March 6, 1928. 1,662,023

W. J. BAUMBERGER

GRINDING MACHINE

Filed Nov. 20, 1922 2 Sheets-Sheet 1

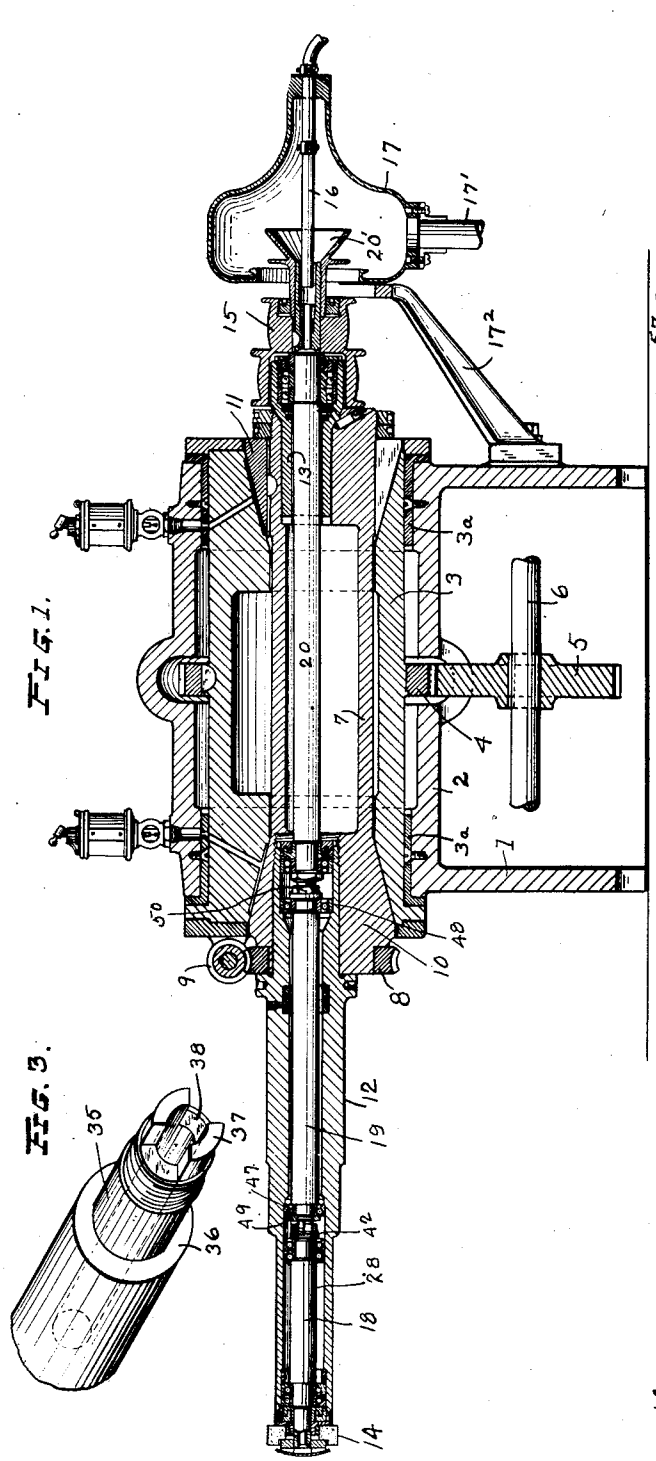

Fig. 1.

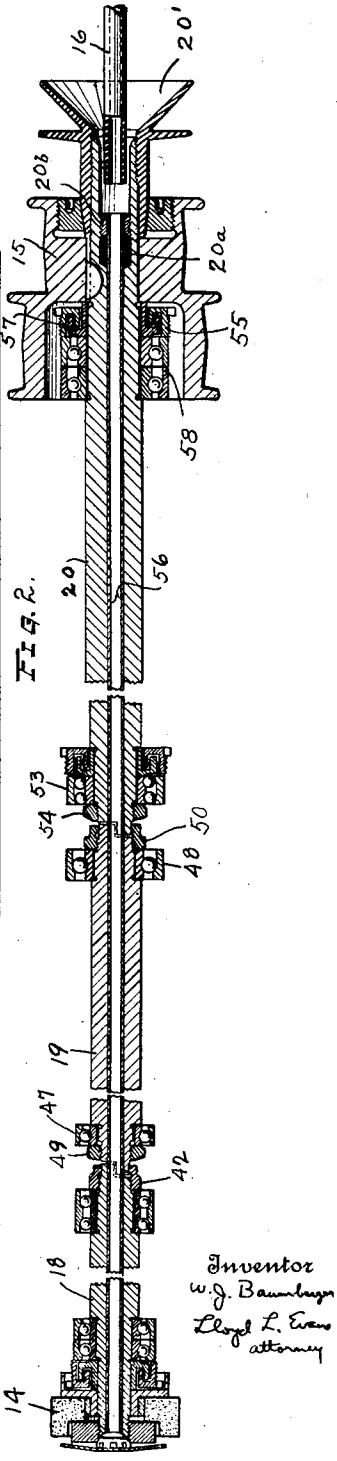

Fig. 2.

Fig. 3.

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FIG. 4.

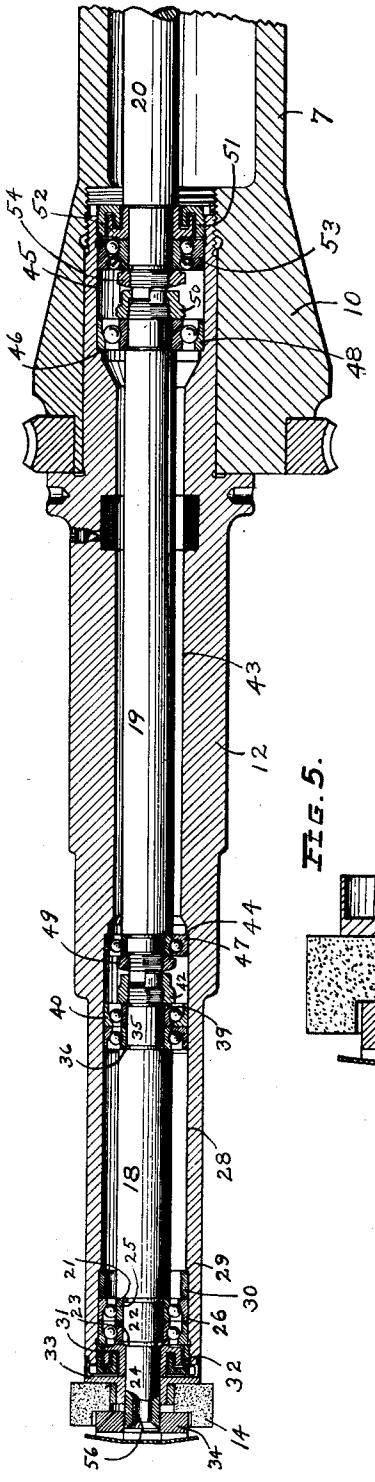
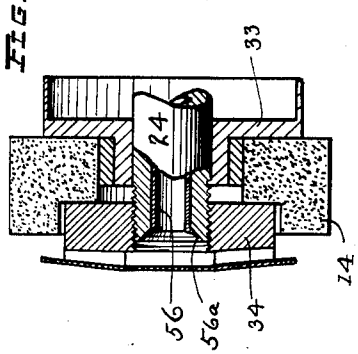


FIG. 5.



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Patented Mar. 6, 1928. 1,662,023

UNITED STATES PATENT OFFICE.

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GRINDING MACHINE.

Application filed November 20, 1922. Serial No. 602,068.

This invention relates to grinding machines and more particularly to rotary grinding wheels carried by a rigid arm and adapted for internal grinding. The present invention is an improvement over the constructions disclosed in copending applications of H. M. Jerome Serial No. 483,195, filed July 26, 1921; and of H. F. Joseph, Serial No. 506,301, filed October 8, 1921.

An object of this invention is to provide a construction in which vibration or chattering of the tool spindle is substantially eliminated, even though the spindle be rotated at a high speed.

A further object is to provide the sectional spindle for carrying the grinding wheel with a fluid tight conduit through the spindle sections to carry fluid to the grinding wheel.

Another object is to provide an improved joint between the sections of the tubular spindle.

Other objects will be apparent from the following description and annexed drawings.

The following description and annexed drawings set forth in detail certain means embodying the invention, the disclosed means, however, constituting but one of the various mechanical forms in which the principle of the invention may be applied. Reference should be had to the annexed drawings forming a part of this specification, in which

Figure 1 is a longitudinal central vertical section through the machine.

Fig. 2 is a longitudinal section through the sectional spindle.

Fig. 3 is a fragmentary view showing the end of a section of the spindle in perspective.

Fig. 4 is an enlarged sectional view of the spindle.

Fig. 5 is an enlarged sectional view of the front end of the spindle and grinding wheel.

The invention is shown in connection with a machine for internal grinding such as shown in the copending applications above referred to. The machine frame or support 1 has a cylindrical upper portion 2 in which is rotatably mounted the drum 3 on bearings 3a. The drum 3 has an external gear 4 in mesh with gears 5 on the drive shaft 6. Journaled in the drum is an eccentric sleeve member 7 having a worm wheel 8 fixed to one end, which meshes with a worm 9 carried by the drum 3. The sleeve 7 is held against endwise movement by a conical outwardly flaring integral end portion 10 at its forward end and a conical collar 11 adjustably secured upon its rear end. The sleeve receiving opening in the drum is flared outwardly at the ends to receive the enlarged end of the sleeve 7 and the collar 11. A tubular spindle housing 12 is rigidly secured within an eccentric bore in the enlarged portion 10 of the sleeve 7, and extends parallel with the axis thereof. An alined spindle sleeve 13 is secured within the opposite end of the sleeve 7 in alinement with the tubular housing 12. A spindle is journaled in suitable bearings in the tubular housing 12 and sleeve 13 and carries the grinding wheel 14 which is suitably secured thereto at its forward end which projects from the forward end of the tubular housing 12. The spindle is driven by a belt pulley 15 suitably secured to it to rotate therewith at a point in the rear of the sleeve 13. The spindle is tubular and is preferably composed of a plurality of sections having interfitting flanges and recesses as more fully described hereinafter.

The eccentric sleeve 7 may be adjusted by the worm 9 to vary the eccentricity of the spindle housing with respect to the drum. When the drum 3 is rotated, the spindle housing 12 is revolved bodily in a circular path about the axis of the drum. The diameter of such path may be varied by adjusting the sleeve 7 in the drum. The circular movement of the spindle housing causes the grinding wheel 14 to move in a path around the interior of the cylinder or work being ground.

It is desirable to eliminate in so far as possible the vibration of the spindle upon which the tool is mounted, especially adjacent the end on which the tool is mounted. This is accomplished by providing a series of bearings mounted within the tubular housing 12 as hereinafter described to independently support the sections of the spindle. Even though the spindle sections have their interfitting projections 37 accurately made so that there is substantially no

play perceptible between the radially abutting side walls of the projections, yet these joints will absorb vibrations and break up the long waves or periods of vibration which might otherwise be present.

A tube 56 may be inserted in the spindle and extends through the sections 18, 19 and 20. Preferably the forward end of the tube 56 is swaged to engage the tapered opening 56^a at the forward end of the spindle 18 and the tube is secured thereto by tinning and sweating, or by any other suitable means so that a tight joint is made between the spindle and tube to prevent any liquid from seeping backward between the tube 56 and the spindle section 18. At the rear end the spindle section 20 is recessed to receive suitable packing 20^a, which is compressed against the tube 56 by means of the nut 20^b to prevent fluid from passing between the tube and the spindle section 20.

The tube 56 does away with the necessity of making an absolutely liquid tight fit between the spindle sections and yet insures that none of the liquid carried through the spindle will come in contact with the bearings supporting the various sections of the spindle. It insures that all the liquid furnished at the rear end will be carried to the nozzle portion where it is desired to direct it at such an angle that the liquid will be forced into the path of the grinding wheel. While the water will be forced under more or less pressure through the tube 56, centrifugal action of the grinding wheel augments this pressure, it being understood that the grinding wheel is rotated at a very high speed. The water is directed in the path of the wheel so that the wheel will engage only clean fresh surfaces and will not collect the dust and débris common when a dry grinding wheel is used. This insures a more rapid cutting action, a smoother cut, and the accuracy of the cut will be greater as all cutting points of portions of the wheel are operating and are not choked or covered with previously cut material.

To supply the fluid I provide an enlarged bore at the rear end of the spindle to receive a flexible hose 16 of somewhat smaller diameter, so that there will be sufficient clearance between the hose 16 and the end of the spindle section to prevent the latter from wearing or burning the hose due to its rapid rotation. The excess water supplied by the hose seeps backward through this space and prevents contact between the hose and spindle. The flexible hose 16 is carried by the hood 17 which is shaped to surround the rear end of the spindle. The end of the spindle 20 may have a funnel shaped guide 20′ threaded thereto. This guide will direct the fluid from the flexible hose 16 into the spindle opening, or if the operator desires, the hose itself may be pushed forward into the recess at the rear of the spindle as above described. The forward end of the guide 20′ may be suitably engaged by nut 20^c laid into the pulley 15 to prevent relative movement of the guide 20′ with respect to the spindle section 20 when the latter is driven in operation. The hood 17 is supported by a suitable bracket 17^a secured to the frame of the machine and carries an outlet pipe to catch the leakage and return the same through the drain pipe 17′ to a suitable tank (not shown) and from there it is again pumped through the hose 16. The forward portion of the hood has an enlarged opening in which the spindle may extend and be revolved and rotated so that the hood at all times surrounds the flared end of the spindle, catching any liquid thrown off by centrifugal force and carrying it into the drain pipe.

The forward section 18 of the spindle to which the grinding wheel is secured is relatively short. The other sections of the spindle are relatively longer, and preferably longer progressively toward the rear of the spindle. The spindle may be composed of any number of sections, but I have found that for a majority of work to divide the spindle into three sections will enable one to rotate the spindle with a relatively high speed of rotation and do away with substantially all vibration or chattering, thus insuring a much smoother and more perfect surface after grinding than when a spindle of one piece is used.

The forward section 18 of the spindle has a driving connection with the section 19 which may extend to the adjacent inner end of the housing 12, and which is in turn connected with a section 20, which extends through the sleeve 7 and carries the belt pulley 15 at the rear of the sleeve 7. The forward end of the section 18 of the spindle is stepped to provide an inner peripheral shoulder 21 and the reduced portion 22, and is further stepped to provide the reduced portion 24 and the shoulder 23. A ball bearing is mounted on the portion 22 of the spindle and comprises inner and outer races 25, 26 fitting tightly upon the reduced portion 22 of the spindle and against the inner surface of the housing 12 respectively. The forward end portion of the tubular housing 12 has a bore 28 of enlarged diameter which is shouldered at 29. Between the shoulder and outer race of the ball bearing is a suitable spacing collar 30.

Fitted upon the reduced end 24 of the spindle section 18 is a spacing collar 31 which may be channel shaped in cross section with its channel facing outwardly and its inner leg of greater length. A spacing collar 32 which is channel shaped in cross section is externally threaded and is adapted to be screwed into the outer end of the

housing 12. The collar 32 has its channel facing inwardly with its short leg fitting within the channel of the collar 31, and its channel receiving the short outer leg of the channel collar 31. The outer longer leg of the threaded collar 32 bears against the outer race of the bearing and holds it against the internal collar 30. A collar 33 which may be Z-shaped in cross section is fitted upon the reduced end portion 24 of the spindle outside the collar 31. The collar 33 has a rearwardly extending peripheral flange overlying the outer end of the collar 32 and an outwardly extending hub flange upon the reduced end 24 of the spindle section 18. A nut 34 upon the threaded end of the spindle section 18 clamps the grinding wheel 14 against the collar 33, and holds the collar 33 against the inner long leg or flange of the collar 31 and the bearing race 25 against the shoulder 21. The interfitting flanges of the collars 31 and 32 also prevent leakage of the lubricant for the bearings in the spindle housing.

The inner end portion 35 of the short section 18 is reduced, forming a shoulder 36, and is threaded part way from the end. The extreme inner end of the section 18 has portions cut away on radial lines, forming unthreaded projections 37 and notches 38 adapted to interfit with similar notches and projections on the outer end of the intermediate spindle section 19. A bearing is fitted upon the unthreaded part of the reduced inner end of the section 18 and consists of inner and outer races 39 and 40 fitted on the spindle and within the bore 28 of the housing 12. A nut 42 is screwed upon the threaded part of the end portion 35 of the section 18, and has an unthreaded outer portion overlying the interfitting notched ends of the sections 18 and 19. The nut 42 holds the inner race 39 of the bearings tightly against the shoulder 36.

The enlarged bore 28 of the tubular housing 12 terminates a short distance beyond the inner end of the outer spindle section 18 where the tube has a smaller bore 43 forming a shoulder 44. The inner end of the tubular housing 12 has an enlarged bore 45 forming a shoulder 46 at the inner end of the bore 43. The intermediate spindle section 19 has reduced notched and threaded ends similar to the inner end of the outer spindle section 18, and is provided with ball bearings 47 and 48 at its outer and inner ends similar to the ball bearings at the ends of the spindle section 18. The outer notched end of the spindle section 19 interfits with the inner notched end of the spindle section 18 and has a nut 49 which clamps the bearing 47 against the spindle shoulder and against the internal shoulder 44 of the tubular housing 12. The inner notched end of the spindle section 19 interfits with the outer end of the inner spindle section 20, and has a nut 50 similar to the nut 42 on the spindle section 18 which clamps the bearing 48 against the spindle shoulder and against the internal shoulder 46 of the tubular housing 12. The bearings 47 and 48 clamped to the housing 12 by the nuts 49 and 50 serve to hold the intermediate spindle section 19 against longitudinal movement with respect to the housing 12.

The outer end of the inner spindle section 20 has a reduced threaded and notched outer end interfitting with the inner end of the intermediate section 19. A threaded collar 51 similar to the collar 32 at the outer end of the housing is screwed into the enlarged inner end of the housing 12, and has a channel receiving the flange of a collar 52 similar to the collar 31 at the outer end of the spindle, and fitted upon the reduced outer end of the inner spindle section 20. A ball bearing 53 is fitted on the reduced end of the spindle section 20 outside the collar 52. A nut 54 clamps the bearing 53 and collar 52 against the spindle shoulder. The threaded collar 51 engages the collar 52 to prevent leakage of lubricant.

The opposite end of the inner spindle section 20 is provided with ball bearings 58 within the enlarged outer end of the sleeve [illegible] on the opposite end of the bearing sleeve 7, similar to its bearings within the inner end of the tubular housing 12. The bearings are clamped against a shoulder on the sleeve 13 by a collar 55 threaded into the open end of sleeve 13. The spacing collar 57 is locked on the spindle section between the bearings 58 and the pulley 15. The collars 55 and 57 are channel shaped and have cooperating flanges to prevent the leakage of lubricant. The spindle 20 is thus clamped against endwise movement with respect to the tubular housing 12 and sleeve 7.

It is well known that any vibrational waves which may be set up are of less amplitude in a relatively short spindle section. I have therefore made my spindle section shorter progressively toward the tool carrying section, the latter being the shortest of all. By connecting the sections of the spindle as above described and mounting them independently and rigidly in spaced bearings which serve to maintain them in alinement the transmission of vibrations from one section of the spindle to another through the driving sections is substantially prevented.

It will thus be seen that the tool carrying spindle section is relatively short and rigidly supported and therefore that the critical speed of rotation of the spindle is relatively much higher and that my spindle may be operated at relatively high speeds and with

substantially no vibration, thus obtaining a much smoother surface on the work being ground.

With grinding wheels for internal work it is desirable to have a hollow spindle for conducting water to the wheel. If the spindle is sectional it is necessary to provide means for preventing leakage at the joints to prevent the liquid from coming into contact with the bearings supporting the spindle sections.

It will therefore be seen that I have avoided the complications arising from attempting to make a sectional spindle construction with water tight joints and I have made the sections and joints of such nature that vibration will not be transmitted. For in my construction I have made the spindle hollow or tubular and provided an inner tube 56 of brass or other suitable material, preferably flexible, extending throughout the length of the sections of the spindle.

Furthermore, it is to be understood that the particular forms of apparatus shown and described, and the particular procedure set forth, are presented for purposes of explanation and illustration and that various modifications of said apparatus and procedure can be made without departing from my invention as defined in the appended claims.

Having fully described my invention, what I claim is:

1. In a grinding machine for use in wet grinding, in combination, a hollow grinding wheel spindle comprising a plurality of longitudinally aligned hollow spindle sections, each said spindle section being rigidly supported in rotatable manner by suitable bearings adjacent each end thereof, operative connections between adjacent spindle sections whereby said sections may be simultaneously rotated by rotation of one spindle section, a grinding wheel secured to one of said spindle sections at one end of said spindle, means for rotating another spindle section, and means for conducting liquid through said spindle to the end section thereof carrying the grinding wheel, said liquid conducting means comprising a tube rotatable with said spindle and extending through said spindle from adjacent one end thereof past the joints of adjacent spindle sections to adjacent the other end of said spindle, said tube being secured at its ends to respective spindle sections in liquid-tight manner, said tube cooperating relatively closely throughout its length with the interior walls of said spindle, said tube being, when disposed in said spindle, relatively rigid in character but sufficiently flexible to function satisfactorily when there is slight misalignment of adjacent spindle sections.

2. In a grinding machine for use in wet grinding, in combination, a hollow grinding wheel spindle comprising a plurality of longitudinally aligned hollow spindle sections, each said spindle section being independently mounted in rotatable manner and so as to prevent appreciable longitudinal movement thereof with respect to the other spindle sections, operative connections between adjacent spindle sections whereby said sections may be simultaneously rotated by rotation of one spindle section, a grinding wheel secured to one of said spindle sections at one end of said spindle, means for rotating the spindle section at the other end of said spindle, means for conducting liquid through said spindle to the end section thereof carrying the grinding wheel, said liquid conducting means comprising a metal tube rotatable with said spindle and extending through said spindle from adjacent one end thereof past the joints of adjacent spindle sections to adjacent the other end of said spindle, said tube being secured at its ends to the respective spindle sections in liquid-tight manner, said tube cooperating relatively closely throughout its length with said spindle sections, said tube being, when disposed in said spindle, relatively rigid in character but sufficiently flexible to function satisfactorily when there is slight misalignment of adjacent spindle sections, means to guide liquid into one end of said hollow spindle, and means adjacent the opposed end of said spindle to deflect said liquid radially of the grinding wheel.

3. In a grinding machine, in combination, a rotatable drum, a rotatably adjustable sleeve mounted in said drum, an integral spindle housing extending into and secured to said sleeve and extending outwardly beyond one end thereof, a grinding wheel spindle extending from within said sleeve through said spindle housing, said spindle being arranged to carry a grinding wheel comprising a plurality of sections progressively decreasing in length toward the outer end of said spindle housing, said spindle housing being reduced in section toward the outer end thereof adjacent successive spindle sections disposed in said housing, said spindle sections being independently mounted in bearings and connected together for simultaneous rotation, and means for rotating said spindle.

4. In a grinding machine for use in wet grinding, in combination, a rotatable drum, a rotatably adjustable sleeve mounted in said drum, an integral spindle housing extending into and secured to said sleeve and extending outwardly beyond one end thereof, a hollow sectional grinding wheel spindle extending through said sleeve and spindle housing, said spindle being arranged to carry a grinding wheel adjacent the outer end of said spindle housing, said spindle comprising a plurality of spindle sections progressively decreasing in length toward the outer end of said spindle housing, said spindle

sections being independently mounted in bearings and connected together for simultaneous rotation, means for rotating one of said spindle sections, and means for conducting liquid through said spindle to the end section thereof carrying the grinding wheel, said liquid conducting means comprising a tube rotatable with said spindle and extending through said spindle from adjacent one end thereof past the joints of adjacent spindle sections to adjacent the other end thereof, said tube being secured at its ends to the respective spindle sections in liquid-tight manner, said tube cooperating relatively closely throughout its length with said spindle sections, said tube being, when disposed in said spindle, relatively rigid in character but sufficiently flexible to function satisfactorily when there is slight misalignment of the spindle sections.

5. In a grinding machine, in combination, a rotatable drum, a rotatably adjustable sleeve mounted in said drum, an integral spindle housing extending into and secured to said sleeve and extending outwardly beyond one end thereof, a sectional grinding wheel spindle extending through said sleeve and spindle housing, said spindle being arranged to carry a grinding wheel adjacent the outer end of said spindle housing, said spindle comprising a plurality of sections progressively decreasing in length toward the outer end of said spindle housing, said spindle housing being reduced in section toward the outer end thereof adjacent successive spindle sections disposed in said housing, each said spindle section being independently mounted in bearings adjacent the ends thereof and connected together for simultaneous rotation, means for rotating said spindle, said spindle housing carrying all of the bearings for at least two spindle sections and the bearings for one end of another spindle section.

In testimony whereof, I hereunto affix my signature.

WILLIAM J. BAUMBERGER.