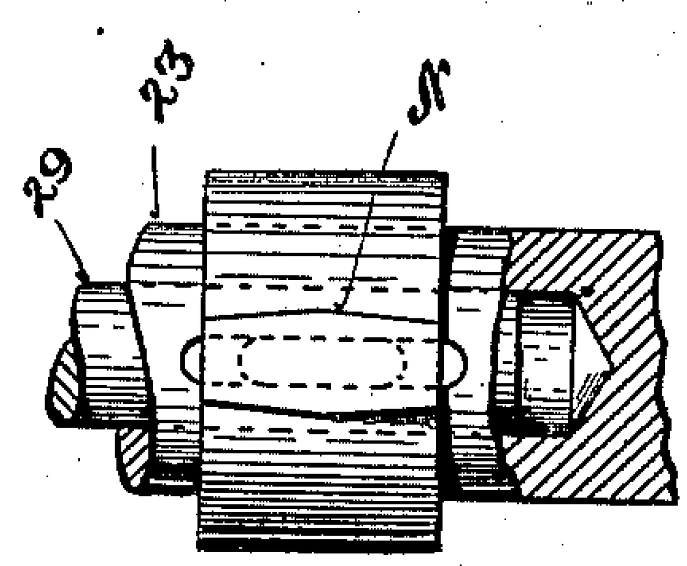

Fig. 7.

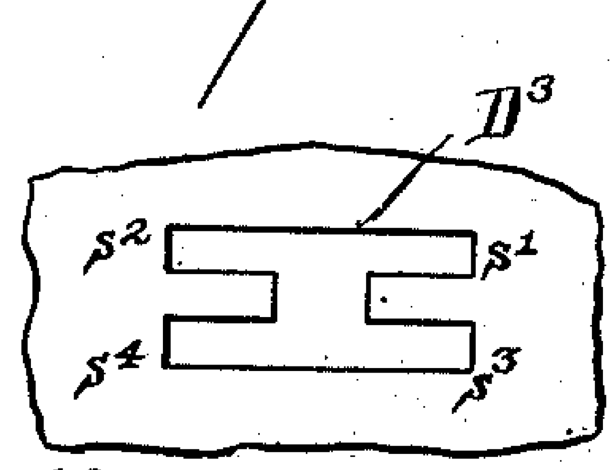

Fig. 19.

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(Application filed May 27, 1901.)

(No Model.)

3 Sheets—Sheet 3.

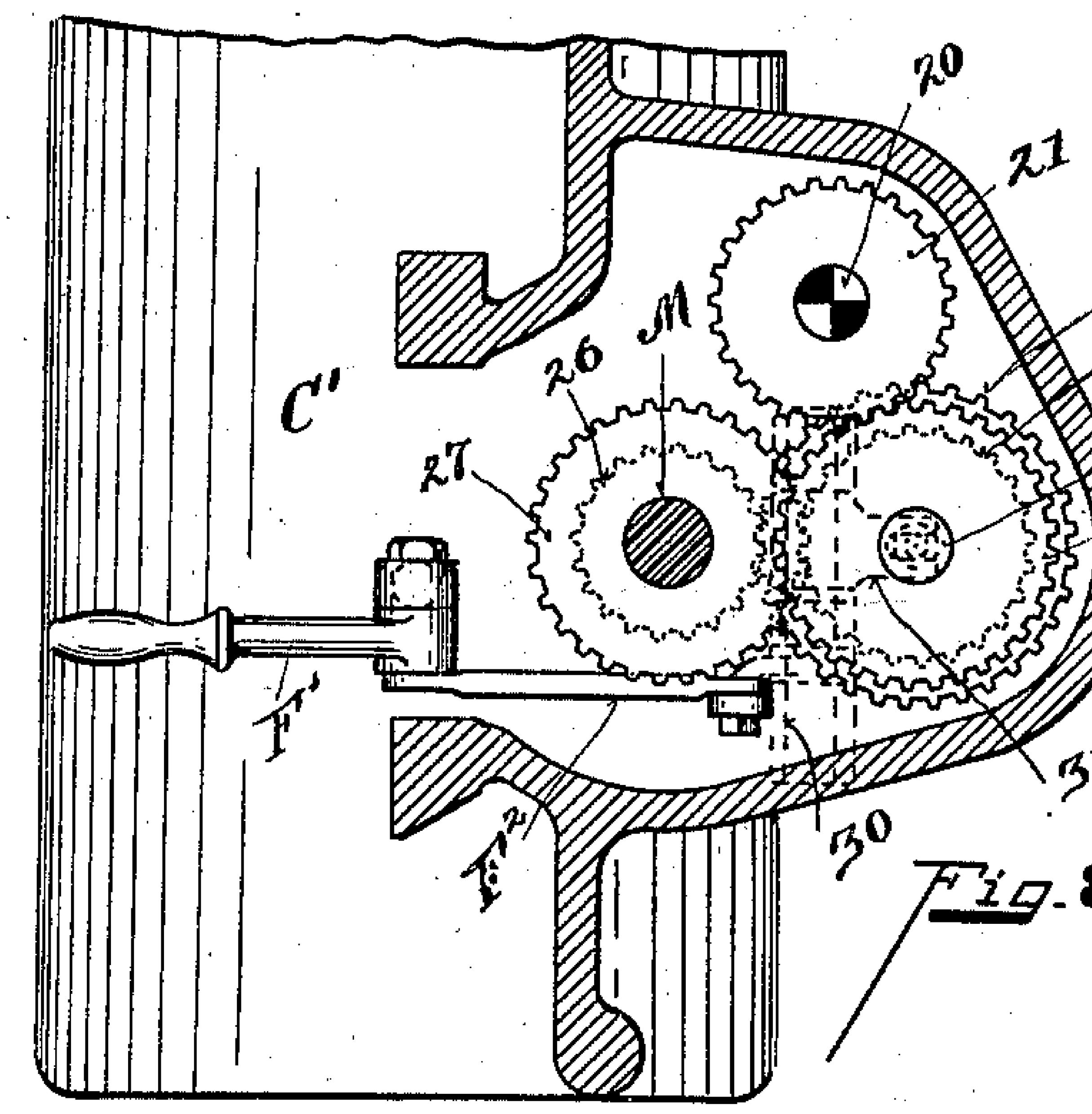

Fig. 8.

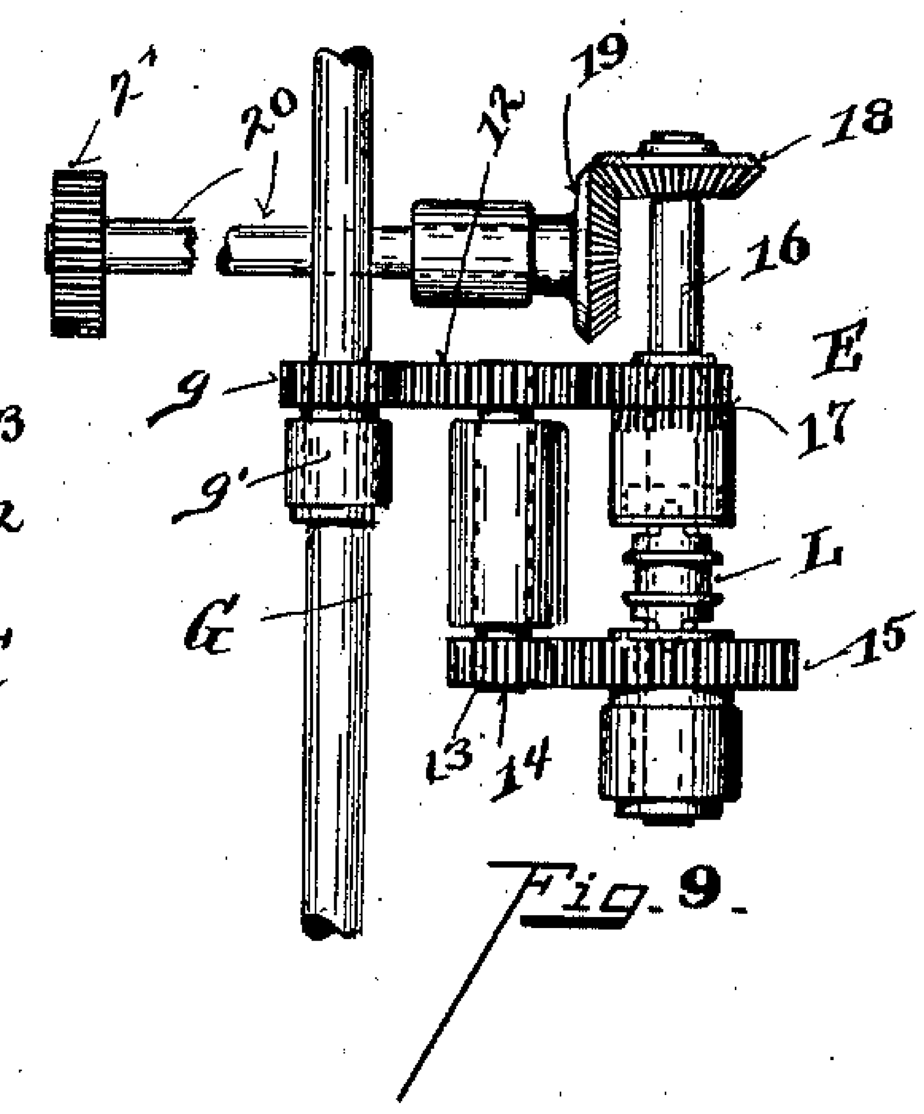

Fig. 9.

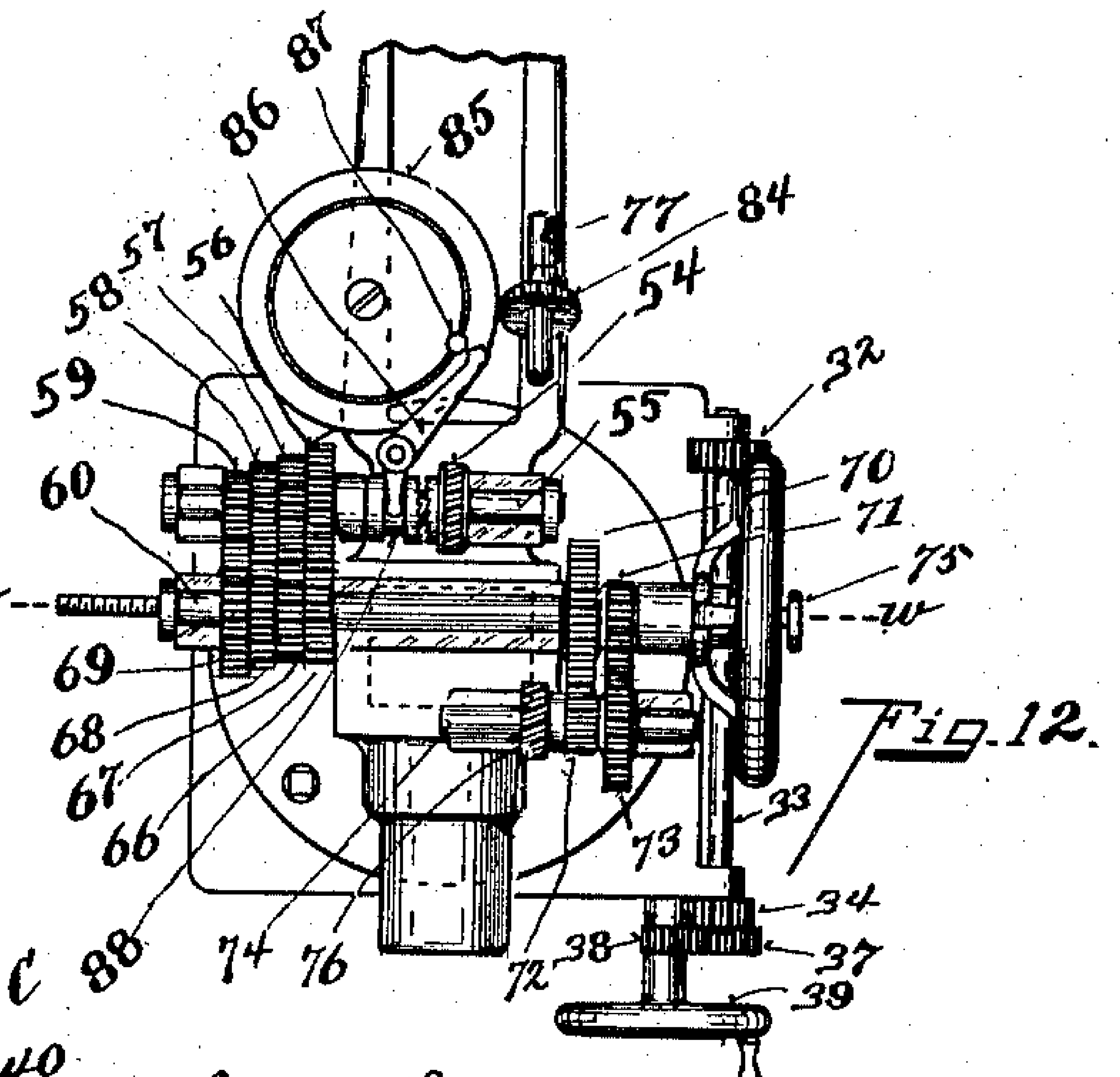

Fig. 12.

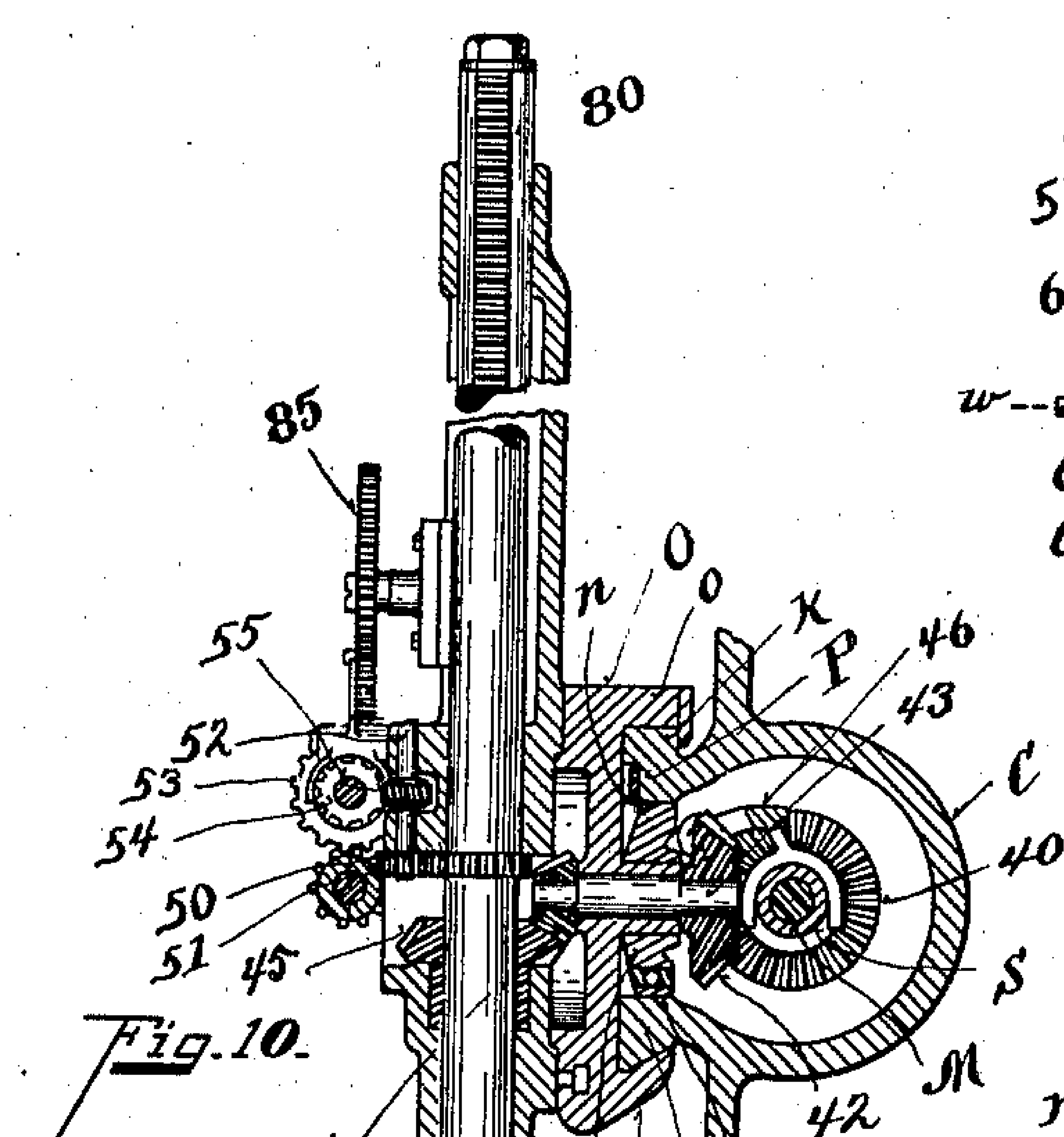

Fig. 10.

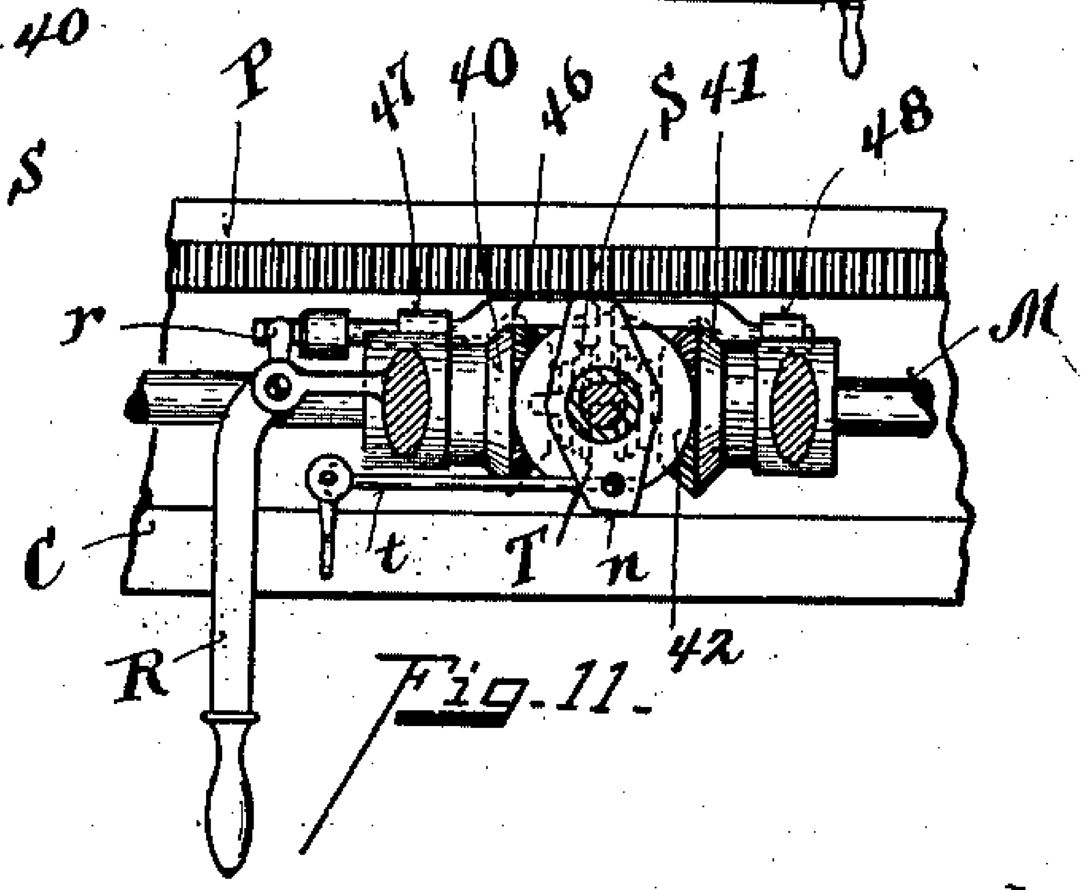

Fig. 11.

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UNITED STATES PATENT OFFICE.

HENRY McCOY NORRIS, OF CINCINNATI, OHIO, ASSIGNOR TO THE BICKFORD DRILL AND TOOL COMPANY, OF CINCINNATI, OHIO, A CORPORATION.

DRILL.

SPECIFICATION forming part of Letters Patent No. 686,116, dated November 5, 1901.

Application filed May 27, 1901. Serial No. 62,042. (No model.)

To all whom it may concern:

Be it known that I, HENRY McCOY NORRIS, a citizen of the United States, residing at Cincinnati, in the county of Hamilton and State of Ohio, have invented certain new and useful Improvements in Drills, of which the following is a specification.

My invention relates to drills particularly of the radial class.

In drills it is very desirable to obtain a large range of speeds, due to the different classes of work which they are daily called upon to perform—as, for instance, slower speeds are required for drilling the same-sized holes in steel than in cast-iron. It has also been found by experience that the commercial tools of a given size are adapted to a given number of feet travel per minute, depending upon the speed and upon the material. This speed must be proportioned to their capacity. The gradation of speeds for a large range of tools has hitherto not been employed in a single drill.

The object of my invention is to provide a much greater range of speeds on the same tool than has hitherto been obtained, to better adapt it to the ordinary demands of shop practice. In the accompanying drawings I have illustrated a radial drill containing sixteen speed changes, which consist of four primary speed changes and two sets of back gear changes each in advance of the other and between the primary speed-changer and drill-spindle, so that each one of the primary speed changes may be changed four times. Of course this principle of speed-changing might be carried to a greater range; but I have found that sixteen speed changes are sufficient for the ordinary shop practice. A gradation of speeds approximating a geometrical series is necessary to adapt the machine to the different classes of work and size of tools, obtaining approximately the proper speeds for any given work.

Another object of my invention is to provide a wide range of power-feeds, so that the feeding speed shall be properly adapted to the kind of work required.

Another object of my invention is to provide means for properly gaging the depth of tool travel and automatically tripping the power-feed at appropriate times and also to provide an automatic safety-trip.

Another object of my invention is to so construct the tool as to enable the various changes to be quickly and positively made.

In order to accomplish these results, it is desirable to have the speed changes made positive by means of gears and to do away with the belt system of cone-pulley changes.

The various features of my invention are more fully set forth in the description of the accompanying drawings, forming a part of this specification, in which—

Figure 1 is a front elevation of the drill-column and speed-changing mechanism. Fig. 2 is a sectional elevation of the speed-changing mechanism located at the base of the drill-column. Fig. 3 is a section on line $x\,x$, Fig. 2. Fig. 4 is a top plan view of the clutch-shifting mechanism. Fig. 5 is a side elevation of the same. Fig. 6 is a section on line $y\,y$, Fig. 1. Fig. 7 is a detail view of the clutch shown in Fig. 6. Fig. 8 is an end elevation of the internal gearing shown in Fig. 6. Fig. 9 is a side elevation of the external gearing shown in Fig. 6. Fig. 10 is a sectional elevation of the head, saddle, and arm. Fig. 11 is a detail view of the reversing-clutch mechanism and saddle-locking device. Fig. 12 is a front elevation of the drill-head and its gearing. Fig. 13 is an elevation, partly in section, of the feeding mechanism. Fig. 14 is a section on line $w\,w$, Fig. 12. Fig. 15 is an elevation showing the radial arm in section of the saddle-adjusting mechanism. Fig. 16 is a plan view of the depth-gage and feed-tripping mechanism. Fig. 17 is an enlarged longitudinal section of the tripping-lever shown in Fig. 16. Fig. 18 is a side elevation of one of the tripping-dogs. Fig. 19 is a plan view of the opening in the top of the gear-box shown in Fig. 1. Fig. 20 is a plan view of one of the feed-gears.

A represents the base of the drill.

B represents the speed-change box.

A′ represents the column of the drill; A^2, the vertical shaft passing through the center of the column.

C represents the radial arm; C′, the collar of said arm, journaling on the drill-sleeve.

C^2 represents a screw engaging a thread on the collar of the radial arm for raising and lowering the same.

C^3 represents the reversing and transmitting gearing on the top of the drill-column. These gears are of the usual construction. The speed-changing mechanism in the preferred form of construction is divided into three gear systems, which, as shown, are capable of obtaining sixteen speed changes for increasing or governing the revolution of the drill-spindle. These three sets of speed changes consist of the speed-changer D, mounted on the base of the machine, made as shown. This system is capable of obtaining four different speeds, which changes are produced by the manipulation of the single lever D'. The second set of speed-changers E is supported on the collar of the radial arm, consisting in the preferred form of two changes which are effected by the manipulation of the lever E'. By the use of the speed-changers D and E combined, eight changes of speed may be obtained. The third speed-changing system F is mounted in some radials within the radial arm, as shown in Fig. 6, while in others it is mounted on the head and takes its motion from the gears of the secondary speed-changing system. It is shown as having two speed-changers operated by lever F' and doubles each of the first two systems of speed-changes. In the form shown the second and third set of speed-changers are back gears.

The primary speed-changers consist of the following devices:

b a^5 represent parallel shafts journaled in a frame or casing B, as shown, b being the driving-shaft carrying the driving-pulley a. These mechanisms will be understood from Figs. 2, 3, 4, and 5.

1 2 3 4 represent different-diameter gear-wheels fixed to driving-shaft b, and a' a^2 a^3 a^4 represent gear-wheels loose on the driven shaft a^5, respectively intermeshed with driving gear-wheels 1 2 3 4.

H H' represent clutches on shaft a^5, clutch H being between loose gear-wheels a' a^2 and slidable in either direction to fix either of said gear-wheels to shaft a^5. Clutch H' is between gear-wheels a^3 and a^4 and slidable in either direction to fix either of said gear-wheels to shaft a^5. The clutches are independently operated in either direction to fix any selected one of said gear-wheels a' a^2 a^3 a^4 to shaft a^5 by means of a single lever D', operated through the following instrumentalities:

8 9 represent rock stub-shafts properly journaled in the casing B transversely to shaft a^5 and extended under clutches H H', respectively.

10 represents a rock-arm on shaft 8 engaging into clutch H for shifting said clutch in either direction, and 11 represents a rock-arm on shaft 9 engaging into clutch H' for shifting that clutch in either direction. When these arms 10 11 stand in vertical position, the clutches H H' stand in neutral position. The outer end of rock-shaft 8 has a second rock-arm I upwardly extended, and rock-shaft 9 has a second rock-arm I^2 upwardly extended. Rock-arms I I^2 are connected by means of links J K in the following manner: Link J is supported at each of the ends of the rock-arms I I^2 by means of screw-bolts. One end of said link is provided with a round hole, so that every movement of said link affects rocker-arm I. The other end is provided with an oblong hole, so that no movement is imparted to rock-arm I^2. Link K is a similar link to that of link J on the opposite sides of the rocker-arms I I^2, but having hole and slot in reverse to that of link J, thus only imparting motion to rock-arm I^2. These links are parallel, and when link J is thrown in either direction it will rock arm I, rock-shaft 8, and second clutch-rocking arm 10, and hence clutch H correspondingly. So when link K is moved in either direction it will rock arm I^2, rock-shaft 9, second rock-arm 11, and hence clutch H' correspondingly. The following is the mechanism employed to rock either of said links J K in either direction:

7 represents a journal-shaft between links J K and also between rock-shafts 8 9. 6 represents a journal-sleeve on said shaft 7, and D' represents a lever having at its lower end a yoke embracing or straddling the sleeve 6 and having pintles engaging said sleeve, so that the lever and its sleeve may be rocked on shaft 6 in either direction in a plane transverse to rock-shafts 8 9 and parallel to links J K to move said links in either direction, and said lever may be rocked on its pintles on sleeve 6 in either direction in a plane transverse to the links J K and parallel to the rock-arms 8 9 to swing said lever into engagement with either of said links J K. The lever when vertical is in the neutral position, and it has pins d projected on each side to engage into orifices formed in the middle of links J K, according to which direction the lever is moved.

The following guide and lock are employed for lever D'.

In Fig. 19, D^3 represents a substantially **H**-shaped opening formed in casing B, through which lever D' projects. The lever when in the neutral vertical position projects through the transverse limb of the **H**-shaped opening. If said lever is rocked on sleeve 6 toward the limb of the **H**-shaped opening marked s' s^2 in Fig. 19, the pin d enters the orifice in the middle of link K, and if the lever is rocked toward the limb marked s^3 s^4 in Fig. 19 the pin d enters the orifice in the link J. When the lever is rocked with its sleeve 6 on journal 7 in the plane parallel to links J K, assuming the lever to be in the limb marked s' s^2 in Fig. 19, the clutch H' will be shifted to give the speeds s' or s^2, according to the direction of lever movement, and so if the lever is in the limb marked s^3 s^4 in Fig. 19 the other clutch H will be shifted to give either speed s^3 or s^4, according to the direction of lever movement. When the lever is in the transverse limb of the H-shaped opening, it cannot engage either link, and the clutches are in neutral position between their respective gears. Thus the lever can only engage and disengage from the clutch-shifting position in neutral position of the several parts, and it can only engage into one of the clutch-shifting mechanisms at a time. This arrangement produces a perfect guide, lock, and safety-holder for the lever-clutch-shifting mechanism and clutches, enabling the desired change to be made instantly with perfect precision and safety.

The secondary speed-changing system consists of gears mounted or supported on the collar C′ of the radial arm, and they consist of gear *g*, which is in continual mesh with gear 12, mounted upon shaft 14, which carries a gear 13, meshing with gear 15 on shaft 16. On the same shaft is gear 17, meshing with gear 12, so that the vertical shaft G transmits two different ratios of speed to shaft 16. L represents a clutch operated by the lever E′ to throw clutch L, so as to bring in either of these speed-changing gears, as may be desired. When power is transmitted through gears 12 and 17, the ratio of speed is not changed; but when the trains 13 and 15 are working the speed of shaft 16 is lowered. Thus each one of the four speeds of the primary system may be changed, giving a different ratio of speed to the drill-spindle.

The third system of speed changes may be located within the hollow of the radial arm, as shown in Figs. 6 and 9; but it is obvious that it may be variously placed with the same result. In the form shown motion is transmitted from the secondary system to this system in the following manner, (see Fig. 9:)

18 represents a bevel-gear on shaft 16, meshing with bevel-gear 19 on shaft 20.

21 represents a transmitting-gear on shaft 20, always in mesh with gear 22 on shaft 23. (See Fig. 6.)

M represents the radial-arm shaft, and 23 an intermediate shaft transmitting motion thereto. On said shaft 23 are mounted alternate transmitting-gears 24 25, meshing with gears 26 27 on the radial-arm shaft M. Shaft 23 is made of two concentric shafts. The outer shaft or sleeve is cut away at the center to allow of the movement of the clutch N, which is mounted upon the inner shaft 29. As said shaft is reciprocated back and forth it operates the clutch N, which is shipped in the following manner:

F′ represents a shipping-lever; F^2, a bell-crank lever, which is hinged to the crank or shipping-arm F′ and is journaled upon the stud-shaft 30, mounted on the collar C′.

31 represents a forked crank-arm, which engages the pull-shaft 29, so that as the shipping-lever F′ is moved the pull-shaft moves the clutch N into engagement with either one of the opposing gears, as desired.

It will be observed that gear 25 engages with a gear smaller than that of gear 24. Hence when the motion is transmitted to gear 24 it is slower and makes a corresponding decreased ratio of transmission of each of the primary sets of transmitting-gears and also of the primary transmitting-gears produced by the secondary system, thus multiplying the eight ratios of these two combined speed systems and obtaining sixteen different ratios of speed when the three systems are operated through their entire ranges.

It is essential to provide a system of power feeds for varying ranges of work, and I have shown two sets of speed changes for the feeding mechanism.

O represents the drill-stock, (see Fig. 10,) which is provided with flanges *o o*, gibbed upon the flanges *k k* of the radial arm.

P represents a rack mounted upon the face of the radial armway. 32 represents a gear meshing therewith, mounted upon shaft 33, which is journaled in the drill-stock O. 34 represents a gear at the lower end of said shaft, (see Fig. 15,) which is driven by gear 35 on stud-shaft 36, which carries gear 37, (see Fig. 12,) which meshes with and receives motion from gear 38, mounted on the hub of hand-wheel 39, so when said hand-wheel is turned the head-stock is laterally adjusted on the radial arm. The radial-arm shaft carries a pair of bevel reversing-gears 40 41, which alternately drive a bevel-gear 42, which transmits motion to shaft 43.

44 represents a bevel-gear-driving gear 45, splined to the drill-spindle Q.

The reversing-gears are operated by the shipping-lever R in the following manner:

46 represents a yoke-arm which slides in the brackets 47 48, within which the hubs of the respective gears journal. The yoke-arm is engaged by the fork *r* of the lever R, and as the same is operated by the lever it moves the friction-clutch S, which engages either gear 40 or 41, according to the direction in which the lever is moved.

T represents a lock-plate which is journaled or pivoted on a boss on the head-stock, as shown in Fig. 10. The ends of this plate are made eccentric. It is rocked by bell-crank lever *t*, which brings the eccentric ends into engagement with the inner faces *n* of the radial arm, as seen in Fig. 10, thereby locking the head-stock firmly in position. This lock further serves the purpose of a support for the radial arm, acting as a strut and preventing vibration from the thrusts of the spindle.

The power-feeding mechanism takes its motion from the gear-wheel 50 on the drill-spindle, (see Fig. 10,) transmitting motion to gear-wheel 51 on shaft 52.

53 represents a worm-gear engaging with worm-wheel 54, mounted on the upper feed-shaft 55. (See Fig. 12.) Upon said shaft 55 are mounted four gears 56, 57, 58, and 59. 66 67 68 69 represent another cone of gears in mesh with gears 56 57 58 59, respectively, and

loosely mounted upon the shaft 60, so that they may be respectively clutched to said shaft.

61 represents a pull-pin which projects into the outer end of shaft 60, which is made hollow. This pin carries a spring-pawl W, *w* representing the spring for holding the pawl in engagement. Pawl W is beveled at its front and rear edge, as shown in Fig. 14. The gear-wheels 66 67 68 69 are slotted, as shown in Fig. 20, so as to allow the pawl to more readily clutch the gear it is desired to drive. As force is applied to the push-pin laterally it will compress the spring and allow the pawl to be passed from one gear to another. In order to apply this force, the outer end of said push-pin is provided with a series of grooves 62.

63 represents a spur-wheel mounted upon a stud-shaft which is operated by a crank 64 to revolve the spur-wheel and drive the push-pin in or out, changing the pawl engagement with the respective gears.

In order to obtain greater changes of feed, I provide upon the opposite end of shaft 60 change-gears consisting of gears 70, 71, 72, and 73, gears 72 and 73 being mounted upon shaft 74.

W′ represents a pawl sliding in the hollow opposite end of shaft 60 and operated by a push-pin 75 to bring it into engagement with the gears 70 or 71, so as to change the speed transmitted to the main transmitting feed-gear 76, mounted on the transmitting-shaft 74.

The change-gears are mounted upon two sides of the head-stock for the purpose of balancing the same.

It is obvious that the same changes of speed might be made by increasing the cone of gears on one side. All these different ratios of changes of speed are for the purpose of changing the ratio of feed primarily operated from gear 76.

77 represents the power-feed shaft which carries spiral gear 78, receiving motion from the spiral gear 76. 79 represents a worm on the end of said shaft, meshing with the rack 80, fixed to the drill-spindle sleeve in the usual manner.

81 represents a clutch for locking spiral gear 78 to the shaft. 82 represents the hand-nut for operating the said clutch. When the clutch is thrown out, the hand-wheel 83 can be turned to feed the drill-spindle by hand.

It is desirable to automatically trip the feed when the drill-spindle has reached its lowest point of travel to prevent accident to the machinery. It is also desirable to trip the feed at varying depths of travel of the drill-spindle. Thus it may be desired to bore a two-inch-deep hole, then a three-inch-deep hole, without the necessity of resetting the spindle, and thus trip the feed at intervals during its progressive travel. I accomplish all these results by the following mechanism:

84 represents spiral pinion on the feed-shaft 77. (See Fig. 12.) 85 represents a gear-wheel driven by said pinion, and it is supported upon the head-stock, as shown. I have provided a clutch intermediate of the cone-gear 55 and the worm-gear 54.

88 represents a clutch. It is operated by a tripping-lever 86. This tripping-lever is operated to automatically stop the feed just before the drill-spindle has reached its lowest point of travel by the safety-dog 95, (see Fig. 16,) which is permanently fixed to the gear-wheel 85. The parts are so disposed that this gear travels one complete revolution during the time the spindle is traveling its full course.

In order to trip the feed at predetermined points of traverse, I provide the following:

87 represents adjustable tripping-dogs inserted and movable in the face of gear 85. Two of these dogs are shown. Any number can be employed.

90 represents a dial-plate revoluble on the center 91. It is provided with marks indicating inches and fractions thereof.

The tripping-lever is provided with two projecting fingers. (See Figs. 16 and 17.)

The base 94 is fixed to the tripping-lever 86, and it has a point that engages with the safety-dog 95. Hinged upon this base is the tripping-finger 93. This tripping-finger engages with the tripping-dog 87. (See Fig. 17.) The engagement of the tripping-dog is across the track of the tripping-finger 94, moving the tripping-lever 86 and operating the clutch 88.

The tripping of the feed at predetermined distances is accomplished in the following manner: The dial-plate 90 is revolved to bring its zero-point in a central line with the tripping-fingers 93 94 on the arm 86. Then a dog is set from the zero-point the desired drilling depth. Thus as the drill advances in its operation gear-wheel 85 is revolved, bringing the dog into engagement with the tripping-lever 86, stopping the operation of the drill.

Sometimes it is desirable to trip the feed-mechanism by hand at predetermined depths, and to indicate the depths of drilling a fixed pointer 92 is employed, which, in combination with the revoluble dial-plate, renders it easy for the operator to determine the depth of drill travel. The feeding by hand is accomplished by loosening the knurl 82, releasing the clutch 81 from engagement with gear 78, permitting the shaft 77 to be revolved by hand-wheel 83.

Sometimes it is desirable to set the dogs 87 and not move them and pass over the same without tripping. For this purpose the hinged finger 93 is snapped back to the position shown in dotted line, Fig. 17, from which position it is thrown into its working position before the desired dog is reached.

The permanent safety-stop is a safeguard against accidents, and the arrangement of adjustable tripping-dogs and an index dial-plate for tripping the feed at any predetermined depth is very convenient and secures accuracy and uniformity of boring or drilling to exact predetermined depths, as may be desired.

Having described my invention, I claim—

1. In combination with a drill-column and a vertical driving-shaft thereof, speed-changing mechanism consisting of a plurality of shafts carrying intermeshing gears, a plurality of intermeshing gears mounted thereon, and a plurality of clutches upon one of said shafts between the different gears, slidable in either direction, a pair of parallel links each adapted to move in either direction, connections between said links and clutches respectively adapted to transmit motion thereto, a lever pivoted between said links adapted to independently move each of said links whereby any one set of said intermeshing gears may be clutched to said shaft by the manipulation of the lever, substantially as specified.

2. In combination with the column of a drill, employing a vertical driving-shaft, having a gear connection with a transmitting-shaft, of a plurality of gears mounted upon said transmitting-shaft, a plurality of clutches mounted thereon intermediate of a plural set of gears, slidable in either direction, parallel links adapted to move in either direction, connections between said links and clutches respectively adapted to transmit motion thereto, a lever pivoted between said links adapted to independently move each of said links, a casing surrounding said parts provided with an opening through which the lever projects directing the movement of said lever whereby any one set of said intermeshing gears are independently clutched to said transmitting-shaft, substantially as specified.

3. In a drill employing a vertical transmitting-shaft, a speed-changing mechanism composed of a pair of shafts each having a plurality of intermeshing gears, clutch-and-lever mechanism for bringing into operation a single train of gears, a secondary set of speed-changing gears mounted upon the outer periphery of the collar of the radial arm and receiving motion from an outside vertical driving-shaft, and clutch-and-lever mechanism for changing the ultimate speed of said secondary speed-changes, thereby changing the speed furnished by each train of the primary set of speed-changes, substantially as specified.

4. In a drill employing a hollow column, a central driving-shaft located therein, a primary set of speed-changing gears consisting of a plurality of shafts, gears and clutches transmitting power to the central vertical shaft, an outside vertical driving-shaft employing a gear supported upon the collar of the radial arm and moving therewith, said shaft receiving motion through geared connection with the central driving-shaft, a secondary set of speed-changing gears mounted upon the outer periphery of the collar of the radial arm, receiving motion through said outside vertical driving-shaft, a third set of speed-changing gears between the secondary set and the drill-spindle having gear connection with the radial-arm shaft and receiving motion through said secondary speed-changing system and separate clutch-and-lever mechanism for each of said speed-changing systems whereby a large number of speeds may be imparted to the spindle, substantially as specified.

5. In combination with the column of a drill, a hollow radial arm having a journal-support upon said column, of a drill-saddle gibbed to flanges formed upon said radial arm and spanning a longitudinal opening therein, rack-and-gear mechanism for adjusting said saddle longitudinally on the radial arm, and a locking device mounted radially upon a shaft journaled in the drill-stock and having frictional engagement with the opposite edges of the opening in said radial arm, substantially as specified.

6. In combination with the column of a drill, a hollow radial arm having a journal-support upon said column, a drill-saddle gibbed upon flanges formed upon said radial arm and spanning a longitudinal opening therein, and a locking device mounted upon a boss forming part of the saddle and having frictional engagement with the opposite edges of the opening in said radial arm, substantially as specified.

7. In combination with a hollow arm of a drill, of a radial-arm shaft centrally journaled therein, a drill-saddle gibbed upon ways formed on said radial arm and spanning a slot or opening in said radial arm, a transmitting-shaft journaled upon the drill-saddle centrally within said radial-arm slot, and having reversing-gear connections with the radial-arm shaft and the vertical drill-spindle operated by clutch-and-lever mechanism, substantially as specified.

8. In a drill employing a transmitting-shaft, a primary-speed-changing mechanism composed of a pair shafts, each having a plurality of intermeshing gears, clutch-and-lever mechanism for bringing into operation a single train of gears, a secondary set of speed-changing gears mounted between the primary system and drill-spindle operated by clutch-and-lever mechanism, having driven connection with said primary speed system, whereby a greater number of speeds may be imparted to the drill-spindle, a radial-arm shaft having driven connection with said secondary speed system, reversing-gears mounted on said radial-arm shaft, operated by clutch-and-lever mechanism and adapted to travel with the head-stock of the drill-spindle, a transmitting-shaft journaled upon the head-stock having a gear intermeshing with said reversing-gears, and gear connection with the drill-spindle for operating the same, substantially as specified.

9. In a drill employing a hollow arm, a drill-stock gibbed thereon, a transmitting-shaft

journaled on said drill-stock and having gear connection with the radial-arm shaft and with the drill-spindle, a wedge locking-plate journaled upon a sleeve on said drill-stock and mechanism for bringing the edges of said plate into frictional engagement with the edges of the slotted opening of the radial arm, substantially as specified.

10. In a drill employing an open hollow radial arm, a radial-arm shaft centrally journaled therein, a pair of reversing-gears loosely mounted on said radial-arm shaft, lever-and-clutch mechanism for locking either of said gears to the radial-arm shaft, a head-stock mounted upon ways upon each side of the opening in the radial arm, a transmitting-shaft journaled upon the drill-stock and centrally disposed within and having a gear connection with the reversing-gears, mounted on said shaft, substantially as specified.

11. In combination with the head-stock of a drill, employing a train of power-feeding gears, of the shaft 60, having a hollow at each end thereof, a train of gears mounted upon each end of the said shaft, longitudinal slots through the periphery of said shaft, spring-actuated pawls pivotally connected to pull-pins projected into said hollow shaft at each end thereof, cones of gears having slotted hubs mounted upon each of the hollow ends thereof, each of said gears meshing with opposing gears carried by another shaft, whereby the said shaft 60 is enabled to receive from an opposing shaft a variable rate of speed and to transmit a plurality of speeds each of which is varied by the variable speed at the opposite end thereof, substantially as specified.

12. In a drill employing a head-stock having a power-feeding mechanism, the combination of the drill-spindle of a feeding-shaft having a gear connection therewith, and a tripping mechanism consisting of a gear carrying a tripping-dog, a tripping-arm operating a clutch upon a transmitting power-shaft, the parts being so disposed that the dog engages the tripping-arm and operates the clutch, and thereby automatically stops the feed to the drill-spindle, substantially as specified.

13. A tripping device for the power-feed of a drill consisting of a clutch mounted upon power-feeding transmitting-shaft, a tripping-arm engaging said clutch at one end, a gear carrying a tripping-dog and having a gear connection with a power-feed shaft, the free end of said tripping-arm being projected across the path of travel of said tripping-dog, substantially as specified.

14. In combination with the power-feed operating a drill-spindle of a drill, an automatic tripping mechanism consisting of the power-feed shaft, having gear connection with the drill-spindle, a transmitting-gear mounted thereon and engaging a gear, a tripping-dog mounted upon said head-stock gear, a transmitting-shaft having a gear connection with the feed-shaft and a loose gear meshing with the gear of the transmitting-shaft, a clutch intermediate the receiving and transmitting gear, a tripping-gear having gear connection with the power-shaft, a tripping-dog mounted thereon, a tripping-arm pivoted to the drill-stock, one end of which has a feathered engagement with the clutch and the opposite end is projected across the path of the tripping-dog, whereby the power-feed is automatically tripped at each revolution of the tripping-gear, substantially as specified.

15. In combination with the drill-stock, a tripping-gear receiving motion from a power-feed shaft, one or more tripping-dogs mounted thereon, a tripping-arm projecting across the path of the said tripping-dogs, and having its opposite end connected to and tripping the power of the gear which transmits motion to the feed-shaft, substantially as specified.

16. In combination with the head-stock of a radial drill a tripping-gear mounted thereon and receiving motion from the power-feed shaft a series of tripping-dogs, means for connecting and disconnecting said dogs with the face of said gear, a tripping-arm projected across the travel of said dogs, and having an engagement with the power driving mechanism whereby the power may be tripped at any predetermined point of the vertical travel of the drill-spindle, substantially as specified.

17. In combination with the drill-stock of a radial drill, a tripping gear-wheel journaled thereon and carrying one or more tripping-dogs adapted to operate power tripping mechanism, a dial-plate journaled to and revoluble upon the face of said gear, substantially as specified.

18. A variable-speed device consisting of two parallel shafts, oppositely-disposed intermeshing gear-wheels fixed on one shaft and loose on the other, a clutch for each pair of loose gear-wheels on their shaft slidable in either direction, a pair of parallel links each adapted to move in either direction, connections between said links and clutches respectively adapted to transmit the respective link motions thereto, a casing surrounding said parts having a substantially H-shaped opening, a lever projected through said opening, the said lever pivoted between said links and having movement along the outline of said H-shaped opening, the parallel sides of the opening representing the link movements and devices on said lever and links adapted to be engaged and disengaged only when the lever is moved in its transverse direction between its parallel lines of travel, whereby the said lever may independently actuate each clutch in either direction, substantially as specified.

19. In a drill, a driving and a driven shaft, an intermediate shaft, a pair of different-diameter gear-wheels fixed to the intermediate shaft and intermeshed with a pair of gear-wheels loosely mounted on one of said driv-

ing or driven shafts, a gear-wheel on the other of said driving or driven shafts intermeshed with one of said gear-wheels fixed to the intermediate shaft, and a clutch between the loose gear-wheels adapted to fix either of said gear-wheels to its shaft, substantially as specified.

20. In a drill, a feed-shaft receiving power from the drill-spindle, a clutch controlling said feed-shaft, a rotary gear geared to the feed-shaft so as to revolve once during a complete traverse of the spindle, and a tripping mechanism between the said gear and clutch adapted to disconnect the power-feed at the downward end of the traverse of the drill-spindle, substantially as specified.

21. In a drill, a feed-shaft receiving power from the drill-spindle, a clutch controlling said feed-shaft, a gear driven by the feed-shaft, a circular index on said gear adapted to revolve therewith and to be rotated thereon independently of said gear, a tripping mechanism for said clutch, a dog on said gear adapted to engage said trip, and means for adjusting said dog around the gear and securing the same in selected position whereby the index and tripping mechanism will be operated to automatically throw out the power-feed at any predetermined depth of cut irrespective of the vertical position of the spindle at the time of starting the feed, substantially as specified.

22. In a drill employing a transmitting-shaft, a primary speed-changing mechanism composed of a pair of shafts each having a plurality of intermeshing gears, clutch-and-lever mechanism for bringing into operation a single train of gears, a secondary set of speed-changing gears mounted on the drill-arm, operated by clutch-and-lever mechanism and having driven connection with said primary speed system and a third set of speed-changing gears between the secondary set and drill-spindle, operated by clutch-and-lever mechanism and having driven connection with said secondary system, whereby a greater number of speeds may be imparted to the spindle, substantially as specified.

23. In a drill employing a hollow arm, a drill-stock gibbed thereon, a wedge locking-plate journaled upon said drill-stock and mechanism for bringing the edges of said plate into frictional engagement with the edges of the slotted opening of the arm, substantially as specified.

24. In a drill employing a transmitting-shaft, a primary speed-changing mechanism composed of a pair of shafts each having a plurality of intermeshing gears, clutch-and-lever mechanism for bringing into operation a single train of gears, a secondary set of speed-changing gears mounted between the primary system and drill-spindle, operated by clutch-and-lever mechanism and having driven connection with said primary speed system, whereby sixteen changes of speed may be imparted to the drill-spindle, substantially as specified.

In testimony whereof I have hereunto set my hand.

HENRY McCOY NORRIS.

Witnesses:

OLIVER B. KAISER,

EDWD. T. ALEXANDER.