directions of space except in a disengagement direction. In order to prevent the drag bit from disengaging from the mounting bracket during the rotation of the cutting head, a screw attaches the drag bit to the mounting bracket removably: in a mounted configuration of this excavating tool, the threaded end of the screw is screwed into a tapped hole of the drag bit, the central axis of which is parallel or slightly tilted with respect to the disengagement direction, while the head of the screw is supported on a wall of the mounting bracket through which extends the screw. In order to disengage the drag bit from the mounting bracket while maintaining the screw secured to this drag bit, the screw is partly unscrewed, and it is then necessary to move the drag bit first along a first translational movement of the disengagement direction, and then along a second translational movement in a direction perpendicular to this disengagement direction: the first movement gives the possibility of only partly disengaging the drag bit with respect to the mounting bracket, the continuation of this first movement being impossible because of the interference in the disengagement direction, between the head of the screw and the aforementioned wall of the mounting bracket. The movement of the drag bit according to the second movement is that the stem of the screw crosses the aforementioned wall of the mounting bracket through a slot of this wall, this slot being oriented in the direction of the second translational movement and opened at its end so as to let the stem of the screw move out and thus allow effective disengagement of the drag bit and of the screw with respect to the mounting bracket. The successive application of the first and second aforementioned movements may prove to be delicate, in particular for a robot manipulator.

Embodiments of the present invention seek to propose an excavating tool of the type mentioned above, for which the mounting and the attachment of the drag bit are efficient and fast, as well as particularly simple to apply, potentially automatically by a robot.

For this purpose, embodiments of the invention seek to provide an excavating tool for a tunnel boring machine as defined in claim 1.

According to a first aspect of the present invention, there is provided an excavating tool for a tunnel boring machine, comprising:

- a drag bit for attacking the land to be excavated,
- a mounting bracket for mounting the drag bit, the mounting bracket being provided so as to be permanently fixed to a cutting head of the tunnel boring machine, the mounting bracket and the drag bit being shaped so as to be engaged with each other so as to fixably bind the drag bit with the mounting bracket in all the directions of space except in a disengagement direction, and

- a screw for removably attaching the drag bit to the mounting bracket, the screw being provided with threading which is screwed into a tapped hole of the drag bit, the disengagement direction being transverse to the central axis of this tapped hole,

wherein, in a mounted configuration of the excavating tool, the drag bit is in direct mechanical engagement with the mounting bracket in the directions other than the disengagement direction and the screw interferes with the mounting bracket in the disengagement direction for blocking the drag bit with respect to the mounting bracket, and

wherein the tapped hole of the drag bit and the threading of the screw are designed for, by screwing-unscrewing, maintaining the drag bit and the screw secured to each other while having the excavating tool pass between the mounted configuration and a disassembled configuration in which the screw does not interfere with the mounting bracket in the disengagement direction so that, by driving only in the disengagement direction, the drag bit and the screw are disengaged from the mounting bracket, while by driving only in a direction opposite to the disengagement direction, the drag bit and the screw are mounted on the mounting bracket.

According to embodiments of the invention, the attachment of the drag bit on the mounting bracket is achieved with at least one screw which, both when the drag bit is mounted on the mounting bracket and the tool is thus in an operating condition, and when the drag bit is disassembled with respect to the mounting bracket and the tool is thus in a maintenance condition for purposes of repair or of changing the drag bit, it is physically maintained secured to the drag bit, while remaining screwed into this drag bit. Therefore, there is no risk of loosening or losing the screw during the handling operations of the drag bit. The passage of the tool according to embodiments of the invention between its mounted and disassembled configurations is carried out by relative screwing-unscrewing between the screw and the

drag bit. Further, once the tool is in a disassembled configuration, the joint drive of the drag bit and of the screw exclusively in the disengagement direction gives the possibility of completely disengaging this drag bit and this screw with respect to the mounting bracket; the mounting of the assembly « drag bit + screw » on the mounting bracket is, as for it, totally obtained by driving this assembly exclusively in a direction opposite to the disengagement direction. Thus, the movements engaged for mounting and disassembling the tool, i.e. the screwing-unscrewing of the screw and the rectilinear drive of the « screw + drag bit » assembly parallel to the engagement direction, are limited, constant and repetitive, the assembly « drag bit + screw » remaining entire and secured: the mounting and disassembling operations are facilitated and shortened for a human operator, these operations being even easily adaptable to automatic application by a robot manipulator.

Further, in the mounted configuration of the tool, the screw only supports few, or even no forces exerted by the land on the drag bit during the scraping action of the latter on the cutting front: indeed, because of the direct engagement between the drag bit and the mounting bracket, notably by blocking, these forces are in majority absorbed or even exclusively absorbed by the mounting bracket, except in the disengagement direction of the drag bit with respect to the mounting bracket, a direction in which the screw ensures the blocking of the drag bit with respect to the mounting bracket while interfering with the latter. In practice, the proportion of the forces specifically applied in this disengagement direction is small, or even marginal with respect to the whole of the forces which, upon accumulation, are exerted on the drag bit, these forces being oriented in a very large number of directions, depending on the irregularities of the cutting front and gradually during the rotation of the cutting head. It is understood that the screw of the excavating tool according to embodiments of the invention may advantageously be dimensioned accordingly to a minimum and only be provided in a single version, which reinforces the handling facility, while guaranteeing the reliability of the operating excavating tool.

Advantageous additional features of the excavating tool according to embodiment of the invention are specified in claims 2 to 10.

According to a second aspect of the present invention, there is provided a tunnel boring machine, comprising a cutting head and at least one excavating tool, as defined in the first aspect and the mounting bracket of which is permanently fixed to the cutting head.

The invention will be better understood upon reading the description which follows, only given as an example and made with reference to the drawings wherein:

- Fig. 1 is a front face of a mole according to the invention;

CLAIMS

1.- An excavating tool for a tunnel boring machine, comprising:

- a drag bit for attacking the land to be excavated,
- a mounting bracket for mounting the drag bit, the mounting bracket being provided so as to be permanently fixed to a cutting head of the tunnel boring machine, the mounting bracket and the drag bit being shaped so as to be engaged with each other so as to fixably bind the drag bit with the mounting bracket in all the directions of space except in a disengagement direction, and
- a screw for removably attaching the drag bit to the mounting bracket, the screw being provided with threading which is screwed into a tapped hole of the drag bit, the disengagement direction being transverse to the central axis of this tapped hole,

wherein, in a mounted configuration of the excavating tool, the drag bit is in direct mechanical engagement with the mounting bracket in the directions other than the disengagement direction and the screw interferes with the mounting bracket in the disengagement direction for blocking the drag bit with respect to the mounting bracket, and

wherein the tapped hole of the drag bit and the threading of the screw are designed for, by screwing-unscrewing, maintaining the drag bit and the screw secured to each other while having the excavating tool pass between the mounted configuration and a disassembled configuration in which the screw does not interfere with the mounting bracket in the disengagement direction so that, by driving only in the disengagement direction, the drag bit and the screw are disengaged from the mounting bracket, while by driving only in a direction opposite to the disengagement direction, the drag bit and the screw are mounted on the mounting bracket.

2.- The excavating tool according to claim 1, wherein the threading of the screw is located in a current part of the screw.

3.- The excavating tool according to one of claims 1 or 2, wherein, in the mounted configuration of the excavating tool, the screw interferes with the mounting bracket in the disengagement direction at both opposite longitudinal ends of the screw.

4.- The excavating tool according to claim 3, wherein a first of both ends of the screw forms a head for driving the screw in screwing-unscrewing relatively to the tapped