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(54) **Directional boring machine for drilling underground ducts**

(57) A directional boring machine (1) for drilling underground ducts, comprising a cutting bit (3) designed to carry out removal of the material, a chuck (2) connected to the cutting bit (3) for ensuring rotation thereof about an axis (Z) of its own, a first actuator (6, 7, 8) designed to cause slewing of the chuck (2) about a first axis (Y) perpendicular to the axis (Z) of rotation of the cutting bit, and a second actuator (10, 11) designed to cause slewing of the chuck (2) about a second axis (X) perpendicular to the first axis (Y) and parallel to a drilling axis (S).

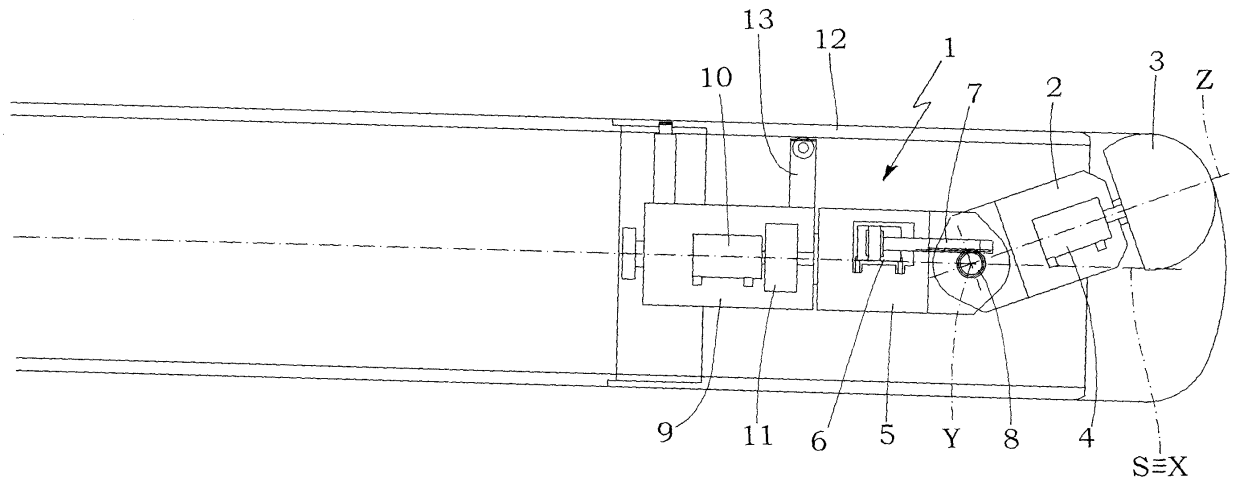

FIG. 1

EP 2 000 627 A2

Description

[0001] The present invention relates to a directional boring machine for drilling underground ducts.

[0002] Usually, drilling underground ducts, such as sewer lines, ducts for electric power cables or cables and optical fibres for telecommunications etc., requires two different types of operation: a first operation regards the vertical shaft having a depth comprised between 2 m and 15 m, with a cross section as contained as possible (a diameter comprised between 75 cm and 120 cm), and the purpose of which is to reach the depth suitable for carrying out the second operation, which regards drilling of the substantially horizontal duct, in which the pipes with a diameter comprised between 20 cm and 60 cm for a length comprised between 2 m and 50 m are to be laid.

[0003] Generally, these types of operation are carried out by means of mechanical shovels, excavators, and/or other earth-moving machines. Such a technique presents the disadvantage of not being applicable in the case where the excavation originates within a building or can jeopardize the static stability of structures in the vicinity or else it is not possible to interrupt the circulation of road traffic.

[0004] Alternatively, it is possible to carry out the excavation using a drill controlled from the surface. In this case, in addition to not providing any guarantee of the exact position of outlet, large spaces are required on the surface, and the machinery cannot be transported inside basements or underground areas of existing buildings.

[0005] A further technique used regards percussion drilling, which envisages the use of an ogival-shaped percussion drill that advances underground by means of successive impacts at high frequency. Said system, in addition to penetrating into the target excavation, causing considerable damage as a result of the disruptive percussive force, does not guarantee the position of penetration given that it is not equipped with any device for correction of the bore path.

[0006] The aim of the present invention is to provide a directional boring machine for drilling underground ducts, the technical characteristics of which are such as to guarantee reduced dimensions and weight so as to be usable also for works where a treading surface of small dimensions is available, without this implying any loss of efficiency.

[0007] The subject of the present invention is a directional boring machine for drilling underground ducts, characterized in that it comprises a cutting bit designed to carry out removal of the material, a chuck connected to the cutting bit for ensuring rotation thereof about an axis of its own, a first actuator designed to cause slewing of the chuck about a first axis perpendicular to the axis of rotation of the cutting bit, and a second actuator designed to cause slewing of said chuck about a second axis perpendicular to said first axis and parallel to a drilling axis.

[0008] The ensuing example has the purpose of providing a nonlimiting illustration of the invention, to enable a clearer understanding thereof with the aid of the figures of the annexed drawing, wherein:

Figure 1 is a lateral cross section of a preferred embodiment of the directional boring machine forming the subject of the present invention; and

Figure 2 illustrates two different modes of use of the machine of Figure 1.

[0009] In Figure 1, designated as a whole by 1 is the directional boring machine forming the subject of the present invention.

[0010] The directional boring machine 1 comprises a chuck 2, fixed to which is a hemispherical cutting bit 3. The chuck 2 comprises an hydraulic motor 4 designed to maintain the hemispherical cutting bit 3 in operating rotation about an axis Z of its own.

[0011] The directional boring machine 1 comprises a central structure 5 hinged onto the chuck 2 along an axis Y orthogonal to the axis Z of rotation of the cutting bit 3. In particular, the central structure 5 comprises an oleodynamic hydraulic actuator 6 having a rack stem 7, which engages a pinion 8 fixed to the chuck 2. Coupling of the rack 7 with the pinion 8 enables the chuck 2 and, hence, the cutting bit 3, to rotate about the axis Y passing through the pinion 8 itself.

[0012] The machine 1 comprises a rear structure 9, in turn comprising a hydraulic motor 10 connected to an epicyclical reduction gear 11, which is in turn connected to the central structure 5, causing rotation thereof about an axis X parallel to a drilling axis S.

[0013] As will emerge clearly to a person skilled in the branch, the two degrees of freedom (rotation about the axis Y and rotation about the axis X) of the chuck 2 guarantee a high freedom of movement and positioning of the cutting bit 3 itself in such a way as to be able to carry out drilling of underground ducts or conduits of different dimensions, as will be described hereinafter.

[0014] As illustrated in Figures 1 and 2, the rear structure 9 is, in use, fixed inside a pipe 12, which will have to be set in operation within the underground duct made, this implying that, once drilling of the duct is terminated, the directional boring machine 1 will be released and brought out onto the surface whilst the pipe 12 remains within the duct. Fixing of the rear structure 9 to the pipe 12 is provided by means of three brackets 13. In particular, the directional boring machine 1 can be set in a position coaxial to the pipe 12 (as illustrated in Figure 1), or else in a misaligned position, for example, to optimize the efficiency of a suction unit (which is known and for this reason is not illustrated or described) for suction of the drilling debris, said suction unit also being located within the pipe 12.

[0015] The directional boring machine 1 is moved by means of oleodynamic actuators, the energy of which is generated by a power unit driven by an electric motor or

internal-combustion engine that is located at the top of the vertical shaft or in any case on the surface. In the same way, the supply of oil to the oleodynamic actuators is guaranteed by a pressurized-oil generator positioned on the surface and driven by an electric motor or internal-combustion engine. To make the aforementioned electrical connections and to ensure the supply of oil a system of cables and pipes to which the machine 1 is connected is necessary. Said systems of cables and pipes are known and for this reason are not illustrated or described.

[0016] As is illustrated in Figure 2, the directional boring machine 1 forming the subject of the present invention, thanks to its technical characteristics, is able to make excavations of different dimensions, which, to make underground ducts, means being able both to sink the vertical shaft and to drill the substantially horizontal ducts. In fact, by varying the angle of the central structure 5 with respect to the axis S of drilling, it is possible to vary the diameter of the action of drilling between a maximum diameter, which can be obtained when the central structure 5 is set orthogonal to the drilling axis S, and a minimum diameter, which can be obtained when the central structure 5 is set parallel to the drilling axis S. In other words, the bore is obtained by the action of the cutting bit 3 for removal of the material, whilst the simultaneous rotation of the chuck 2 about the axis Y and the axis X, respectively, by means of the coupling between the pinion 8 and the rack 7 and by means of the epicyclic reduction gear 11, enables definition of the dimensions of the bore.

[0017] In this regard, it should be pointed out that it is possible to make excavations of considerable diameters by adding to the directional boring machine one or more further structures, which would hence increase the arm of excavation thereof.

[0018] In addition, it should be specified that the particular type of rotation actuators that enable slewing of the chuck 2 about the axis X and the axis Y does not constitute a limiting aspect of the present invention, as specified by tenor of the main claim.

[0019] In use, initially the directional boring machine 1 is employed for sinking the vertical shaft, as illustrated in Figure 2. In this step of excavation, the directional boring machine 1 is fixed to a portion of pipe 14, which will constitute a part of the walls of the shaft. Once the vertical shaft has been sunk, the directional boring machine 1 is released from the pipe 14 and engaged to a pipe 12 of considerably smaller diameter, which will constitute the end portion of the pipe in service in the duct to be made.

[0020] In this new configuration, the directional boring machine 1 is set in a substantially horizontal position. As the excavation and, hence, the drilling of the duct advances, further lengths of pipe are progressively added, the first of which will be fixed precisely to the end portion represented by the pipe 12. In this way, it is possible to perform simultaneously the operation of drilling and the operation of formation and housing of the piping.

[0021] Once the duct has been made and the piping has been completed, the directional boring machine 1 is released from the pipe 12 constituting the end portion of the piping, and the entire piping formed with the progressive addition of lengths of pipe is left within the duct that has been made.

[0022] As emerges clearly from the above description, the directional boring machine presents the advantages of having particularly small dimensions and weight and, at the same time, of being able to carry out all the excavation operations necessary for carrying out excavations, without thereby having to occupy large spaces on the surface with the drawbacks that this entails. Said advantages hence enable duct-drilling operations to be carried out also within dwellings or in the proximity of roads without, however, creating any inconvenience to the circulation of traffic.

[0023] Finally, a further advantage of the directional boring machine of the present invention regards the possibility of describing by means of the cutting bit 3, not only circular orbits, but also elliptical orbits, etc., in such a way as to correct the possible involuntary swerving of the system due to errors of positioning or to the penetration of the pipe 12 within markedly unhomogeneous terrains.

Claims

1. A directional boring machine (1) for drilling underground ducts, **characterized in that** it comprises a cutting bit (3) designed to carry out removal of the material, a chuck (2) connected to the cutting bit (3) for ensuring rotation thereof about an axis (Z) of its own, a first actuator (6, 7, 8) designed to cause slewing of the chuck (2) about a first axis (Y) perpendicular to the axis (Z) of rotation of the cutting bit, and a second actuator (10, 11) designed to cause slewing of said chuck (2) about a second axis (X) perpendicular to said first axis (Y) and parallel to a drilling axis (S).

2. The directional boring machine according to Claim 1, **characterized in that** said first actuator (6, 7, 8) comprises an oleodynamic actuator (6), a rack stem (7), and a pinion (8); said pinion (8) being fixed to said chuck (2) and engaging said rack stem (7) to perform the rotation of said chuck (2) about the axis (Y).

3. The directional boring machine according to Claim 1 or Claim 2, **characterized in that** the second actuator (10, 11) comprises a hydraulic motor (10) and an epicyclic reduction gear (11) connected to a central structure (5) carrying said first actuator (6, 7, 8); said second actuator (10, 11) being designed to slew said central structure (5) about an axis (X) perpendicular to the axis (Y) and parallel to the drilling axis (S).

4. The directional boring machine according to any one of the preceding claims, **characterized in that** said chuck (3) comprises a hydraulic motor (4).

5. The directional boring machine according to any one of the preceding claims, **characterized in that** it is moved by means of oleodynamic actuators, the energy of which is generated by a power unit driven by an electric motor or internal-combustion engine positioned on the surface.

6. The directional boring machine according to any one of the preceding claims, **characterized in that** it comprises a rear structure (9) carrying said second actuator (10, 11) and designed to be fixed to the internal surface of a pipe (12; 14) during operation of the directional boring machine (1).

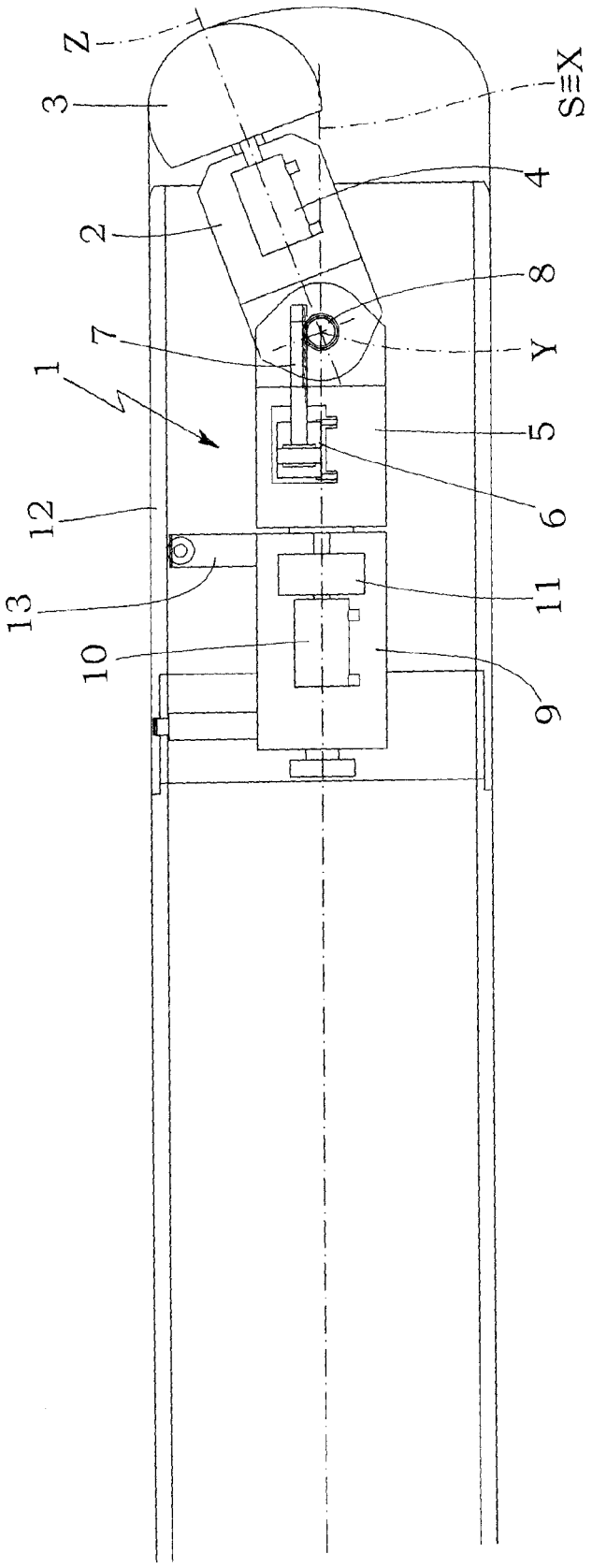

FIG. 1

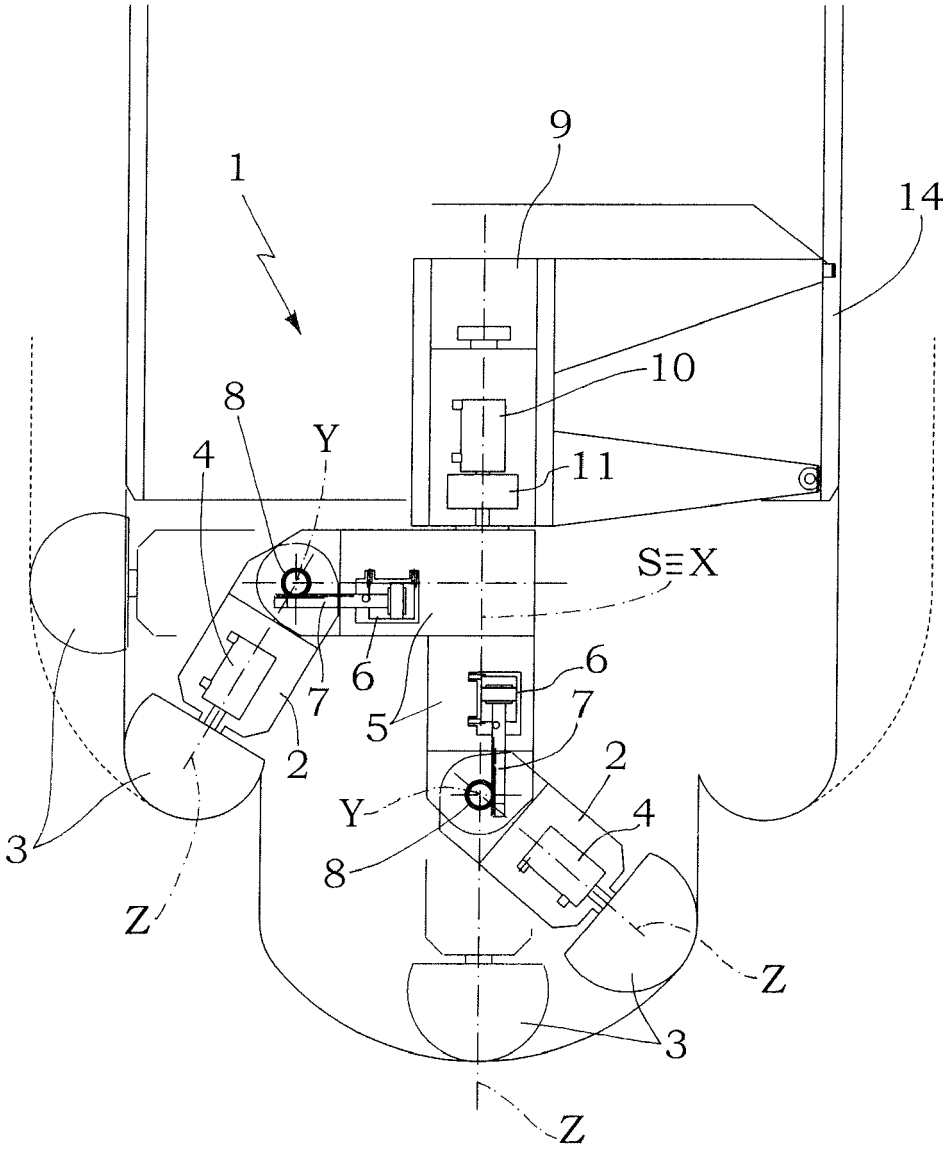

FIG. 2