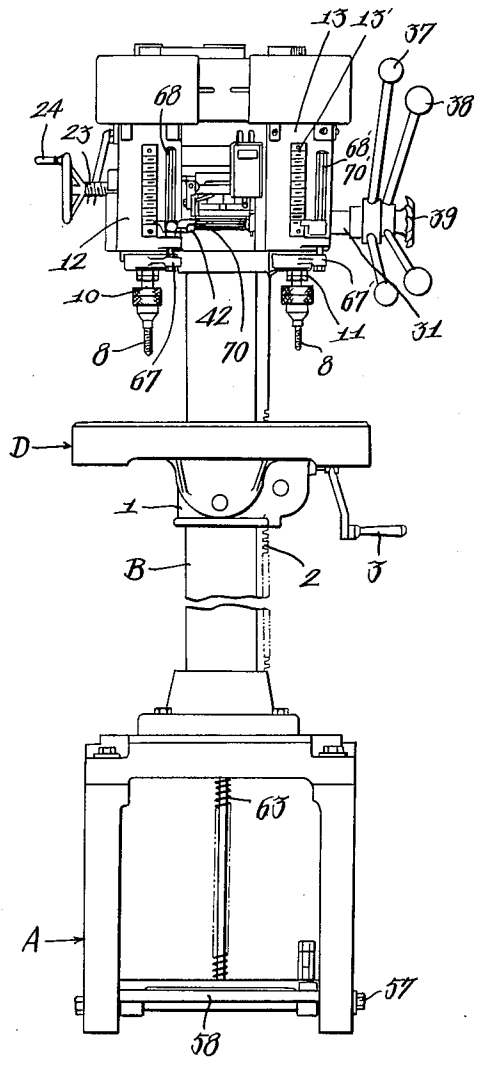
Aug. 17, 1965 KIYOSHI KAWASAKI 3,200,672

MULTIPLE SHAFT TYPE DRILLING MACHINE

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FIG. 1



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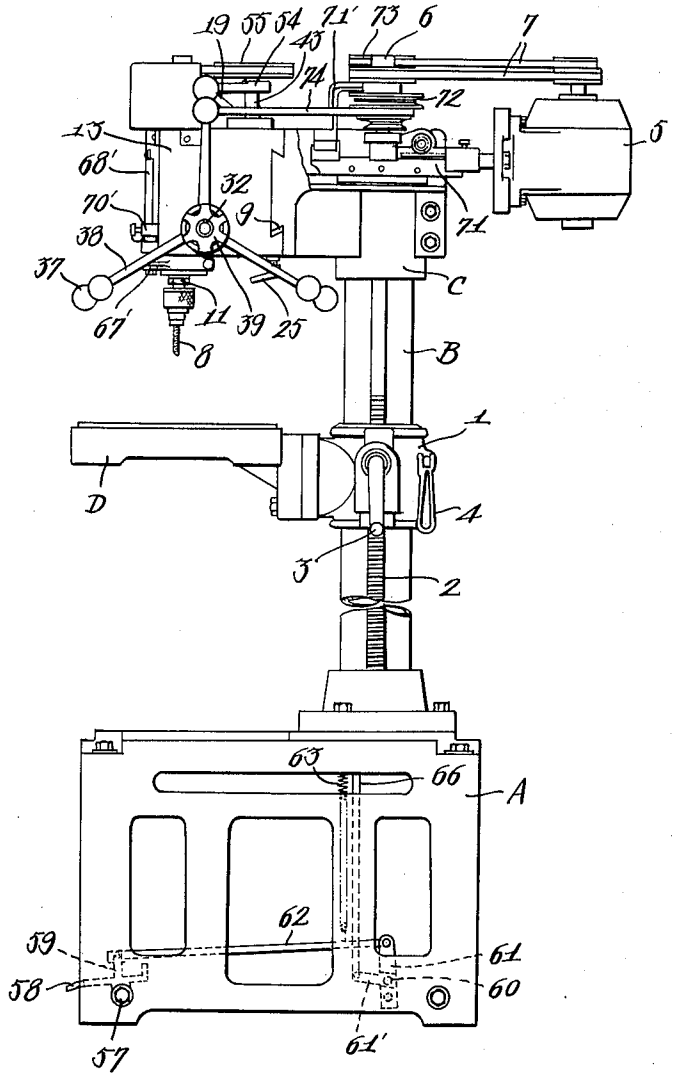
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MULTIPLE SHAFT TYPE DRILLING MACHINE

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FIG. 2.



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MULTIPLE SHAFT TYPE DRILLING MACHINE

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FIG. 3.

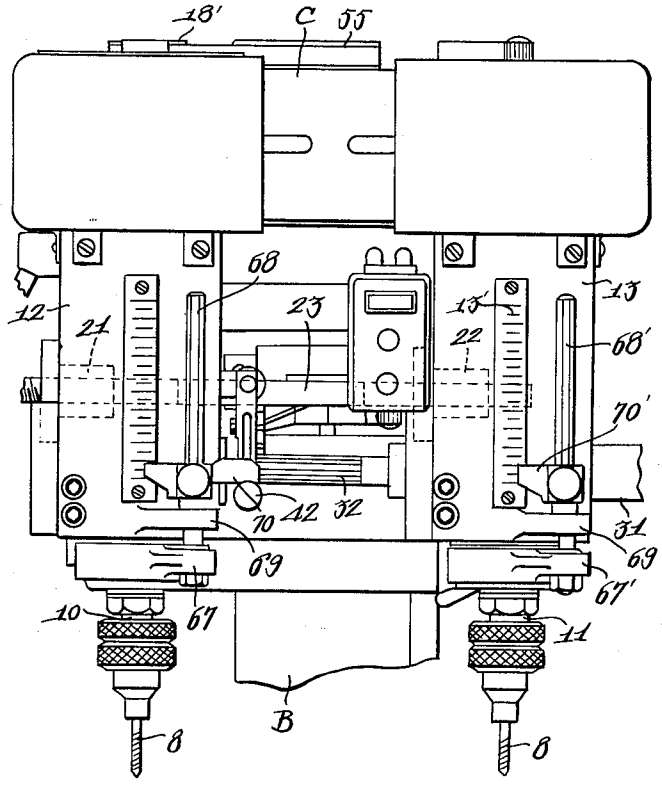
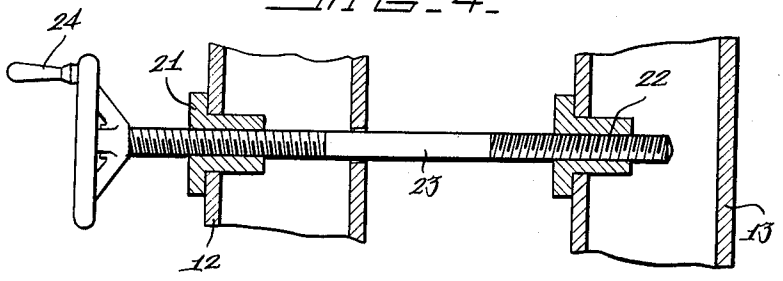


FIG. 4.



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MULTIPLE SHAFT TYPE DRILLING MACHINE

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FIG. 5.

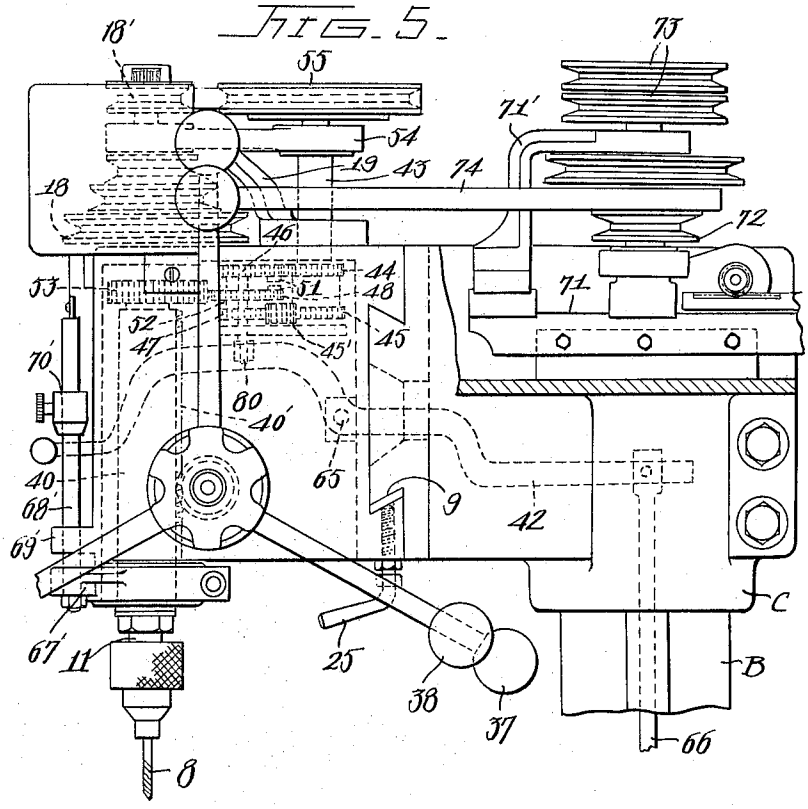
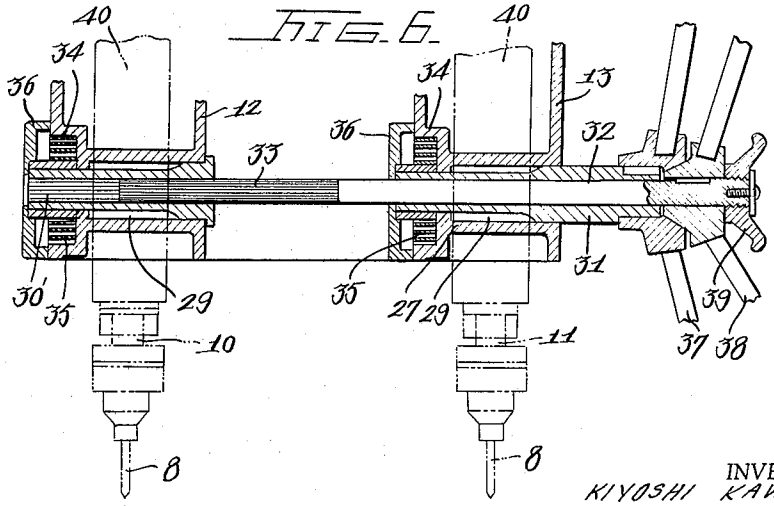


FIG. 6.



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MULTIPLE SHAFT TYPE DRILLING MACHINE

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FIG. 7.

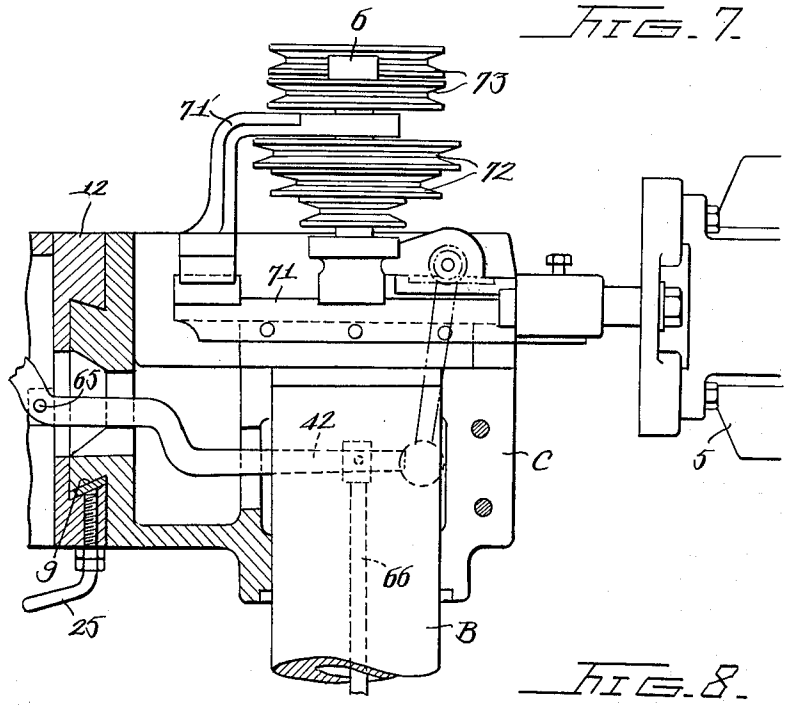
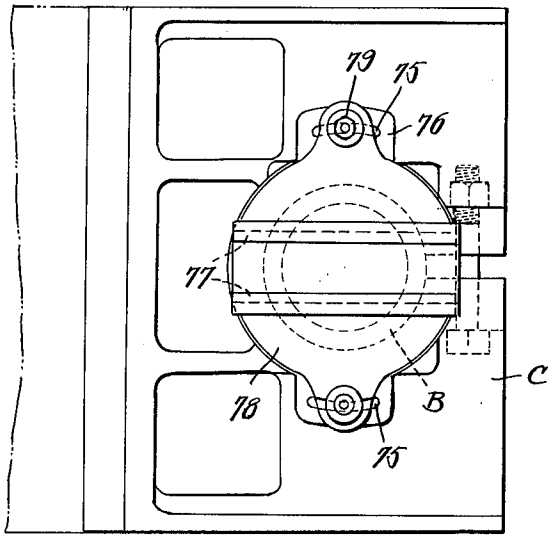


FIG. 8.



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MULTIPLE SHAFT TYPE DRILLING MACHINE

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FIG. 9

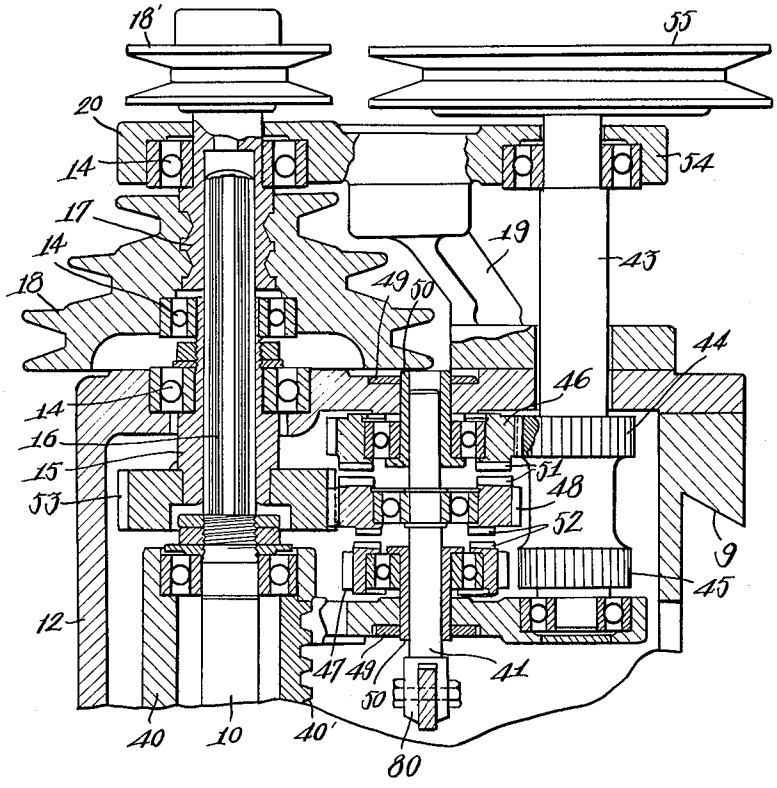
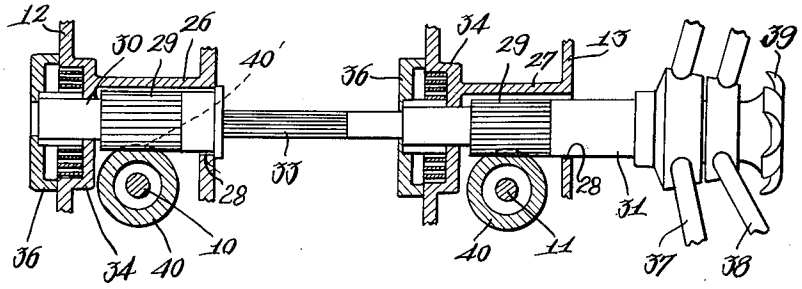


FIG. 10



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MULTIPLE SHAFT TYPE DRILLING MACHINE

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FIG. 12.

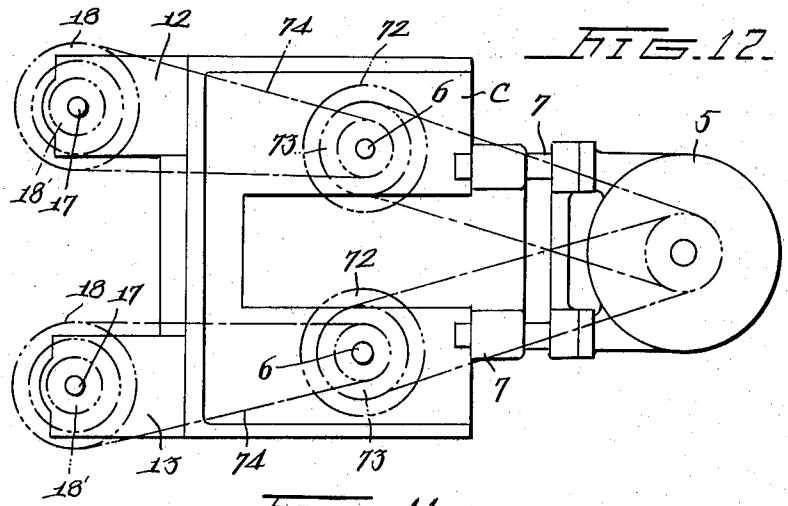
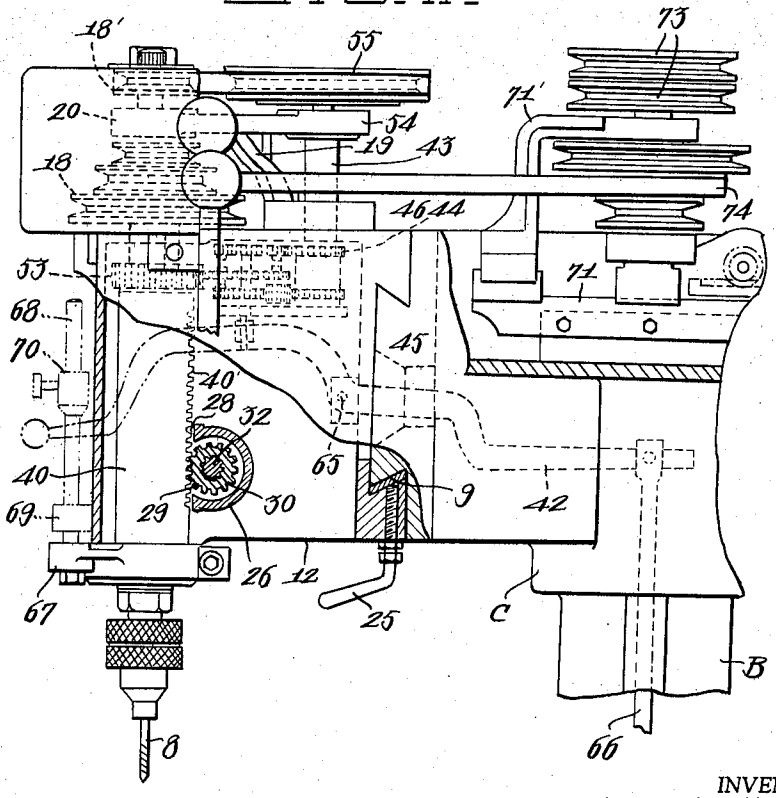


FIG. 11.



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MULTIPLE SHAFT TYPE DRILLING MACHINE

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FIG. 13

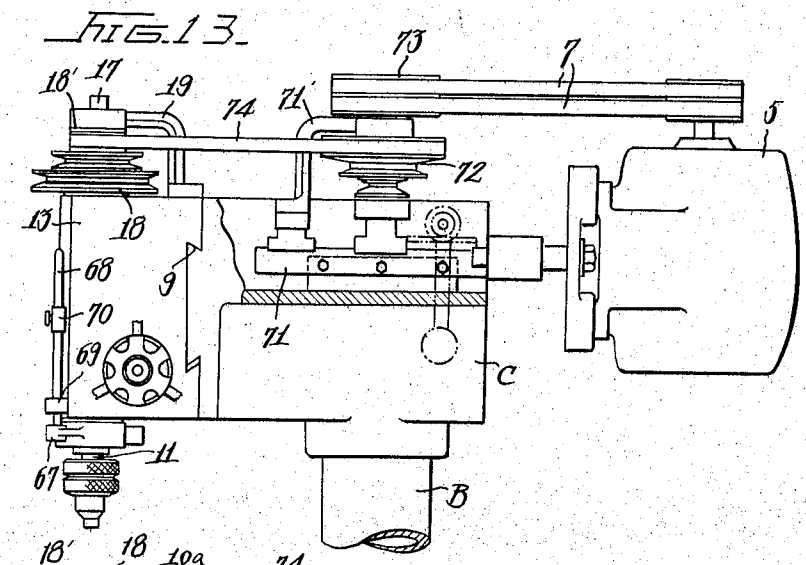
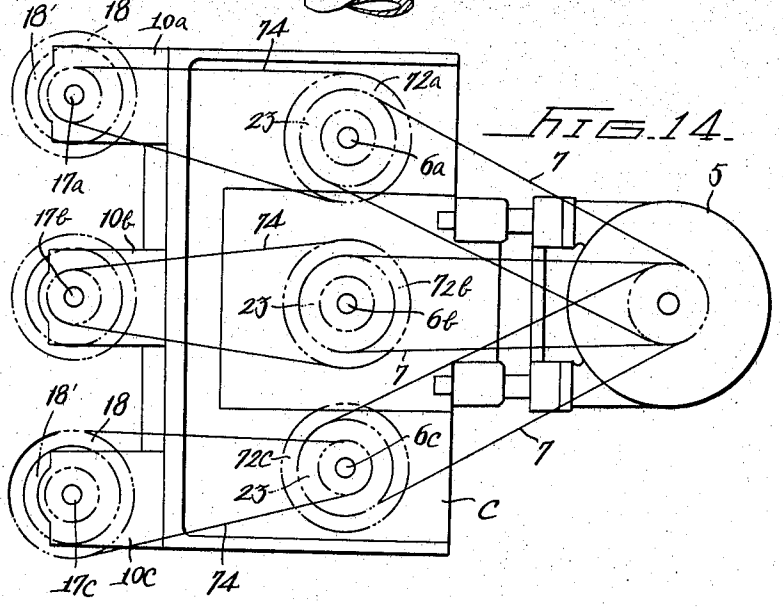


FIG. 14



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United States Patent Office 3,200,672 Patented Aug. 17, 1965

3,200,672

MULTIPLE SHAFT TYPE DRILLING MACHINE

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Filed Oct. 2, 1962, Ser. No. 227,917
Claims priority, application Japan, Oct. 2, 1961, 36/49,946
8 Claims. (Cl. 77—24)

The present invention relates to an improved type of drilling machine and more particularly to a multiple shaft drilling machine having a plurality of spindles.

The multiple shaft type drilling machine of the present invention is characterized in that the cylindrical shafts for rotating the spindles are connected to the drive motor via intermediately disposed transmission shafts instead of these cylindrical shafts being directly connected to the motor as is commonly practiced in the prior art drilling machines. By virtue of such improvement it has been found that the rotational motion transmitting parts of the machine will not be subjected to excessive leading during its operation, permitting the drilling machine to perform its designated function with increased accuracy and achieving a longer useful life.

It is another object of the present invention to provide a drilling machine of the type wherein the boxes in which the spindles are disposed are provided on the front side of the head assembly for free frictional movement in the horizontal direction. Dovetail grooves are formed therein with corresponding H-shape projections being formed on the foreside of the head assembly. A threaded bar having oppositely directed threads formed at its opposite end portions is threaded into said boxes whereby the spindles can be moved in the same direction or in the opposite directions relative to each other so as to adjust the position of the drills.

It is another object of the present invention to provide a drilling machine of the type wherein each spindle is surrounded by a cylindrical member. An intermediate cylindrical member having a toothed portion in its outer periphery is provided at right angles relative to said first mentioned cylindrical member. An operation bar is inserted into each intermediate cylindrical member whereby the spindles may be vertically moved in the same direction or in the opposite directions relative to each other. Further, the individual spindles may be moved together or separately.

It is still another object of the present invention to provide a drilling machine of the type wherein the rotation of each spindle can be reversed, and its movement halted with a simple operation.

The above and still further objects, features and advantages of the present invention will become apparent upon consideration of the following detailed description of one specific embodiment thereof, especially when taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is a front view in elevation of a drilling machine embodying the present invention;

FIG. 2 is a side view in elevation of said embodiment;

FIG. 3 is an enlarged view of the head assembly thereof;

FIG. 4 is a longitudinal sectional view of the mechanism which is designed to horizontally move the spindles in the same direction or in the opposite directions relative to each other;

FIG. 5 is a side view in elevation of the head assembly as shown in FIG. 3;

FIG. 6 is a longitudinal sectional view of the mechanism which is designed to move the spindles either together or separately in the vertical direction;

FIG. 7 is a side view of a part of the head assembly shown partially in section;

FIG. 8 is a top view of FIG. 7 with the intermediate shafts and motor removed therefrom;

FIG. 9 is a side view in section of the mechanism which is designed to change the rotational movement direction of the spindles;

FIG. 10 is a top view of the mechanism as shown in FIG. 6;

FIG. 11 is a side view in elevation of the head assembly and spindle boxes with some portions thereof broken away;

FIG. 12 is a top view diagrammatically illustrating the arrangement of the transmission mechanism when two spindles are employed;

FIG. 13 is a side view of the transmission mechanism as shown in FIG. 12; and

FIG. 14 is a top view diagrammatically illustrating the arrangement of the transmission mechanism when three spindles are employed.

Referring now specifically to FIGS. 1 and 2 of the accompanying drawings, in which there is illustrated a drilling machine comprising a base A which serves to support said drilling machine for stabilization thereof when installed on a floor, a cylindrical pillar member B vertically and upwardly extending at an area near the rear side of the base, a head assembly C mounted at the upper end of said pillar member B for supporting the spindle drive mechanism, and a table D supported by the pillar member B for upward and downward movement along the pillar member, which construction is conventional in the art.

The table D has a sleeve member 1 attached at its rear end, said cylindrical member 1 being slidably disposed around said pillar member B. The table D is free to move upwardly and downwardly by a rack 2 provided on the pillar member and a worm adapted to engage with said rack 2 being turned by a hand operated handle 3. The table D can be held at any desired position along the pillar member B by means of an adjusting screw having a handle 4.

The head assembly C has a motor 5 vertically mounted at its rear end. The drive transmission between the head assembly and motor is provided through intermediate shafts 6 and belts 7.

On the front side of the head assembly C there is provided the mechanism for actuating spindles 10 and 11 (in which tools such as drills 8 are held), for free horizontal movement by means of the dovetail's groove and the corresponding projection as mentioned above.

The illustrated drilling machine is designed to employ two spindles 10 and 11 and the spindles 10 and 11 are vertically disposed within their respective boxes 12 and 13 which are mounted on different positions in the head assembly C. The upper end portions of the spindles 10 and 11 extend through the upper walls of the boxes 12 and 13 into cylindrical tubular members 15 which are rotatably supported on ball bearings 14, as shown in FIG. 9. The cylindrical tubular member 15 and the upper portions of the spindles are caused to rotate together by means of the splines 16, but yet the spindles can move upwardly and downwardly relative to the cylindrical tubular members. At the upper ends of the cylindrical tubular members 15 stepped pulleys 18 are mounted by means of the similar ball bearings 14 for rotational movement thereon and the stepped pulleys 18 are provided with connector tubes 17 therein. The upper end portions of the connector tubes are provided with pulleys 18' for rotational movement about the axis of the tubes 17. The connector tubes 17 are rotatably supported by the bearings 20 of a support arm 19 which is supported on the upper surfaces of the boxes 12 and 13 and the upper end portions of the spindles 11 and 12 are free to pass through the connector tubes 17 and to rotate therein.

Cylindrical nut members 21 and 22 are provided with oppositely directed female threads which are secured to the respective boxes 12 and 13 in such manner that these cylindrical members are aligned in a straight line as shown in FIGS. 3 and 4. A threaded bar 23 whose opposite ends are provided with oppositely directed threads corresponding to the oppositely directed threads of the respective cylindrical members 21 and 22 are threaded into the cylindrical nut members. The threaded bar 23 has a handle 24 secured at its one end. The turning of the handle 24 causes the bar 23 to turn which simultaneously moves the two boxes 12 and 13 towards or away from each other along the dovetail projection 9 so that the distance between the two spindles 10 and 11 can be easily adjusted for extension or narrowing thereof. When the distance between the spindles 10 and 11 has reached the desired magnitude, these spindles are firmly held at the appropriate position by means of set screws 25 which are disposed in the dovetail groove 9.

It may be required that the two spindles 10 and 11 move upwardly and downwardly together or separately as the case may be. For achieving the above purpose, as shown in FIG. 6 and FIG. 10, cylindrical members 26 and 27 are respectively provided in such a way that they lie in a line in the horizontal direction relative to the respective boxes 12 and 13 in which the respective spindles 10 and 11 are disposed. Each of the cylindrical members 26 and 27 has an opening 28 in a portion thereof for receiving its respective intermediate cylindrical tubular members 30 and 31 to allow free rotational movement thereof, which cylindrical tubular members 30 and 31 have toothed portions 29 on their outer peripheral surfaces. An operative bar 32 is inserted into one intermediate cylindrical tubular member 31 for free rotational movement relative thereto and the fore-end of the bar 32 is provided with a toothed portion 33 which meshes with the inner periphery of the other intermediate cylindrical tubular member 30. The operative bar 32 is free to move relative to the cylindrical tubular member 31, but is prevented from rotating independently of the other cylindrical tubular member 30 by virtue of the meshing of its toothed portion 33 with the corresponding teeth 30' formed in the inner peripheral surface of the cylindrical tubular member 30. The toothed portion 30' of the cylindrical tubular member 30 and the corresponding toothed portion 33 of the operative bar 32 should be long enough to maintain their meshing relation even when the distance between the both spindles has been extended to its maximum magnitude.

The fore-end of each of the intermediate cylindrical tubular members 30 and 31 extends into the respective spring casings 34 and is designed to be urged to return to its original position by the action of a spiral spring 35 disposed within each spring case 34 upon completion of a cycle of operation. The intermediate cylindrical tubular members 30 and 31 are supported at their one end portions by the respective bearings 36 for the stabilization thereof.

The intermediate cylindrical tubular member 31 extends outwardly a short distance and has a handle 37 keyed at the extended end. The outer end of the operative bar 32 extends through the handle 37 and has a similar handle 38 keyed at the extended end. The cylindrical tubular member 31 and the operative bar 32 may be turned in the same direction by gripping both handles 37 and 38 together or may be turned separately by gripping the handles in turn. An adjusting handle 39 is secured to one end of the operative bar 32, and when this adjusting handle is tightened, the intermediate cylindrical tubular members 30 and 31 are caused to be tightened against the operative bar 32 and to turn together whilst when the handle 9 is loosened these handles 37 and 38 are caused to turn individually. In other words, with the adjusting handle 39 loosened, the turning of the handle 37 causes the intermediate cylindrical tubular member 31 to turn regardless of the operative bar 32 wilst the turning of the other handle 38 causes the intermediate cylindrical tubular member 30 to turn.

As explained in the foregoing, since the cylindrical members 26 and 27 are open at their one ends, the toothed portions 29 of the respective intermediate cylindrical members 30 and 31 protrude through the openings 28 as shown in FIG. 11 so that the toothed portions 29 can engage with the racks 40' of cylindrical quill members 40 which are disposed around the spindles 10 and 11 respectively hence the spindles 10 and 11 are caused to move upwardly and downwardly in unison or independently. The separate movement of the spindles in this way enables boring and threading operations to be separately performed on a work disposed on the table D.

Reference will be now had on the mechanism which serves to automatically change the rotational direction of the spindle 10.

According to the present invention, the change in the rotational direction of the spindles 10 is performed by a treadling operation. A vertically movable shaft 41 is provided within the gear drive transmission mechanism for changing the rotational direction of the spindle as shown in FIG. 9. The shaft 41 is caused to move upwardly and downwardly by means of a lever assembly 42 which is connected with the treadle device whereby the upward and downward movement of the shaft 41 can change the clutching relation.

The box 12 in which the spindles 10 and 11 is disposed is provided with a vertical auxiliary shaft 43 therein and at the lower end of the shaft 43 two gears 44 and 45 are disposed with a suitable space therebetween. The shaft 41 is disposed between the cylindrical shaft 15 and the auxiliary shaft 43, said shaft 41 being movable in the vertical direction, but not being rotatable. Three gears 46, 47 and 48 are rotatably mounted on the shaft 41, and the uppermost gear 46 meshes with the gear 44 of the auxiliary shaft 43 and the lowermost gear 47 meshes through an idle gear 45' with the lower gear 45 of the auxiliary gear 43.

The vertically movable shaft 41 is inserted into the box 12 and has its opposite ends disposed within the upper and lower sleeves 50 which are held in position by respective retaining plates 49 so that the shaft 41 can move vertically. The intermediate gear 48 is so designed that the same is free to move relative to the shaft 41, but when the shaft 41 moves upwardly or downwardly this gear 48 also moves following the movement of the shaft 41. Clutches 51 and 52 are respectively provided between the uppermost and intermediate gears 46 and 48 and between the latter gear and the lowermost gear 47. The clutches 51 and 52 are so designed that the upward or downward movement of the intermediate gear 48 in accompaniment with the similar movement of the shaft 41 causes either clutch 51 or 52 to mesh with the upper gear 46 or the lower gear 47 whereby the rotational movement may be transmitted to either the gear 46 or 47.

The lower end of the cylindrical shaft 15 through which the upper portion of the spindle 10 extends has a gear 53 secured thereto which meshes in turn with the intermediate gear 48 of the vertically movable shaft 41.

The upper end of the auxiliary shaft 43 is supported by a bearing 54 provided on the support arm 19 which is mounted on the upper surface of the box 12 and a pulley 55 is secured at said upper end of the shaft. The pulley 55 is connected through a belt with the pulley 18', connected with the connector tube 17.

With the above arrangement, when the gear 48 of the shaft 41 is not in engagement with any of the gears 46 and 47 of the same shaft, the rotational movement of the pulley 18' is not transmitted to the gear 53 of the cylindrical shaft 15, and accordingly, the spindle will not rotate. On the other hand, when the shaft 41 moves upwardly resulting in the engagement of gear 48 with the gear 46, the rotational movement is transmitted to

the gears 48 and 53 rotating cylindrical shaft 15. Therefore, the spindle 10 which is disposed for frictional movement within the cylindrical shaft 15 has rotational movement transmitted thereto. And when the gear 48 moves down to engage the gear 47, the rotational movement of the gear 45 is imparted through an idle gear 45' to the gears 48 and 53 and then to the cylindrical shaft 15 whereby the rotational direction of the spindle 10 can be reversed.

For the attainment of the reversal in the rotational movement of the spindle 10 as just described above, the shaft 41 is operated in the following way.

A treadle piece 58 is pivoted to a shaft 57 provided on the lower front side of the base A and an operative arm 59 is provided extending upwardly at the base of said treadle piece 58. The arm 59 is connected through a connecting bar 62 with an intermediate cross arm 61 pivoted to a lower rear shaft 60. The connecting arm 62 is urged upward by a spring 63 so as to return to its normal position after each cycle of operation.

The head assembly C disposed above the pillar member B includes levers 42 disposed on the front and rear portions thereof and the junction between the two levers 42 is supported on the head assembly by a transverse shaft 65. The rear end of the lever assembly is connected through a connection bar 66 with the intermediate cross arm 61'. With the above arrangement, when the treadle piece 58 is moved down, the levers 42 which are transversely secured through the connecting bars 62, 66 to the upper part of the base A are caused to pivot about the shaft 65. Accordingly, when the lever assembly 42 is actuated by the operation of the treadle piece 58, the shaft 41 is caused to move upwardly and downwardly shifting gears as explained above in order to reverse the rotational direction of the spindle 10.

In the embodiment as illustrated, only the left side spindle 10 can be automatically reversed in its rotational movement direction. The cylindrical member 40 having the spindle 10 therein and being movable upwardly or downwardly together with the spindle 10 has a projecting support arm 67 at its lower end, and an operative bar 68 extends upwardly through the arm 67. The operative arm 68 extends upwardly through the guide piece 69 provided on the box 12 and has a collar 70 mounted thereon which can be moved vertically along the arm 68.

When the spindle 10 moves down, the operation bar 68 also follows the downward movement thereby the collar 70 pushes the fore-end of the lever 42, and accordingly, the lever assembly is pivoted about the shaft 65 and the vertically movable shaft 41 is projectingly positioned forwardly of the pivot shaft 65 of the lever assembly 42 by means of a universal joint 80 on the upper surface of the front lever and the shaft 41 is caused to move upwardly or downwardly in response to the operation of the lever assembly 42 whereby the rotational direction of the spindle 10 can be reversed.

The other spindle or the spindle 11 is adapted to be manually operated, but this spindle may be also connected with the lever assembly 42 as in the case of the lever 42 whereby the same may be automatically reversed in its rotational movement direction. The cylindrical member 40 for the spindle 11 is also provided with a projecting support arm 67' and an operative bar 68' extends upwardly through the support arm 67'. An adjustable indicator 70' is mounted on the operative bar 68' in such a manner that the indicator may indicate the upward and downward movement of the spindle 11 in cooperation with a graduated plate 13'.

In the drilling machine according to the present invention, the spindle carrying boxes 12 and 13 and the motor mounted on the head assembly C are connected through the intermediate shafts 6 disposed therebetween instead of being directly connected to each other as seen in the prior art drilling machine. If the portions in which the spindles are disposed are directly connected with the motor in a multiple shaft type drilling machine, the number of belts would be increased accordingly, and the shafts to which the pulleys are secured would have to extend a considerable distance upward. Consequently, the shafts would be subjected to an excessive load, resulting in uneven wear of the shafts.

According to the present invention the head assembly C includes a support 71 for the intermediate shafts 6. The support 71 supports the intermediate shafts 6 in cooperation with a support arm 71' projecting upwardly from the surface of the support 71. Pulleys 73 are respectively secured to the shafts 6 and these pulleys are connected through the belts 7 with the shaft of the motor 5. The pulleys 72 are in turn respectively connected by means of belts 74 with the stepped pulleys 16 of the cylindrical shafts 15 within the respective boxes 12 and 13. The tension in the belts 7 and 74 should preferably be adjustable and the rotational movement and position of the support 71 should be also adjustable so that replacement of belts can be easily carried out. FIG. 8 illustrates such adjustments in which the head assembly C is shown as having an abutment 76 provided with an arc-shape groove 75 on the surface thereof, and stacked thereon is a rotary disc member 78 having spline grooves 77. The stacked members are then firmly secured to the surface of the head assembly C by means of a clamping bolt 79. The position of the intermediate shafts 6 can be adjusted by the support 71 being frictionally moved along the grooves 77 of the rotary disc member 78.

FIG. 14 illustrates a drilling machine employing three spindles, and in this case there are provided three spindle boxes 10*a*, 10*b* and 10*c* which are free to move frictionally along the dovetail grooves provided on the front side of the head assembly C. Also provided on the upper surface of the head assembly C are three intermediate shafts 6*a*, 6*b* and 6*c*, and each of the intermediate shafts is connected through its respective belt 7 with the common pulley of the motor 5. The respective pulleys 72*a*, 72*b* and 72*c* of these intermediate shafts and the respective cylindrical shafts 17*a*, 17*b* and 17*c* within the respective boxes are connected by means of their respective belts 74.

While I have described and illustrated one specific embodiment of my invention, it will be clear that variations of the details of construction which are specifically illustrated and described may be resorted to without departing from the true spirit and scope of the invention as defined in the appended claims.

What I claim is:

1. In a multiple shaft type drilling machine comprising a base adapted to be secured on a floor, a vertical pillar member upwardly extending at a location near the rear side of said base; a head assembly mounted at the upper end of said pillar member and a table supported by said pillar member for vertical movement along the pillar; characterized by that said drilling machine includes a plurality of spindle boxes disposed within said head assembly for receiving their respective spindles; a common drive motor disposed on said head assembly; spindle drive means interconnected between said common drive motor and said spindles for providing rotational movement of said spindles; a horizontal positioning means including a threaded bar connected between said spnidle boxes for selectively moving said spindle boxes relative to each other in a horizontal direction; vertical positioning means individually engaging the upper portion of said spindles within their respective spindle boxes and including means for seletcively moving said spindles in a vertical direction; said vertical positioning means including means for moving said spindles in unison when in a first condition and separately when in a second condition; said spindle drive means including reversing means for selectively reversing the rotational direction of said spindles; said spindle drive means including in-

termediate shafts corresponding in number to said plurality of spindles, each of said intermediate shafts being connected between said common motor and a connector member disposed in its associated spindle box.

2. A multiple shaft drilling machine according to claim 1, wherein said horizontal positioning means includes a transversely disposed dovetail groove formed on the front side of said head assembly and receiving a cooperating extension of said spindle boxes; said threaded bar having oppositely directed threads at its ends in threaded engagement with said spindle boxes, whereby the distance between the spindles can be adjusted by turning said threaded bar and translating said spindle boxes along said dovetail groove.

3. A multiple shaft drilling machine according to claim 1, wherein said vertical positioning means includes an individual sleeve member encircling each of said spindles; said sleeve members having a vertically disposed rack; intermediate cylindrical members, each having a gear meshing with respective ones of said racks; operative bar members engageable with said intermediate cylinder members for moving its respective gear along its associated rack, whereby said sleeve member is vertically translated.

4. A multiple shaft drilling machine according to claim 1, wherein said reversing means includes means responsive to the vertical location of its respective spindle for automatically effecting said change of rotational direction.

5. A multiple shaft type drilling machine according to claim 1, wherein said intermediate shafts are connected through respective belt means between the respective

ones of said connector members and said common motor.

6. A multiple shaft drilling machine according to claim 1, wherein said reversing means includes an auxiliary shaft within each spindle box; a gear transmission mechanism disposed between said auxiliary shafts and a drive connector member operatively connected to the upper portion of their respective spindles; clutching means for changing the interconnection of said drive connector members and said auxiliary shaft for reversing the rotational direction transmitted to said spindles.

7. A multiple shaft type drilling machine according to claim 5, wherein said intermediate shafts including belt tensioning adjusting means permitting movement thereof relative to the head assembly.

8. A multiple shaft drilling machine according to claim 6, further including a treadle device for clutch changeover operation of said auxiliary shaft and drive connector members.

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