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[54] **ELECTRIC HIGH-SPEED SPINDLE WITH COOLING MEANS**
4 Claims, 4 Drawing Figs.

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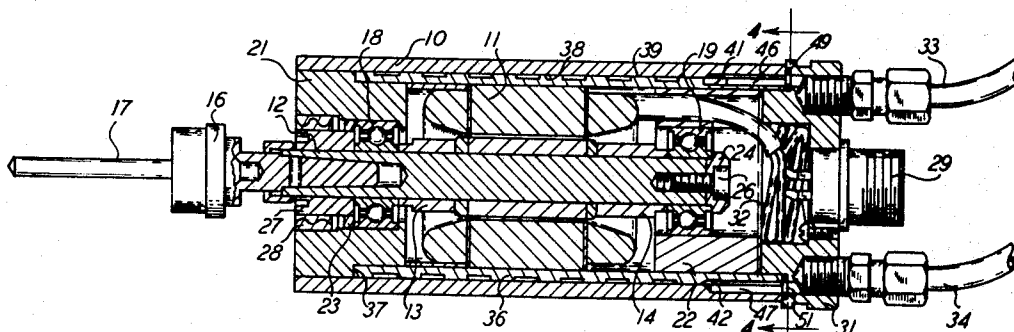
[50] Field of Search. 310/54—65

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ABSTRACT: A tubular housing piece and a tubular member telescoped within the housing piece for defining separate liquid passageways. Connectors are attached to the tubular assembly for conducting liquid into and away from the assembly. An armature is rotatably supported in the assembly by means of a bearing, and a bearing support member is disposed adjacent the tubular member and its liquid passageways so that the bearing support and the bearing itself are cooled by liquid flowing through the passageways. The tubular assembly is of one uniform diameter throughout the extent of the liquid passageways, and the assembly has drilled holes in one end, for providing the liquid inlet port and the liquid outlet port in flow communication with the respective liquid passageways.



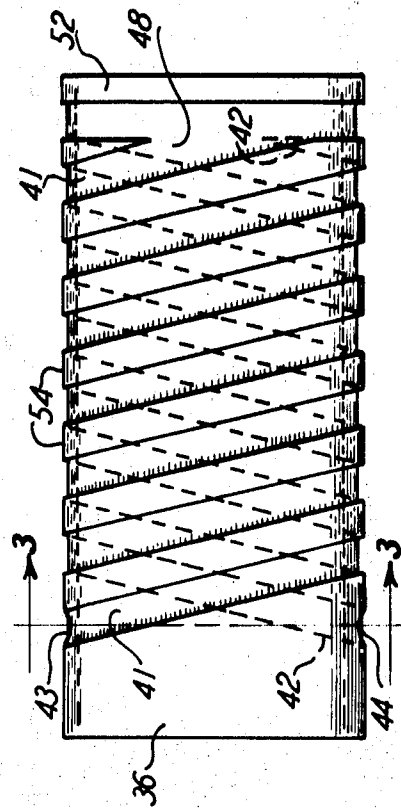
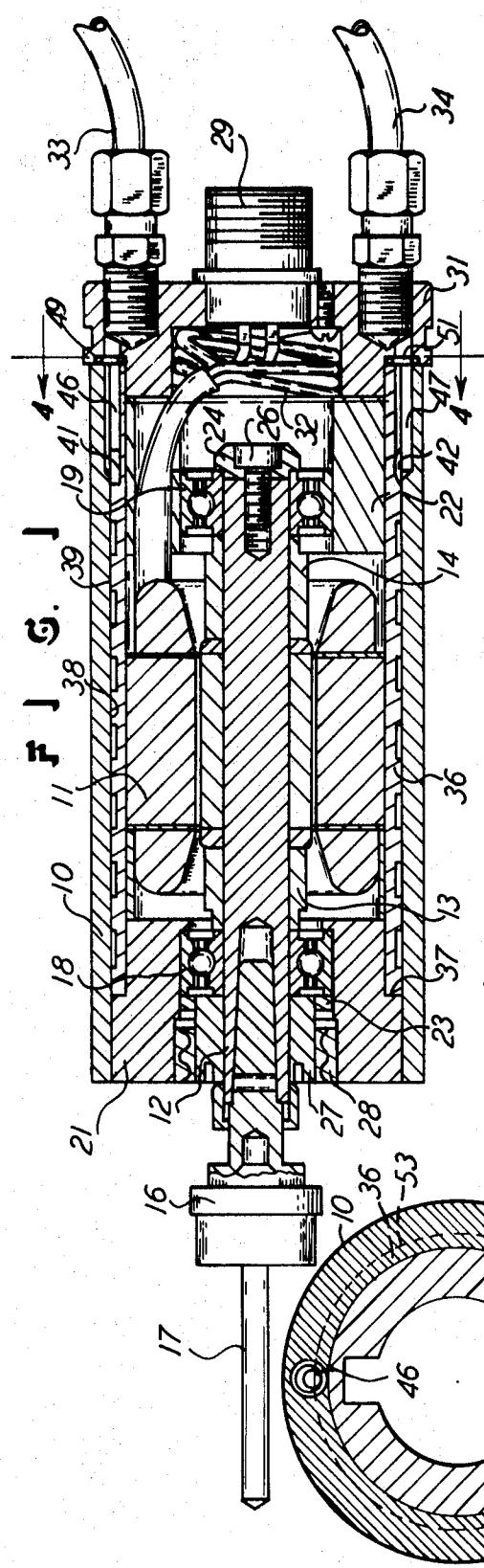


FIG. 4

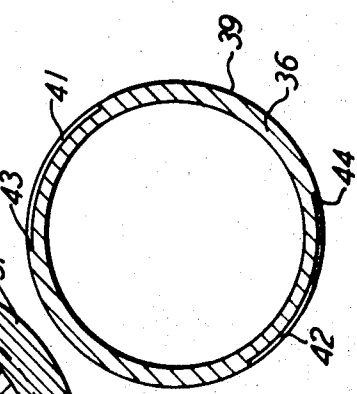
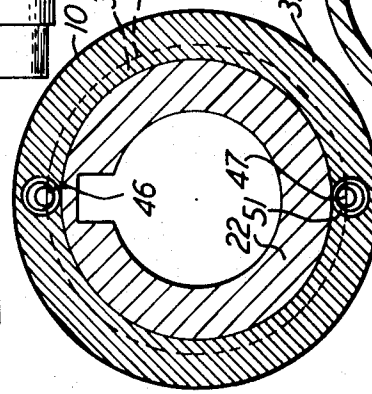


FIG. 2

FIG. 3

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ELECTRIC HIGH-SPEED SPINDLE WITH COOLING MEANS

This invention pertains to an electric high-speed spindle with cooling means. The invention has particular application to spindles used in the continuous production of items wherein there is a problem of the heat generated by the spindle and its assembly. It is the dissipation of this heat that is solved by this invention.

BACKGROUND OF THE INVENTION

The prior art holds many examples of high-speed spindle structures which are used in production of items and are used for drilling, grinding, milling, and like functions. Further, the spindles known heretofore are known to be either liquid or air cooled, and a water-cooled spindle is commonly known. Still further, these high-speed spindles are commonly powered by an electric motor, and the operation of the motor, along with the operation of the drilling or other like work tool, creates the problem of the tool getting hot.

To air cool a high-speed spindle requires a substantial flow of air, and this commonly results in noise produced by the flow of the air. As such, an air-cooled spindle is not desirable. On the other hand, liquid-cooled spindles have commonly required elaborate liquid passageways and compartments, and they have also required special dimensioning of the tool itself so that the tool can be of a size adaptable to standard fixtures and the like in the use and support of the tool. Therefore, the concern of one skilled in the art of constructing high-speed spindles has been to provide a water-cooled spindle which is of a limited outside dimension, say a limited outer diameter, and which is sufficiently sturdy, even though liquid passageways extend through the assembled spindle or tool. The problem is not as simple as providing passageways in the assembly, since the passageways must generally be to the outside of the assembly and away from the inner electric motor, and the provision and location of the passageways either weakens the housing or it creates the probability of leaking the water coolant to the electric motor or other working parts. In efforts to overcome these problems, some prior spindle constructions incorporate a coolant pocket, but this pocket creates the problem of weakening the housing wall. Another problem is trying to seal the water coolant so it stays in the pocket, and if O-rings are used for sealing, they even weaken the wall more so. Where an electric stator is involved, to try for a liquidtight fit directly over the stator creates a problem of keeping liquid away from the stator laminations. Also, to put a protective sleeve over the laminations, then there is the problem of the limitation of the overall dimension or diameter of the assembly. Still further, where the prior art spindles utilize a coolant pocket, there is no control of the path or flow of the coolant through the tool, since the pocket simply collects the coolant rather than guides it through the assembly tool.

It is a general object of this invention to provide a high-speed spindle with cooling means which overcome the aforementioned problems. Specifically, the present invention provides the tool which has a cooling means presenting a definite and continuous path from inlet to outlet and through the tool, and this results in minimum of likelihood of liquid leakage and a maximum of cooling efficiency. At the same time, the overall dimension of the tool is retained within its limitations.

Still further, it is an object of this invention to provide a high-speed spindle with cooling means and with bearings for the rotational mounting of the spindle, and with the cooling means and bearings being related so that the cooling means meets the aforementioned requirements and overcomes the aforementioned problems but also is efficient in cooling the spindle bearings.

Still further, the present invention overcomes the aforementioned problems, and it accomplishes the aforementioned objects and it does so with a tool which is of maximum efficiency and strength in that the passageways provided for the flow of coolant do not weaken the tool.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a longitudinal sectional view showing a preferred embodiment of this invention;

FIG. 2 is a side view of a tubular member in FIG. 1, and showing the member prior to its final form in the assembly and showing it turned end-for-end from the position of FIG. 1;

FIG. 3 is a sectional view taken on the line 3-3 of FIG. 2.

FIG. 4 is a sectional view taken on the line 4-4 of FIG. 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 shows a tubular housing piece 10 enclosing an electric motor having a stator 11 and an armature 12. The armature 12 includes the axial-bearing pieces 13 and 14, and it also has the usual rotational balance means. A collet 16 is attached to the projecting end of the armature 12, in the usual and well-known manner, and the collet releasably supports a work tool 17, which is indicated to be a drill. A front ball bearing 18 and a rear ball bearing 19 are shown in abutment with the armature members 13 and 14, respectively, and the ball bearings 18 and 19 are supported in ball bearing support members 21 and 22, respectively. Further, the support member 21 serves as a housing insert and lends structural support to the tubular housing piece 10, and the member 21 is suitably affixed to the end of the housing piece 10. A bearing retainer ring 23 is threaded or otherwise secured to the support piece 21 to abut the bearing 18, and a bearing retainer washer 24 abuts the bearing 19 and is secured to the armature 12 through the screw 26. Thus the armature 12 is axially located and rotatably mounted in the assembly.

A seal nut 27 and seal 28 are also located in the front end of the tool, and they serve to keep the tool clear of dirt and the like.

The rear end of the tool has an electric receptacle 29 extending through the housing rear end insert or cover member 31 and electric wires 32 extend from the receptacle and to the stator 11, as shown. Also, liquid connectors 33 and 34 are shown threaded into the end piece 31, and it will be understood that they conduct liquid coolant, such as water, into and out of the assembly shown.

A tubular member 36 extends for substantially the length of the housing tubular piece 10, but it ends in the abutment of the housing shoulder 37. The tubular housing piece 10 and the tubular member 36 are of the same cross-sectional shape to the extent that they are telescoped together, and they are preferably cylindrical in their cross-sectional shapes. Thus, the housing piece 10 has an inner surface 38 and the tubular member 36 has an outer surface 39, and these surfaces are in liquidtight contact throughout the length of the tubular member 36, except as hereinafter described.

The outer surface 39 of the tubular member 36 has two sets of liquid passageways, 41 and 42. These passageways 41 and 42 are spirally shaped grooves extending around the tubular piece 36 and for substantially the whole length of the piece 36, as best seen in FIG. 2 which shows the passageway 41 to have an end 43, while passageway 42 has an end 44, and these ends are also shown in FIG. 3. For the purpose of most complete description of the invention, FIGS. 2 and 3 show the tubular piece 36 prior to its final form in the assembly in FIG. 1. That is, in FIG. 1, the telescoped member 10 and piece 36 have drilled openings 46 and 47 cutting into and extending along the mating abutting surfaces 38 and 39 of the member 10 and piece 36, respectively. However, FIGS. 2 and 3 show the piece 36 prior to assembly and therefore prior to the provision of the drilled holes 46 and 47, which serve as the liquid inlet and liquid outlet ports, respectively. That is, the assembly of pieces 10 and 36 is made and they are then prepared with the drilled holes 46 and 47, so that the holes are short and properly located, and they do not weaken the structure to any significant degree. Also, the holes 46 and 47 are in separate flow communication with the liquid passageways 41 and 42, and the passageways 41 and 42 extend along and are defined by the grooves in the member 36, and they are liquidtight from

each other by virtue of the telescoping with the tubular housing piece 10, except for a crossover portion designated 48 in FIG. 2. That is, liquid coolant, such as water, may enter the connection 33 and the inlet port 46 and the inlet liquid passageway 41, and this passageway extends to the designation 41 on the right end in FIG. 2 and is completely separate from the passageway 42 throughout the extent along the tubular member 36, until the passageway 41 reaches the crossover or common passageway 48. Similarly, liquid passageway 42 extends along the length of the member 36 and is in flow communication with the crossover pocket or portion 48. Therefore, liquid flowing in the passageway 41 will be in flow communication with the passageway 42 when the liquid reaches the crossover portion 48, and it will then be in a return flow pattern back to the opening 44 on the passageway 42. The liquid coolant will then enter the outlet port 47, and from there it will flow into the outlet connection 34, all as desired.

To further show the arrangement of the ports and openings and passageways, FIG. 4 shows the inlet port 46 and the outlet port 47 formed at the juncture of the housing piece 10 and tubular member 36. One upper O-ring 49 and one lower O-ring 51 are disposed intermediate the ends of the telescoped assembly of piece 10 and member 36 and against the housing end member 31, as shown in FIGS. 1 and 4. These O-rings 49 and 51 serve to liquid seal the fluid flow paths described, but they do not weaken the structure since they are not located at any point where weakening could occur and where strength is more important, such as at the front end of the housing and adjacent the bearing support member 41, for instance. Instead, at that front end, the tubular piece 36 has its continuous annular surface 52 in liquidtight contact with the inner circumferential surface 38 of the housing piece 10. FIG. 4 further shows the circular mating juncture designated 53 and being the location of the mating surfaces 38 and 39.

It will now be seen and understood that the liquid-flow paths described extend beyond the spacing between the bearings 18 and 19, and, more specifically, the liquid passageways 41 and 42 extend through the ends of the tubular member 36, which ends are in direct contact with the bearing support members 21 and 22. Therefore, the bearings 18 and 19 are also cooled by the arrangement described. Further, there are no sump pockets or other cavities in the assembly for the flow or accumulation of the coolant, so the assembly is not weakened but is a sturdy structure. Likewise, the assembly is limited in overall diameter of say less than the standard 2½ inches across the housing piece 10. Such limited diameter permits the standardized support in mounting of the assemble tool in its work installations. Also, the spiraled groves 41 and 42 are arranged with maximum flow capacity in their cross-sectional areas, and the intervening lands 54 are substantial for structural support, so the passageways are provided but the tool is not structurally weakened, and this is in contrast to cooling

passageways which extend only longitudinally of the tool, rather than being spiraled therearound and having the full flow and guided flow throughout the length of the tool as described herein.

5 We claim:

1. An electric high-speed spindle with cooling means, comprising a tubular housing piece having an inner surface extending along the longitudinal axis of said piece, an electric stator disposed inside said housing piece, an electric armature rotatably mounted in said stator and having an end extending beyond said stator and presenting a front end of said armature, a work tool-holding member connected to said armature front end and extending therebeyond for releasably holding a work tool for rotation with said armature, a bearing on said front end and on the opposite end of said armature for rotatably supporting the latter, a bearing support member interposed between said housing piece inner surface and said bearing on said front end of said armature, a tubular member fluidly tightly telescoped within said tubular housing piece and extending into overlying contact with said bearing support member, said tubular member having a liquid inlet passageway spiraled therealong and having a liquid outlet passageway spiraled therealong and with said passageways extending along said tubular member to be in the plane extending transverse to the longitudinal axis of said armature and through said bearing support member for conducting cooling liquid along said housing and adjacent said bearing support member, said tubular housing piece and said tubular member fully defining said liquid passageways and thereby being arranged to fully contain the cooling liquid between said housing piece and said tubular member for cooling said stator and said armature and said bearing support member.

2. The subject matter of claim 1, wherein said tubular housing piece and said tubular member are cylindrical throughout their lengths and wherein said passageways are spiraled separate from but adjacent each other and with a common crossover passageway in liquid flow communication with both said spiraled passageways at said location adjacent said bearing support member.

3. The subject matter of claim 1, wherein said bearings are spaced-apart along said armature, said passageways extending along said tubular member for a distance greater than the spacing between said bearings for conducting liquid coolant to locations adjacent said bearings.

4. The subject matter of claim 2, wherein said tubular housing piece and said tubular member have both a fluid inlet port and a fluid outlet port formed in both said tubular housing piece and said tubular member and being drilled holes extending along the mating telescoping surfaces thereof, and with respective ones of said two ports being in fluid flow communication with respective ones of said two passageways.

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