Sept. 4, 1928. 1,682,844

D. C. KLAUSMEYER

BOX COLUMN TYPE UPRIGHT DRILL

Filed June 4, 1925 2 Sheets-Sheet 1

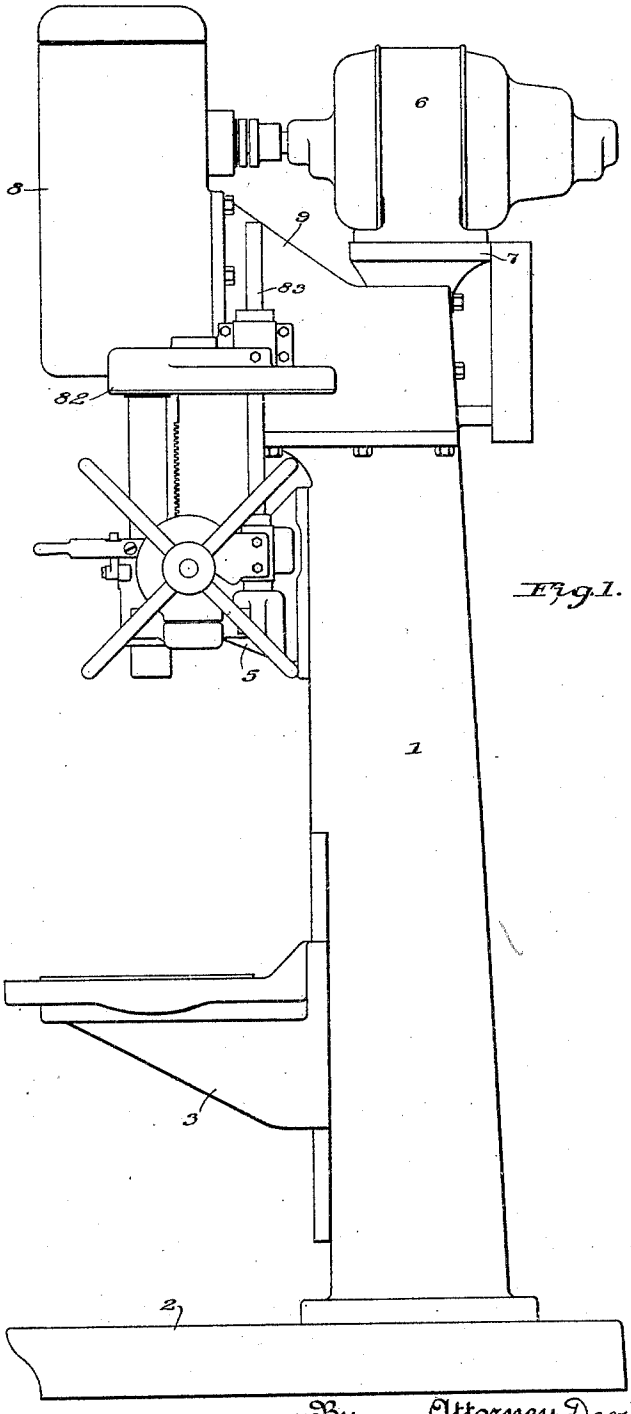

Fig. 1.

Inventor

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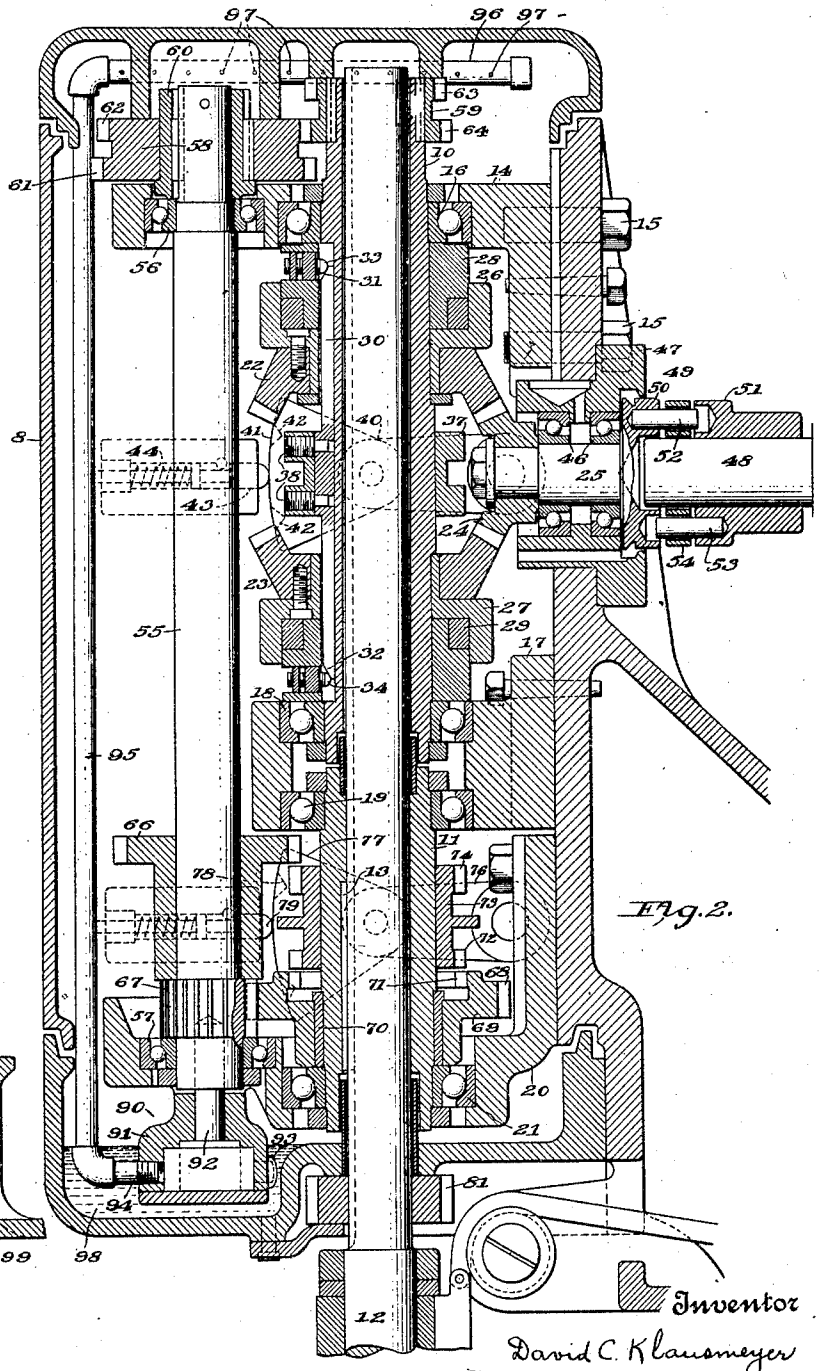

Fig. 2.

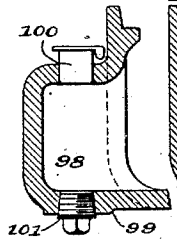

Fig. 3.

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Patented Sept. 4, 1928. 1,682,844

UNITED STATES PATENT OFFICE.

DAVID C. KLAUSMEYER, OF CINCINNATI, OHIO, ASSIGNOR TO THE CINCINNATI BICKFORD TOOL COMPANY, OF CINCINNATI, OHIO, A CORPORATION OF OHIO.

BOX-COLUMN-TYPE UPRIGHT DRILL.

Application filed June 4, 1925. Serial No. 34,829.

My invention is concerned with drilling machines and is particularly concerned with upright drilling machines having box columns.

In a drilling machine of the upright type it is desirable to operate the machine by means of a motor mounted on the top of the column or frame. Moreover in a drilling machine of the above indicated type, having a box column, it is desirable to have the motor mounted as near as possible to the centre line of the box column. The position of the motor on the clumn is controlled to a large extent by the gearing connection between the motor and the drill spindle.

One of the important features of my invention is to construct a drilling machine so as to permit the mounting of the propelling motor on the top of the column near the centre line thereof. Moreover it is an important feature of my invention to simplify the gearing connection between the motor and the drill spindle.

In a drilling machine constructed in accordance with my invention, a work carrying table and a drill head are adjustably and slidably mounted on the side of a box column. At the top of the box column is mounted the propelling motor and a casing for carrying the gearing connection between the motor and the drill spindle. The gearing carried in the casing comprises a back-gear sleeve and a reversing sleeve both of which sleeves are aligned with the drill spindle. A back-gear shaft is provided for connecting the reversing sleeve to the back-gear sleeve. The reversing sleeve is directly connected to the motor through a flexible joint and is provided with means for reversing the direction of its rotation at will. At the upper end of the reversing sleeve and the back-gear shaft is provided a transposition gear mechanism which may be operated to obtain different speeds. Suitable change gears are provided for connecting the lower end of the back-gear shaft to the back-gear sleeve whereby additional speeds are obtained. The back-gear sleeve is splined to the drill spindle and the reversing sleeve permits free rotation and linear movement of the spindle within it. By reason of having the back-gear sleeve and the reversing sleeve, which are in the nature of shafts, aligned with the drill spindle it is possible to mount the propelling motor closer to the main spindle. Accordingly, it is possible to mount the motor very close to the centre line of the column and not to support the motor on a bracket projecting from the side of the column. The above construction also simplifies the connection between the motor and the main spindle.

The back gear shaft, which connects the reversing sleeve to the back-gear sleeve, operates a pump for supplying lubricating material to the mechanism connecting the propelling motor to the drill spindle. The pump is preferably connected to the lower end of the back gear shaft and has an inlet opening connected to a well formed in the bottom of the casing surrounding the sleeve and the back-gear shaft.

Other objects and advantages will be in part indicated in the following description and in part rendered apparent therefrom in connection with the annexed drawings.

To enable others skilled in the art so fully to apprehend the underlying features hereof that they may embody the same in the various ways contemplated by this invention, drawings depicting a preferred typical construction have been annexed as a part of this disclosure and, in such drawings, like characters of reference denote corresponding parts throughout all the views, of which:—

Figure 1 is an elevational view of a drilling machine constructed in accordance with my invention. Fig. 2 is a sectional view through the gearing connection between the motor and the drill spindle. Fig. 3 is a section through a portion of the lubricating well in the bottom of the casing.

Referring to the drawings a box column 1, which is mounted on a base 2, carries a work carrying table 3 and a tool head 5. The work carrying table 3 is adjustable along guides formed on the column 1 and the tool head 5 is movable along guides also formed on the column. A main propelling motor 6 is mounted on a bracket 7, which is supported on the top of the column 1, and a gear casing 8 is mounted on a bracket 9 which is supported on the top of the column. In referring to Fig. 1 of the drawings, it will be noted the motor 6 is mounted near the centre line of the column 1 and does not project over the side of the column to any great extent as in the case of many drilling machines now constructed.

Referring to Fig. 2 of the drawing, a reversing sleeve 10 and a back-gear sleeve 11

are shown aligned with the drill spindle 12. The drill spindle 12 is carried by the drill head 5 and projects through the two sleeves 10 and 11. The drill spindle 12 is slidable and rotatable with respect to the sleeve 10 whereas the back-gear sleeve 11 is splined to the spindle. In Fig. 2 of the drawings the back-gear sleeve 11 is shown connected to the spindle 12 by means of a spline 13. A bracket 14, which is secured to the casing 8 by means of bolts 15, carries a bearing 16 serving as a journal for one end of the reversing sleeve 10. A second bracket 17, which is secured to the casing 8, carries a bearing 18 serving as a journal for the lower end of the reversing sleeve. The bracket 17 also carries a bearing 19 for journaling the upper end of the back-gear sleeve 11. A third bracket 20, which is secured to the casing 8, carries a bearing 21 for journaling the lower end of the back-gear sleeve 11.

The reversing sleeve 10 carries a reversing mechanism which comprises two bevelled gear wheels 22 and 23 rotatably mounted on the sleeve. Between the two bevelled gear wheels 22 and 23 is interposed a bevel gear wheel 24 which is secured to a short shaft 25. The gear wheel 24 meshes with the two gear wheels 22 and 23 and serves to rotate the gear wheels 22 and 23 in opposite directions. The gear wheel 22 is mounted on a collar 26 and the gear wheel 23 is mounted on a collar 27. The collars 26 and 27 are rotatably mounted on the reversing sleeve 10 and are adapted to be connected to the sleeve by means of friction clutches 28 and 29. The two friction clutches 28 and 29 are controlled by a cam rod 30 which slides in a slot formed in the reversing sleeve. Near the ends of the cam rod 30 are formed cam surfaces 31 and 32. The cam surfaces 31 and 32 respectively operate pins 33 and 34 for controlling the friction clutches 28 and 29. The friction clutch mechanism is described and claimed in my co-pending application Serial #805, filed January 6, 1925. Accordingly a detailed description of such mechanism in this application is deemed unnecessary. The cam rod 30 is secured to a collar member 37 by means of set screws 38. The collar member 37 is slidably mounted on the sleeve member 10 and is positioned between the two bevel gear wheels 22 and 23.

The collar member 37 is operated by means of a lever 40 which is pivotally mounted on the casing 8. A segment 41 having detents or notches 42 formed therein is provided on the lever 40. A plunger 43, which is operated on by a spring 44, is provided for engaging the detents or notches 42 formed in the segmental plate 41. The plunger 43 serves to hold the collar 37 in position to rotate the sleeve 10 either in a forward or in a reversed direction. The lever 40 is provided with suitable means for engaging a groove formed in the collar 37 and accordingly upon operation of the lever 40 the cam rod 30 is shifted to operate either the clutch mechanism 28 or the clutch mechanism 29. Upon operation of the clutch mechanism 28 the gear wheel 22 is connected to the sleeve 10 and upon operation of clutch mechanism 29 the gear wheel 23 is connected to the sleeve 10. By such means the direction of rotation of the reversing sleeve is controlled.

The short shaft 25, which carries the bevel gear wheel 24 and which is connected to the motor 6 is journaled in two bearings 46. The bearings 46 are suitably carried by the collar 47 which is supported in the casing 8. The short shaft 46 is connected to the motor shaft 48 by means of a flexible connection 49. The flexible connection 49 comprises a collar 50 which is secured to the short shaft 25 and a collar 51 which is secured to the motor shaft 48. A plurality of pins 52 are mounted on the collar 50 and similar pins 53 are mounted on the collar 51. The pins 52 and 53 project through a collar 54 which is loosely mounted on the motor shaft 48, as shown in Fig. 2 of the drawings. By such means a flexible connection is provided between the driving motor and the short shaft 25.

A back-gear shaft 55 is mounted in the gear case 8 parallel to the drill spindle 12 and adjacent to the sleeve members 10 and 11. The upper end of the back-gear shaft 55 is journaled in a bearing 56 which is supported in the bracket 14. The lower end of the back-gear shaft is journaled in a bearing 57 which is supported in the bracket 20. The upper end of the back-gear shaft is connected to the upper end of the reversing sleeve 10 by means of two transposition gears 58 and 59. The transposition gear wheel 58 is splined to a sleeve 60 which is secured to the back-gear shaft 55. The transposition gear 58 comprises two circular rows of gear teeth 61 and 62 which have teeth of the same pitch but different in number. The transposition gear 59, which is splined to the reversing sleeve 10, is provided with two circular rows of gear teeth 63 and 64. The circular rows of gear teeth 63 and 64 have the same pitch as the teeth on the transposition gear 58. The circular row of gear teeth 64 on the transposition gear 59 is adapted to mesh with the circular row of gear teeth 62 on the transposition gear 58 for operating the back-gear shaft 55 at one speed. When it is desired to operate the back-gear shaft 55 at a different rate of speed the position of the transposition gear 58 is reversed on the sleeve 60 and the position of the transposition gear 59 is reversed on the reversing sleeve 10. In the reversed position of the two transposition gear wheels the row of teeth 63 on the transposition gear 59 meshes with the row of geared teeth 61 on the transposition gear 58. Further changes in speed may be obtained by interchanging

the position of the gears 58 and 59. The transposition gear wheels shown in this application are disclosed and claimed in the companion application of George E. Merryweather, Serial No. 37,468 filed June 16, 1925.

Near the lower end of the back-gear shaft 55 are mounted two gear wheels 66 and 67. The gear wheels 66 and 67 form a part of a change gear system for connecting the back-gear shaft to the back-gear sleeve 11. The gear wheel 67 meshes with a set of external gear teeth 68 which are formed on a gear member 69. The gear member 69 is rotatably mounted on a bushing 70 which is mounted on the back-gear sleeve 11. The gear member 69 is also provided with a set of internal clutch teeth 71. The internal clutch teeth 71 are adapted to mesh with a set of clutch teeth 72 on a shiftable gear member 73. The gear member 73 also carries a second set of gear teeth 74 which are adapted to be moved into mesh with the gear teeth on the gear wheel 66. The gear member 73 is splined to the back-gear sleeve 11 and is shiftable along the sleeve member to mesh the gear teeth 74 with the teeth on the gear wheel 66 or to mesh the clutch teeth 72 with the clutch teeth 71 on the gear member 69. A lever 76, which is pivotally mounted on the casing 8, is provided for moving the gear member 73 along the sleeve member 11. The lever 76 is provided with a plate 77 in the form of a segment which has detents or notches 78 formed therein. The detents or notches 78 are engaged by a spring pressed plunger 79 to exert a force tending to hold the lever 76 in one of its operative positions.

A gear wheel 81, as shown in Fig. 2, is mounted on the drill spindle 12. The gear wheel 81 is connected through a set of gearing not shown but contained in a gear casing 82 to the feed shaft 83. The feed shaft 83 in a well known manner controls the feeding movement during power feeding operation. Inasmuch as my invention is not particularly related to the feeding mechanism and inasmuch as said mechanism is well known a further description thereof is deemed unnecessary.

The back-gear shaft 55 operates a pump 90 for supplying lubricating material to the mechanism contained within the casing 8. The pump 90 comprises a casing 91 which is supported by the bracket 20 in any suitable manner. The rotor of the pump is mounted on a shaft 92 which is secured to the back-gear shaft 55. The pump is provided with an inlet 93 and an outlet 94. The outlet 94 is connected by a conductor 95 which leads to the top of the casing 8 and connects with a discharge pipe 96. The discharge pipe 96 is provided with openings 97 for spraying lubricating material over the mechanism contained in the casing 8.

A well 98 is formed in the bottom of the casing for collecting the lubricating material supplied to the mechanism in the casing 8. The inlet 93 for the pump is connected with the lubricating material in the well and preferably the pump 90 projects into the lubricating material in the well as shown in Fig. 2 of the drawings. The well 98 is provided with a projecting portion 99, as shown in Fig. 3, having an inlet 100 for supplying lubricating material to the well and an outlet 101 for draining the lubricating material when necessary.

In the above described mechanism it will be noted the providing of a gearing system having a reversing sleeve and a back-gear sleeve aligned with the drill spindle not only serves to simplify and reduce the amount of gearing but also permits the moving of the motor much closer to the drill spindle. Accordingly it is possible to mount the propelling motor very close to the centre line of the box column of the machine. Attention is also called to the simplified means for effecting different speed changes of the main drilling spindle.

Without further analysis, the foregoing will so fully reveal the gist of this invention that others can, by applying current knowledge, readily adapt it for various utilizations by retaining one or more of the features that, from the standpoint of the prior art, fairly constitute essential characteristics of either the generic or specific aspects of this invention and, therefore, such adaptations should be, and are intended to be, comprehended within the meaning and range of equivalency of the following claims:—

Having thus revealed this invention, I claim as new and desire to secure the following combinations and elements, or equivalents thereof, by Letters Patent of the United States:—

1. In an upright drill, the combination comprising a drill spindle having a back-gear sleeve and a reversing sleeve aligned therewith, said back-gear sleeve being splined to said drill spindle; a back-gear shaft having an operative connection to the reversing sleeve at one end thereof and an operative connection to the back-gear sleeve at the opposite end thereof, said connections to the back-gear shaft being constructed to provide changes in speed; and a motor connected to the reversing sleeve.

2. In an upright drill, the combination comprising a drill spindle having a back-gear sleeve and a reversing sleeve aligned therewith, said back-gear sleeve having a spline connection with said spindle; a back-gear shaft having an operative connection to said reversing sleeve and to the back-gear sleeve; a reversing mechanism mounted on said reversing sleeve; and a motor connected to said reversing mechanism.

3. In a drilling machine, the combination

comprising a drill spindle; a shaft arranged parallel to the spindle; first and second rotatable elements aligned with said spindle; a motor connected reversibly with the first rotatable element; a driving connection between the second rotatable element and said spindle; a multiple-speed driving connection between the motor driven element and said shaft; and means for connecting said shaft to the second rotatable element to rotate said element and thereby the spindle at different speeds and in forward and reverse directions.

4. In an upright drilling machine, the combination comprising a drill spindle; a motor; a set of bearings aligned with said spindle; a set of bearings located in one line parallel to said spindle; and means including speed change gearing supported in said bearings and rotated by said motor for rotating the spindle at different speeds in both forward and reverse directions.

5. In a drilling machine, the combination comprising a drill spindle; a motor; a set of bearings aligned with said spindle; a set of bearings located in a line parallel to said spindle; and means, including two speed change devices of which one is adapted to multiply the speeds provided by the other, operating in said bearings and rotated by said motor for rotating the spindle at different speeds.

6. In a drilling machine, the combination comprising a drill spindle; a motor; a set of bearings aligned with said spindle; a set of bearings located in a line parallel to said spindle; and means comprising shafts operating in said bearings and rotated by said motor and two speed change devices of which one is adapted to multiply the speeds provided by the other, for rotating said spindle at eight different speeds in a forward and in a reverse direction.

7. In an upright drilling machine, the combination comprising a main frame having a motor mounted on the upper part thereof; a back-gear sleeve; a vertical spindle having a spline connection with said back-gear sleeve; a reversing sleeve aligned with said spindle; a reversing mechanism mounted on said reversing sleeve and connected to said motor; a back-gear shaft; means comprising transposition gears for connecting the reversing sleeve to the back-gear shaft to effect speed changes; and means comprising change gears for connecting the back-gear shaft to the back gear sleeve to effect speed changes.

8. In an upright drilling machine, the combination comprising a main frame having a motor mounted thereon; a drill spindle; a back-gear sleeve and a reversing sleeve aligned with said drill spindle, said back-gear sleeve being splined to said spindle; two bevel gear wheels mounted on the reversing sleeve and selectively connected to it for controlling the direction of rotation of the spindle; a motor gear meshing with said bevel gears and connected to said motor by a flexible connection; and means comprising a back-gear shaft for connecting the reversing sleeve to the back-gear sleeve.

9. In a drilling machine, the combination comprising a drill spindle; a back-gear sleeve and a reversing sleeve aligned with said drill spindle, said back gear sleeve being splined to the spindle; power means for rotating the reversing sleeve in a forward and in a reverse direction; a back-gear shaft mounted adjacent to said drill spindle; and means for connecting the reversing sleeve to the back-gear sleeve through said back-gear shaft to rotate the spindle at various speeds in a forward and in a reverse direction.

10. In a drilling machine, the combination comprising a drill spindle; a back-gear sleeve and a reversing sleeve aligned with said drill spindle, said back-gear sleeve being connected to rotate with said spindle; power means for rotating the reversing sleeve in a forward and in a reverse direction; a back-gear shaft located parallel to said spindle; transposition gears for connecting the reversing sleeve to the back-gear shaft; and change gears for connecting the back-gear shaft to the back-gear sleeve.

11. In an upright drilling machine, the combination comprising a box column, a motor mounted on the top of said column; a drill head movable along said column and having a drill carrying spindle mounted thereon; a casing mounted on the top of the column adjacent to said motor; a back-gear sleeve and a reversing sleeve aligned with said spindle and carried by said casing; means comprising bevel gear wheels for connecting the motor to the reversing sleeve to rotate the latter in a forward and in a reverse direction; a back-gear shaft; transposition gears for connecting the reversing sleeve to the back gear shaft; and change gears for connecting the back-gear shaft to the back-gear sleeve to operate the spindle in a forward and in a reverse direction at different speeds.

12. In an upright drilling machine, the combination comprising a box column; a motor mounted at the top of said column; a drill spindle; a back-gear sleeve and a reversing sleeve aligned with said spindle; reversing mechanism mounted on said reversing sleeve and connected to said motor for controlling the direction of rotation of the spindle; and a back-gear shaft for connecting the reversing sleeve to the back-gear sleeve.

13. In a drilling machine, the combination comprising a drill spindle; a back-gear sleeve splined to said spindle; a reversing sleeve aligned with said spindle; a motor; means comprising bevel gear wheels and clutches for connecting the motor to said reversing sleeve to operate it in a forward and in a reverse

direction; a back-gear shaft located parallel to the spindle; transposition gears for connecting the reversing sleeve to the back-gear shaft to operate the back-gear shaft at different speeds; and change gears for connecting the back-gear shaft to the back-gear sleeve to operate the spindle in a forward and in a reverse direction at different speeds.

14. In a drilling machine, the combination comprising a drill spindle; a reversing sleeve aligned with said spindle; a motor for operating the reversing sleeve in a forward and in a reverse direction; a back-gear shaft; transposition gears for selectively operating the back gear shaft from the reversing sleeve at different speeds; a back gear sleeve having a spline connection with said spindle; and change gears for connecting the back-gear shaft to the back gear sleeve to effect operation of the spindle at different speeds with respect to the back gear shaft.

15. In a drilling machine, the combination comprising a drill spindle; a reversing sleeve aligned with said spindle; two reversing bevel gear wheels rotatably mounted on said reversing sleeve; a motor gear wheel meshing with said reversing gear wheels; a main motor; a flexible connection for joining the motor to said motor gear wheel; a change speed connection between said reversing sleeve and the spindle; and a friction clutch mechanism for selectively connecting the reversing gear wheels to the reversing sleeve.

16. In a drilling machine, the combination comprising a drill spindle; a reversing sleeve aligned with said spindle; two reversing bevel gear wheels rotatably mounted on said reversing sleeve; a motor gear wheel meshing with said reversing gear wheels; a main motor; a flexible connection for joining the motor to said motor gear wheel; a change speed connection between said reversing sleeve and the spindle; a collar rotatably mounted on said reversing sleeve between the reversing gear wheels; a cam rod operated by said collar; and friction clutches operated by said cam rod for selectively connecting said reversing gear wheels to the reversing sleeve.

17. In an upright drill, the combination comprising a box column having a motor mounted on the top thereof; a back-gear sleeve and a reversing sleeve aligned with each other and mounted on said column; a drill spindle having a spline connection to the back-gear sleeve; a back gear shaft for connecting the two sleeves to effect changes in speed between them; two reversing gears rotatably mounted on said reversing sleeve; a sliding collar mounted on the reversing sleeve between the reversing gear wheels; means operated by said collar for selectively connecting said reversing gear wheels to the reversing sleeve; a motor gear wheel meshing with said reversing gear wheels; and a motor connected to the motor gear wheel.

18. In a drilling machine, the combination comprising a drill spindle having a reversing sleeve aligned therewith; two reversing gear wheels rotatably mounted on said reversing sleeve; a sliding collar mounted on the sleeve between the two reversing gear wheels; means operated by said collar for selectively connecting the reversing gear wheels to the reversing sleeve; a motor gear wheel meshing with each of said reversing gear wheels; and a motor connected to said motor gear wheel.

19. In a drilling machine, the combination comprising a drill spindle having a reversing sleeve aligned therewith; two reversing gear wheels rotatably mounted on said reversing sleeve; a sliding collar mounted on said sleeve between the two reversing gear wheels; means operated by said collar for selectively connecting the reversing gear wheels to the reversing sleeve; a motor gear wheel meshing with each of said reversing gear wheels; a motor connected to said motor gear wheel; and means for connecting the reversing sleeve to the spindle so as to operate the spindle at varying speeds.

20. In a drilling machine, the combination comprising a drill spindle having a reversing sleeve aligned therewith; two reversing gear wheels rotatably mounted on said reversing sleeve; a sliding collar mounted on said sleeve between the two reversing gear wheels; means operated by said collar for selectively connecting the reversing gear wheels to the reversing sleeve; a back-gear shaft; transposition gearing for operating the back-gear shaft at different speeds by the reversing sleeve; a back-gear sleeve having a spline connection with said spindle; change gears for connecting the back-gear shaft to the back gear sleeve; a motor gear wheel meshing with each of said reversing gear wheels; and a motor connected to said motor gear wheel.

21. In an upright drill, the combination comprising a drill spindle having a back-gear sleeve and a reversing sleeve aligned therewith, said back-gear sleeve being splined to said drill spindle; a back-gear shaft having an operative connection to the reversing sleeve at one end thereof and an operative connection to the back-gear sleeve at the opposite end thereof, said connections to the back-gear shaft being constructed to provide changes in speed of the drill spindle; a casing for supporting said sleeves and the back-gear shaft; a lubricating well formed in the bottom of said casing; and a lubricating pump secured to the back-gear shaft and projecting into said lubricating well.

22. In an upright drill, the combination comprising a drill spindle having a back-gear sleeve and a reversing sleeve aligned therewith, said back-gear sleeve being connected to said drill spindle; a back-gear shaft having an operative connection to the re-

versing sleeve at one end thereof and having an operative connection to the back-gear sleeve at the opposite end thereof; a casing surrounding said sleeves and the back-gear shaft; a lubricating well formed in the bottom of said casing, and a lubricating pump secured to and operated by said back-gear shaft, said pump projecting into the lubricating well in the casing.

23. In an upright drill, the combination comprising a drill spindle; a motor for operating said spindle; mechanism comprising a back-gear shaft for connecting the motor to the spindle; a casing for enclosing said mechanism and having a lubricating well formed in the bottom thereof; and a pump secured to said back-gear shaft and projecting into said well for supplying lubricating material to said mechanism.

24. In an upright drill, the combination comprising a drill spindle; a motor for operating said spindle; mechanism comprising a vertical back-gear shaft for connecting the motor to the spindle; a casing for enclosing and for supporting said mechanism; a lubricating well formed in the bottom of said casing; a lubricating pump secured to the bottom of said back-gear shaft and projecting into said well; and a fluid system for carrying lubricating material from said pump to said mechanism.

25. In an upright drill, the combination comprising a drill spindle; a motor for operating said spindle; mechanism comprising a back-gear shaft for connecting the motor to the spindle; a casing for enclosing and for supporting said mechanism; a lubricating well formed in the bottom of said casing; a lubricating pump secured to and operated by said back-gear shaft, said pump projecting into said lubricating well; and an outlet pipe connected to said pump and extending to top of said casing for delivering lubricating material over said mechanism.

26. In an upright drill, the combination comprising a drill spindle; a motor for operating said spindle; mechanism comprising a back-gear shaft for connecting the motor to the spindle; a casing for enclosing said mechanism; a lubricating well formed in the bottom of said casing; a pump operated by said back-gear shaft; and an inlet port for said pump connected to the lubricating material in said well.

27. An upright drill combining a spindle; a prime-mover; means actuated by said prime-mover for rotating said spindle in forward and reverse directions at a plurality of speeds, said means including a forward and a reverse drive and a plurality of speed change mechanisms, of which one is adapted to multiply the number of speeds provided by the other, operatively connecting the prime-mover with the spindle.

28. An upright drill combining a spindle; a prime mover; a rotatable member; means selectively to give said member forward and reverse rotations from said prime-mover; and a plurality of speed change mechanisms, of which one is adapted to multiply the number of speeds provided by the other, operatively connecting said rotatable member with said spindle, said spindle, rotatable member and speed change mechanisms being arranged on only two axes.

29. An upright drilling machine combining a column; a casing and a driving motor supported upon said column; a tool spindle rotatably journaled in said casing; a driving gear journaled in said casing co-axial with the driving motor shaft; means actuated by said driving gear for rotating said spindle in forward and reverse directions; and a flexible connection between said motor and said driving gear.

30. An upright drill combining a column; a supporting bracket provided by said column; a plurality of bearing brackets secured upon said supporting bracket; a plurality of aligned bearings provided by said bearing brackets and arranged on two parallel axes; a reversing sleeve journaled in two of said bearings; a back-gear sleeve journaled in two of said bearings in alignment with said reversing sleeve; a back-gear shaft journaled in two of said bearings parallel with the axes of said sleeves; a spindle splined within said back-gear sleeve; means to rotate said reversing sleeve in forward and reverse directions; and back-gear mechanism acting through said back-gear shaft to transmit to said spindle the forward and reverse rotations of said reversing sleeve at any one of a plurality of speeds.

31. An upright drill combining a spindle; a reversing sleeve rotatably journaled coaxial with said spindle; a second sleeve arranged coaxial with said spindle and having a driving connection therewith; means selectively to rotate said reversing sleeve in forward and reverse directions; and means to transmit to the second sleeve at varying rates the rotations of said reversing sleeve.

32. An upright drill combining a spindle; two gears rotatably journaled coaxial with said spindle; means to rotate said gears in reverse directions; a sleeve arranged coaxial with said spindles and having a driving connection therewith, and means including speed change gears for selectively connecting either of said two gears with said sleeve to rotate said sleeve and thereby the spindle at a plurality of rates from either of said reversely driven gears.

33. An upright drill combining a spindle; a prime-mover; a member rotatably journaled coaxial with said spindle; means to give said member oppositely directed rotary motions by said prime-mover; a sleeve surrounding said spindle and having a driving connection

therewith; and speed change mechanism operatively connecting said rotatable member with said sleeve to give the sleeve and thereby the spindle oppositely directed rotary motions at a plurality of rates from a single rate in the prime mover.

34. A drilling machine combining a drill spindle; a prime mover; forward and reverse driving mechanism mounted coaxially with said spindle; a driving connection between said prime mover and said mechanism; an element rotatably mounted adjacent said spindle; change speed gearing connecting said forward and reverse mechanism to drive said element; and change speed gearing connecting said element to drive said spindle.

In witness whereof, I have hereunto subscribed my name.

DAVID C. KLAUSMEYER.