# United States Patent [19]

**Auphan et al.**

[11] **3,783,515**

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[54] **DENTAL DRILLING MACHINE HAVING IMPROVED COOLING**


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[51] **Int. Cl.** ..... **A61c 1/08**

[58] **Field of Search** ..... 32/27, 28



[56] **References Cited**

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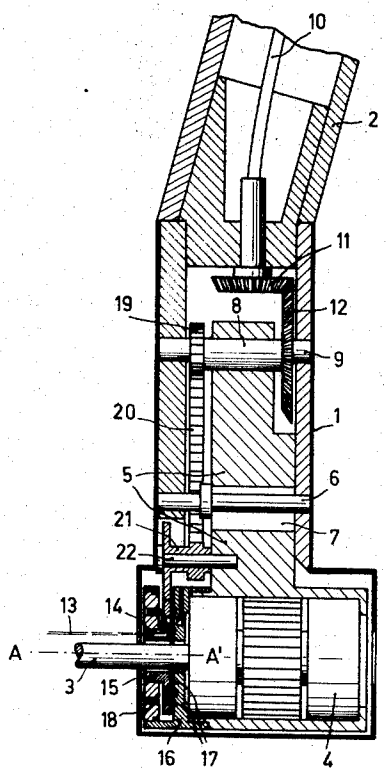
[57] **ABSTRACT**

A dental drilling machine having a drill spindle which performs two periodic movements: a fast rotary movement about its own axis and a comparatively slow rotary movement about a stationary axis which is parallel to the drill spindle. Moreover, a cooling liquid jet which is parallel to the drill spindle performs a slow periodic movement about the same stationary axis such that the liquid jet is periodically directed to the part of the borehole which has been vacated as a result of the slow movement of the drill spindle.


**7 Claims, 5 Drawing Figures**



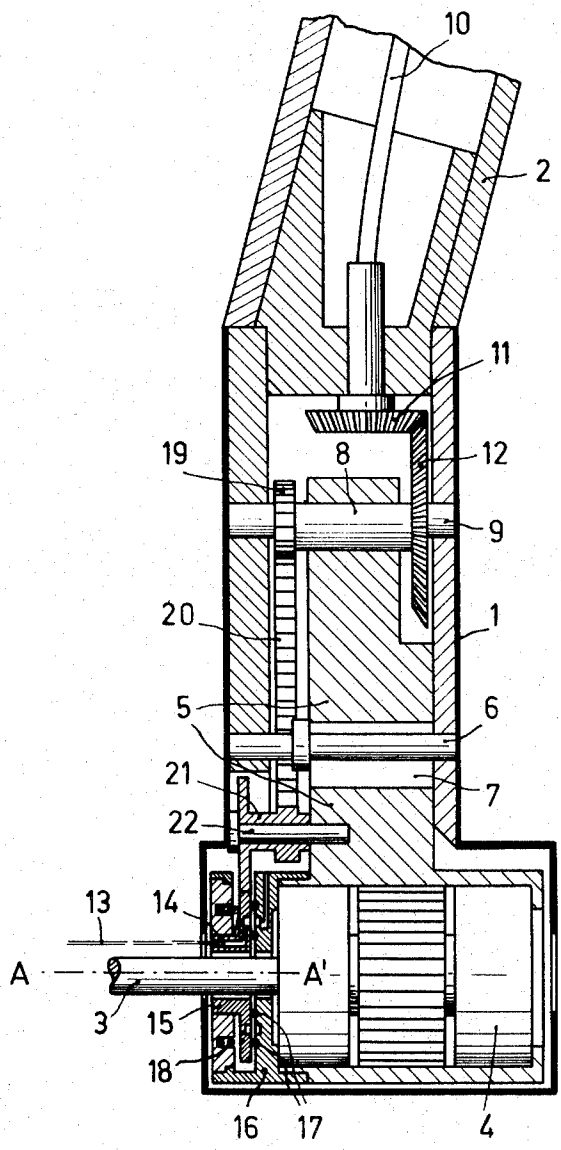
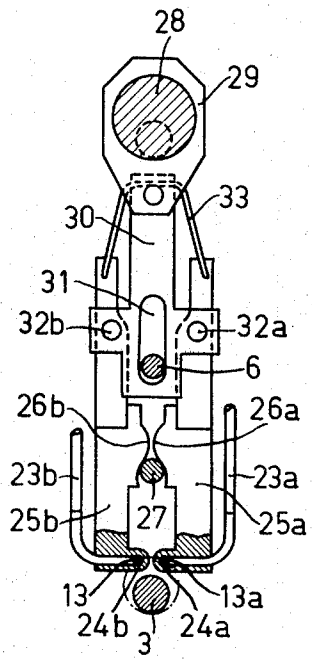



Fig.1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29
33
30
31
32b
32a
6
26b
26a
23b
23a
27
25b
25a
13
13a
24b
24a
3

Fig.3

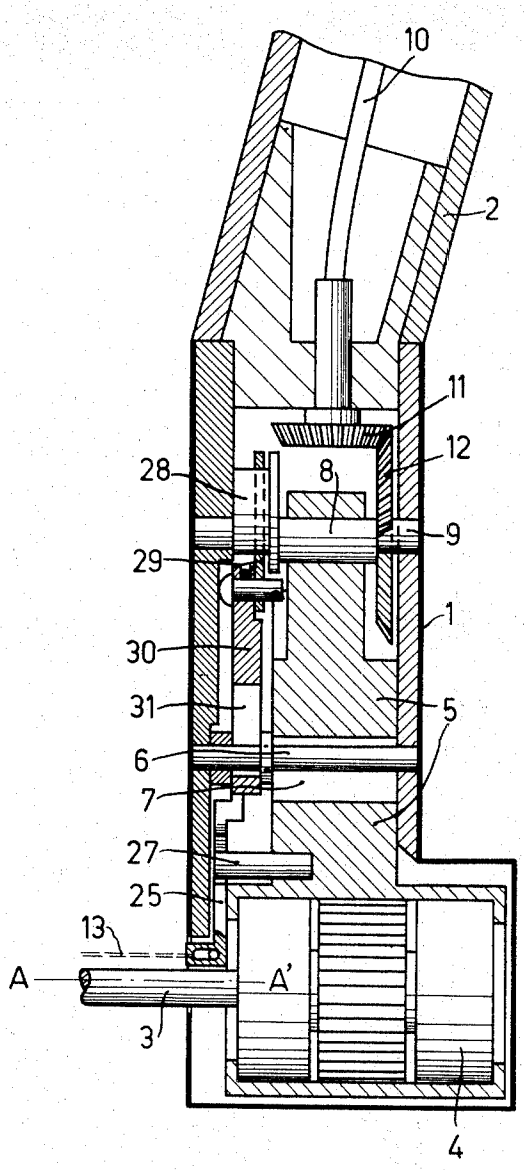

10
2
11
12
28
8
9
29
1
30
31
5
6
7
27
25
13
A
A'
3
4

Fig.2

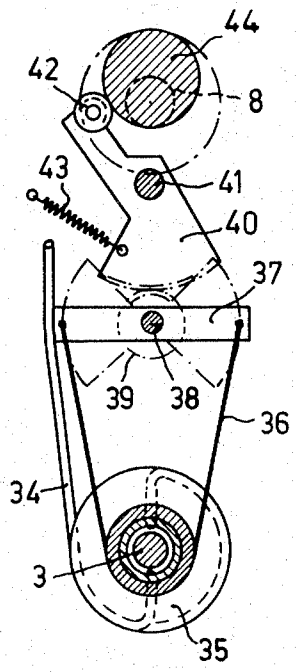
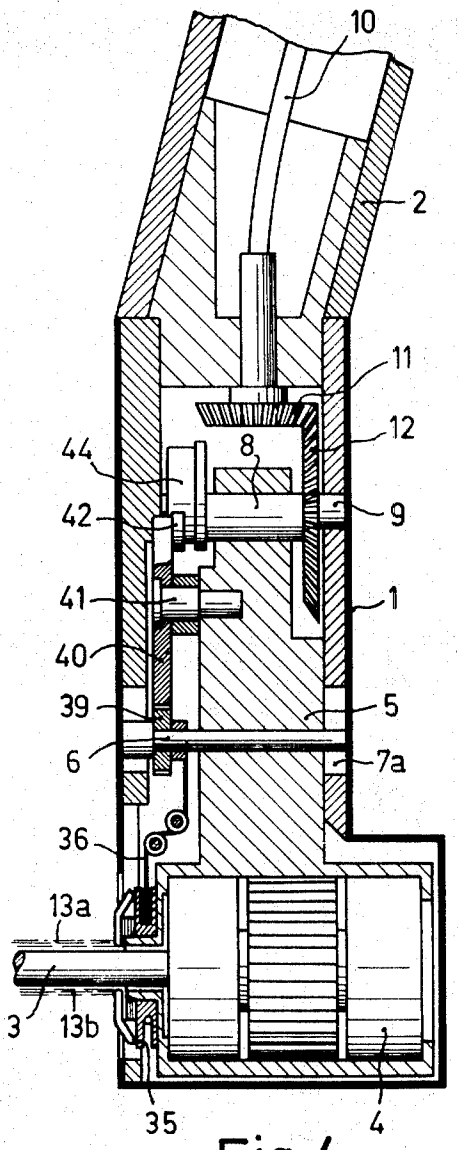

44
42
8
43
41
40
37
39
38
36
34
3
35

Fig.5


10
2
11
12
44
8
42
9
41
1
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39
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6
7a
36
13a
3
13b
35
4

Fig.4

# DENTAL DRILLING MACHINE HAVING IMPROVED COOLING

The invention relates to a dental drilling machine comprising a drill which is connected to the end of a drill spindle which is rotatable about its axis by means of a first drive system, and a cooling system which has at least one outlet aperture from which a liquid jet which is to be directed onto the hole to be drilled can flow.

Comtemporary dental drilling machines usually comprise a turbine drive system by means of which a very high rotary speed can be imparted to the drill. An advantage of these high speeds is that the patient to be treated suffers less pain, but it is a drawback that more heat is generated in the borehole which can damage the vital part of the tooth. Directing one or more liquid jets onto the borehole does not solve this problem since the liquid jet generally does not penetrate between the drill and the wall of the borehole which is in contact with the drill and where the heating is greatest. As soon as the liquid jet comes into contact with the drill the liquid is spun away so that it does not come into contact with the treated tooth surface.

The invention has for its object to provide a new type of high-speed dental drilling machine in which the said drawback is eliminated so that the borehole is effectively cooled.

The dental drilling machine according to the invention is characterized in that a second drive system is provided by means of which the drill spindle can be subjected to a second periodic movement during which it is displaced substantially parallel to itself, the said second periodic movement having a period which exceeds the revolution time of the drill spindle resulting from the first drive system, the cooling system being provided with means for periodic displacement of the liquid jet such that the liquid jet always remains directed to a portion of the borehole which has been vacated by the drill as a result of the second periodic movement of the drill spindle.

It is to be noted that French Patent Specification No. 1,158,033 describes a dental drilling machine in which the drill is connected to the end of the drill spindle in a sleeve of an elastic material so that the end of the drill rotates eccentrically, the axis of the drill thus covering a conical surface. However, in this case the drill performs only one movement and there is no superimposition of a rotary movement of the drill spindle about its own axis on a periodic movement of this axis, as is the case in the drilling machine according to the invention.

The dental drilling machine proposed in the said patent specification claims to offer a better cutting function of the drill with few vibrations occurring at the area of the tooth while the dentist has to exert merely a slight pressure. However, this seems to be in contradiction with the dentists' experience which shows that the drill should not have a rapid movement of its own outside its rotary movement.

The second periodic movement of the drill spindle preferably consists of the completion of a circular path about a fixed axis which is parallel to the drill spindle. According to a favourable embodiment, the drill spindle is located in an end of a drive rod, the other end of which can be driven by means of an eccentric such that is obtains a rotary movement which is parallel to the rotary movement of the drill spindle, a shaft being provided which is inserted through a slot so as to guide the drive rod. The outlet aperture of the cooling system is preferably directed such that the liquid jet is substantially parallel to the drill spindle, the outlet aperture being also displaceable such that the liquid jet can perform a circular movement about the stationary axis at a speed which is equal to that of the circular movement of the drill spindle, said movements having a phase difference with respect to each other, the said circular movements being, for example, in phase-opposition.



According to a preferred embodiment, the discharge aperture is situated in a rotatable sleeve which is provided about the drill spindle and which can be moved in synchronism with the movement of the drive rod. It is alternatively possible to provide the drilling machine with a cooling system having two outlet apertures, each of which is directed such that the liquid jet is substantially parallel to the drill spindle, said outlet apertures being movable such that each liquid jet can describe a to and fro movement along a half circle whose centre point is situated on the stationary axis.

The invention will be described with reference to the drawing, in which:

FIG. 1 is a sectional view of a first embodiment of a dental drilling machine according to the invention, having a cooling system comprising only one rotating liquid jet,

FIG. 2 is a sectional view of a second embodiment of a dental drilling machine according to the invention in which the cooling system comprises two liquid jets, each of which can describe half a circle circumference,

FIG. 3 is a plan view of the mechanism for controlling the liquid jets of the dental drilling machine shown in FIG. 2,

FIG. 4 is a sectional view of a third embodiment of a dental drilling machine according to the invention in which the cooling system again comprises two liquid jets, each of which is capable of describing one half circle circumference, and

FIG. 5 is a plan view of the mechanism for controlling the liquid jets of the dental drilling machine shown in FIG. 4.

The drive systems for the drill spindle, both for producing a rotary movement of the drill spindle about its axis and for producing a periodic movement of the drill spindle, are denoted by the same references for all three embodiments. In a housing 1 which is mounted on the end of a tube 2, a drill spindle 3 is connected in the extension of the axis of a known turbine 4 which is capable of imparting a very high rotary speed to the drill spindle. The turbine 4 is contained in an aperture of a drive rod 5 which is capable of performing a periodic movement in the housing 1; to this end, the drive rod 5 comprises a guide aperture 7 in which a shaft 6 is located. The drive rod 5 is driven via an eccentric 8 which is rotatable about a shaft 9 which is located in the housing 1. The dimensions of the various elements are such that the drill spindle 3 performs a substantially circular movement about a stationary axis AA'. The assembly is put into (a comparatively slow) motion by an electric motor (not shown) which drive the eccentric 8 via a flexible shaft 10 and two gearwheels 11 and 12.

For cooling purposes one or more liquid jets 13 can be directed onto the borehole (not shown), said liquid jets being periodically movable such that always one liquid jet is directed onto a portion of the borehole

which has been vacated by the drill as a result of the slow movement of the drill spindle **3**. The cooling liquid can be applied to the dental drilling machine in known manner (not shown), for example, via a flexible tube.

The figures illustrate three embodiments by means of which it is possible to impart a periodic movement to the liquid jet **13** about the axis AA', the speed of this movement being preferably equal to that of the drill spindle **3**, the two movements having a phase difference with respect to each other such that the described object is achieved.

By a suitable choice of the distances with respect to the stationary axis AA', the drill spindle **3** and the liquid jet **13** can be made to describe the same path about this axis in succession.

In FIG. **1** the liquid jet **13** which is parallel to the axis AA' is discharged from an outlet aperture **14** of a rotating sleeve **15** which is connected, via a sealing, to a fixed crown **16**. The sealing is obtained by means of toroidal seals **17** and a spring **18**. The sleeve **15** is driven by the shaft **9** by means of a gearwheel **19** and a toothed belt **20** which transfers the movement to a stepped gearwheel **21**, whose shaft **22** is connected to the drive rod **5** and which engages the teeth provided on the sleeve **15**.

As a result, the liquid jet **13** describes a circular movement about the axis AA', said movement being phase-shifted with respect to the movement of the drill spindle **3** about this axis AA', these movements being preferably performed in phase-opposition.

FIGS. **2** and **3** (in more detail) illustrate a cooling system utilizing two liquid jets **13***a* and **13***b* which are symmetrical with respect to the plane of the drawing of FIG. **2**. The liquid is supplied via flexible tubes which are schematically denoted at **23***a* and **23***b*. When the drilling machine is in operation, each liquid jet **13** describes one half circle circumference which corresponds to one half of the path of the drill spindle **3** about the axis AA'.

The two liquid supply tubes **23***a* and **23***b* open into two outlet apertures **24***a* and **24***b* which are accommodated in a symmetrical pair of arms **25***a* and **25***b*. The sides of the two arms **25***a* and **25***b* which face each other are provided with a profile (**26***a* and **26***b*, respectively) which slides along a cylindrical pin **27**, connected to the drive rod **5**, when the arms are displaced in their longitudinal diretion, so that the arms are laterally deflected with the result that each of the outlet apertures **24***a* and **24***b* describes one half circle.

The arms are driven by an eccentric **28**, the phase of the movement of which opposes that of the eccentric **8**; the eccentricity of **28** is larger than that of the eccentric **8**.

For a better understanding of the transfer of the movement from the eccentric **8** to the liquid jet **13**, the drive rod **5** will be considered as a reference. With respect to the drive rod **5**, the pin **27** performs a linear to and fro movement in the symmetrical plane of FIG. **3**. This movement is caused by the eccentric **28** which drives a drive rod **29** which is coupled to a slide **30** on which the pin **27** is provided. The slide **30** is guided by the shaft **6** which projects into an aperture **31** which is recessed in the slide. The arms **25***a* and **25***b* are symmetrically connected in a hinged manner to the slide **30** via hinges **32***a* and **32***b*, a double spring **33** keeping the two profiles **26***a* and **26***b* pressed against the pin **27**.

The cooling system shown in FIG. **4** and FIG. **5** (in more detail) also has two liquid jets **13***a* and **13***b* which are supplied via a flexible tube **34** with two outlet apertures. The end portion of the tube **34** is connected to a disc **35** which can rotate about an axis which is concentrical to the drill spindle **3**. In this manner each of the two liquid jets **13***a* and **13***b* can describe one half circle about the axis AA'.

In the embodiment shown in FIG. **4** the shaft **6** is rigidly connected to the drive rod **5** so as to simplify the construction, whilst instead of the aperture **7** in the drive rod an aperture **7***a* is provided in the housing **1** so as to guide the shaft **6**. Like in the foregoing embodiment, the drive rod **5** will be used as a reference for the movements in the following description.

The disc **35** obtains a to and fro rotary movement via a drive cord **36** which is connected to an arm **37** which performs a to and fro rotary movement about a shaft **38**. The latter to and fro rotary movement is produced by a gearwheel **39** which engages the teeth of an element **40** which oscillates about a shaft **41** which is rigidly connected to the drive rod **5**. The element **40** is put into an oscillating motion by a roller **42** which is pressed, by means of a spring **43**, against an eccentric **44** which is connected to the shaft **9**, the phase of the movement of the eccentric **44** opposing that of the eccentric **6**. The eccentricity of the eccentric **44** exceeds that of the eccentric **6**.

The described examples merely illustrate feasible embodiments of the invention, the main advantage being the effective cooling of the inside of the borehole: the liquid flow contacts an area in this hole at which the drill is no longer present.

What is claimed is:

**1.** A dental drilling machine comprising a drill spindle rotatable about its axis a first drive system for causing rotation of said spindle, a drill connected to the end of said spindle a cooling system having at least one outlet aperture through which a liquid jet may be directed onto the hole to be drilled a second drive system by means of which the drill spindle can be subjected to a second periodic movement during which it is displaced substantially parallel to itself, the said second periodic movement having a period which exceeds the revolution time of the drill spindle caused by the first drive system, the cooling system being provided with means for periodic displacement of the liquid jet such that the liquid jet always remains directed to a portion of the borehole which has been vacated by the drill as a result of the second periodic movement of the drill spindle.

**2.** A dental drilling machine as claimed in claim **1**, wherein the second periodic movement of the drill spindle comprises the completion of a circular path about a stationary axis which is parallel to the drill spindle.

**3.** A dental drilling machine as claimed in claim **2**, wherein the drill spindle is located in one end of a drive rod an eccentric for driving, the other end of said rod such that it obtains a rotary movement parallel to the rotary movement of the drill spindle, a shaft for guiding said drive rod inserted through a slot.

**4.** A dental drilling machine as claimed in claim **2**, wherein the outlet aperture of the cooling system is directed such that the liquid jet is substantially parallel to the drill spindle, the outlet aperture being displaceable such that the liquid jet can perform a circular movement about the stationary axis at a speed which is equal

to that of the circular movement of the drill spindle, the phase of the said movements being different with respect to each other.

5. A dental drilling machine as claimed in claim 4, wherein the phase of the circular movement of the liquid jet is opposed to that of the drill spindle.

6. A dental drilling machine as claimed in claim 4 wherein the outlet aperture is situated in a rotatable sleeve mounted about the drill spindle arranged for movement in synchronism with the movement of the drive rod.

7. A dental drilling machine as claimed in claim 2, wherein the cooling system comprises two outlet apertures, each of which is directed such that the liquid jet is substantially parallel to the drill spindle, the said outlet apertures being movable such that each liquid jet can describe a to and fro movement along a half circle with a point on the stationary axis as the center point.

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