No. 725,645. PATENTED APR. 14, 1903.

A. W. WIGGLESWORTH.

DRILLING MACHINE.

APPLICATION FILED MAR. 8, 1902.

NO MODEL. 5 SHEETS—SHEET 1.

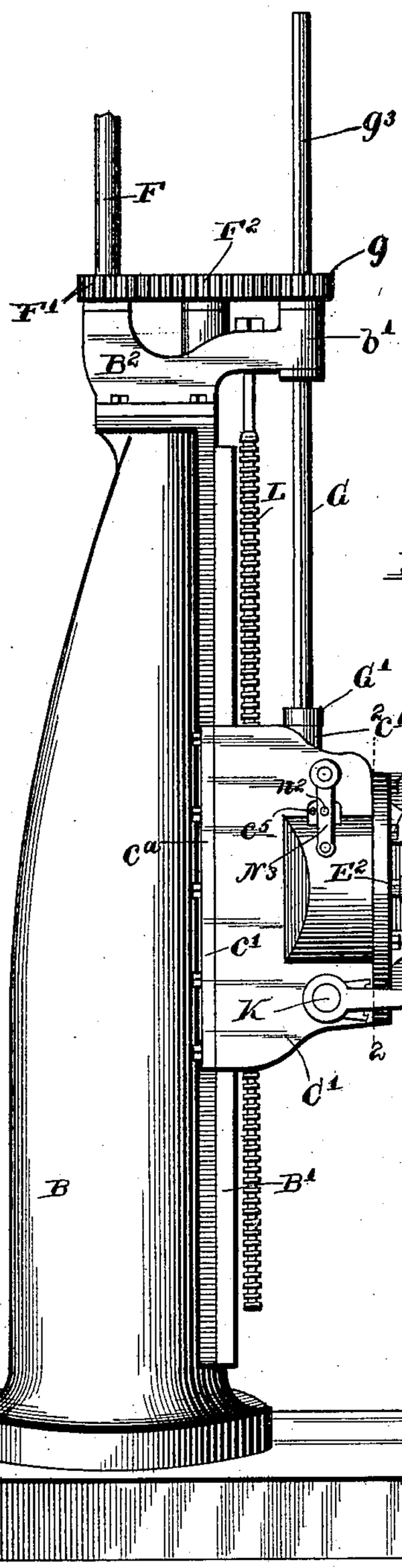
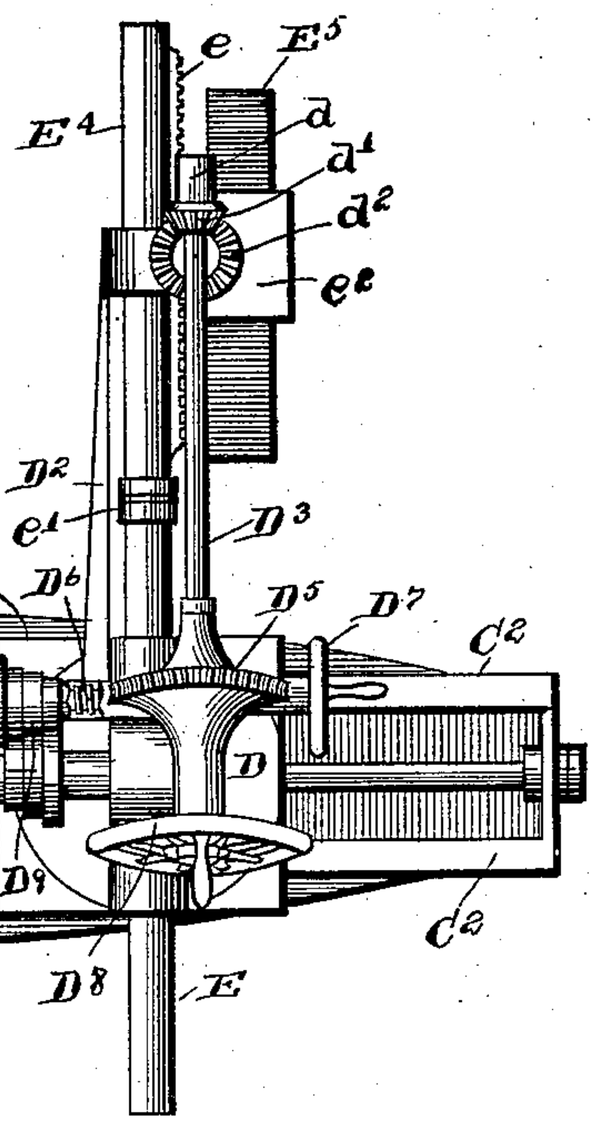


Fig 1.



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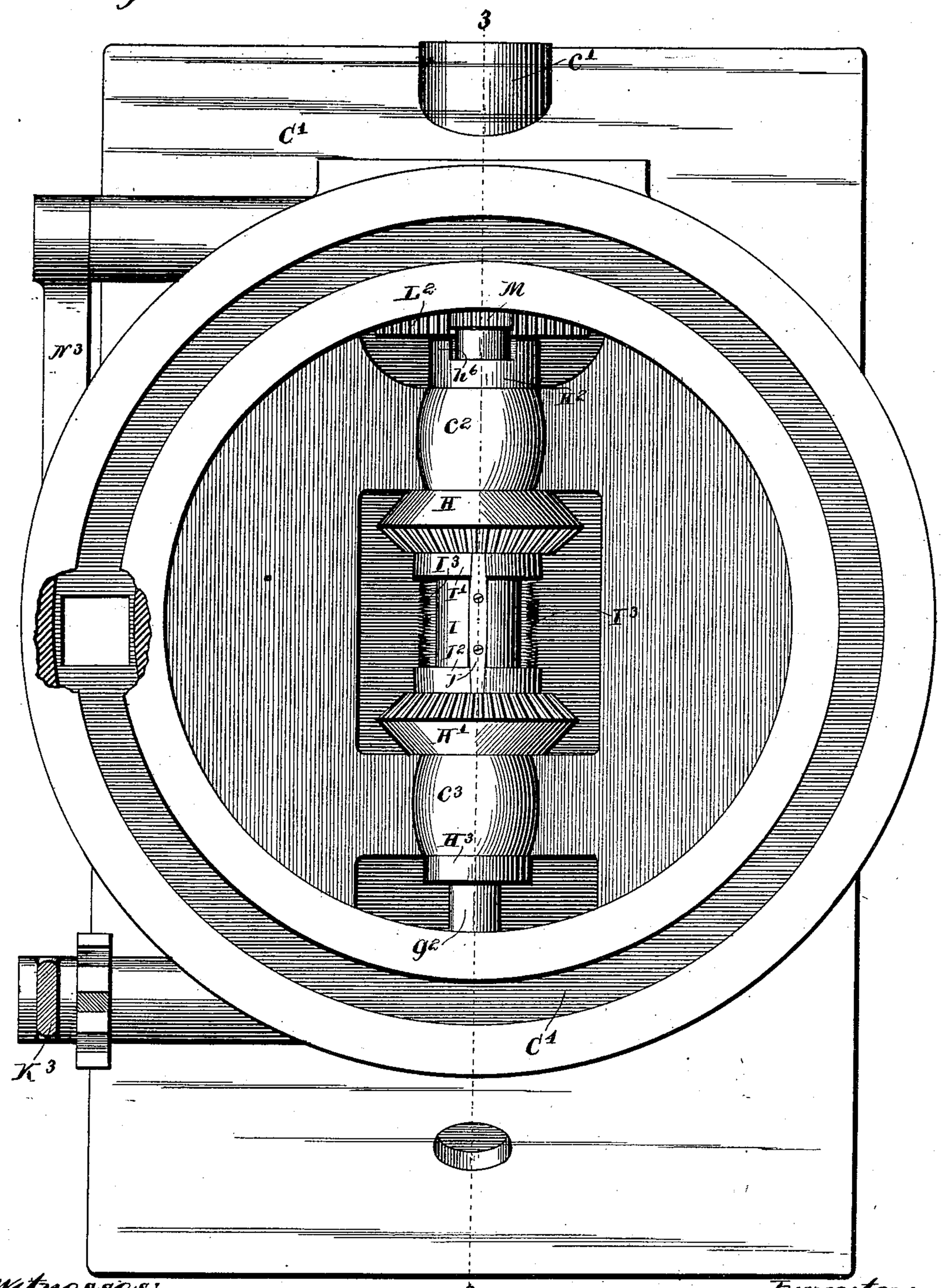
NO MODEL. 5 SHEETS—SHEET 2.

Fig 2



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NO MODEL. 5 SHEETS—SHEET 3.

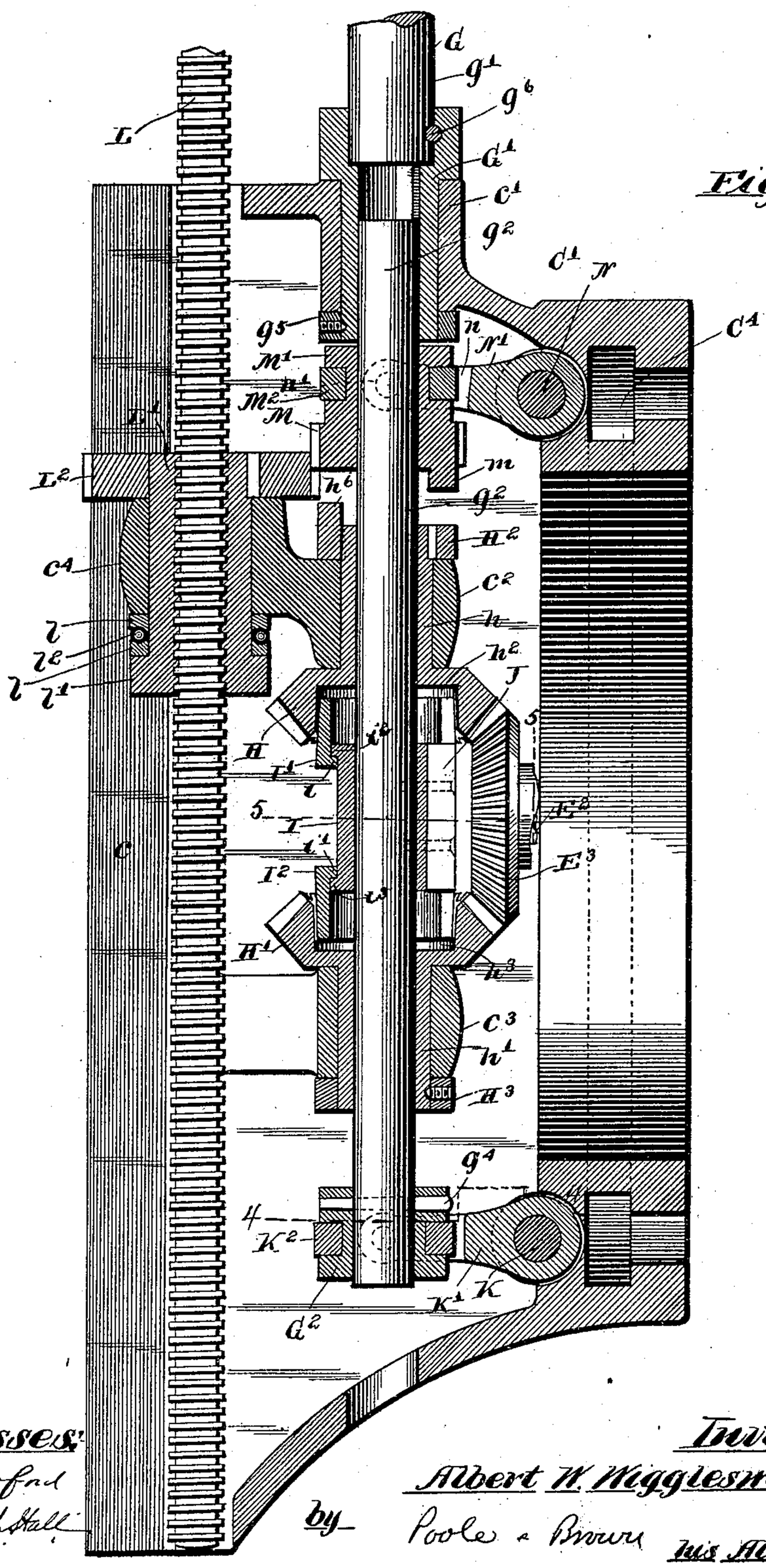

Fig 3

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NO MODEL. 6 SHEETS—SHEET 4.

Fig 4

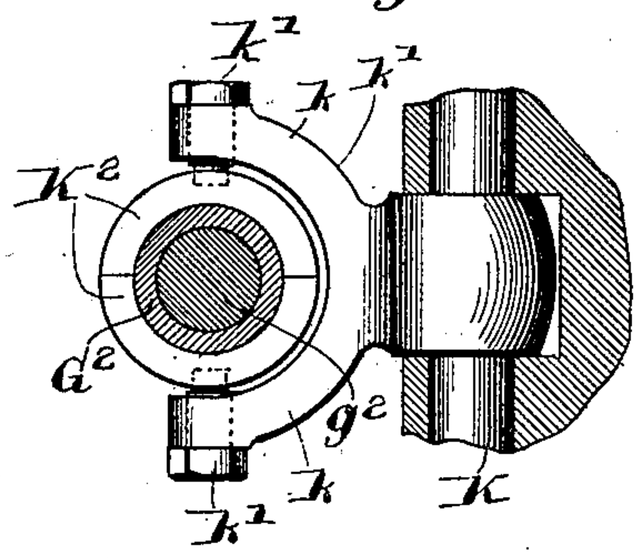


Fig 5

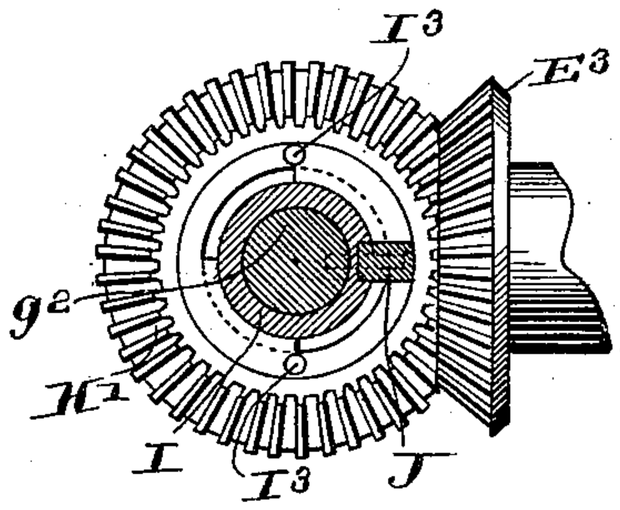


Fig 6

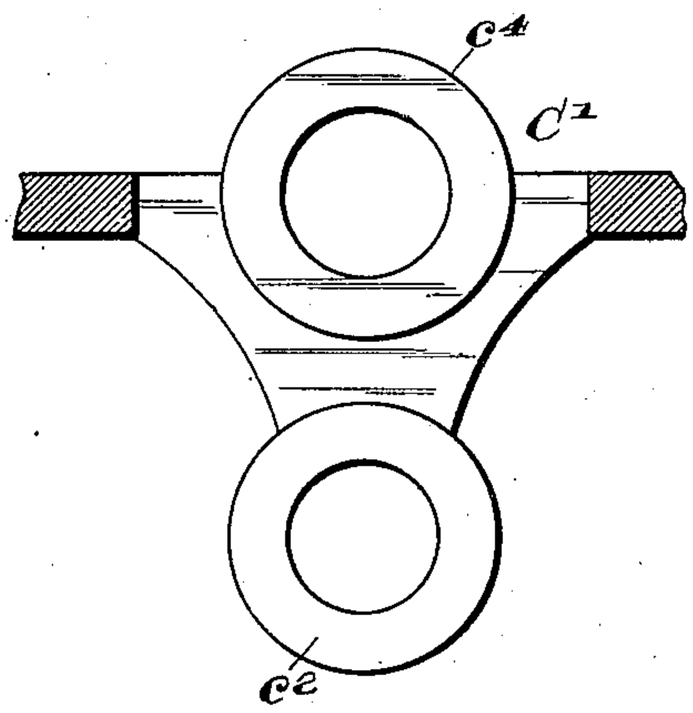
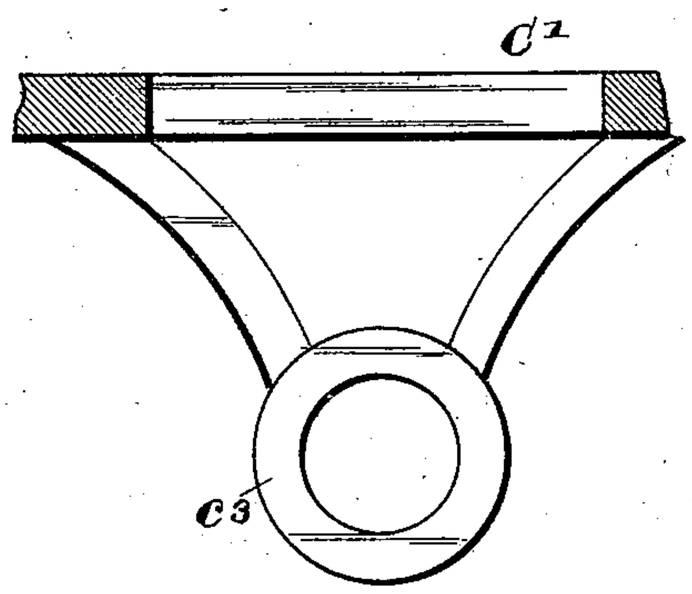


Fig 7



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DRILLING MACHINE.

APPLICATION FILED MAR. 8, 1902.

NO MODEL. 5 SHEETS—SHEET 6.

Fig 8.

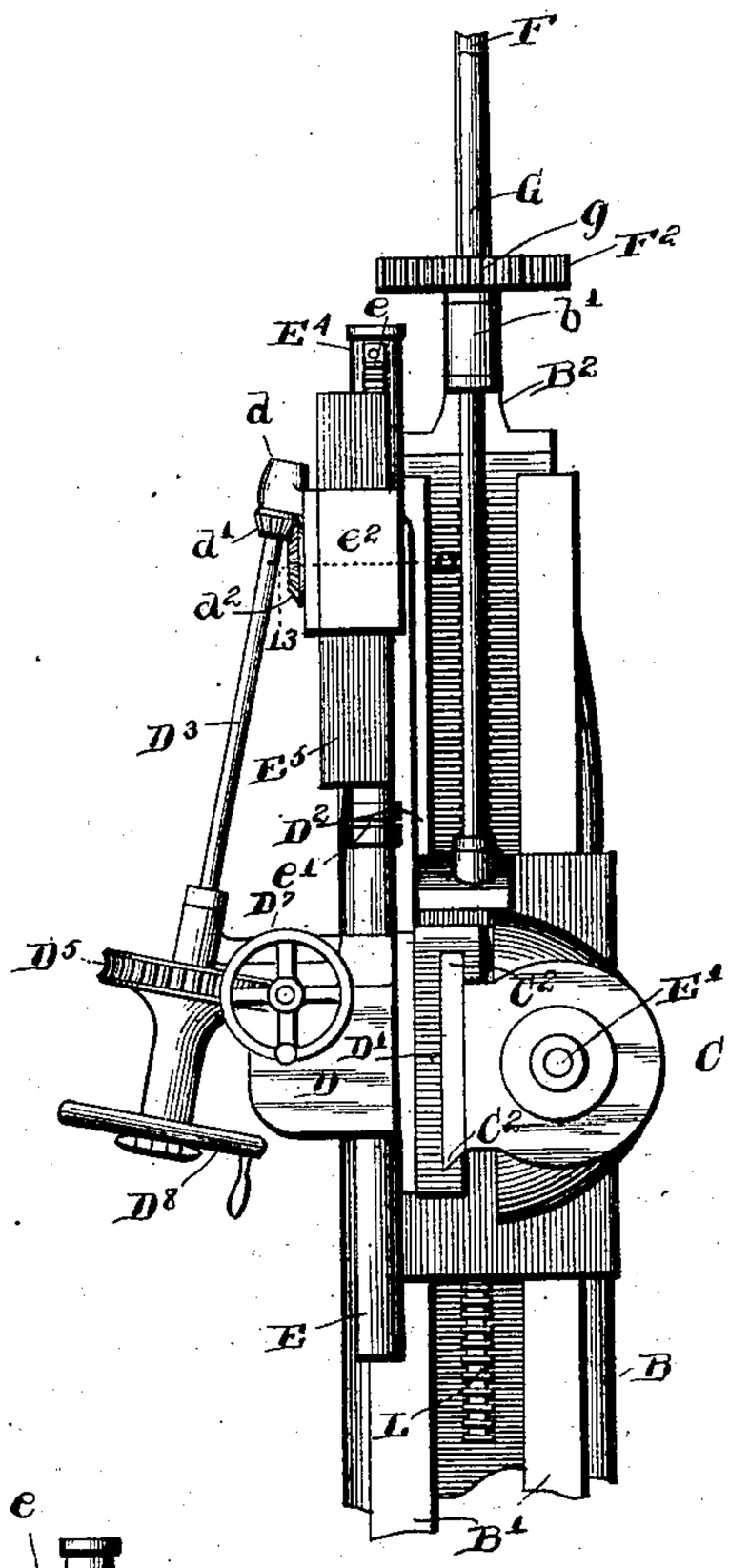


Fig 9.

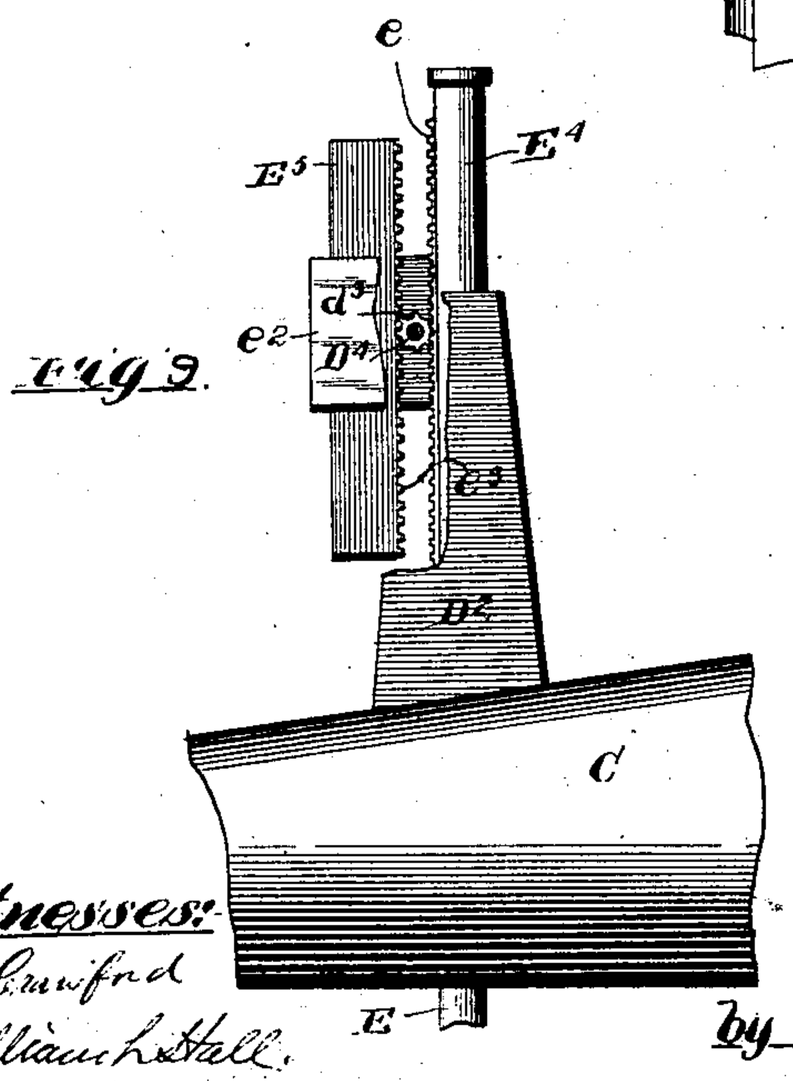
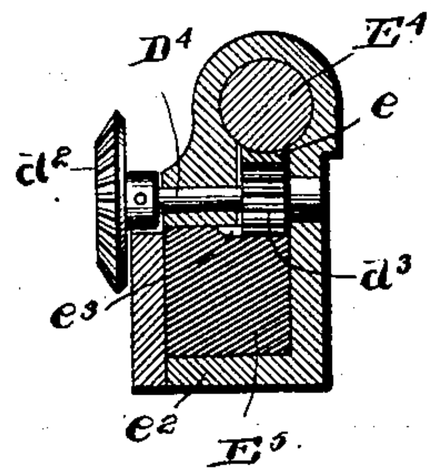


Fig 10.



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Inventor:
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UNITED STATES PATENT OFFICE.

ALBERT W. WIGGLESWORTH, OF CHICAGO, ILLINOIS.

DRILLING-MACHINE.

SPECIFICATION forming part of Letters Patent No. 725,645, dated April 14, 1903.

Application filed March 8, 1902. Serial No. 97,278. (No model.)

To all whom it may concern:

Be it known that I, ALBERT W. WIGGLESWORTH, of Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Drilling-Machines; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form a part of this specification.

This invention relates to improvements in drilling-machines.

Certain of the features of my improvements have been designed more specifically for use in connection with radial drills or drills wherein the main column or support thereof is provided with a horizontal overhanging arm or beam which is movable vertically on said column. My invention embraces an improved means for raising and lowering the overhanging arm of the drill of this character and also an improved counterweight for the drill-spindle, which is also applicable to drills of other types.

The invention consists in the matters hereinafter set forth, and more particularly pointed out in the appended claims.

In the drawings, Figure 1 is a side elevation of the principal parts of a drilling-machine embodying my improvements. Fig. 2 is a transverse sectional and elevational view taken on line 2 2 of Fig. 1. Fig. 3 is a vertical section taken through the principal parts of the raising and lowering devices for said arm or beam, this view being taken on line 3 3 of Fig. 2. Fig. 4 is a transverse section taken on line 4 4 of Fig. 3. Fig. 5 is a transverse section taken on line 5 5 of Fig. 3. Figs. 6 and 7 are views, partly in section and partly in top plan, of the bearing-bracket in the hollow slide-block C′ of the radial arm C of the drill in which the shaft g^2 and L are supported. Fig. 8 is a partial end elevation of the drilling-machine looking toward the end of the overhanging arm or beam which supports the drill-head. Fig. 9 is a detail illustrating the connection between the drill-spindle and the counterbalance-weight. Fig. 10 is a transverse section taken on line 10 10 of Fig. 8. Fig. 11 is a partial end elevation of a drilling-machine looking toward the end of the overhanging arm or beam which supports the drill-head. Fig. 12 is a detail illustrating the connection between the drill-spindle and the counterbalance-weight. Fig. 13 is a transverse section taken on line 13 13 of Fig. 11.

As shown in said drawings, and referring more particularly to Fig. 1, A designates the base of the drill; B, a vertical column supported and rotatively connected at its lower end in any suitable manner with said base.

C designates an overhanging beam or arm, which carries a drill-head (indicated as a whole by D) and in which drill-head are mounted a drill-spindle E and suitable driving mechanism by which the same is rotated from the main shaft of the machine, as will hereinafter more fully appear. The inner end of the arm C consists of a hollow cast-metal slide-block C′, which has interfitting engagement with vertical ways B′ on the column B, as shown in Figs. 1 and 8, permitting said arm to slide vertically on said column. For this purpose the inner end of said slide-block is provided at its sides with recesses or rabbets *c*, as shown in Fig. 3, and removable plates c^a are attached, Fig. 1, to the rear margins of said block and engage the rear faces of said guides or ways B′ and between which and the body of the block are formed grooves occupied by said guides or ways. The overhanging arm or beam C is similarly provided with guides or ways C^2, with which the base-plate D′ of the head has interlocking connection, said plate being provided with an undercut groove, which fits over the ways of said arm or beam, as shown in Fig. 8. The head carrying the spindle is adapted to swivel completely around on its base or saddle in a manner common to machines of this type, so as to change the angular position of the drill-spindle to any point desired in a plane parallel with the plane of the axis of the arm. Said arm is also connected with the slide-block C′, so as to be rotatively adjustable thereon, and thereby vary the angular position of the drill-spindle in a plane transverse to the axis of said arm. For this purpose the arm proper is connected with the block C′ by means of bolts c^3, Fig. 1, the heads of which occupy an annular groove C^4 in the block, as shown in Fig. 3.

F designates a short vertical driving-shaft which is journaled in a bearing-casting B^2 at the upper end of the column B. Said driving-shaft is connected with a vertical rotative shaft G through the medium of a gear-pinion F′ on the shaft F, a gear-pinion g on the shaft G and an idler F^2 meshing with the pinions F′ and g. Said shaft G is rotatively mounted at its upper end in a short vertical bearing-sleeve b' and at its lower end in a vertical bearing-sleeve c' at the top of the sliding block C′ of the drill-supporting arm or beam. The shaft G is operatively connected with the drill-spindle E by means of horizontal shafts E′ E^2 and a beveled gear-wheel E^3, as will hereinafter more fully appear. The shaft G is made of two parts or sections, an upper part g' and a lower part g^2, as shown in Fig. 3, the upper part carrying the gear-pinion g. Said upper section of the shaft slides in the gear-pinion g, being for this purpose provided with a key or spline g^3. Said upper and lower sections of the shaft are connected by means of a sleeve G′, Fig. 3, a reduced part thereof having rotative bearing in the vertical bearing-sleeve c', before referred to. Said connecting-sleeve G′ is non-rotatively affixed to the lower end of the upper shaft-section g' by a transverse pin g^6, and the lower section of said shaft is affixed non-rotatively to said connecting-sleeve, but has longitudinal sliding engagement therewith, permitting said lower section to move toward and from the upper section thereof. Said sleeve is provided below the bearing c' with the collar g^5, the sleeve extending below said bearing and said collar being rigidly attached to the bearing and serving as a stop to prevent the sleeve rising out of its bearing. Said lower section of the shaft G extends downwardly from the bearing-sleeve c' through other bearings c^2 c^3, Fig. 3, which are formed integral with the cast-metal sliding block of the drill-spindle arm. Loosely mounted on said shaft between said bearings c^2 c^3 are upper and lower beveled gear-wheels H H′, which face toward each other. Said gear-wheels are formed on the ends of sleeve-sections h h', which surround said shaft-section g^2 between the bearings c^2 c^3. The short sleeve-section h associated with the gear-wheel H extends above the bearing c^2 and is provided above said bearing with a collar H^2, which is non-rotatively mounted on the sleeve and constitutes the stop which holds said sleeve and gears H, respectively, in place. The short sleeve-section h' associated with the lower gear H′ similarly extends below its associated bearing c^3 and is provided with a stop-collar H^3, which is non-rotatively secured to said sleeve-section. Said gear-wheels H H′, as before stated, are loosely mounted on the shaft-section g^2 and are adapted to be separately locked to said shaft through the medium of a suitable clutch mechanism. Said clutch mechanism is made as follows:

The gear-wheels H H′ are provided on their proximate faces with circular tapered recesses h^2 h^3.

I designates a short sleeve which is immovably fixed on the shaft-section g^2. Surrounding the ends of said sleeve I are upper and lower split expansible rings I′ I^2, which are tapered and adapted to enter, respectively, the recesses h^2 h^3 in the proximate faces of the gear-wheels H H′. The expansible rings I′ I^2 are movable endwise on said sleeve I and are prevented from slipping out of engagement with said sleeve by means of curved radial flanges i i' on the rings and oppositely-directed curved radial flanges i^2 i^3 at the ends of the collar in the manner shown in Fig. 3. Said split rings are adapted to be held normally separated by means of spiral expansion-springs I^3 I^3, interposed therebetween. The flanges on the sleeve and rings, respectively, are separated by corresponding intervening spaces, and the rings are slipped on the sleeve from the end thereof, at which time the flanges of the rings are turned in alinement with the spaces between the flanges of the sleeve, and after the rings have been slipped over the sleeve they are turned to bring the flanges thereof in alinement with those of the sleeve. The openings or spaces between the ends of the split rings I′ I^2 are made tapering, and said spaces are occupied by the upper and lower ends of a stationary key J, which is affixed to the sleeve I by means of screws. Said screws pass through the sleeve and into the shaft-section g^2 and afford means by which the sleeve is affixed to said shaft-section. When the clutch-collar is in its intermediate position, as shown in Fig. 3, the springs I^3 act to hold said expansible rings in their outermost position against the flanges i^2 i^3 and with their outer ends entering the sockets in the faces of the gear-wheels H H′. In this position of the parts said split rings enter slightly the recesses h^2 h^3, but are not in contact with the walls of said recesses, so that rotation of the shaft-section is not communicated therethrough to either of the gear-wheels. When it is desired to lock one of said gear-wheels to the shaft, the sleeve is moved toward that one of the gear-wheels which is to be locked to the shaft. Inasmuch as the sleeve is shown as fixed to the shaft, such movement of the sleeve is herein accomplished by endwise movement of the shaft. Upon moving said sleeve toward the gear-wheel to be locked to the shaft the expansible ring on the end of said sleeve toward which the sleeve is moving by reason of the presence of the springs I^3 is caused to further enter the socket or recess in the adjacent gear-wheel until limited by contact thereof with the bottom of the recess. When the advance end of said ring comes into contact with the bottom of said socket and the movement of said ring is thereby arrested, the wedge or inclined key J continues its movement, said wedge or key acting against the ends of said split ring to expand the same into intimate

contact with the tapered side walls of the socket. At this time the shafts E^2 and E′ are rotated through the medium of the gear-wheel H or H′, which is locked to the shaft, and the gear-wheel E^3, which latter is at all times in mesh with the gear-wheels H H′, and the gear-wheel which is not locked to the shaft rotates loosely on the shaft. When it is desired to reverse the direction of rotation of the drill-spindle E, the clutch device described is moved out of contact with the gear-wheel engaged therewith and into contact with the other gear-wheel, this operation acting to release the first-mentioned gear-wheel and lock the second gear-wheel to the shaft, and thereby change the direction of rotation of the drill-spindle. When it is desired to stop the rotation of the drill-spindle, the clutch device is moved into its intermediate position, as shown in Fig. 3, at which time the lower shaft-section will communicate no motion to either of the gear-wheels H or H′. In the construction herein shown the clutch device is moved into and out of engagement with the gear-wheels H and H′ through bodily endwise movement of the shaft-section g^2. Said shaft-section is given longitudinal movement through the following devices:

K designates a short rock-shaft which is journaled in a bearing in the slide-block C′, as shown in Figs. 1 and 3. Fixed to said rock-shaft is an arm K′, which is bifurcated at its outer end and the members k of which pass on either side of the shaft-section g^2. Surrounding said shaft-section at the level of the arm K′ is a collar G^2, which is shown as nonrotatively mounted on the shaft by means of a transverse pin g^4 extending through said collar and shaft.

K^2 K^2 designate the two parts of a split ring which occupies an annular groove in the outer face of the collar G^2. k' k' designate set-screws which extend laterally through screw-threaded openings in the outer ends of the members k of the arm K′ and bear at their inner ends against the parts K^2 of said split ring.

The rock-shaft K is provided outside of the slide-block C′ with a rigidly-attached lever K^3, Fig. 1, by which said rock-shaft is rocked to impart to the shaft-section g^2 vertical movement and therethrough actuate the clutch mechanism. Said hand-lever K^3 is provided with a familiar form of spring-pressed locking-pawl, which coöperates with a notched segment to hold said lever in either one of its three positions of adjustment, as shown in Fig. 1.

The driving connection between the shaft E′ and spindle E are such as to maintain their proper operative relation in all of the angular positions of the head on the arm and in all the adjustments of the head on the arm, longitudinally considered. These features of construction constitute no part of my present invention and are not illustrated.

D^3, Figs. 1 and 8, designates an oblique shaft which is journaled in its lower end in bearings formed on the head D and on its upper end in a bearing d, located at the upper end of a vertical standard D^2, rising from said head. Said shaft is provided near its upper end with a gear-pinion d', which meshes with a gear-wheel d^2, affixed to one end of a short horizontal shaft D^4, Fig. 10, which is journaled in a bearing in the upper end of said standard D^2. The end of said short shaft remote from the gear-wheel d^2 is provided with a gear-pinion d^3, which meshes with a rack e, formed on a bar E^4, which moves endwise with the spindle E, but is nonrotative. Said bar has sliding engagement with a vertical bearing in the upper end of the standard D^2 and is connected, by means of a rotative joint e' at its lower end, with the upper end of the drill-spindle E. The shaft D^3 is provided at its lower end, adjacent to the head, with a worm-wheel D^5, which is adapted to engage a horizontal worm-shaft D^6, Fig. 1, which has suitable bearing in the head D and which is operatively connected through a change-speed mechanism (indicated as a whole by D^9) with the shaft E′. Through the mechanism described the drill-spindle E is adapted to be fed gradually endwise to its work or retracted therefrom through the medium of the shaft E′, which latter directly rotates the spindle E in the manner before described. The worm-shaft D^6 is provided on its outer end with a hand-wheel D^7, through which power may be applied to advance the drill-spindle more rapidly than the automatic mechanism described.

The drill is adapted to be retracted from its work or to be advanced toward the same when the drill is out of the work and more rapidly than by the means just described through the medium of a hand-wheel D^8, which is affixed to the lower end of the shaft D^3 below its bearing in the head. Power is applied through said wheel D^8 directly to the shaft D^3, so that upon rotation of said shaft through the medium of the said wheel the drill-spindle is rapidly retracted from and advanced to its work.

In connection with the feed mechanism described I have provided a counterweight mechanism for counterbalancing the weight of the spindle and the parts which move therewith, so that the same is perfectly balanced in all the angular positions of the drill-spindle and may be readily raised and lowered. Said mechanism is made as follows:

E^5 designates a weight which has sliding engagement with a bearing e^2, formed on the upper end of the standard D^2. Said weight is provided on one side thereof with a series of teeth e^3, forming a rack which is adapted to be engaged by the pinion d^3 on the shaft D^4, before referred to and shown in Figs. 9 and 10. It will be seen that the bar E^4 and the counterbalance-weight E^5 are directly connected through the interposed pinion d^3, so that when

one of said parts is raised the other part is correspondingly lowered, and vice versa. The weight E^5 is so proportioned with respect to the weight of the spindle and its associated parts—to wit, the bar E^4, the drill-chuck, and drill—as to balance said parts, so that said spindle may be raised or lowered with little power. By reason of the connection of said weight with the spindle-shaft in the manner described both ends of the weight are free, and counterbalancing movement is transmitted directly from the weight to the spindle through the intervening pinion by movement of the weight in either direction of its length, and the proper balance of the spindle is maintained notwithstanding the angular position of the spindle with respect to its axis of adjustive rotation.

Means are provided for automatically raising and lowering the overhanging arm or beam C which carries the drill-head, said means being actuated through mechanism operated by the driving and reversing mechanism, made as follows:

L designates a vertical screw-threaded shaft located between the column B and shaft G and which is attached at its upper end to the bearing-bracket B^2 at the upper end of the column B, as shown in Fig. 1, said shaft being suspended from the bracket. L′, Fig. 3, designates an interiorly-screw-threaded sleeve, through which said shaft extends and with which it has screw-threaded engagement. Said sleeve L′ is rotatively mounted in a vertical bearing c^4, which is made integral with the bearing c^2, hereinbefore referred to. The sleeve is provided at its lower end below the bearing with an annular flange l', forming a supporting-shoulder, and interposed between said flange and bearing is an antifriction-bearing consisting of two rings l, having opposing annular recesses and balls l^2 located in said recesses. Said shaft L receives, through the sleeve L′ and the bearing c^4, the weight of the arm or beam C, the arm being guided by its connection with the column. Attached to the upper end of said sleeve L′, above the bearing c^4, is a gear-wheel L^2, which meshes with a gear-pinion M, which is formed on the lower end of the sleeve M′, which latter surrounds the shaft-section g^2 just below the coupling-sleeve G′. Said sleeve M′ is loosely mounted on the shaft-section g^2, so that the shaft-section turns freely therein and the sleeve slides longitudinally of the shaft-section. The adjacent faces of the gear-pinion M and the collar H^2 at the upper end of the sleeve h, respectively, are provided with projecting parts or lugs m h^6, which are adapted to interlock to form a spur-clutch, whereby when said parts are moved into engagement one with the other rotative movement imparted through the sleeve h is transmitted through the gear-wheel M and the gear-wheel L^2 to the sleeve L′, and rotation of said sleeve on said stationary shaft causes the arm C to be raised or lowered, depending upon the direction of rotation of the sleeve. The members of said spur-clutch are interlocked through longitudinal movement of the sleeve M on the shaft-section, the devices for this purpose being provided as follows: N, Fig. 3, designates a rock-shaft which is mounted in suitable bearings in the cast-metal slide-block C′, and N′ designates an arm rigid with said shaft and projecting inwardly toward the sleeve or collar M′. The inner end of said arm N′ is bifurcated similar to the arm K′, before described, and the members n thereof pass on opposite sides of the sleeve or collar M′. The connection of the said arm with the sleeve M′ is similar to the connection of the arm K′ with the sleeve G^2, before described, said members of the arm being provided with set-screws n', as shown in dotted lines in Fig. 3, which engage at their inner ends the parts M^2 of a split ring which occupies a groove in the cylindric outer part of the sleeve or collar M′. Attached to said rock-shaft N outside of the cast-metal slide-block is a lever N^3, Fig. 1, by which the rock-shaft and associated parts are operated to throw the clutch into and out of their locking relation. Any suitable means may be employed for locking said lever in its adjusted position—as, for instance, a pin n^2, which is adapted to engage shallow notches c^5 in the adjacent face of the slide-block C′, one of said notches being shown in Fig. 1. When the lever occupies a vertical position, as shown in said Fig. 1, the clutch members are in interlocking engagement, and when thrown to the left of the position shown in Fig. 1 and locked therein said clutch members are moved out of the interlocking connection. The extent of movement of the combined clutch member and gear-wheel M is such that when moved out of engagement with the associated clutch member the gear-wheel M remains in mesh with the gear-wheel L^2, as shown in Fig. 3. With this construction when it is desired to raise or lower the radial drill-head-supporting arm the clutch member M is lowered to bring the same into interlocking engagement with the associated clutch member formed by the ring H^2, whereby the rotation of the driving and reversing mechanism is imparted to the screw-threaded sleeve L′, which, rotating on the shaft L, causes said sleeve and the arm C supported thereon to be raised or lowered, depending upon the direction of the rotation of said sleeve.

The construction described for controlling the drill-spindle driving and reversing mechanism and for controlling therefrom the raising and lowering devices of the overhanging arm is a very simple one and enables all of said operations to be effected by the use of but two manually-operated parts—to wit, the levers K^3 N^3. When the lever K^3 is in an intermediate position, as shown in Fig. 1, no motion is communicated from the driving-shaft G to the drill-spindle. Said shaft G is adapted to be operatively connected with the drill-spindle to rotate the spindle in either

direction by moving said actuating-lever K^3 to one of its limits of movement, and thereby throwing the clutch mechanism into operative connection with either one of the beveled gears H or H'. When it is desired to raise or lower the arm C, the lever N^3 is swung on its axis of vibration to bring the clutch member actuated thereby into operative relation with its companion clutch member, so as to transmit rotative motion to the gear-wheel L^2 and sleeve L', and the lever K^3 is actuated to operate the clutch mechanism associated with the gear-wheels H H' to give the proper direction of rotation to said gear-wheel and sleeve to thereby raise or lower the arm, as desired. If the clutch mechanism associated with the gear-wheels H H' be moved into contact with the upper gear-wheel H, motion is communicated directly to the upper clutch through the sleeve *h*, while if said clutch mechanism is moved into engagement with the lower gear-wheel H' motion is communicated to said lower clutch mechanism and to the sleeve L' through the medium of the gear-wheels H', E^3, and H and the direction of rotation of said upper clutch is reversed.

An advantage of the form of friction-clutch herein shown is that the friction members are moved entirely out of contact with each other when the clutch is released, so that there is no wear on the friction-rings or the coöperating surfaces of the gear-wheels when the clutch is out of action.

It is obvious that the details of construction, as well as the arrangement and proportioning of the parts, may be considerably varied without departing from the spirit of my invention, and I do not limit myself to such details except as hereinafter made the subject of specific claims. For instance, the counterweight may be employed on a boring-machine and the construction of the parts varied to suit such adaptation.

I claim as my invention—

1. In a radial drilling-machine, the combination with a column or support, a radial arm which has sliding connection therewith, a drill-head supported on said arm, a drill-spindle in said head, and driving and reversing mechanism for said spindle located at the inner end of said arm, of raising and lowering mechanism for said arm and operative connections between said raising and lowering mechanism and the driving and reversing mechanism located at the inner end of said arm.

2. In a radial drilling-machine, the combination with a column or support, a radial arm which has sliding connection therewith and having a hollow inner end, a drill-head mounted on said arm, a drill-spindle in said head, an operating-shaft mounted on said column or support, and operative connections between said operating-shaft and drill-spindle embracing a reversing mechanism located at the inner end or base of said arm, of mechanism for raising and lowering said arm, and operative connections contained within the inner end of said arm between said raising and lowering mechanism and said driving and reversing mechanism.

3. In a radial drilling-machine, the combination with a column or support, a radial arm which has sliding engagement therewith, a drill-head mounted on said arm, a drill-spindle in said head, an operating-shaft mounted on said column or support, and operative connections between said operating-shaft and drill-spindle embracing a reversing mechanism located at the inner end of said arm, of an upright screw-threaded shaft mounted on said column or support which supports said arm, and operative connections located at the inner end of said arm between said screw-threaded shaft and said reversing mechanism.

4. In a radial drilling-machine, the combination with a column or support, a radial arm which has sliding connection therewith, a drill-head mounted on said arm, a drill-spindle in said head, an operating-shaft mounted on said column or support and operative connections between said operating-shaft and drill-spindle embracing a reversing mechanism located at the inner end of said arm, of an upright screw-threaded shaft mounted on said column and supporting said arm, and operative connections between said screw-threaded shaft and said reversing mechanism, embracing a clutch mechanism located at the inner end of said arm and manually-operable means for actuating said clutch mechanism.

5. In a radial drilling-machine, the combination with a column or support, a radial arm which has sliding connection therewith, a drill-head on said arm, a drill-spindle in said head, driving and reversing mechanism for said drill-spindle located at the inner end of said arm, and a single, manually-operable part for operating said driving and reversing mechanism constructed to disconnect the driving mechanism from the drill-spindle or connect the same therewith to rotate the drill-spindle in either direction, of mechanism for raising and lowering said arm, and operative connections located at the inner end of said arm between said raising and lowering mechanism and the driving and reversing mechanism operated by a single manually-operable part.

6. In a radial drilling-machine, the combination with a column or support, a radial arm which has sliding connection therewith, a drill-head on said arm, a drill-spindle in said head, and an upright rotative shaft mounted on said column or support, of a non-rotative screw-threaded shaft supported on said column and on which the weight of said arm is sustained, a screw-threaded sleeve surrounding said shaft and having bearing with the inner end of said arm, a gear-wheel on said sleeve, a gear-pinion meshing with said gear-wheel, and a clutch mechanism located at the inner end of said arm adapted to connect

said gear-pinion with a part which rotates with said operating-shaft.

7. In a radial drilling-machine, the combination with a column or support, a radial arm which has sliding connection therewith, a drill-head on said arm, a drill-spindle in said head, an operating-shaft and operative connections between said operating-shaft and the drill-spindle, of an upright non-rotative screw-threaded shaft mounted on said column or support, a screw-threaded sleeve engaging said shaft and having bearing in said arm, a gear-wheel on said sleeve, a sleeve loosely surrounding the operating-shaft and provided with a gear-pinion meshing with said gear-wheel, a second sleeve constituting part of the operative connection between the operating-shaft and drill-spindle, said second sleeve surrounding said operating-shaft and adapted to turn therewith and also to be rotated in a direction the reverse of that of the operating-shaft, said two sleeves constituting members of a clutch mechanism which are adapted to be brought into engagement by movement of one of said sleeves endwise on said shaft.

8. In a radial drilling-machine, the combination with a column or support, a radial arm which has sliding connection therewith, a drill-head on said arm, a drill-spindle in said head, an operating-shaft and operative connections between said operating-shaft and drill-spindle embracing a reversing mechanism, of an upright non-rotative screw-threaded shaft mounted on said column or support, a screw-threaded sleeve engaging said screw-threaded shaft in the arm, a bearing in said arm in which said screw-threaded sleeve is mounted, a gear-wheel on said screw-threaded sleeve, a gear-pinion meshing with said gear-wheel, a rotative part constituting a portion of said reversing mechanism, and clutch members formed on said part and on the gear-pinion which are adapted to be brought into operative engagement by movement of one of said parts toward the other part.

9. In a radial drilling-machine, the combination with a column or support, a radial arm, which has sliding connection therewith, a drill-head thereon, a drill-spindle in said head, and an operating-shaft, of two opposing beveled gear-wheels mounted in bearings in said arm through which said shaft loosely extends, a third gear-wheel meshing with said opposing gear-wheels and operatively connected with the drill-spindle, a clutch mechanism for separately locking said gear-wheels to said shaft, raising and lowering mechanism for said arm, and operative connections located at the inner end of the arm between said reversing mechanism and the raising and lowering mechanism.

10. In a radial drilling-machine, the combination with a column or support, a radial arm which has sliding connection therewith, a drill-head on said arm, a drill-spindle in said head, and an operating-shaft, of two opposing beveled gear-wheels loosely mounted on said shaft and rotating in bearings in the inner end of said arm, a gear-pinion meshing with said gear-wheels and operatively connected with the drill-spindle, a friction-clutch device on said shaft between said gear-wheels adapted to be separately moved into operative engagement with said gear-wheels by endwise movement of the shaft, raising and lowering mechanism for said arm, and operative connections located in the inner end of said arm between said reversing mechanism and raising and lowering mechanism.

11. The combination with a drill-head, means for raising and lowering the same and a drill-spindle rotatively mounted in said head, of a counterweight carried by and movable with the head and having sliding engagement therewith, and a gear connection between said spindle and counterweight and acting directly on said spindle to counterbalance the latter.

12. The combination with a drill-head, means for raising and lowering said head and a drill-spindle rotatively mounted in said head, of a counterweight carried by and movable with said head and having sliding engagement therewith, a non-rotative part connected with said spindle, a rack on said part, a rack on the counterweight, and a pinion interposed between and meshing with said racks.

13. The combination with a drill-head, a drill-spindle rotatively mounted therein, a non-rotative part connected with said spindle, a rack on said part and feed mechanism for advancing and retracting the spindle embracing a rotative pinion meshing with said rack, of a counterweight and a rack on said counterweight with which said pinion meshes.

14. The combination with a drill-head, a spindle rotatively mounted therein and means for angularly adjusting said spindle on an axis transverse to its longitudinal axis, of a counterweight carried by said head and having sliding engagement therewith in two opposing directions, and gear connections between said counterweight and spindle and acting directly upon the spindle to transmit a counterbalancing action to the spindle in all angular adjustments of the spindle.

15. The combination with a drill-head, a spindle rotatively mounted therein and means for angularly adjusting said spindle throughout the entire sweep of a circle, of a counterweight carried by said head and partaking of the angular adjustment of the spindle, and gear connections between said counterweight and spindle constructed to transmit a counterbalancing action from the counterweight directly to the spindle in all the angular adjustments of the spindle.

16. The combination with a drill-head, a drill-spindle which is rotative and endwise movable in said head, and a part which moves endwise with said spindle but is non-rotative, of an arm on said head in which said spindle

and the parts connected therewith have bearing, a counterweight, a guide on said arm in which said counterweight slides, racks on said counterweight and on the part which moves endwise with the spindle, and a gear-pinion interposed between said racks.

17. The combination with a rotative endwise-movable spindle, a part which moves endwise with said spindle, a rotative joint connecting said parts, a counterweight which has sliding engagement with the head, and gear connections between said counterweight and the part which moves endwise with the spindle.

In testimony that I claim the foregoing as my invention I affix my signature, in presence of two witnesses, this 28th day of February, A. D. 1902.

ALBERT W. WIGGLESWORTH.

Witnesses:

WILLIAM L. HALL,

GERTRUDE BRYCE.