Patent Claims

1. A device (10) for the automated installation of at least one tunnel lining segment (110) of a tunnel lining ring for lining a tunnel section driven by a tunneling machine, which device can be coupled to the tunneling machine,

- having a manipulator (20) with at least one tool (23) for picking up, holding and placing the at least one tunnel lining segment, and with at least one actuator (17, 22, 24) for moving the at least one tool, wherein the at least one tool can be moved by means of the at least one actuator in a radial, tangential and/or axial direction with respect to a machine axis of the tunneling machine in a space of the tunnel section created by the tunneling machine,
- having at least one tool position sensor, which is provided on the manipulator and/or tool, for sensing the respective actual position and actual location of the tool in the space of the tunnel section,
- having at least one tunnel lining segment sensor (230), which is provided on the manipulator and/or the tool, with which an actual position and/or actual location of at least one section of at least one already arranged tunnel lining segment can be sensed, and/or with which an actual position and/or actual location of the tunnel lining segment respectively to be placed can be sensed,
- having at least one controller, which accesses installation data of the tunnel lining segments and which accesses the measurement data of the at least one tool position sensor and the at least one tunnel lining segment sensor, and with which the at least one actuator and the at least one tool can be controlled on the basis of the installation data and measurement data in order to move the tool from a picking-up position to a target placing position of the respective tunnel lining segment, to align it in the actual placing position and to arrange the tunnel

lining segment against at least one already placed tunnel lining segment of the tunnel lining ring,

wherein at least two tunnel lining segment sensors are provided, characterized in that the tunnel lining segment sensor is a time-of-flight camera.

2. The device as claimed in claim 1, characterized in that the at least one tool is a picking-up element.

3. The device as claimed in claim 1 or 2, characterized in that the at least one tool position sensor is a displacement measuring cylinder, rotary encoder, location sensor, inclinometer and/or displacement transducer.

4. The device as claimed in one of claims 1 to 3, characterized in that the data are a laying plan of the tunnel lining segments to be placed, a delivery plan of the tunnel lining segments to be placed, the picking-up position for picking up the tunnel lining segment respectively to be placed, the target placing position of the tunnel lining segment respectively to be placed, and/or information about the type and physical properties, such as for example the weight and dimensions, of the respective tunnel lining segment to be placed.

5. The device as claimed in one of claims 1 to 4, characterized in that at least one additional tunnel lining segment sensor is provided, preferably as a time-of-flight camera or 2D camera.

6. The device as claimed in claim 5, characterized in that the additional tunnel lining segment sensor is provided in the region of the tunnel lining segment sensors or in the region of the tool.

7. The device as claimed in one of claims 1 to 6, characterized in that advancing presses of the tunneling machine can be activated extendably and retractably by the controller, so that they can be pressed against placed tunnel lining segments.

8. The device as claimed in one of claims 1 to 7, characterized in that a feeding unit (segment feeder) for feeding the tunnel lining segment to the picking-up position for picking up the tool can be activated by the controller, so that the tunnel lining segment can be made ready by way of the controller.

9. The device as claimed in one of claims 1 to 8, characterized in that a sensor of the time-of-flight camera records a 2D image.

10. A method for the automated installation of at least one tunnel lining segment (110) of a tunnel lining ring for lining a tunnel section driven by a tunneling machine with a device (10) as claimed in one of claims 1 to 9 on which a manipulator (20) fitted with at least one tool for picking up, holding and placing the at least one tunnel lining segment is provided, and which is provided in a tunneling machine,

- moving the at least one tool by at least one actuator (17, 22, 24) in a radial, tangential and/or axial direction with respect to the machine axis of the tunneling machine in the space of the tunnel section created by the tunneling machine,
- sensing an actual position and actual location of the tool in the space of the tunnel section by at least one tool position sensor, which is provided on the manipulator and/or tool,
- sensing an actual position and/or actual location of at least one section of at least one already arranged tunnel lining segment by at least one tunnel lining segment sensor (230), which is

provided on the manipulator and/or tool, and/or sensing an actual position and/or actual location of the tunnel lining segment respectively to be placed by the at least one tunnel lining segment sensor,

- providing at least one controller, which accesses installation data of the tunnel lining segments and the measurement data of the at least one tool position sensor and the at least one tunnel lining segment sensor,
- wherein the at least one controller controls the at least one actuator and the at least one tool on the basis of the installation data and measurement data, so that the tool with the tunnel lining segment is moved from its respective picking-up position to its respective target placing position and, on the basis of the measurement data of the tunnel lining segment sensor, the tunnel lining segment is aligned in the actual placing position and arranged against at least one already placed tunnel lining segment of a tunnel lining ring,
- providing at least two tunnel lining segment sensors, wherein the tunnel lining segment sensor is a time-of-flight camera.

11. The method as claimed in claim 10, characterized in that the at least one tool is a picking-up element.

12. The method as claimed in claim 10 or 11, characterized in that the at least one tool position sensor is a displacement measuring cylinder, rotary encoder, location sensor, inclinometer and/or displacement transducer.

13. The method as claimed in one of claims 10 to 12, characterized in that the data are a laying plan of the tunnel lining segments to be placed, a delivery plan of the tunnel lining segments to be placed, the picking-up

position for picking up the tunnel lining segment respectively to be placed, the target placing position of the tunnel lining segment respectively to be placed, and/or information about the type and physical properties, such as for example the weight and dimensions, of the respective tunnel lining segment to be placed.

14. The method as claimed in one of claims 10 to 13, characterized in that at least one additional tunnel lining segment sensor is provided, preferably as a time-of-flight camera or 2D camera.

15. The method as claimed in claim 14, characterized in that the additional tunnel lining segment sensor is provided in the region of the tunnel lining segment sensors or in the region of the tool.

16. The method as claimed in one of claims 10 to 15, characterized in that a sensor of the time-of-flight camera records a 2D image.

17. The method as claimed in one of claims 14 to 16, characterized in that the data of the two tunnel lining segment sensors are combined with the data of the additional tunnel lining segment sensor.

18. The method as claimed in one of claims 10 to 17, characterized in that a feeding unit (segment feeder) for feeding the tunnel lining segment to a picking-up location for being picked up by the tool is controlled by the controller, so that the tunnel lining segment is made ready by way of the controller.

19. The method as claimed in one of claims 10 to 18, characterized in that advancing presses of the tunneling machine are activated extendably and retractably by the

controller, so that they are pressed against placed tunnel lining segments.

20. The method as claimed in one of claims 10 to 19, characterized in that, once the last tunnel lining segment (keystone) of the tunnel lining segment ring has been fitted, the manipulator measures with at least two time-of-flight cameras a distance between the tunnel lining segments of the tunnel lining segment ring and a borehole wall of the tunnel section, preferably in that the tunnel lining segment ring is at least partially travelled along.

21. The method as claimed in claims 19, characterized in that, after the placing of the tunnel lining segment at the target position, the tool of the manipulator remains connected to the placed tunnel lining segment and, when the tunnel lining segment is being pressed by at least one of the advancing presses of the tunneling machine, is moved along with it, and in that during this the movement of the tool is sensed.