June 3, 1930. L. F. NENNINGER 1,761,841

MILLING MACHINE

Filed June 16, 1926 3 Sheets-Sheet 1

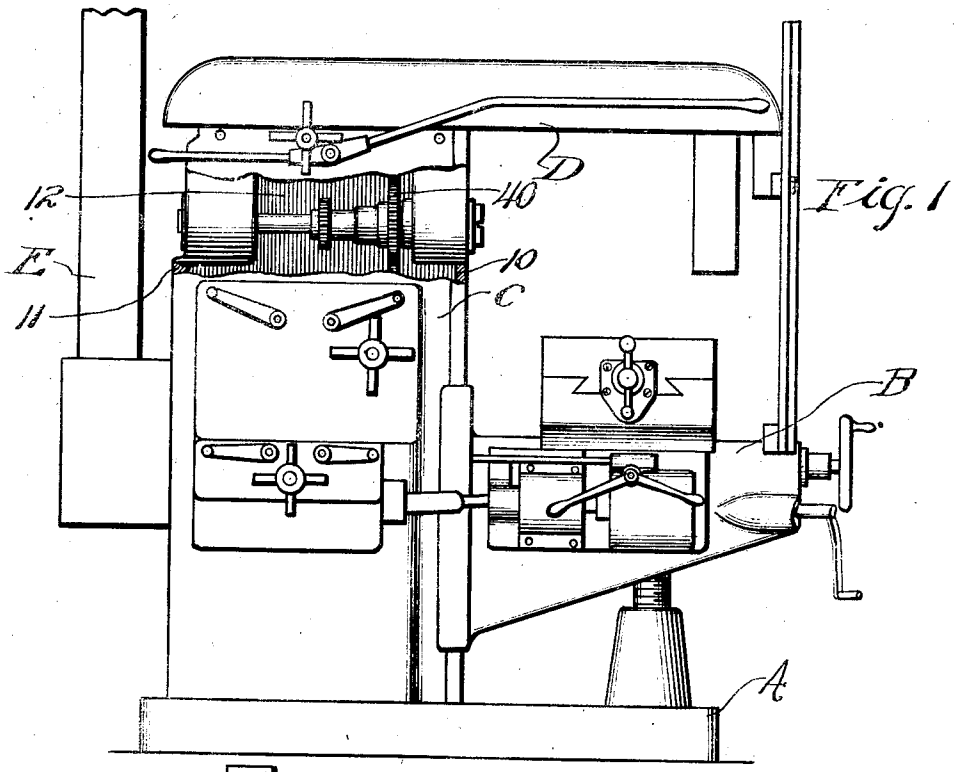

Fig. 1

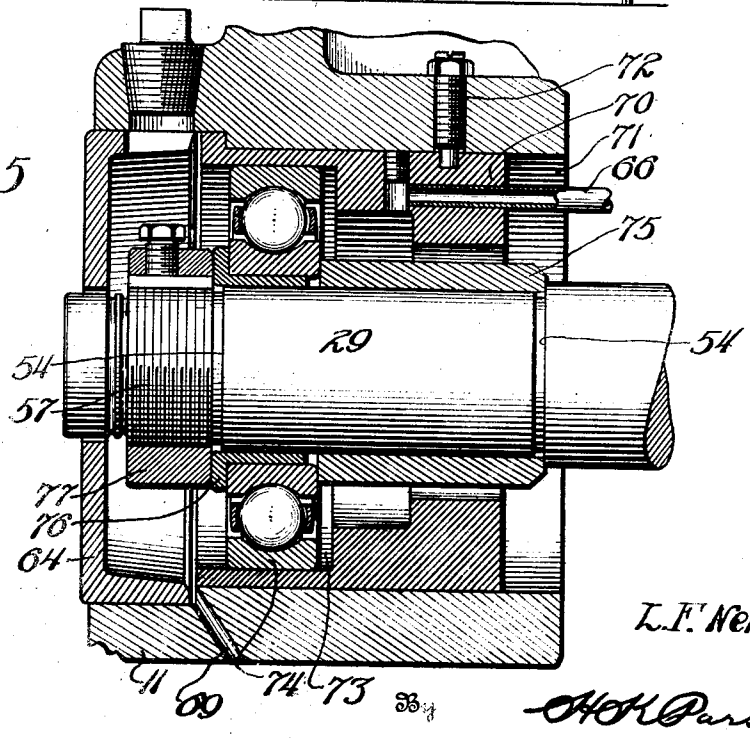

Fig. 5

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MILLING MACHINE

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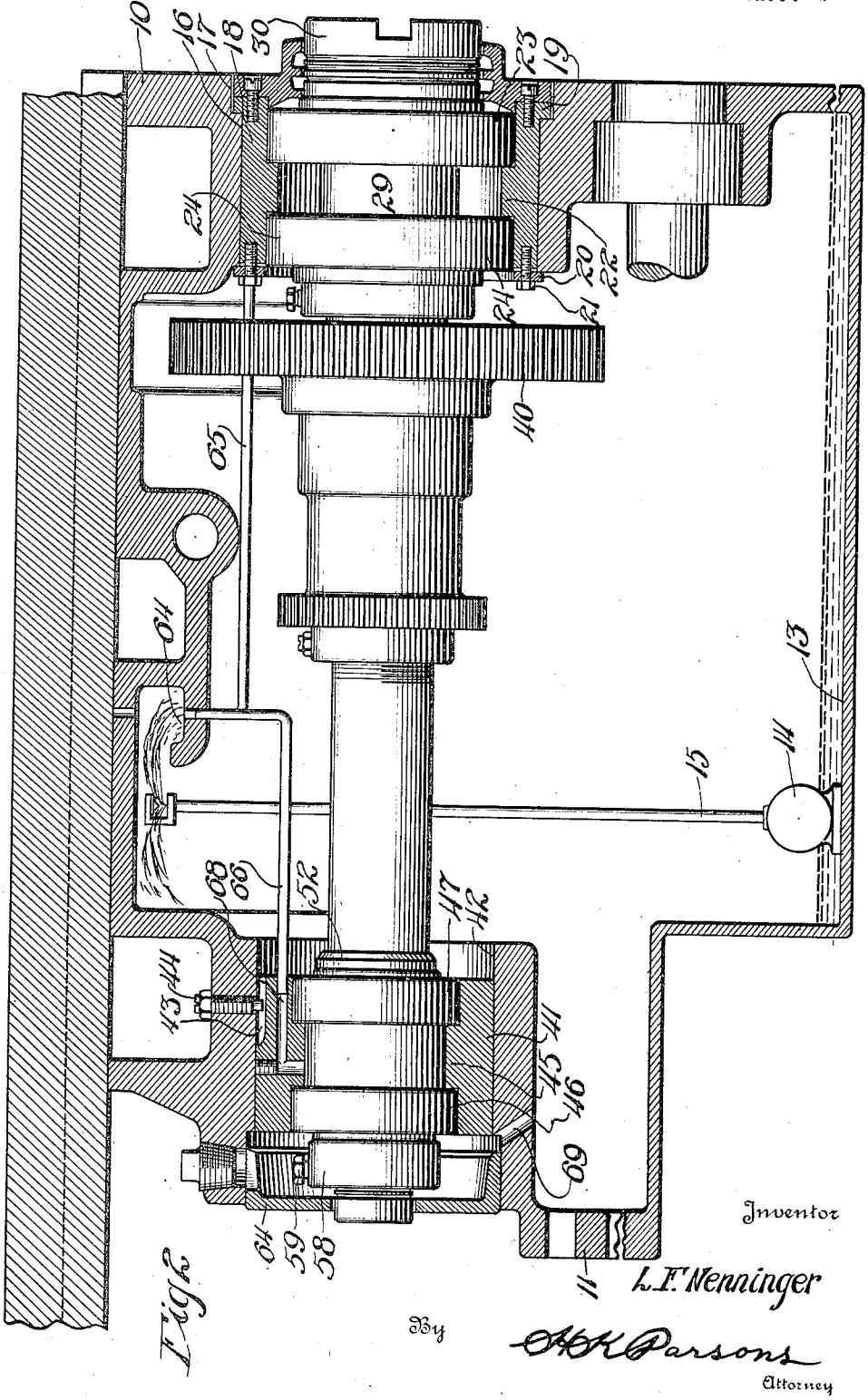

Fig. 2

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MILLING MACHINE

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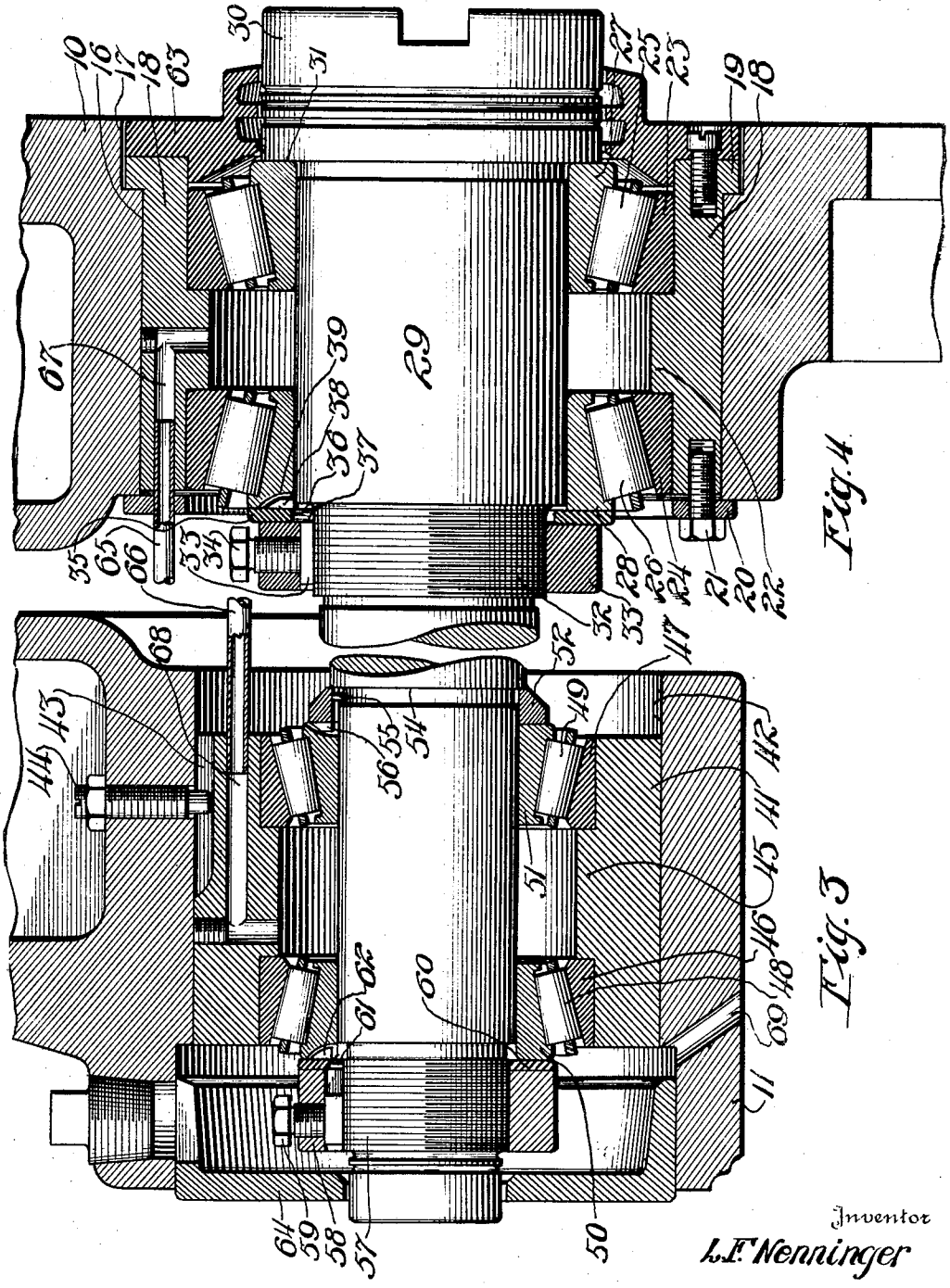

Fig. 4

Fig. 3

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UNITED STATES PATENT OFFICE

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MILLING MACHINE

Application filed June 16, 1926. Serial No. 116,446.

This invention relates to improvements in milling machines and has particular reference to the spindle structure of such machines.

Prior to the present invention it has been customary in the construction of milling machinery to make use of an ordinary bushed bearing for supporting the milling machine spindle, and in view of the particular strains and stresses to which such a spindle is subjected, it has been believed impractical to endeavor to utilize anti-friction bearings of the ball or roller type.

The object therefore of the present invention is to provide an improved form of anti-friction bearing for milling machine spindles which will satisfactorily take care of the several strains and stresses to which such a spindle is subjected, and which will do away with the friction difficulties and wear hitherto experienced with the mountings for this part.

A further object of the invention is the provision of a combination supporting structure for such spindles, which will automatically accommodate itself to the spindle contraction and expansion and which may be satisfactorily continuously lubricated to eliminate wear and insure free running of the parts.

Other objects and advantages of the improved construction should be readily apparent by reference to the following specification taken in connection with the accompanying drawings, forming a part thereof, and it will be understood that I may make any modifications in the specific structural details hereinafter disclosed within the scope of the appended claims, without departing from or exceeding the spirit of the invention.

Figure 1 is a side elevation of a milling machine, embodying the invention with a portion of the column broken away.

Figure 2 is a vertical sectional view of the upper portion of the column, illustrating the manner of mounting the improved spindle bearing structure.

Figure 3 is a longitudinal section through the rear bearing for the spindle.

Figure 4 is a similar section of the front bearing member, and Figure 5 is a view similar to Figure 3, illustrating the employment of a ball in place of a roller bearing at this point.

In the drawings the reference character A designates the base of a milling machine having the knee B and the upright column C bearing the overarm D. Power is suitably applied to the various drive mechanisms contained within the column, as by medium of the belt E.

The column C as has been mentioned, is of hollow formation and includes a front wall portion 10 and rear wall 11 and incloses a chamber portion 12, having an oil sump formed therein as at 13. A suitable oil circulating system is employed for lubricating the mechanism within the column and has been diagrammatically illustrated as comprising a pump 14 and distributor pipe 15.

The front wall 10 of the column is formed with an aperture 16, counter-sunk as at 17, within which fits the bushing sleeve 18. This sleeve has a circumferential flange portion 19, fitting within and abutting the counter-sink 17 and is locked in position within the front of the column as by the ring 20, bearing against the interior of the column and the clamp bolts 21, passing through the ring and threaded into bushing 18.

The bushing is also provided with a central interior annular flange 22 against which are seated on opposite sides the taper roll bearing cups 23 and 24 respectively. Contained within these cups are the taper roll bearings 25 and 26 interiorly engaged by the cones 27 and 28. These cones are fitted on the milling machine spindle 29, having the enlarged nose 30 forwardly adapted to engage a cutter arbor or the like and having the rear abutment face 31 fitting against the forward face of cone 27. The spindle is further provided with a reduced threaded portion as at 32 for the clamp nut 33, which locks the bearing in place on the spindle; this clamp nut being in turn secured in position as by set screw 34.

It will be understood that in certain forms of milling work the pressure against the spindle is largely radial and in other instances, largely axial. To prevent creeping of the cone 28 with respect to nut 33, and thus

possible loosening of the nut or wearing of the interengaged faces of the nut and cone, causing loosening of the bearing and consequent inaccuracy in operation of the machine, use is made of the intermediate washer 35 having a keyway 36 to receive pin 37 on the spindle, and having a lug 38 fitting within the notch or recess 39 of cone 28. This structure is such as to permit of free in and out sliding movement of washer 35 as the bearing is clamped in position on the spindle, but preventing relative rotation of cone 28 and the spindle, and also preventing any wearing against nut 33 or tendency to loosen such nut.

It will be understood that the front cone 27 is preferably a pressed fit on the spindle, so that liability of creeping action is thus prevented.

Power is ordinarily applied to the spindle for rotation thereof as through the gear unit 40 and in operation it is found that under varying work and temperature conditions there is a longitudinal expansion and contraction of the rotating spindle, making it impossible to have the spindle rigidly connected to the column by rigid bearings. On the other hand, for extremely accurate work preformed by machines of this sort it is essential that all longitudinal play of the spindle be prevented. In the accomplishment of these results therefore, the front end of the spindle is held as described against any possible movement as respects the column, while to take care of this expansion and contraction, use is made of a floating rear bearing member. This bearing member as illustrated in Figure 3 comprises primarily a sleeve 41, slidably mounted within the aperture 42 in the rear wall of the column. This sleeve 41 is formed with a slot or keyway 43 engaged by the screw 44 to lock the sleeve against rotation while permitting its longitudinal sliding movement. Centrally the sleeve, like sleeve 18 is formed with an internal annular flange or rib 45 against which is seated the cups 46 and 47 of rollers 48 and 49 of the rear double opposed tapered roller bearing for the spindle 29. These rollers in turn engage the inner cones 50 and 51. Cone 51 is forwardly engaged by washer 52 which is intermediate the cone and the shoulder 54 on the spindle. The washer is locked against rotation relative the spindle as by the stud 55, while the cone is locked to the washer as by the lug 56 on the washer, engaged in a suitable notch in the end of the cone.

The rear end of the spindle is preferably threaded as at 57 to receive the lock nut 58, in turn locked in position as by set screw 59. Disposed intermediate the cone 50 and lock nut 58 is a washer 60, similar to the washer 35 and having interlocking connections as by pin 61 and tongue 62 with the spindle and cone 50 respectively, to secure these parts against relative creeping movement tending to wear or loosen the nut.

It will be noted that at the forward end a cap plate 63 is centered by sleeve 18 and has ribs embracing the spindle to collect inwardly deflected oil tending to run out along the spindle, while at the rear a second closure cap 64 is employed for a similar purpose.

In order that the roller bearings just described may be properly lubricated, the feed pipe 15 discharges into a trough 64 at the top of the column from which lead distributor pipes 65 and 66. Pipe 65 projects into oil passage 67 in sleeve 18, from which the oil flows by gravity to both of the rollers and thence drains back into the center of the column. Similarly, distributor pipe 66 is slidably engaged in oil passage 68 of sleeve 41 to supply oil centrally thereto, and thence to the spindle bearings. This oil or lubricant is drained back as through passage 69 to the oil containing sump 13 in the column.

From the foregoing description it will be noted that the front portion of the spindle is longitudinally held against any axial movement on account of the positive mounting of sleeve 18 within the front of the column, and the interengagement of the rib 22 of said sleeve with the bearing cups of the front spindle bearings. Additionally, it is to be noted that on account of the fact that the sleeve 41 is supported for axial sliding movemen while being held against rotation, it is possible for the bearing to shift to compensate for expansion and contraction of the spindle or like effects, without causing any binding of the spindle and its bearings and at the same time must satisfactorily support the rear end of the spindle against buckling, disalinement or play, greatly increasing the efficiency of the machine over previously known types and decreasing the power necessary for proper spindle operation.

In Figure 5 there has been shown an alternative form of the construction in which a ball bearing in place of a double roller bearing is utilized as the floating support for the rear end of the spindle. In this instance, use is made of a rigid bushing member or sleeve 70, locked in place within aperture 71 in the rear of the column as by the stud screw 72. This sleeve has an enlarged bore as at 73 to receive the ball bearing unit 74. In this instance the construction of spindle 29 is the same as that previously illustrated, but a spacing sleeve 75 is interposed between shoulder 54 on the spindle and the forward edge of the bearing, while a second spacing bushing 76 may be interposed between the bearing and spindle and clamped in such a position by the securing nut 77, similar to the nut 58 described in connection with Figure 3 of the drawings. In this instance the bearing floats with the end of the spindle inside the bore of the sleeve 70 in place of sleeve 70 and con-

tained parts moving as a unit as was the case with sleeve 41.

I claim:—

1. A milling machine spindle mounting, including a spindle support, having an aperture, a sleeve secured in the aperture against movement relative thereto and having an inwardly projecting annular rib, spaced roller bearing cups engaging said rib, antifriction rollers disposed within the cups, bearing cones for the rollers, and a milling machine spindle disposed within the cones and having a shouldered head engaging one of the cones for limiting relative movement of the bearing and spindle, said spindle being additionally formed with a threaded portion and a clamp nut adjustably mounted on said threaded portion and adapted to urge the other cone toward the shoulder on the spindle, whereby the adjustment of the nut serves to adjust jointly both bearings and to secure the parts in position determined by the rib and prevent relative axial movement of the spindle and spindle support.

2. A milling machine spindle mounting, including a spindle support, having an aperture, a sleeve secured in the aperture against movement relative thereto and having an inwardly projecting annular rib, spaced roller bearing cups engaging said rib, antifriction rollers disposed within the cups, bearing cones for the rollers, and a milling machine spindle disposed within the cones and having a shouldered head engaging one of the cones for limiting relative movement of the bearing and spindle, said spindle being additionally formed with a threaded portion and a clamp nut adjustably mounted on said threaded portion and adapted to urge the cones toward the shoulder on the spindle to secure the parts in position and prevent relative axial movement of the spindle and spindle support, and a washer member on the spindle intermediate the nut and the adjacent cone, said washer member, spindle and cone having interlocking parts preventing relative rotative movement of the parts one toward the other, whereby creeping or wear of the cone is prevented.

3. In a milling machine, the combination with a spindle having a terminal cutter engaging portion and a central drive gear portion, of a supporting column for said spindle having spaced apertured walls to receive the spindle and enclose the gear an antifriction bearing adjacent the cutter engaging end of the spindle supporting said spindle against longitudinal or radial cutter thrust, a second anti-friction bearing intermediate the terminus of the spindle and the drive gear portion thereof for absorbing radial or other thrust imparted through the drive gear, means securing said spindle and bearings in the aperture in the column to prevent relative axial movement thereof with respect to the column, whereby the spindle is supported in the column for free rotation about a definitely determined axis in fixed position while restrained against axial or radially displacing strains, a third anti-friction bearing secured on the other end of the spindle, and means slidably supporting said anti-friction bearing in the other column wall aperture whereby said bearing will prevent radial play or displacement of the opposite end of the spindle but will be axially self-adjusting to compensate for expansion and contraction of the parts.

4. The combination with a milling machine including a hollow support member and a spindle extending transversely of the support member and having a driving connection disposed within the support member, of a mounting for said spindle including a fixed anti-friction roller bearing circumscribing the spindle adjacent one end thereof and disposed to take up both axial and radial thrust thereagainst, a second anti-friction roller bearing spaced from the first and disposed to absorb radial thrust on the spindle as through the drive connections therefore, means locking the bearings against axial movement relative the support therefore, said bearings jointly restraining axial movement of the spindle and definitely determining the position of the spindle end with respect to the support member the spindle having a portion extending to the opposed wall of the hollow support and an anti-friction bearing carried by said extending end and slidably engaging the support whereby said sliding engagement permits automatic compensation for expansion and contraction of the parts.

5. The combination with a milling machine including a pair of spaced walls providing an enclosing column, said walls having aligned spindle receiving apertures formed therein, of a spindle adapted to be supported by the column, and journaled within the apertures, means for mounting the spindle within the column, including a pair of opposed anti-friction bearings having their outer races carried by one wall of the column and their inner races carried by one end of the spindle, said parts being disposed within the aforesaid aperture in one of the column walls, a sleeve slidably mounted in the aperture in the other column walls, an anti-friction bearing member having an outer race carried by the sleeve and an inner race carried by the opposite end of the spindle, whereby said latter end of the spindle is both rotatably and slidably supported in the aperture of the column by the sleeve and its associated parts, means preventing rotary movement of the sleeve with respect to the column while permitting longitudinal sliding thereof, and means for preventing relative rotary movement between the spin-

dle and certain of the races in engagement therewith, whereby wear impairing the accuracy of the spindle is prevented.

6. A machine for the performance of accurate milling operations including an enclosing column member having spaced walls provided with aligned apertures, and means for accurately supporting a milling machine spindle within the apertures including a sleeve member fitting in one of said apertures and locked against movement relative to its supporting wall, a pair of anti-friction bearings having their outer races inter-locking with the sleeve, and their inner races inter-locked with the spindle for rotation therewith, anti-friction members inter-posed between the set of races for rotatably supporting the spindle end and eliminating wear and looseness thereof, a second sleeve slidably mounted in the aligned aperture of the opposite wall for automatic axial adjusting movement relative thereto, means securing the sleeve against rotary movement in the aperture, a pair of outer races in inter-locking engagement with the sleeve and movable therewith, a pair of inner races carried by the spindle, anti friction bearing members interposed between said races, and means for locking said inner races in position on the spindle, said locking means having portions for securing the spindle engaging races against rotary or creeping movement relative to the spindle, whereby creeping and consequent relative wear of the parts is eliminated.

In testimony whereof I affix my signature.

LESTER F. NENNINGER.