C. H. NORTON.

GRINDING MACHINE.

APPLICATION FILED JULY 21, 1914.

1,150,222.

Patented Aug. 17, 1915.

4 SHEETS—SHEET 1.

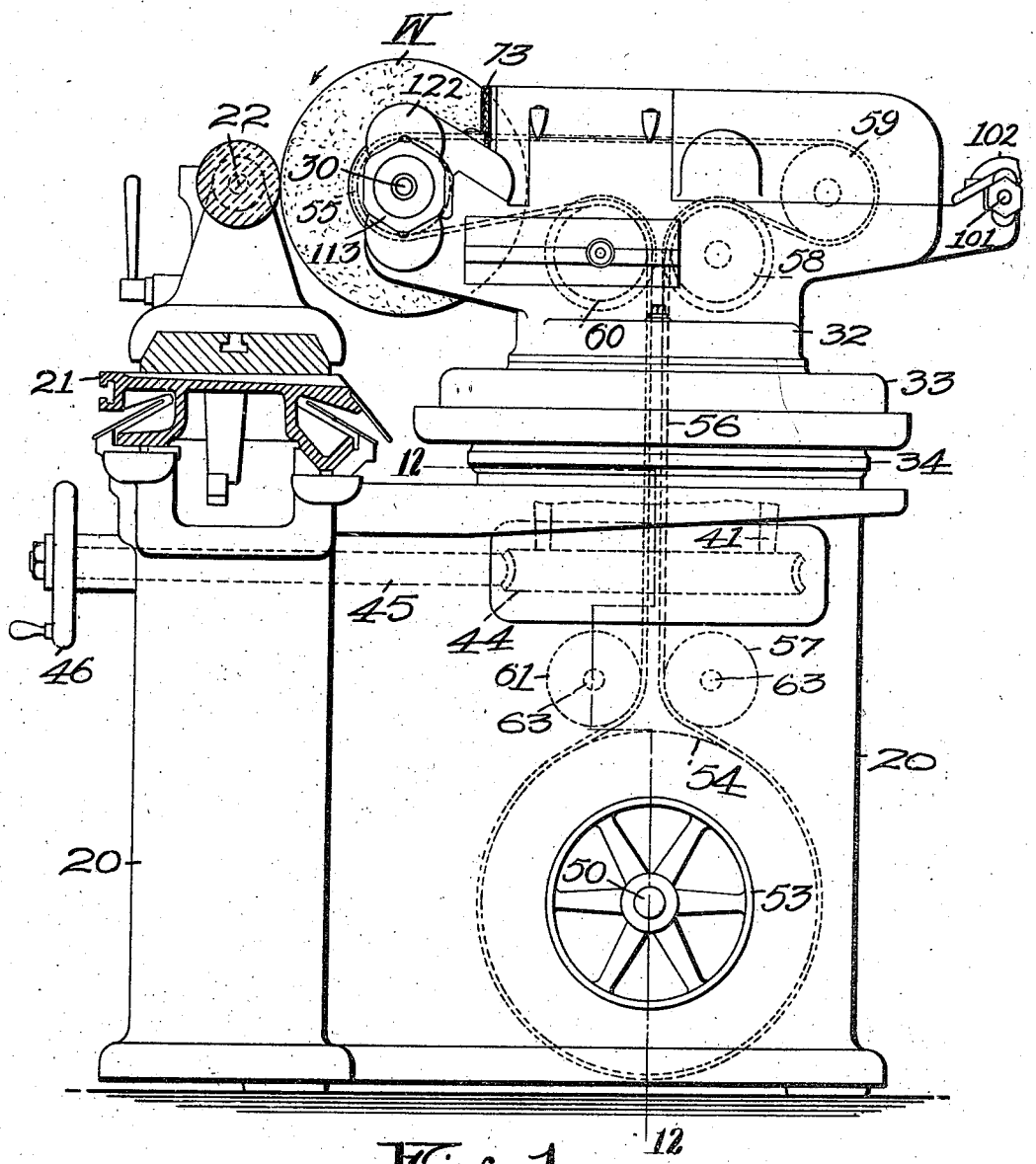


Fig. 1.

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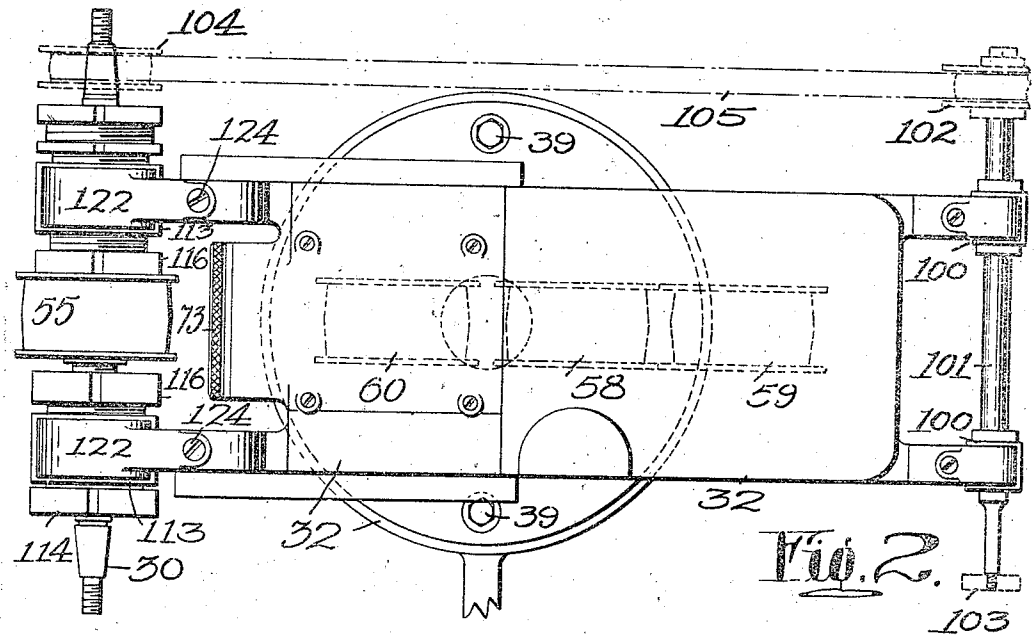


Fig. 2.

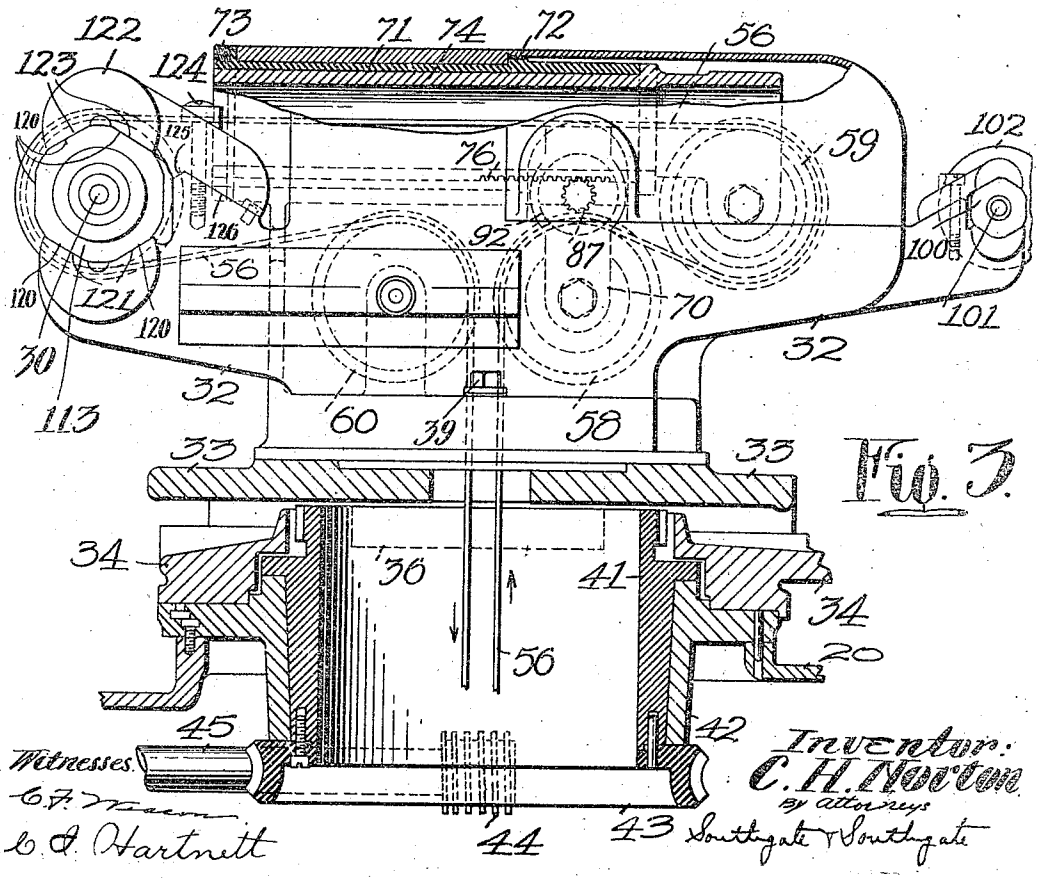


Fig. 3.

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4 SHEETS—SHEET 3.

Fig. 6.

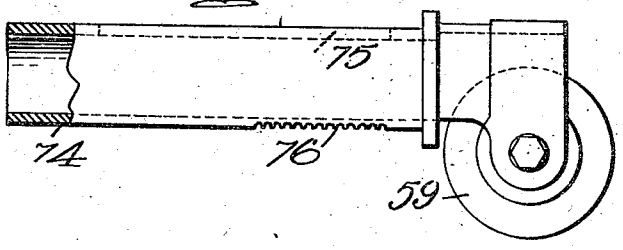


Fig. 7.

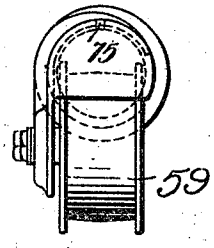


Fig. 8.

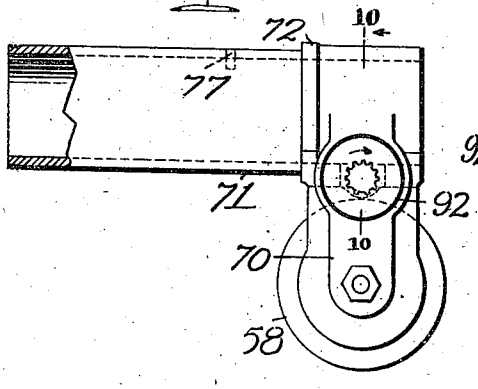


Fig 9

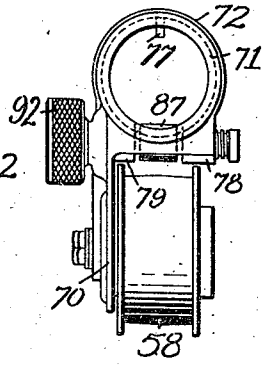


Fig. 10

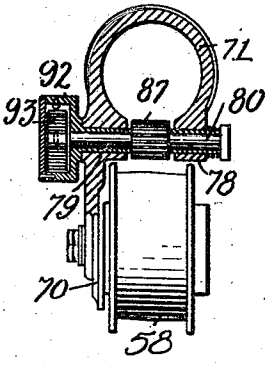


Fig. 4

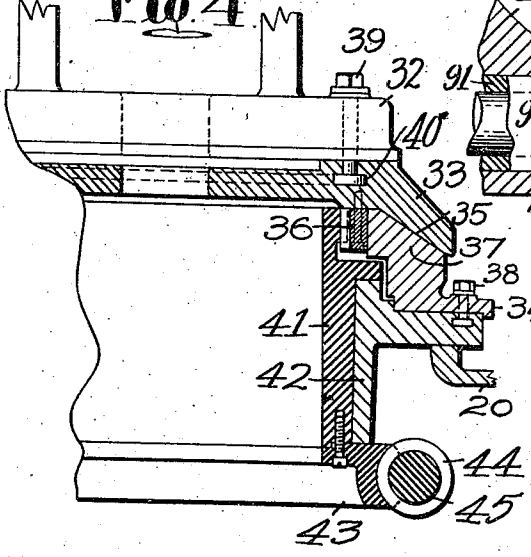


Fig. 11.

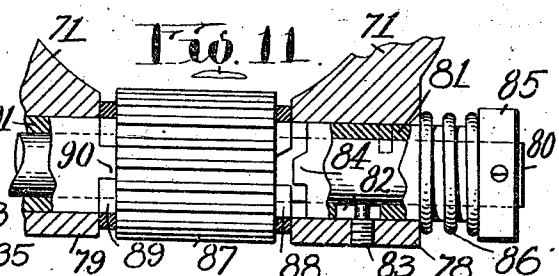
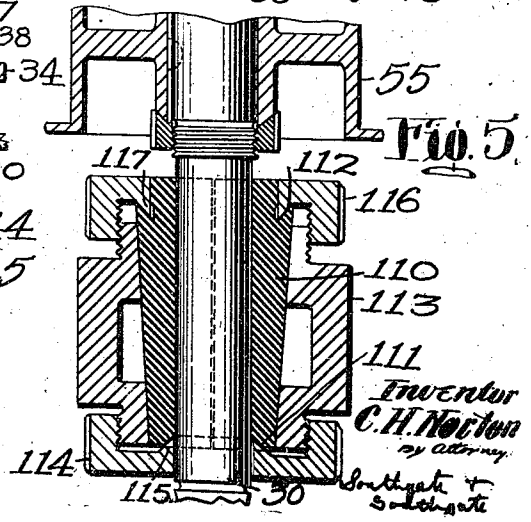


Fig. 5.



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4 SHEETS—SHEET 4.

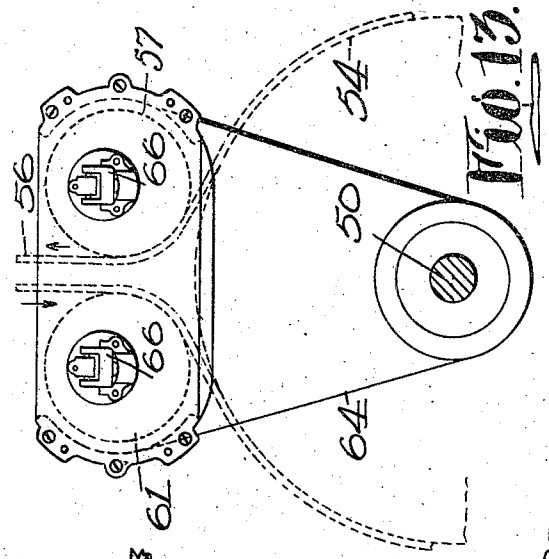


Fig. 13.

Fig. 12.

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UNITED STATES PATENT OFFICE.

CHARLES H. NORTON, OF WORCESTER, MASSACHUSETTS, ASSIGNOR TO NORTON GRINDING COMPANY, OF WORCESTER, MASSACHUSETTS, A CORPORATION OF MASSACHUSETTS.

GRINDING-MACHINE.

1,150,222. Specification of Letters Patent. Patented Aug. 17, 1915.

Application filed July 21, 1914. Serial No. 852,287.

To all whom it may concern:

Be it known that I, CHARLES H. NORTON, a citizen of the United States, residing at Worcester, in the county of Worcester and State of Massachusetts, have invented a new and useful Grinding-Machine, of which the following is a specification.

This invention relates to a grinding machine and particularly to a type of machine in which the grinding wheel is driven from below the grinding head.

Many of the features of my invention hereinafter described are particularly useful and valuable when used in a grinding machine of the universal type, but other features are also of great value when used in a plain grinding machine and I do not wish to be limited to a particular type of machine, otherwise than as set forth in the claims.

It is the usual practice in universal grinding machines to support the grinding wheel upon a wheel head which is angularly adjustable upon a wheel slide. The wheel slide is mounted for longitudinal movement upon a slide base which, in turn, is angularly adjustable upon the frame of the machine.

It is one of the objects of my invention to provide a construction, in a grinding machine of this type, in which the connections for driving the grinding wheel are brought from below to the wheel head along a path substantially coincident with the vertical axis about which the slide base is angularly adjustable. In a preferred form of my invention the wheel is belt driven and the belt is guided by idle pulleys to travel in parallel runs to and from the wheel shaft, the line of each run being closely adjacent to the axis above mentioned.

To the accomplishment of the above object, I provide an annular gear rotatably mounted upon the frame and a rack upon the wheel slide. This gear and rack constitute means for moving the wheel slide longitudinally when in any angular position and the annular gear is provided with an axial opening through which the wheel is driven.

When the invention is embodied in a plain grinding machine, simpler devices for moving the wheel slide may be substituted for the annular gear and rack but the method of driving the wheel by driving means extending upwardly through an opening in the lower part of the wheel slide is still advantageous.

Further objects of my invention are the provision of improved devices for alining the wheel shaft with the work centers, and also the provision of an internal grinding attachment on a universal grinding machine.

With reference to the latter object my invention consists in providing an auxiliary grinding shaft on the rear end of the wheel head and in providing for the driving of said auxiliary shaft from the main grinding shaft.

With these and other objects in view my invention also consists in certain devices, arrangements and combinations of parts which will be hereinafter described and more particularly pointed out in the appended claims.

A preferred form of my invention is shown in the drawings, in which—

Figure 1 is a side elevation of a universal grinding machine with parts of the work table shown in section; Figs. 2 and 3 are a top plan view and elevation respectively of the wheel head and the wheel driving mechanism, drawn on an enlarged scale; Fig. 4 is a detail sectional view of the devices for moving the wheel slide longitudinally, taken on a plane normal to the plane of Fig. 3; Fig. 5 is a detail sectional view of one of the bearings for the wheel shaft; Figs. 6 and 7 are side and end elevations respectively of the take-up guide pulley; Figs. 8 and 9 are side and end elevations respectively of the swivel guide pulley; Fig. 10 is a sectional view taken along the line 10—10 of Fig. 8. Fig. 11 is an enlarged detail view of certain of the parts shown in Fig. 10; Fig. 12 is a longitudinal view taken along the line 12—12 in Fig. 1 and showing parts of the driving mechanism; and Fig. 13 is a partial side elevation taken along the line 13—13 in Fig. 12.

Referring to Fig. 1, I have shown the wheel head mounted upon a frame 20 which supports also a work table 21 having work centers 22 secured thereto in any usual manner. Suitable devices (not shown) are provided for moving the work table 21 longitudinally, these devices being driven from the pulley 23 shown in Fig. 12.

The grinding wheel W (Fig. 1) is mounted upon a wheel shaft 30 (Figs. 2 and 3) which is supported in bearings secured to the wheel head 32. The wheel head 32 is

mounted to swivel upon a wheel slide 33 which is longitudinally movable upon the slide base 34.

The wheel slide is provided upon its lower face with an inclined guiding surface 35 (Fig. 4) and also has a rack 36 secured thereto. The inclined surface 35 and the vertical face of the rack 36 coöperate with an upwardly extending rib 37 upon the slide base to guide the wheel slide in its longitudinal movements.

The slide base 34 is angularly adjustable upon the frame 20, being held in adjusted angular position by bolts 38 (Fig. 4) moving in a T-slot in the frame. The wheel head 32 is similarly retained in adjusted angular position upon the wheel slide 33 by bolts 39, the heads of which move in a T-slot 40 in the slide 33. The angular adjustment of both the wheel head and the slide base is accomplished by loosening the bolts 38 or 39 and then turning the parts manually to the desired angular position.

In order to move the wheel slide 33 longitudinally under all conditions of angular adjustment, I provide an annular gear 41 (Fig. 3) meshing with the rack 36 (Fig. 4) and mounted to turn in a bearing 42 secured to the frame 20. At its lower end the gear 41 carries a worm wheel 43 in mesh with a worm 44 mounted upon a shaft 45. The shaft 45 extends to the front of the machine and is provided with a hand wheel 46 (Fig. 1) by means of which the slide 33 may be manually moved longitudinally. It will be obvious that the rack 36 is at all times in mesh with the gear 41 regardless of the angular position of the slide base.

In the lower part of the frame 20 I provide a power shaft 50 (Figs. 1 and 12) suitably supported in bearings 51 and 52 (Fig. 12) and provided with a driven pulley 53 which may be connected by a suitable belt to any convenient source of power. A driving drum 54 is secured to the shaft 50 within the frame 20 and constitutes means from which the grinding wheel is driven.

The connection between the driving drum 54 upon the shaft 50 and the driven pulley 55 (Fig. 2) upon the wheel shaft 30 consists of a belt 56 (Fig. 1) passing around the drum 54 and thence upwardly past an elongated guiding pulley 57, through the opening in the annular gear 41, and around guiding pulleys 58 and 59 to the driven pulley 55 upon the wheel shaft 30. The belt 56 thereafter passes around the fixed guiding pulley 60, down through the annular gear 41 to the elongated guiding pulley 61 mounted adjacent to the guiding pulley 57, and thence to the driving drum 54.

With this arrangement of guiding pulleys, best shown in Fig. 1, the belt passes to and from the wheel head in closely adjacent parallel runs which are positioned substantially along the vertical axis around which the slide base is angularly adjusted.

The elongated guiding pulleys 57 and 61 are shown in detail in Figs. 12 and 13, in which they are shown as of substantially the same width of face as the drum 54. The pulleys 57 and 61 are rotatable upon sleeves 62 secured to non-rotatable shafts 63 fixed in a casting 64 supported upon an inward extension of the bearing 51. The casting 64 is keyed to the extension of the bearing and supports the two shafts 63 in parallel relation as shown in Fig. 1.

At their outer ends the shafts 63 are provided with caps 65 which include means for oiling the pulleys 57 and 61. The oiling means comprises an oil cover 66 pivoted to each cap and closing the end of a passage 67 extending into the shaft 63 for a portion of its length and communicating with an oil pocket 68 within the sleeve 62.

The guiding pulley 60 (Figs. 1 and 3) in the wheel head 32 is mounted upon fixed bearings and guides the belt as it passes from the driven pulley 55 downward to the guiding pulley 61 and the driving drum 54.

The guiding pulley 58 is rotatably mounted on a depending arm 70 (Fig. 8) formed upon the end of a cylindrical sleeve 71. The sleeve 71 is supported in a bearing in the head 32, as shown in Fig. 3, a shoulder 72 on the sleeve positioning it longitudinally in one direction and a nut 73 threaded upon the opposite end of the sleeve preventing its displacement in the opposite direction. The pulley 58 is thus free to swing about the axis of the sleeve 71 as a center and may accommodate itself to the varying angles at which the driving belt 56 approaches the pulley.

The guiding pulley 59 (Figs. 6 and 7) is mounted on a bearing supported upon the end of a sleeve 74. The sleeve has a key way 75 formed in one side thereof and has a plurality of rack teeth 76 cut or inserted in the opposite side. The sleeve 74 is mounted within the sleeve 71 previously described and is prevented from moving angularly relatively thereto by a key or pin 77 (Fig. 8) extending into the keyway 75.

The depending arms upon the sleeve 71 provide bearings 78 and 79 (Fig. 10) for a short transverse rod 80. A bushing 81 (Fig. 11) is fixed to the rod 80 and has formed therein a slot 82 adapted to receive the reduced end of a screw 83 threaded into the bearings 78. The rod 80 is thus permitted longitudinal movement in the bearings 78 but is non-rotatable therein. The bushing 81 has one or more clutch teeth 84 formed upon its inner end for purposes to be hereinafter described.

A collar 85 is fixed to the end of the rod 80 and a coil spring 86 surrounds the rod between the collar and the bearing 78 and

normally forces the rod to the right as viewed in Fig. 11.

A pinion 87 is loosely rotatable upon the rod 80 and meshes with the rack teeth 76 formed upon the sleeve 74. The pinion 87 is provided with two sets of clutch teeth 88 and 89 formed upon its opposite ends. The clutch teeth 88 under certain conditions mesh with the clutch teeth 84 upon the sleeve 81, while the clutch teeth 89 under other conditions mesh with clutch teeth 90 formed upon a cylindrical extension 91 of a spring barrel 92 (Fig. 10). The extension 91 is rotatable within the bearing 79 and provides a bearing or support for the left hand end of the rod 80.

A flat or ribbon spring 93 is coiled within the barrel 92, having one end secured to the inner face of the barrel and having the opposite end secured to the non-rotatable rod 80. The barrel 92 is movable longitudinally with the rod 80 but is rotatable thereon under the influence of the spring 93. As the coil spring 86 (Fig. 11) slides the rod 80 to the right in said figure, the clutch teeth 90 upon the extension 91 of the barrel 92 engage the clutch teeth 89 upon the pinion 87.

The ribbon spring 93 is so disposed that it tends to rotate the pinion in the direction indicated by the arrow in Fig. 8, thus acting to force the sleeve 74 rearwardly and carrying the guiding pulley 59 in the same direction. The pulley 59 thus acts as a take-up pulley under the tension of the spring 93 and is adapted to be yieldingly moved longitudinally, thereby adjusting the effective length of the belt 56 to the varying positions of the wheel head 32 and the slide 33.

If it is desired to vary the tension of the spring 93, it is merely necessary to push the rod 80 to the left, as viewed in Fig. 11, against the pressure of the spring 86. This movement of the rod 80 will disengage the clutch teeth 90 from the teeth 89 and will at the same time engage the teeth 84 with the teeth 88.

As the teeth 84 are formed upon the non-rotatable sleeve 81, the pinion 87 is thus locked against rotation, while at the same time the spring barrel 92 is released and may be turned manually to place any desired tension upon the spring 93. When the desired tension is attained, the rod 80 is permitted to move to the right to its normal position, the teeth 90 again engage the teeth 89, and the spring 93 is connected to rotate the pinion 87 as above described.

It should be noted that the driving belt in passing from the guiding pulley 59 to the driven pulley 55 passes through the center of the sleeves 71 and 74, and also that the pulleys 57 and 61 in the frame 20 cooperate with the pulleys 58 and 60 in the head 32 to guide the belt in closely adjacent parallel runs, each normally substantially coincident with the axis of the annular gear 41.

If the slide base 34 is so adjusted angularly that the wheel slide 33 travels at right angles to the work table 21 and to the shaft 50, the parallel runs of the belt 56 will swing forward and backward about the pulleys 57 and 61 as centers, the varying distances between the several pulleys being provided for by the longitudinally movable take-up pulley 59. The opening in the annular gear 41 is of such diameter as to permit this forward and backward movement within the limits necessary for the practical operation of the machine. If, on the other hand, the slide base 34 is angularly adjusted so that the slide 33 will move parallel to the work table 21 and to the shaft 50, the driving belt will follow the movement of the slide and will travel from end to end of the drum 54 and the elongated guiding pulleys 57 and 61, the opening in the annular gear 41 similarly permitting this travel within the necessary limits.

When the slide base is positioned at any angle between the two just defined, the movement of the belt will be the resultant of the combination of a certain angular movement about the pulleys 57 and 61 with a definite longitudinal movement upon the drum 54. In any and all of these positions the swivel pulley 58 swings to accommodate itself to the approach angle of the belt 56 and the take-up pulley 59 positions itself longitudinally to keep the necessary tension upon the belt.

The wheel head 32 is shown in its normal position in Fig. 1 and is adjustable upon the slide 33 through an angle of 180 degrees in either direction. The head may thus be exactly reversed upon the slide if desired, the driving belt then becoming a cross belt instead of an open belt.

Upon the rear end of the head 32 I provide bearings 100 (Fig. 2) for an auxiliary grinding shaft 101. This shaft is provided with a driven pulley 102 upon one end and has means for supporting a small grinding wheel 103 upon the opposite end, the auxiliary grinding shaft being particularly adapted for internal grinding. When it is found desirable to use this attachment, a driving pulley 104 is mounted upon the main shaft 30 and is connected by a belt 105 with the pulley 102.

By merely reversing the position of the wheel head I am thus enabled to adapt my machine to internal grinding. This is a matter of great convenience when it is desirable to perform both external and internal grinding upon the same piece of work without changing the position of the work upon the work centers.

In all cylindrical grinding machines it is

of the greatest importance that the grinding shaft should be located exactly in the horizontal plane of the work centers. If the shaft is located in a parallel plane either above or below the centers, it will be impossible to grind a straight taper upon work held on the centers, while the location of the shaft in a plane at an angle to the plane of the centers makes it impossible to grind either cylindrical or tapered work accurately.

In order to facilitate the exact location of the grinding wheel shaft with reference to the work centers I have provided special bearings which will be now described. Each bearing consists of a split tapered sleeve 110 (Fig. 5) provided with undercut tapered recesses 111 and 112 at the ends of the tapered portion of the bushing. This sleeve is supported in a tapered hole in a box or casing 113 having externally threaded portions upon its opposite ends. A nut 114 is provided to fit upon the screw thread at one end of the casing 113 and upon its inner face the nut has a tapered projection 115 adapted to fit into the tapered recess 111. A similar nut 116 is mounted upon the opposite end of the casing 113 and is provided with a tapered projection 117 fitting into the recess 112. With this construction it will be evident that by loosening the nut 114 and tightening the nut 116 the split sleeve 110 can be moved longitudinally with relation to the casing 113. This longitudinal movement will necessarily contract the sleeve to the desired relation with the shaft 30. When the sleeve is properly positioned longitudinally, the nuts 114 and 116 may be tightened to firmly clamp the sleeve in the casing 113, the tapered projections 115 and 117 forcing the split sleeve 110 firmly into contact with the casing 113.

Upon its exterior the casing 113 is provided with a plurality of angularly disposed flat surfaces 120 (Fig. 3). The head 32 has a pair of similarly disposed surfaces 121 for each bearing and is also provided with clamps or caps 122 having angularly disposed surfaces 123 upon their lower faces. Each clamp 122 is secured to the head 32 by a screw 124, and is laterally positioned upon the head by bearing surfaces 125 and 126. With the casings and their supporting surfaces constructed in this manner it is a comparatively simple matter to adjust the boxes vertically until the shaft is alined in the exact horizontal plane of the work centers. This vertical adjustment is ordinarily accomplished by filing or scraping one or more of the surfaces 120 and 121 until the shaft is exactly alined. Similar provision is made for the alinement and adjustment of the auxiliary grinding shaft 101.

The operation of my machine has been indicated in connection with the detailed description of the several parts and further description thereof is considered unnecessary.

When my improved construction for driving the grinding wheel is used in a plain machine the swivel pulley 58 may be arranged as a fixed pulley similar in all respects to the pulley 60, while the slide for the take-up pulley 59 and its operating mechanism may be mounted directly upon the wheel head instead of upon the rotatable sleeve 71. Simpler devices of well known construction, such as a screw upon the shaft 45 and a nut projected downward from the wheel head, will serve to move the head longitudinally. The wheel slide may be merged with the wheel head and the slide base may be formed integral with the frame of the machine. With these changes the take-up and guide pulleys perform their functions as previously described and an extremely simple self contained belt driven machine results.

It will be apparent that other driving connections may be substituted for the belt drive shown in either the universal or the plain type of machine, without losing many of the advantages shown and described. It will also be evident from the foregoing description that many other changes and modifications can be made therein by those skilled in the art without departing from the spirit and scope of my invention as set forth in the claims and I do not wish to be limited to the details herein disclosed, but

What I do claim is:—

1. A grinding machine having, in combination, a frame, a wheel head longitudinally movable thereon, a wheel shaft and wheel rotatably mounted on said head, a power shaft, means including an annular member for moving said wheel head longitudinally, and driving means passing freely through the annular member from the power shaft to the wheel shaft and effective to rotate the latter.

2. A grinding machine having, in combination, a frame, a wheel head longitudinally movable thereon, a wheel shaft and wheel rotatably mounted on said head, a power shaft, means including an annular member for moving said wheel head longitudinally, and a belt passing freely through said annular member from said power shaft to said wheel shaft for driving the latter.

3. A grinding machine having, in combination, a frame, a wheel head longitudinally movable on said frame, a rack, an annular gear meshing with said rack to move said head longitudinally, a wheel shaft, and wheel on said head, a power shaft mounted in said frame, and driving means passing through said annular gear for transmitting

power from the power shaft to the wheel shaft.

4. A universal grinding machine having, in combination, a frame, a power shaft supported therein, a wheel head mounted to swivel on said frame, a wheel shaft and wheel rotatable on said head, a rack for moving the head longitudinally, an annular gear for driving said rack, and driving means for said wheel, said driving means passing through said annular gear from the power shaft to the wheel shaft.

5. A universal grinding machine having, in combination, a frame, a slide base angularly adjustable thereon about a vertical axis, a slide longitudinally movable on said base, means to move said slide longitudinally, a grinding wheel supported on said slide, a power shaft mounted below the slide, and means for driving said grinding wheel from said power shaft, said means passing upwardly through the frame substantially along said vertical axis.

6. A universal grinding machine having, in combination, a frame, a slide base angularly adjustable thereon about a vertical axis, a slide longitudinally movable on said base, means to move said slide longitudinally, a wheel head swiveled on the slide and supporting a wheel shaft and grinding wheel, a power shaft mounted in the frame below the slide, and a driving belt from said power shaft to said wheel shaft, said belt passing in parallel runs substantially coincident with said vertical axis of angular adjustment.

7. A universal grinding machine, having in combination, a frame, a slide base angularly adjustable thereon, a slide longitudinally movable on said base, a rack on the slide, an annular gear meshing with said rack, means to rotate said gear to move the slide longitudinally, a wheel shaft and wheel supported on said slide, a power shaft mounted in the frame, and means for driving said wheel shaft from said power shaft, said latter means passing freely through the center of annular gear.

8. A universal grinding machine, having in combination, a frame, a slide base angularly adjustable thereon, a slide longitudinally movable on said base, a rack on the slide, an annular gear meshing with said rack, means to rotate said gear to move the slide longitudinally, a swivel head angularly adjustable on said slide, a wheel shaft and wheel mounted on said head, a power shaft mounted in the frame, and driving connections from said power shaft to said wheel shaft, said connections passing through the opening in the annular gear.

9. A universal grinding machine, having in combination, a frame, a slide base angularly adjustable thereon, a slide longitudinally movable on said base, a rack on the slide, an annular gear meshing with said rack, means to rotate said gear to move the slide longitudinally, a swivel head angularly adjustable on said slide, a wheel shaft and wheel mounted on said head, a power shaft mounted in the frame, pulleys on said wheel shaft and said power shaft, and a driving belt passing over said pulleys and also passing freely through the opening in the annular gear.

10. A universal grinding machine, having in combination, a frame, a power shaft mounted in said frame, a longitudinally extending drum on said power shaft, a wheel head mounted to swivel and to be moved longitudinally on said frame, a rack, an annular gear meshing with said rack for moving said head longitudinally, a wheel shaft and wheel on said head, a pulley on the wheel shaft, a belt running over the drum and said pulley, and a plurality of guiding pulleys which direct said belt through the opening in said annular gear.

11. A universal grinding machine, having in combination, a frame, a power shaft mounted in said frame, a longitudinally extending drum on said power shaft, a wheel head mounted to swivel and to be moved longitudinally on said frame, a rack, an annular gear meshing with said rack for moving said head longitudinally, a wheel shaft and wheel on said head, a pulley on said shaft, a belt running over the drum and said pulley, guiding pulleys for said belt mounted on said head and including a take-up pulley, and guiding pulleys adjacent said drum, said belt being thereby guided to pass freely through said annular gear.

12. A universal grinding machine, having in combination, a frame, a power shaft mounted in said frame, a longitudinally extending drum on said power shaft, a wheel head mounted to swivel and to be moved longitudinally on said frame, a rack and annular gear for moving said head longitudinally, a wheel shaft and wheel on said head, a pulley on said shaft, a belt running over the drum and said pulley, and longitudinally extending guiding pulleys adjacent said drum and effective to guide said belt freely through the opening in said annular gear.

13. A universal grinding machine, having in combination, a frame, a power shaft mounted in said frame, a longitudinally extending drum on said power shaft, a wheel head mounted to swivel and to be moved longitudinally on said frame, a rack and annular gear for moving said head longitudinally, a wheel shaft and wheel on said head, a pulley on said shaft, a belt running over the drum and said pulley, guiding pulleys for said belt mounted on said head and additional guiding pulleys on said frame, said two sets of guiding pulleys being effec-

tive to guide the belt in closely adjacent parallel runs through the opening in said annular gear.

14. A universal grinding machine, having in combination, a frame, a power shaft mounted in said frame, a driving pulley on said shaft, a wheel head angularly adjustable upon a slide, means to angularly adjust said slide relatively to the frame, a rack on said slide, an annular gear for driving said rack to move the slide longitudinally, means to rotate said gear, a wheel shaft mounted on said head, a grinding wheel and a driven pulley on said wheel shaft, a belt for transmitting power from the driving to the driven pulley, and a plurality of guiding pulleys on said head comprising a fixed pulley, a take-up pulley and a swivel pulley, said pulleys operating to guide the belt through an opening in the annular gear.

15. In a universal grinding machine, in combination, a frame, a wheel head angularly adjustable thereon, a power shaft mounted in said frame, a wheel shaft in said head, a belt from the power shaft to the wheel shaft, and a plurality of guiding pulleys for said belt, said pulleys including a swivel pulley mounted to swing freely about a horizontal axis normal to the wheel shaft.

16. In a grinding machine, in combination, a wheel head, a wheel shaft on said head, a belt for driving said shaft, a take-up pulley for maintaining constant tension on said belt, a slide for said take-up pulley, a spring tending normally to force said slide rearwardly, and means to adjust the tension of said spring.

17. In a grinding machine, in combination, a wheel head, a guiding pulley mounted on a slide on said head, a rack on said slide, a pinion meshing with said rack, clutch teeth on the end of said pinion, a non-rotatable rod slidable in said pinion, a spring barrel mounted on said rod and having clutch teeth upon an extension thereof, a coiled spring within said barrel having its ends connected respectively to said barrel and to said rod, and a spring on said rod tending to slide the rod to hold the clutch teeth in mesh.

18. In a grinding machine, in combination, a wheel head, a guiding pulley mounted on a slide therein, a rack on said slide, a pinion meshing with said rack, a spring barrel connected to rotate said pinion, and means to simultaneously disengage said barrel and to lock said pinion against rotation, thereby permitting manual adjustment of the spring tension by turning the barrel.

19. In a grinding machine, in combination, a wheel head, a guiding pulley mounted on a slide thereon, a rack on said slide, a pinion meshing with said rack, clutch teeth on both ends of said pinion, a non-rotatable rod slidable in said pinion, a toothed sleeve fixed to said rod, a spring barrel rotatable on said rod and having clutch teeth upon an extension thereof, a flat coiled spring having its ends connected respectively to said barrel and to said rod, and a spring surrounding said rod and tending to slide the rod to engage the clutch teeth on the spring barrel with the teeth on one end of the pinion, said rod being manually movable in the opposite direction to engage the teeth upon the non-rotatable sleeve with the teeth upon the opposite end of the pinion and to simultaneously disengage the clutch teeth upon the spring barrel, said barrel being thereby released to permit manual adjustment of the spring tension.

20. In a grinding machine, in combination, a wheel head, a wheel shaft mounted on said head, a grinding wheel and a driven pulley on said wheel shaft, and guiding pulleys comprising a fixed pulley, a take-up pulley and a swivel pulley also mounted on said head to guide a belt to and from the driven pulley, said swivel pulley being mounted on a sleeve angularly movable about a horizontal axis normal to the wheel shaft, and said take-up pulley being supported by a slide longitudinally movable relative to said sleeve and angularly movable therewith.

21. A universal grinding machine having, in combination, a frame, a power shaft mounted in said frame, an angularly adjustable wheel head, a main grinding shaft mounted at one end of said head, an auxiliary grinding shaft mounted at the other end of said head, means to drive the main grinding shaft from the power shaft, and means to drive the auxiliary grinding shaft from the main grinding shaft.

22. A universal grinding machine having, in combination, a wheel head supporting a wheel shaft and a grinding wheel, means permitting adjustment of said wheel head through an angle of 180 degrees in either direction from its normal position, and means for driving the grinding wheel with the head in different angular positions, said driving means being positioned entirely below the wheel head.

23. A universal grinding machine having, in combination, a wheel head supporting a wheel shaft and grinding wheel, means permitting the adjustment of said wheel head through an angle of 180 degrees in either direction from its normal position, an auxiliary grinding shaft mounted upon the rear end of the wheel head, and means to rotate said auxiliary shaft.

24. A grinding machine having, in combination, a longitudinally movable work supporting table having a pair of centers mounted thereon, a wheel head, a wheel shaft rotatably mounted in said wheel head, and bearings for said shaft, each compris-

ing a sleeve having a plurality of flat surfaces angularly disposed upon its exterior, said wheel head also having a plurality of flat surfaces disposed at corresponding angles and having means to clamp said sleeves upon the last mentioned surfaces.

25. A grinding machine having, in combination, a longitudinally movable work supporting table having a pair of centers mounted thereon, a wheel head, a wheel shaft rotatably mounted in said wheel head, bearings for said shaft, and means for adjusting said shaft in the horizontal plane of the centers, said means comprising a plurality of angularly disposed surfaces upon the exterior of said bearings, a pair of similarly disposed surfaces upon the head for each bearing, and caps having a pair of surfaces disposed at the same angle and effective to hold said bearings upon said head, each bearing being adjustable in a plurality of angular positions relative to said head.

26. A grinding machine having, in combination, a frame, a power shaft mounted thereon, a driving pulley on said shaft, a wheel head movable longitudinally on said frame, means for moving said head longitudinally, a wheel shaft and wheel on said head, a pulley on said shaft, a belt running over said pulleys, guiding pulleys for said belt mounted on said head, and additional guiding pulleys mounted on the frame, the two sets of guiding pulleys being effective to guide the belt in closely adjacent parallel runs through an opening in the lower portion of the wheel head.

27. In a grinding machine, in combination, a wheel head, a wheel shaft on said head, a belt for driving said shaft, a take-up pulley for maintaining constant tension on said belt, a slide supporting said take-up pulley, and a spring tending normally to force said slide rearwardly, said belt passing longitudinally through said slide from said take-up pulley to a pulley on said wheel shaft.

In testimony whereof I have hereunto set my hand, in the presence of two subscribing witnesses.

CHARLES H. NORTON.

Witnesses:
A. G. BELDEN,
R. D. HUBBELL.