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(19)

(54) A MACHINE TOOL

(71) We, FUJITSU FANUC LIMITED, a Company organized and existing under the laws of Japan of 5-1, Asahigaoka 3-chome, Hino-shi, Tokyo, Japan, do hereby declare

the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed to be particularly described in and by the following statement—:

The present invention relates to a machine tool, such as a lathe, milling machine or boring machine.

Generally speaking, conventional machine tools have spindles to which a rotational drive force is transmitted from electric motors fixed on bases through suitable transmitting mechanisms, such as belt transmissions comprising belts and pulleys, or gear transmissions. Because transmitting mechanisms are necessary for fulfilling the above purpose, the constructions of such conventional machine tools become complicated thereby increasing the costs thereof. Additionally, it is difficult to increase the stability in the rotational speeds of the main spindles, due to the slippage caused in the transmitting mechanisms or in the backlash of gear trains. In machine tools where the spindle directly supports the armature of an electrically driven motor, the armature tends to become overheated by the electrical currents exciting the armature.

It is an object of the invention to provide means whereby the dissipation of heat from the armature winding can be achieved efficiently.

According to the present invention there is provided a machine tool comprising a bed and a head stock mounted on the bed, wherein said head stock comprises a rotatably mounted spindle for supporting either a workpiece or a tool, armature windings rigidly secured to the spindle, a heat pipe for conducting away heat generated in the armature windings, field means arranged around the armature windings so as to define a clearance in the radial direction therewith, and means for supplying electrical power to the armature windings.

Two embodiments of the present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a vertical cross sectional view of the head stock portion of a conventional machine tool;

Figure 2 is a vertical cross sectional view of the head stock portion of a modified machine tool according to the invention;

Figure 3 is a vertical cross sectional view of the head stock portion of a further embodiment of a modified machine tool according to the invention.

With reference to Figure 1, a machine tool, in this case a lathe, generally indicated by reference numeral 10 comprises a bed 11 fixed on a floor and a head stock 12 mounted on the bed 11. A spindle 13 is rotatably mounted on the head stock 12 by a front bearing member 14 and a rear bearing member 15. The spindle 13 has at one end thereof an end member 13*a* formed integrally with the spindle 13. A chuck member 16, including means for holding a workpiece, is rigidly mounted on the end member 13*a* and is rotated integrally with the spindle 13. At the central portion of the spindle 13, armature windings 17 are rigidly secured thereto. The armature windings 17 are provided with commutators 18, with which brushes 19 contact. Coil springs 21 are disposed between the brushes 19 and the spring adjusting screws 20. Electric power is supplied to the armature windings 17 from an outside voltage source 24*a* through the brushes 19 and the commutators 18 in a well-known manner. The armature windings 17 are sur-

rounded by static field means 22 which are constructed from permanent magnets and circumferentially arranged at regular spaces, so that a slight clearance is formed between the armature windings 17 and the static field means 22 in the radial direction. The static field means 22 are supported by a cover member 23 which is secured to the head stock 12 and arranged so as to cover the armature windings 17. That is to say, the spindle 13, armature windings 17 and field means 22 construct a spindle D.C. motor.

For the arrangement of Figure 1, it is not necessary to provide any transmission mechanism, such as pulleys, belts, gears, couplings and the like, because the spindle 13 is constructed as the output shaft of the drive motor, so that the machine tool is simple in construction. Additionally, the performance and reliability of the machine tool are good, because no slippage occurs in the transmission mechanism or in the backlash of the gear trains. However the armature tends to be overheated by the electrical currents exciting the armature.

The arrangement shown in Figure 2 overcomes the problem of overheating. Referring to Figure 2 a spindle 33 has a heat pipe 34 therein, which pipe 34 is rigidly inserted into a cylindrical hollow portion 35 formed axially in the main spindle 33 so as to be opened at one end and closed at the other end thereof. This heat pipe 34 is constructed to be a fluid-tight pipe, into which working fluid 36, such as water or alcohol, is received. The free end of the heat pipe 34 is extended into a casing 37 mounted on a head stock 32 and is provided with a plurality of fins 38 positioned in the casing 37. At the upper portion of the casing 37, a fan assembly 39 is mounted, and at the bottom portion thereof an air slot 40 is formed. The casing 37 is formed as an air flow chamber 37*a*.

The heat pipe 34 conducts the heat generated by the electric currents exciting the armature windings 17 from the spindle 33 toward the end of the heat pipe 34 which is provided with the plurality of fins 38. The working fluid 36, such as water, in the heat pipe 34 conducts heat by means of the processes of the vaporization and condensation thereof. The heat pipe 34 is cooled with the plurality of fins 38 by the cooling air which is supplied into the casing 37 by the fan assembly 39. That is to say, the cooling air flows into the casing 37 through an air slot 40 and is heated by the fins 38, then the heated air flows out through the fan assembly 39. It is thus possible to avoid the harmful influences caused by the heat generated in the armature windings 17, which can disadvantageously affect every part of this machine tool.

In a second embodiment of the invention, shown in Figure 3, an axial cylindrical bore 42 is formed in spindle 43, in which bore 42 there is disposed an inner pipe member 44. At the ends of the inner pipe 44 two annular sleeves 45 and 46 are fluid-tightly disposed between the outer surface of the pipe 44 and the inner surface of the bore 42. Thus, an annular hollow chamber or a heat conductive passage 47 is formed between the inner surface of the bore 42 and the pipe member 44. This annular chamber 47 is maintained in a substantial vacuum condition and contains a little quantity of the heat conductive medium, such as 10% of the volume of the chamber 47 being water. The constructions of the other portions of this embodiment are the same as those of the embodiment illustrated in Figure 2.

In this embodiment the annular chamber 47 conducts the heat generated in the armature windings 17 in the same manner as that of the heat pipe 34 of the embodiment illustrated in Figure 2. According to this machine tool illustrated in Figure 3, it is possible to machine a long-sized workpiece because the spindle has a cylindrical bore therethrough.

WHAT WE CLAIM IS:—

1. A machine tool comprising a bed and a head stock mounted on the bed, wherein said head stock comprises a rotatably mounted spindle for supporting either a workpiece or a tool, armature windings rigidly secured to the spindle, a heat pipe for conducting away heat generated in the armature windings, field means arranged around the armature windings so as to define a clearance in the radial direction therewith, and means for supplying electrical power to the armature windings.

2. A machine tool according to claim 1, wherein said heat pipe has a plurality of fins attached on a free end thereof, said fins being positioned in an air flow casing which has a cooling fan assembly and an air outlet slot.

3. A machine tool substantially as herein described with reference to Figures 2 and 3 of the accompanying drawings.

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Fig. 1

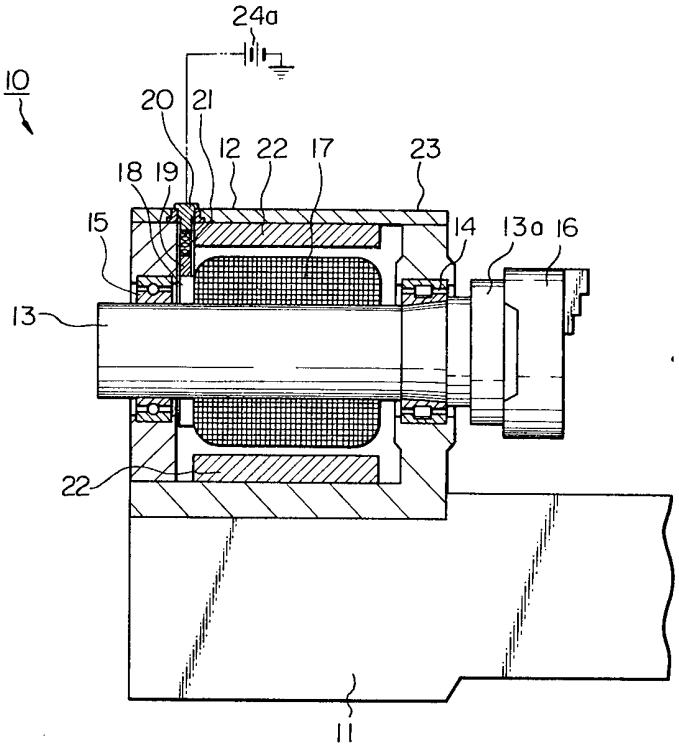

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Fig. 2

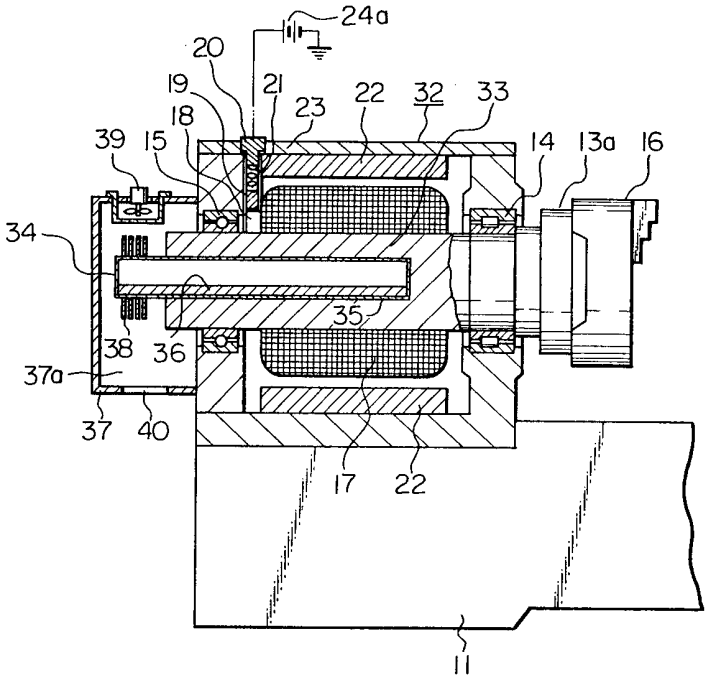

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Fig. 3