

**Oct. 15, 1963**

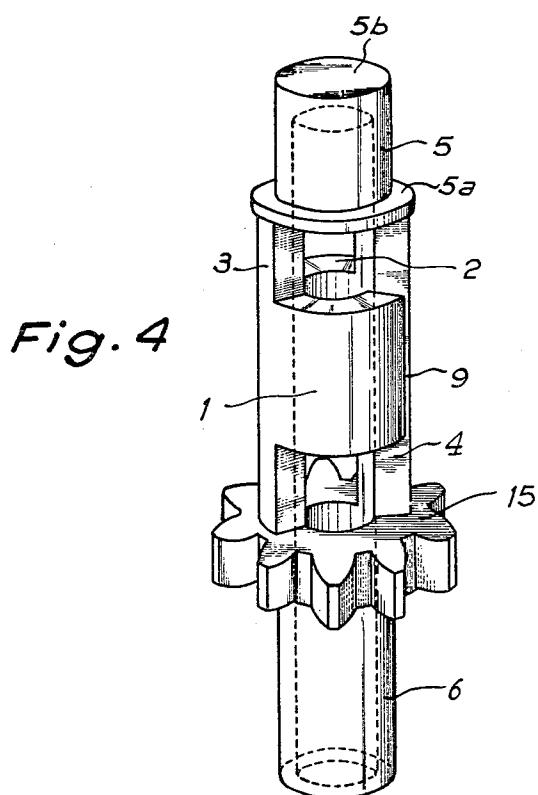
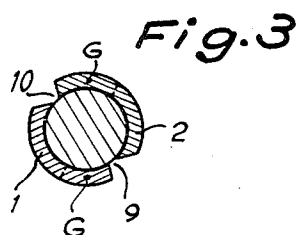
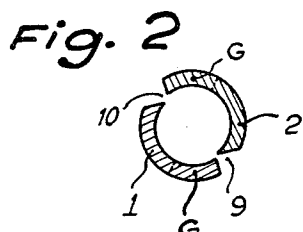
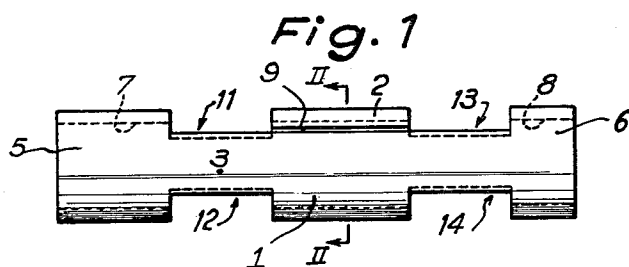
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# HIGH-SPEED ROTARY TOOL HOLDER

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HIGH-SPEED ROTARY TOOL HOLDER

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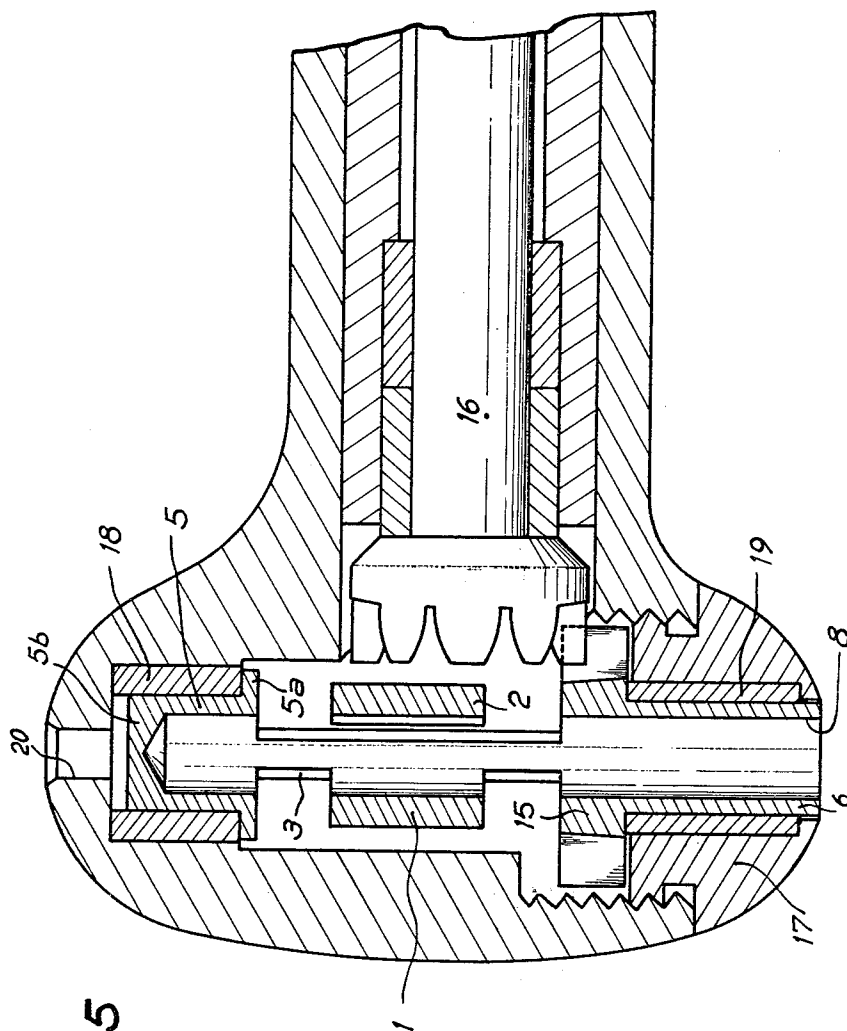


Fig. 5

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## HIGH-SPEED ROTARY TOOL HOLDER

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This invention relates to mounting means for high-speed rotating tools, especially hand tools, and still more specifically tools as used in dental surgery in connection with dental engines of the kind having high-speed rotating means, e.g. an air-spun turbine, for rotating the tool.

The application to dental tool holders constitutes a preferred aspect of this invention and the objects and advantages of the invention will accordingly be described with primary reference to such specific use.

With the increasingly high velocities of tool rotation that are currently being used in the dental art it is becoming more and more difficult to provide a satisfactory mounting device for the tool in the non-revolving support provided on the extension arm of a dental engine. Such mounting device, besides permitting quick and easy insertion and removal of the tool for readily changing from one type of tool to another, must be of such character as to retain the tool very firmly when inserted, since at the extremely high angular velocities involved—sometimes as high as 300,000 revolutions per minute—any clearance or backlash in the mounting assembly however slight will rapidly be amplified by centrifugal force to produce vibrations of substantial amplitude constituting a hazard both to the patient and the equipment.

For a similar reason it is required that the revolving assembly comprising the tool and its holder should be journaled in the support with great accuracy since any out-of-center condition will be amplified by centrifugal force with similar objectionable results.

At the high angular drive speeds here referred to, the load torque required to be developed when working with the tool is comparatively very low, corresponding to a working pressure of about 20 grams, and the turbine is arranged to stall if the pressure exceeds say about 50 grams.

It has already been proposed to provide a tool holder in the form of an elastic sleeve or tube of non-metallic material in which the tool shank is resiliently gripped and which is journaled in bearings of the support. However the non-metallic materials from which such elastic tool holders have been made tend to wear, harden and/or deform with time, whereupon the stringent conditions mentioned above are no longer fulfilled by them.

In another type of resilient tool holder of the prior art, the tool shank and holder have been provided with coating tapers and the resilient tool gripping action provided by spring means forcing the tool shank into the tapered recess of the holder. This type of mounting device has been found unsatisfactory chiefly because it lacked rigidity and at the high speeds contemplated the spring was incapable of restraining the tool in position against the powerful action of the centrifugal forces generated.

In another known type of resilient tool holder, the holder has been provided as a longitudinally slotted sleeve. While this construction has avoided many of the drawbacks mentioned above, such a slotted tubular construction has not been generally capable of providing the smooth, continuous bearing surfaces required for journaling the holder in the bearing surfaces of the support, and imperfect dynamic balancing was present. The slot or slots had to be formed with extremely small transverse dimensions so that they were rapidly clogged

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with dirt and the requisite radial resiliency of the holder was no longer present.

It is generally an object of this invention to provide an improved mounting means for a high-speed rotating tool, which will be substantially free of the various drawbacks listed above. Specific objects of the invention are to provide an all-metallic tool holder that will have substantial radial resiliency for firmly gripping the tool to ensure vibration-free support thereof even at the highest rotational velocities that may be encountered in practice; and to provide such a resilient holder that will nevertheless have smooth, continuous cylindrical bearing surfaces for perfect rotational support in corresponding non-revolving bearings. Another important object is to provide such a holder that can be conveniently machined from an integral piece of steel tubing so that extremely close machining tolerances can be maintained. Further specific objects are to provide various forms of such tubular holders combined with integral rotating means therefor: in one form of the invention such rotating means may comprise a rotor for an air-turbine secured to or formed integrally with one end of the holder, and in another form the rotating means may comprise a gear annulus secured to or formed integrally around the holder. Other objects include the provision of improved methods of manufacturing the tool holder of the invention.

The tool holder embodying the invention may, in one form, comprise an integral metallic body of tubular cylindrical shape having a pair of diametrically opposed longitudinal slots formed over an intermediate longitudinal portion of said body, arcuate segmental apertures being cut in the body adjacent the opposite ends of the slots and each aperture extending circumferentially from one wall of one slot to a point short of a wall of the other slot. The slots and apertures thus define a pair of opposed segmental flanges and oppositely-extending longitudinal arms integrally projecting from opposite ends of the respective flanges, which arms are integrally interconnected at their outer ends by end portions of the body beyond the opposite ends of the slots. These end portions provide cylindrical outer bearing surfaces adapted to be journaled in correspondingly spaced inner bearing surfaces of the non-rotatable support. The tool is adapted to be inserted through the axial aperture in one of said end portions into engagement with the inner surfaces of the segmental flanges, to be forcibly yet resiliently retained thereby for rotation with the holder.

Exemplary embodiments of the invention will now be described for purpose of illustration but not of limitation with reference to the accompanying drawings, wherein:

FIG. 1 is a side elevational view of an improved tool holder according to the invention;

FIG. 2 is a cross section on line II—II of FIG. 1;

FIG. 3 is a sectional view similar to FIG. 2, but illustrates a tool shank inserted into the holder;

FIG. 4 is a perspective view of an embodiment of the invention comprising a tool holder generally similar to that of FIGS. 1-3, but further including a drive gear thereon; and

FIG. 5 is a sectional view of a tool holder according to FIG. 4 mounted within a support provided on an arm of a dental engine, of the type in which the axis of tool rotation is at right angles to the longitudinal dimension of the arm.

The improved tool holder illustrated is desirably made from a single integral length of stainless steel tubing and the peculiar form of the holder of the invention can best be explained by describing the various machining steps to which this length of tubing is subjected.

Machined (or otherwise formed) in an intermediate section of the tubular body, are a pair of diametrically

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opposed, longitudinal slots 9 and 10, which extend short of the respective ends of said body, so as to leave full cylindrical end portions designated 5 and 6. Desirably, one wall of each slot 9 and 10 may be bevelled as shown in FIG. 2.

Next, two pairs of cuts are made through the wall of the tubular body, adjacent the respective ends of the slots. Thus there is a first pair of cuts 11 and 12 adjacent the end portion 5 and another pair of cuts 13 and 14 adjacent the end portion 6 of the body. Each cut in each pair extends from one wall of one of the slots, in a circumferential direction around the tubular body, as far as a point short of the near wall of the other slot. The resulting arrangement is perhaps most clearly seen in FIG. 4, and it will be apparent that there have thus been provided a pair of segmental, arcuate or part-cylindrical flanges 1 and 2, which extend in reverse circumferential directions around the tube and are positioned in generally diametrically opposed relationship therearound. Moreover, because of the manner in which the cuts 11—12, and 13—14 are made, there is a pair of aligned arms, 3 and 4 respectively, extending from the opposite longitudinal ends of the flanges. These arms are integrally interconnected at their outer ends with one another by way of the longitudinal end portions 5 and 6 of the tubular body. In the embodiment of FIGS. 1—3, these end portions are uncut and may have substantially the same outer and inner diameters as the initial length of tubing.

It will be evident that there has thus been provided an all-metallic, one-piece tool holder which includes an intermediate section that is slotted to be capable of resiliently gripping the shank of a tool inserted into the holder through the aperture 8 in one of the end portions, say end portion 6, as will be later described, and which also includes two end portions that are not slotted but are provided with continuous cylindrical surfaces capable of acting as rigid, accurate bearing surfaces in cooperation with correspondingly axially-spaced inner bearing surfaces of a non-rotatable support in which the holder is to be journaled.

After the body has been machined in the manner described, the two segmental flanges 1 and 2 are preferably each distorted or bent inwardly by a small amount, and the part is then exposed to an annealing, quenching and tempering treatment, or any other suitable heat treatment, for imparting the desired resiliency and hardness characteristics to the metal in its deformed condition. The distorted condition of the flanges 1 and 2 is apparent from the showing of FIG. 2, and it will be understood that the dimensioning is such that the tool shank can be forcibly yet readily inserted into the tubular body to force the flanges 1 and 2 outwards to their initial undeformed shape, as shown in FIG. 3, thereby providing a firm grip of the holder about the tool.

The embodiment just described with reference to FIGS. 1 to 3 is especially suitable for use in connection with a dental engine tool support of the type in which the tool holder and tool are driven in rotation by a direct drive from one end of the holder. Thus, the end portion 5 of the holder of FIG. 1 may be adapted for force-fit engagement with the rotor of an air turbine positioned in the support. According to a desirable modification (not shown) of this form of the invention the air-spun rotor of the turbine may be formed integrally with the tubular body of the holder, whereby the rigidity and concentricity of the revolving assembly are even further enhanced.

FIG. 4 illustrates a somewhat modified embodiment which is especially suitable for use with a dental engine tool support in which the axis of tool rotation is at right angles to the axis of rotation of the turbine or other rotating means used. In this case, a gear 15 is secured around the tubular body near one of its end portions, beyond the corresponding ends of the slots. According to a preferred modification of this embodiment, the gear 15 may be formed integrally with the body. The embodiment of

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FIG. 4 further differs from the first-described embodiment in that the end portions 5 and 6 have a somewhat smaller outer diameter than the initial tube diameter, and an abutting flange 5a is provided between the end portion 5 and the main body portion. Further the outer end of body portion 5 is sealed with an integral web or end wall 5b. The reasons for these minor modifications will appear presently.

FIG. 5 illustrates the tool holder of FIG. 4 mounted in a support of the rectangular-drive type above referred to. It will be noted that the holder is inserted in a recess of the support with the outer surface of end portion 5 seated in an upper bearing sleeve 18 of the support, and the upper side of flange 5a abutted against a corresponding shoulder of the support. A threaded cover insert or plug 17 containing another bearing sleeve 19 is then passed around the lower end portion 6 of the holder and is screwed into a corresponding screw threaded opening of said recess until the upper end face of sleeve 19 abuts against the lower end face of gear 15. In this position gear 15 meshes with a gear annulus provided at one end of a shaft 16 journaled in the support at right angles to the tool axis and driven from a suitable power means (not shown).

A lubricating aperture 20 is provided at the upper end of the support and it will be noted that owing to the sealing web 5b at the top of the holder the lubricant will serve to lubricate the cooperating bearing surfaces. While smooth bearings have been shown and implied so far, it will be appreciated that any desired type of anti-friction bearings may be provided instead if desired for mounting the holder in the support.

Whatever the particular form of embodiment used, a tool holder constructed in accordance with the invention shows superior performance, at high and very high speeds of tool rotation, to any of the holder constructions heretofore proposed. This is due in part to the fact that the holder, while being of one-piece construction and hence strong and easily machinable to close tolerances, is yet of a composite character, in that it simultaneously presents a resilient intermediate portion for gripping the tool shank and rigid continuous end portions for providing perfect bearing support. The resilient segmental flanges 1 and 2 are integrally connected with the end portions through the arm portions 3 and 4 which work as torsion bars, by twisting about their centers of gravity G (FIGS. 2 and 3) when the flanges 1 and 2 are forced outwards on insertion of the tool shank. The slots 9 and 10 can be made quite wide and chamfered as shown, and are not liable to be clogged up with dirt so that the resilient grip on the tool shank is not impaired.

When the rigid revolving assembly comprising the tool and its holder is journaled in its support, there is positively no radial clearance except between the cooperating bearing surfaces of the holder and the support, and this can be reduced to a very low and accurately controllable value by current machining techniques.

Even at the highest drive speeds that may be encountered and high attendant values of centrifugal force, the holder of the invention provides smooth vibrationless rotation for indefinitely long periods of time.

It will be understood that various changes may be introduced into the embodiments illustrated and described without exceeding the scope of the invention claimed.

What we claim is:

1. A tool holder for a high-speed rotary tool comprising a generally tubular body including a resilient intermediate portion for gripping the shank of a tool inserted into said body and non-resilient continuous generally cylindrical end portions for rotatable engagement in bearing surfaces of a support, said intermediate portion comprising segmental generally part-cylindrical flanges and longitudinal arm portions connecting said flanges with the respective end portions for resilient torsional deformation of said flanges about said arms on gripping a tool

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shank, at least one of said end portions being perforate for insertion of said tool shank therethrough into gripping engagement with an intermediate portion.

2. A tool holder for a high-speed rotary tool comprising a generally tubular one-piece body including a resilient intermediate portion for gripping the shank of a tool inserted into said body and non-resilient, continuous generally cylindrical end portions for rotatable engagement in bearing surfaces of a support, said intermediate portion comprising a pair of segmental flanges cut out of the tubular wall of said body and diametrically-opposed longitudinal arm portions integrally connecting said flanges with the respective end portions for resilient torsional deformation of said flanges about said arms on gripping a tool shank, at least one of said end portions being perforate for insertion of a tool shank therethrough into gripping engagement with said intermediate portion.

3. A tool holder for rotatable insertion in a non-revolving support having axially spaced bearing surfaces and into driven engagement with a high-speed rotating means, comprising an integral metallic body of generally tubular cylindric form, said body having a pair of diametrically opposed longitudinal slots formed over an intermediate longitudinal portion of said tubular body, said body further having arcuate segmental apertures being formed in said body adjacent the opposite ends of said slots and each extending circumferentially from a related one of said slots to a point short of the other slot, so that said

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slots and apertures cooperate to define a pair of opposed segmental flanges and oppositely-extending longitudinal arms integrally projecting from opposite ends of the respective flanges, said arms being integrally interconnected at their outer ends by end portions of said body beyond the opposite ends of said slots, at least one of said end portions having an axial opening for insertion of a tool therethrough into forcible yet resilient engagement with the inner surfaces of said segmental flanges for rotation with said holder.

4. The tool holder claimed in claim 3, wherein said flanges are distorted in a radially inward direction for increasing the forcible resilient engagement of a tool therewith.

5. The combination with a tool holder as claimed in claim 3 of a gear rigid with and coaxially surrounding said body to constitute means through which the tool holder is adapted to be rotatably driven from a high speed rotating means.

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