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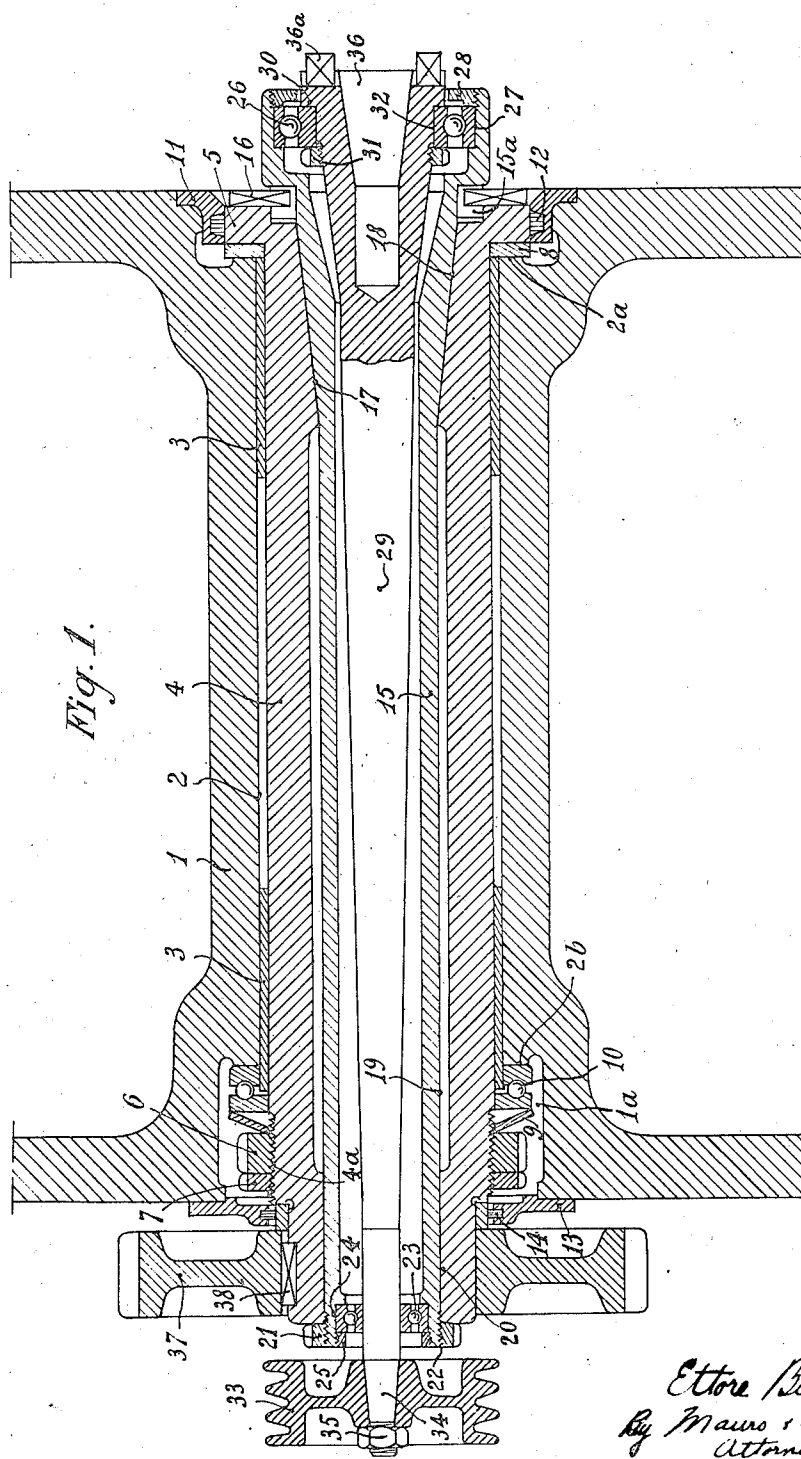
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2,434,639

SPINDLE FOR MILLING MACHINES

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2 Sheets-Sheet 1



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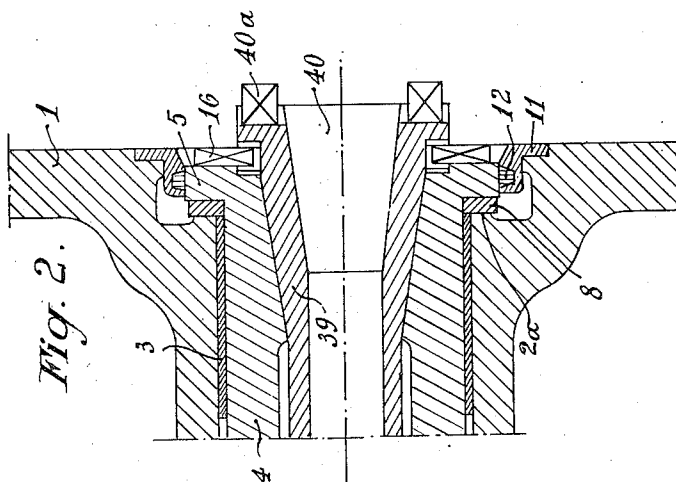
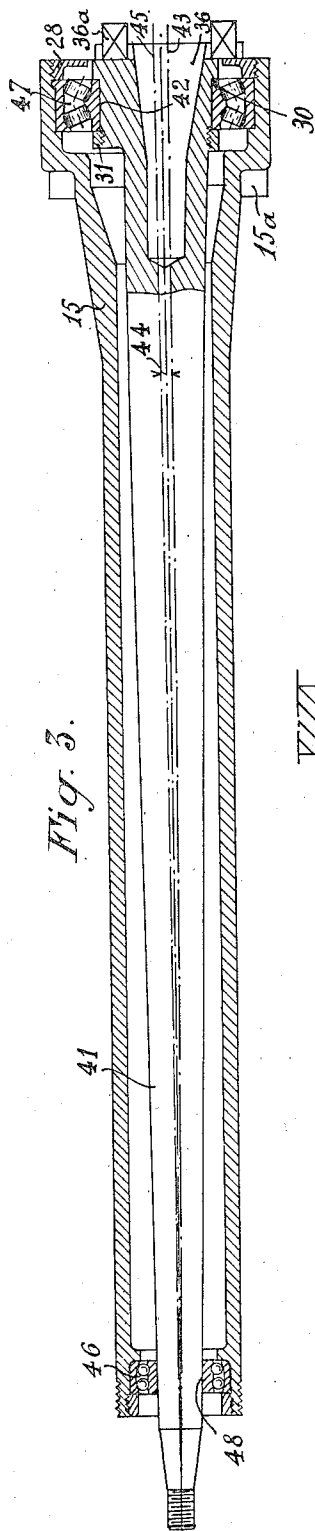
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SPINDLE FOR MILLING MACHINES

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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

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SPINDLE FOR MILLING MACHINES

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4 Claims. (Cl. 90—11)

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Horizontal or vertical milling machines comprise a shaft of large diameter called spindle, the function of which consists in guiding the mill and in transmitting to it the rotary movement necessary to do the work.

In order to reduce as much as possible resilient deformations due to the stresses transmitted by the mill, which deformations give rise to vibrations of all kinds, which are detrimental to the accuracy of the work and the proper preservation of the machine parts, it is necessary to make the shafts or spindles of dimensions larger than is strictly required.

It follows that the production of high speeds of rotation, which it would be natural to use when operating with a mill of small diameter, presents difficulties inherent in the mass of the spindle and the dimensions of the bearings which support it. In regard to the latter, it is not possible to exceed a certain peripheral speed on account of the lubrication which then would be effected under such conditions that the film of oil between the shaft and the bushes, which is constantly indispensable, would be destroyed.

These conditions limit the extent of the useful range of milling machines, inasmuch as the operator is often obliged either to employ a machine of low capacity, if he wants to use normal rotary and cutting speeds, in which case it becomes necessary to reduce the advance, or else to do the same work on a bigger machine allowing a normal advance. This, however, interferes with the cutting speed. This speed is, in fact, a function of the diameter of the mill and of the speed of rotation of the spindle, the latter factor being limited as above, stated, by the dimensions of the member in question.

In both cases there is a loss of output, either owing to the insufficient advance of the carrier, or to a cutting speed which is too low.

This invention has for its object to provide improvements in spindles for milling machines in order to allow the execution, with the same machine, of a great variety of operations with mills of any size used under proper conditions of cutting speed and advance.

In the form of construction preferably adopted, the machine improved in accordance with the invention, comprises a revolving part having the shape of a hollow shaft, and guided in bearings of the frame according to the usual method. This hollow shaft is designed so as to guide and drive the counter-shaft, which is also hollow, and which at its ends comprises two bearings, preferably ball or roller bearings, which hold a third shaft. The

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third shaft acts as a high speed spindle; it is provided with a conical housing and standardised driving dogs adapted to centre and drive either a mill or a shaft, or a milling spindle, as is often the case with horizontal milling machines.

When it is necessary to operate with a small mill, use is made of the third inner shaft or spindle above mentioned, which is driven by a pulley and belts, or by any other known transmission means. This shaft, which is of light construction, offers little inertia, and revolves in the ball or roller bearings of the counter-shaft. This counter-shaft, and the hollow shaft with which it is integral, do not revolve.

If, on the contrary, the work to be done requires a mill of large diameter, the counter-shaft is dismounted without being separated from the high speed spindle, and it is replaced by another shaft or spindle provided with the same centering and fixation elements. This spindle, called "high speed" spindle, comprises a conical housing and standardised driving dogs of dimensions adapted to those of the mill. These dimensions differ appreciably from the cone of the high speed spindle and are calculated for the adaptation of small mills.

In this case, the low speed spindle receives its movement direct through a gear permanently keyed on the hollow outer shaft above mentioned, or through a pulley and belts, or by any other known means.

The members for transmitting the movement of the high speed and low speed spindles are naturally connected to the motor of the machine through belts, chains or gears designed so as to produce all combinations of speeds required, and making it possible to pass without discontinuity from the range of speeds of the rapid spindle to the range of speeds of the slow spindle, and vice versa.

For the purpose of producing chequered surfaces required for the purpose of appearance (for instance, for tables or machine tool frames, or again, for certain visible parts of the motors or other engines), use may be made of a high speed spindle slightly offset perpendicularly to one of the counter-shaft bearings. The result is that the high speed spindle becomes slightly inclined relatively to the axis of the machine.

This inclination may be as small as desired, especially if it is the bearing of the spindle situated on the side of the drive which is offset. The displacements of the axis being dependent on the offset of the bearing under consideration and of the ratio between the lengths of the lever arms

measured on the spindle between the bearings, on the one hand, and between the mill and the next bearing, on the other hand, it will be seen, upon considering the order of magnitude of these different factors, that the angle of inclination of the spindle is capable of assuming extremely low values.

In these conditions, the high speed spindle describes a conical surface and compels the mill, the flat face of which would normally operate at the end, to work on its edge, the result being that the surface of the piece is scratched, and patterns having the appearance of interlaced circles are produced on said piece.

The following description, with reference to the accompanying drawing, given by way of non-limitative example, clearly shows how the invention can be performed.

Figure 1 is a broken section of a horizontal milling machine provided with a high speed spindle.

Figure 2 shows a fragment of the same machine after a low speed spindle has been substituted for the high speed spindle.

Figure 3 represents the device making it possible to slightly incline the axis of the high speed spindle for the purpose of producing chequered surfaces.

The frame 1 (Figures 1 and 2) has a bore 2, which by means of bushes or bearings 3 guides the hollow shaft 4. This shaft is held axially by a flange 5 thereon and by a nut 6, and a counter-nut 7, which are screwed on a threading 4a of the shaft 4.

A ring 8, which rests on the face 2a of the frame at the mouth of the bore 2, frictionally engages flange 5; under a pressure which is adjusted by the nuts and counter-nuts 6 and 7 in cooperation with an elastic ring 9 (for instance, a Belleville ring). This ring rests on the face 2b at the other end of the bore 2 through a ball thrust-bearing 10.

An annular cover 11, provided with a stuff-box 12, insulates and protects the different elements of the frame 1 from its bearings 3, the hollow shaft 4 and its accessories, which constitute the essential part of the machine.

In a similar way, a cover 13, and its stuff-box 14, close the housing 1a of the ball thrust-bearing 10.

The hollow shaft 4 is coupled with a counter-shaft or casing 15 through pins or driving dogs 16, which are embedded in the mortises 15a of the shaft 15. This shaft is, moreover, centered in the shaft 4 through a conical part 17, which corresponds to a female cone 18 of the shaft 4, and through a cylindrical part 19, which engages a bore 20 in shaft 4.

The tubular casing or shaft 15 is held in the shaft 4 by a nut 21, screwed on its threading 22. This nut 21 is easily accessible from the rear of the machine, so that the shaft 15 can be quickly dismantled. This shaft comprises, as shown in the left side of the figure, a ball or roller bearing 23, held in housing 24 of the shaft 15, by means of a nut 25. On the right of the figure, another ball or roller bearing 26 is centered in the lodgment 27 of the shaft 15 where it is fixed by a nut 28.

The two bearings 23 and 26 guide a high speed spindle 29, which is held axially by the bearing 26 cooperating with a shoulder 30 and nut 31, situated on both sides of the bearing 32 of the spindle 29. The spindle is provided at its left-hand extremity with a grooved pulley 33, for instance, locked on a cone 34 by a nut 35. The right-hand extremity is provided with a female

cone 36, the dimensions of which correspond to the standard of the milling cutters and the shafts or milling tool holders chosen amongst the smallest. The latter fit in the cone 36 and are driven by the pins or dogs 36a in the usual way.

On hollow shaft 4 is secured a toothed wheel 37 by means of one or more pins 38, and said shaft constitutes the last element of a transmission comprising all the members usually provided for this kind of machine, as, for instance, the various sliding gears which make it possible to produce a suitable range of speeds for shaft 4.

The description of this part of the machine, as well as the mode of transmission of movement to the pulley 33 and to the spindle 29, would be outside the scope of the invention, because these parts are found in most of the machines constructed at the present time, or they can be produced by various simple combinations of known elements.

High speed of rotation can be imparted to the spindle 29, which is of small dimensions, and revolves in ball or roller bearings. If such speed can be altered by using kinematic combinations similar to those mentioned in connection with the shaft 4, it is natural to constitute a range of possible speeds of the spindle 29 by giving to the smaller term of said range a value higher than that of the greater term of the range of possible speeds of the shaft 4. For instance, if the speeds of the shaft 4 are divided into stages of between 5 and 500 revolutions a minute, it is possible to take 600 and 3,000 revolutions a minute, or other approximate values as extreme terms of the range of speeds of the spindle 29.

In order to replace the high speed spindle 29 by a low speed spindle 39, the counter-shaft 15, which has first been released by unscrewing the nut 21, is dismantled. The shaft 15 is removed with its bearings 23 and 26, and the spindle 29, as well as all the accessories, are also removed. These different elements constitute a body which forms part of the machine equipment. The spindle 39 is mounted instead of the shaft 15; the dogs or pins 16 transmit the movement to the shaft 4, which being stationary in the previous case (spindle 29), receives in its turn a movement of rotation proceeding from the toothed wheel 37.

The left-hand extremity of the spindle 39, not shown in the figure, is similar to the extremity of the shaft 15 as regards the outside (threading 22). Inside, there is, of course, no necessity to provide the housing 24, which would be useless.

The right-hand extremity of the spindle 39 has a female cone 40, the dimensions of which correspond to the standard of the mills or milling cutters and of the shafts or milling tool holders chosen amongst the largest. The latter fit in the cone 40 and are driven by pins or dogs 40a in the usual way.

Figure 3 shows, as a modification of Figure 1, an embodiment of a high speed spindle 41, the bearing 42 of which is offset relatively to the axis 43 of the spindle 41. The result is that, in its rotation, the axis 43 of said spindle 41, describes a conical surface, the angle of which at the apex is twice the angle 44 comprised between the axis 43 aforesaid and the axis 45 of the shaft 15.

This conical movement is obtainable by using a knuckle ball bearing 46 of the well-known type on the side of the drive, and of a knuckle roller bearing 47 on the side of the mill or milling cutter. This last type of bearing is chosen in this case on account of its great capacity for absorbing axial

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stresses due to the working of the mill or milling cutter.

If it is desired to obtain very small values for the angle 44, it is preferable to offset the bearing 48 corresponding to the bearing 46. The displacements of the mill around the axis 45 of the shaft 15 are, in this case, inversely proportional to the length of the lever arms measured on the spindle 41 between the axis of the spindle 46 and the axis of the bearing 47, on the one hand, and between the axis of the bearing 47 and the end of the mill or milling cutter, on the other hand.

The shaft 4 may be directly used as a slow spindle, that is to say, that the special spindle 39 can be dispensed with when the sizes of the elements of the rapid spindle 29 and the counter-shaft are consistent with the size of the cone and the shaft 4.

What I claim is:

1. A mill driving device which comprises a shaft having an axial bore; means at an end of said shaft for receiving a driving torque and transmitting the same to said shaft; a tubular casing fitted in said bore of the shaft and detachably secured thereto so as to be interchangeable with a low speed mill driving spindle having the same outer dimensions; and a high speed mill driving spindle rotatably borne in said tubular casing.

2. A mill driving device which comprises a first tubular shaft; means at an end of said shaft for receiving and transmitting a driving torque thereto; a second tubular shaft fitted in said first tubular shaft and detachably secured thereto; a mill driving spindle accommodated in the second tubular shaft; bearing means in the second tubular shaft for rotatably supporting said spindle

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therein; means at an end of said spindle for receiving and transmitting a driving torque thereto; and means at the other end of said spindle for securing a milling cutter thereto.

3. A mill driving device which comprises a tubular shaft; means at an end of said shaft for receiving and transmitting a driving torque thereto; means at the other end thereof for securing a milling cutter thereto; an independent mill driving spindle accommodated in said tubular shaft; means at an end of said spindle for receiving and transmitting a driving torque thereto; and means detachably secured to said tubular shaft for rotatably bearing said spindle therein.

4. A mill driving device which comprises a first tubular shaft; means at an end of said first shaft for receiving and transmitting a driving torque thereto; a second tubular shaft fitted in said first tubular shaft; coupling means between the first and the second shaft, adapted to transmit said driving torque from the first shaft to the second shaft; a mill driving spindle accommodated in the second tubular shaft; bearing means in said second tubular shaft for rotatably supporting said spindle therein; means at an end of said spindles, for receiving and transmitting a driving torque thereto; and means at the other end of said spindle for securing a milling cutter thereto.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,938,782	Ott	Dec. 12, 1933
314,433	Cobb	Mar. 24, 1885