the large number of actuators makes it difficult and excessively time-consuming to unload the airplane in the event the tractor breaks down.

Embodiments of t~~T~~he invention aim~~s~~ to avoid these drawbacks by proposing an airplane tractor comprising a gripping device making it possible to improve the loading and unloading of the airplane on the tractor, and in particular a gripping device adapted to pull an airplane toward a takeoff runway.

~~To that end, an airplane tractor is proposed having a gripping system for gripping the nose gear of the airplane, comprising:~~

- ~~a chassis;~~
- ~~wheel modules connected to the chassis, each wheel module including at least one actuator for inducing a vertical movement of the module in relation to the chassis;~~
- ~~a gripping platform of the nose gear of an airplane, the platform together with the chassis having freedom of movement substantially in circular translation; and~~
- ~~an actuating means connecting the platform and the chassis, said actuating means also constituting a damping means for damping the free movement of the platform in relation to the chassis.~~

According to a first aspect, there is provided an airplane tractor having a gripping system for gripping a nose gear of an airplane, the airplane tractor comprising:

a chassis;

wheel modules connected to the chassis, each of the wheel modules including at least one actuator for inducing a vertical movement of the wheel module in relation to the chassis;

a gripping platform for gripping the nose gear of the airplane, the gripping platform having freedom of movement such that the gripping platform is movable in a substantially pendular movement in relation to the chassis; and

an actuating means connecting the platform and the chassis, the actuating means including a damping means for damping the freedom of movement of the gripping platform in relation to the chassis.

The tractor according to embodiments of the invention can also comprise at least one of the following features:

- at least one gate intended to oppose the force exerted on at least one wheel of the nose gear of the airplane by the gripping platform;

- the gripping platform comprises a locking device for locking at least one wheel of the nose gear of the airplane;

- the locking device of said at least one wheel of the nose gear is installed on a turret positioned on the gripping platform, the turret rotating freely around a substantially vertical axis in relation to the gripping platform;

- the locking device for said at least one wheel comprises:

- a wheel abutment for the nose gear of the airplane;

- a tightening device to maintain the wheel of the nose gear of the airplane against the abutment;

- the tightening device comprises a tightening plate connected to a triangle actuated by a cylinder;

- the tightening plate is retractable in the absence of an airplane wheel on the platform;

- the abutment has an adjustable location;

- the actuator of each wheel module is a hydraulic cylinder;

- the cylinder of the tightening device is a hydraulic cylinder;

- the damping and actuating means constitutes a sensor of the relative movement between the platform and the chassis;

- the platform has a base connected to the chassis by vertical tie rods;

- an actuator for inducing an incline of the base of the platform in relation to a horizontal plane;

- the vertical tie rods have adjustable lengths and/or adjustable fastening points to the chassis;

- each wheel module has a respective angle of rotation in relation to a longitudinal axis of the tractor and around an axis of rotation substantially vertical to the chassis of the tractor;

- the turret comprises at least one sensor measuring an angular displacement of the turret in relation to the gripping platform, and each respective angle of rotation is determined as a function of the measured angular displacement of the turret.

~~Also proposed is a method for gripping the nose gear of an airplane using an airplane tractor comprising:~~

~~- a chassis;~~

~~- wheel modules connected to the chassis, each wheel module including at least one actuator for inducing a vertical movement of the module in relation to the chassis;~~

~~- a gripping platform for gripping the nose gear of an airplane, the platform being moveable substantially in circular translation in relation to the chassis, the platform going from a retracted position to a gripping position by way of an equilibrium position;~~

~~- a damping and actuating means connecting the platform and the chassis.~~

~~The method comprises the following steps:~~

~~- actuating the damping and actuating means to place the gripping platform in the retracted position;~~

~~- lowering the chassis;~~

~~- moving the tractor so as to place the retracted gripping platform in contact with at least one wheel of the nose gear of the airplane;~~

~~- actuating the damping and actuating means to move the gripping platform from its retracted position toward its gripping position while adjusting the height of the~~

~~chassis by controlling the actuators of at least two wheel modules so as to slide the gripping platform under the wheel;~~

~~- raising the chassis;~~

~~- bringing the platform back to its equilibrium position.~~

According to a second aspect, there is provided a method for gripping a nose gear of an airplane using an airplane tractor, the airplane tractor including a chassis; wheel modules connected to the chassis, each of the wheel modules including at least one actuator for inducing a vertical movement of the wheel module in relation to the chassis; a gripping system for gripping the nose gear of the airplane, the gripping system including a gripping platform being moveable in a substantially pendular movement in relation to the chassis, the gripping platform going from a retracted position to a gripping position by way of an equilibrium position; and a damping and actuating means connecting the gripping platform and the chassis, the method comprising:

actuating the damping and actuating means to place the gripping platform in the retracted position;

lowering the chassis;

moving the airplane tractor so as to place the retracted gripping platform in contact with at least one wheel of the nose gear of the airplane;

actuating the damping and actuating means to move the gripping platform from the retracted position toward the gripping position while adjusting the height of the chassis by controlling the actuators of at least two wheel modules so as to slide the gripping platform under the wheel;

raising the chassis; and

bringing the platform back to the equilibrium position.

The gripping method for gripping the nose gear of an airplane using an airplane tractor can also include at least one of the following features:

- a step consisting of closing a gate of the tractor when the gripping platform is in contact with said at least one wheel of the nose gear of the airplane;

- a step consisting of opening the gate of the tractor when the chassis raises;

- when the gripping platform has been slid under the wheel, a step consisting of moving the tractor to bring said at least one wheel onto a locking device;

- steps consisting of:

  - setting the location of an abutment as a function of the type of airplane and/or the type of wheel;

- bringing said at least one wheel onto the locking device against the abutment;

- bringing a tightening plate against the wheel to maintain it against the abutment;

- a step consisting of inclining the platform in relation to a horizontal plane.

Disclosed herein~~Also proposed~~ is a method for pulling an airplane comprising the following steps:

- loading the airplane on a tractor according to the gripping method for gripping the nose gear of an airplane using an airplane tractor;

- making the tractor travel at a constant speed;

- regulating the speed of the tractor as a function of the force measured by the damping and actuating means.

The method for pulling a airplane can also comprise at least one of the following features:

- the speed of the tractor is checked when the measured force exceeds a dynamically determined threshold level;

- the platform of the tractor comprises a turret receiving said at least one wheel of the nose gear of the airplane, the turret freely rotating around a substantially vertical axis in relation to the gripping platform, the direction of the tractor being modified as a function of the rotation of the turret in relation to the gripping platform;

- the rotation of the turret is induced by a rotational movement of the nose gear;

CLAIMS

1. An airplane tractor having a gripping system for gripping the nose gear of the airplane, comprising:
   - a chassis (5);
   - wheel modules (3) connected to the chassis (5), each wheel module including at least one actuator for inducing a vertical movement of the module in relation to the chassis;
   - a gripping platform (20) for gripping the nose gear of an airplane (4), the gripping platform having freedom of movement substantially in circular translation in relation to the chassis; and
   - an actuating means (8) connecting the platform and the chassis, said actuating means (8) also constituting a damping means for damping the free movement of the platform in relation to the chassis.

2. The airplane tractor according to claim 1, also comprising at least one gate (6) intended to oppose the force exerted on at least one wheel of the nose gear of the airplane by the gripping platform.

3. The airplane tractor according to claim 1 or 2, wherein the gripping platform provided with a locking device for locking at least one wheel of the nose gear of the airplane.

4. The airplane tractor according to claim 3, wherein the locking device of said at least one wheel of the nose gear is installed on a turret positioned on the gripping platform, the turret rotating freely around a substantially vertical axis in relation to the gripping platform.

5. The airplane tractor according to one of claims 3 or 4, wherein the locking device for said at least one wheel comprises:
   - a wheel abutment for the nose gear of the airplane;
   - a tightening device to maintain the wheel of the nose gear of the airplane against the abutment.

6. The airplane tractor according to one of claims 3 to 5, wherein the tightening device comprises a tightening plate connected to a triangle actuated by a cylinder.

7. The airplane tractor according to claim 5, wherein the tightening plate is retractable in the absence of an airplane wheel on the platform.

8. The airplane tractor according to one of claims 5 to 7, wherein the abutment has an adjustable location.

9. The airplane tractor according to one of claims 1 to 8, wherein the actuator of each wheel module is a hydraulic cylinder.

10. The airplane tractor according to one of claims 1 to 9, wherein the cylinder of the tightening device is a hydraulic cylinder.

11. The airplane tractor according to one of claims 1 to 10, wherein the damping and actuating means constitutes a sensor of the relative movement between the platform and the chassis.

12. The airplane tractor according to one of claims 1 to 11, wherein the platform has a base connected to the chassis by vertical tie rods.

13. The airplane tractor according to claim 12, comprising at least one actuator for inducing an incline of the base of the platform in relation to a horizontal plane.

14. The airplane tractor according to claim 13, wherein the vertical tie rods have adjustable lengths.

15. The airplane tractor according to claim 13 or 14, wherein the vertical tie rods have adjustable fastening points to the chassis.

16. The airplane tractor according to one of claims 4 to 15, wherein each wheel module has a respective angle of rotation in relation to a longitudinal axis of the tractor and around an axis of rotation substantially vertical to the chassis of the tractor.

17. The airplane tractor according to claim 16, wherein
    - the turret comprises at least one sensor measuring an angular displacement of the turret in relation to the gripping platform, and
    - each respective angle of rotation is determined as a function of the measured angular displacement of the turret.

18. A method for gripping the nose gear of an airplane using an airplane tractor comprising:
    - a chassis;
    - wheel modules connected to the chassis, each wheel module including at least one actuator for inducing a vertical movement of the module in relation to the chassis;
    - a gripping system for gripping the nose gear of an airplane, the gripping system comprising a gripping platform being moveable substantially in circular translation in relation to the chassis, the platform going from a retracted position to a gripping position by way of an equilibrium position;
    - a damping and actuating means connecting the platform and the chassis.

    the method comprising the following steps:
    - actuating the damping and actuating means to place the gripping platform in the retracted position;
    - lowering the chassis;
    - moving the tractor so as to place the retracted gripping platform in contact with at least one wheel of the nose gear of the airplane;
    - actuating the damping and actuating means to move the gripping platform from its retracted position toward its gripping position while adjusting the height of the chassis by controlling the actuators of at least two wheel modules so as to slide the gripping platform under the wheel;
    - raising the chassis;
    - bringing the platform back to its equilibrium position.

19. The method according to claim 18, also comprising:
    - a step consisting of closing a gate of the tractor when the gripping platform is in contact with said at least one wheel of the nose gear of the airplane.

20. The method according to claim 19, also comprising:

- a step consisting of opening the gate of the tractor when the chassis raises.

21. The method according to any one of claims 18 to 20, also comprising, when the gripping platform has been slid under the wheel:
- a step consisting of moving the tractor to bring said at least one wheel onto a locking device.

22. The method according to claim 21, also comprising the following steps consisting of:
- setting the location of an abutment as a function of the type of airplane and/or the type of wheel;
- bringing said at least one wheel onto the locking device against the abutment;
- bringing a tightening plate against the wheel to maintain it against the abutment.

23. The method according to one of claims 18 to 22, also comprising:
- a step consisting of inclining the platform in relation to a horizontal plane.

24. A method for pulling an airplane comprising the following steps:
- loading the airplane on a tractor according to the gripping method of any one of claims 18 to 22;
- making the tractor travel at a constant speed;
- regulating the speed of the tractor as a function of the force measured by the damping and actuating means.

25. The method for pulling an airplane according to claim 24, wherein the speed of the tractor is checked when the measured force exceeds a dynamically determined threshold level.

26. The method for pulling an airplane according to claim 24 or 25, the platform of the tractor comprises a turret receiving said at least one wheel of the nose gear of the airplane, the turret freely rotating around a substantially vertical axis in relation to the gripping platform, the direction of the tractor being modified as a function of the rotation of the turret in relation to the gripping platform.

27. The method for pulling an airplane according to claim 26, wherein the rotation of the turret is induced by a rotational movement of the nose gear.

28. The method for pulling an airplane according to one of claims 24 to 27, the tractor comprising wheel modules connected to the chassis, each wheel module being able to perform a rotation along an axis of rotation substantially vertical to the chassis of the tractor, in which each wheel module has its own rotation and the longitudinal axis of the airplane is merged with the longitudinal axis of the tractor.

29. A method for pulling an airplane by an airplane tractor comprising:
- blocking the primary brakes of the airplane;
- gripping the nose gear of the airplane by tractor;
- exerting a pulling force on the airplane by the tractor;
- releasing the primary brakes of the airplane thereby causing the resistance force of the airplane to be less than the pulling force of the tractor, and allowing the pulling force to drive the tractor together with the airplane.

30. A method according to Claim 29, wherein the step of gripping the nose gear of the airplane is performed before the step of blocking the primary brakes of the airplane.

31. A method according to any one of Claims 29 and 30, wherein said tractor comprises: a chassis; wheel modules connected to the chassis, each wheel module includes at least one actuator for inducing a vertical movement of the module in relation to the chassis; a gripping system for gripping the nose gear of an airplane, the gripping system comprising a gripping platform moveable substantially in circular translation in relation to the chassis, the platform going from a retracted position to a gripping position by way of an equilibrium position; a damping and actuating means connecting the platform and the chassis; and wherein said step of gripping the nose gear of the airplane comprises:
- actuating the damping and actuating means to place the gripping platform in the retracted position;
- lowering the chassis;
- moving the tractor so as to place the retracted gripping platform in contact with at least one wheel of the nose gear of the airplane;
- actuating the damping and actuating means to move the gripping platform from its retracted position toward its gripping position while adjusting the height of

the chassis by controlling the actuators of at least two wheel modules so as to slide the gripping platform under the wheel of the nose gear;

- raising the chassis;
- bringing the platform back to its equilibrium position.

32. The method according to any one of Claims 29 to 31, wherein the step of releasing the primary brakes of the airplane is performed by the airplane's pilot.

33. The method according to any one of Claims 29 and 32, further comprising a step of accelerating the tractor until it reaches a constant cruising speed.

34. The method according to any one of Claims 29 to 33, further comprising a step of regulating the speed of the tractor is performed as a function of the force measured by the damping and actuating means.

35. The method for pulling an airplane according to claim 34, wherein the speed of the tractor is controlled such that the measured force exceeds a dynamically determined threshold level.

36. A method for controlling direction of an airplane being pulled by an airplane tractor comprising:

- a chassis;
- wheel modules connected to the chassis, each wheel module including at least one actuator for inducing a vertical movement of the module in relation to the chassis, each wheel module having an axis of rotation and a respective angle of rotation in relation to a longitudinal axis of the tractor and around an axis of rotation substantially vertical to the chassis of the tractor; and
- a gripping system having: a gripping platform; a turret positioned on the gripping platform; and a locking device installed on the turret for locking at least one wheel of the nose gear of the airplane; the turret being configured to rotate on the platform about a substantially vertical axis together with the nose gear of the airplane, when being locked by the locking device;

the method comprising steps of:

- estimating the direction the pilot of the airplane wishes to apply to the airplane for rotating it around a center of rotation by measuring an angle of rotation of the

turret in relation to the gripping platform, while the wheels of the nose gear being locked by to the locking device; and

- modifying the direction of the tractor by rotating each of the wheel modules to its respective angle of rotation, such that the axis of rotation of each of the wheel modules being directed towards said center of rotation of the airplane, thereby causing the longitudinal axis of the airplane to merge with the longitudinal axis of the tractor during the change of direction.

37. A method according to Claim 36, wherein the turret comprises means capable of measuring the angle of rotation of the turret in relation to the gripping platform.

38. A method according to Claim 37, wherein said means for measuring the angle of rotation is at least one sensor measuring an angular displacement of the turret in relation to the gripping platform.

CLAIMS

1. An airplane tractor having a gripping system for gripping a nose gear of an airplane, the airplane tractor comprising:

a chassis;

wheel modules connected to the chassis, each of the wheel modules including at least one actuator for inducing a vertical movement of the wheel module in relation to the chassis;

a gripping platform for gripping the nose gear of the airplane, the gripping platform having freedom of movement such that the gripping platform is movable in a substantially pendular movement in relation to the chassis; and

an actuating means connecting the platform and the chassis, the actuating means including a damping means for damping the freedom of movement of the gripping platform in relation to the chassis.

2. The airplane tractor according to Claim 1, further comprising at least one gate intended to oppose a force exerted on at least one wheel of the nose gear of the airplane by the gripping platform.

3. The airplane tractor according to Claim 1, wherein the gripping platform comprises a locking device for locking at least one wheel of the nose gear of the airplane.

4. The airplane tractor according to Claim 3, wherein the locking device of the at least one wheel of the nose gear is installed on a turret positioned on the gripping platform, the turret rotating freely around a substantially vertical axis in relation to the gripping platform.

5. The airplane tractor according to Claim 1, wherein the damping and actuating means comprise a sensor of the relative movement between the gripping platform and the chassis.

6. The airplane tractor according to Claim 1, wherein the gripping platform includes a base connected to the chassis by vertical tie rods.

7. A method for gripping a nose gear of an airplane using an airplane tractor, the airplane tractor including a chassis; wheel modules connected to the chassis, each of the wheel modules including at least one actuator for inducing a vertical movement of the wheel module in relation to the chassis; a gripping system for gripping the nose gear of the airplane, the gripping system including a gripping platform being moveable in a substantially pendular movement in relation to the chassis, the gripping platform going from a retracted position to a gripping position by way of an equilibrium position; and a damping and actuating means connecting the gripping platform and the chassis, the method comprising:

actuating the damping and actuating means to place the gripping platform in the retracted position;

lowering the chassis;

moving the airplane tractor so as to place the retracted gripping platform in contact with at least one wheel of the nose gear of the airplane;

actuating the damping and actuating means to move the gripping platform from the retracted position toward the gripping position while adjusting the height of the chassis by controlling the actuators of at least two wheel modules so as to slide the gripping platform under the wheel;

raising the chassis; and

bringing the platform back to the equilibrium position.

8. The method according to Claim 7, further comprising closing a gate of the airplane tractor when the gripping platform is in contact with the at least one wheel of the nose gear of the airplane.

9. The method according to Claim 8, further comprising opening the gate of the airplane tractor when the chassis raises.

10. The method according to Claim 7, further comprising, when the gripping platform has been slid under the wheel, moving the airplane tractor to bring the at least one wheel onto a locking device.

11. The method according to claim 10, further comprising:

setting the location of an abutment as a function of a type of airplane and/or a type of wheel;

bringing the at least one wheel onto the locking device against the abutment; and

bringing a tightening plate against the wheel to maintain the wheel against the abutment.