CLAIMS

~~1. A towbarless airplane tug comprising:~~

a chassis mounted on a plurality of tug wheels, at least some of said plurality of tug wheels being steerable tug wheels;

a base assembly, mounted on said tug chassis;

an airplane nose wheel support turret assembly, rotatably mounted on said base assembly, for supporting wheels of nose landing gear of an airplane;

at least one force sensor operative to sense force applied to said nose landing gear of said airplane in at least one generally horizontal direction resulting from at least one of airplane pilot-controlled braking, deceleration and acceleration of said airplane;

at least one tug wheel driver unit operative to drive said plurality of tug wheels in rotation to provide displacement of said chassis;

at least one tug wheel steering mechanism operative to steer said steerable tug wheels during airplane taxiing; and

at least one tug controller operative at least partially in response to an output of said at least one force sensor indicating airplane pilot-controlled braking of said airplane to operate said at least one tug wheel driver unit so as to reduce the force applied to said nose landing gear of said airplane as the result of said airplane pilot-controlled braking.

2. A towbarless airplane tug according to claim 1 and also comprising:

at least one rotation detector operative to sense rotation of said airplane nose wheel support turret assembly relative to said chassis resulting at least from pilot-controlled ground steering of said airplane and wherein

said at least one tug controller is also operative to control operation of at least said at least one tug wheel steering mechanism, said at least one tug controller being operative at least partially in response to an output of said at least one rotation detector ~~indicating pilot-controlled steering of said airplane to operate said at least one tug wheel~~

~~steering mechanism so as to steer said steerable tug wheels such that said chassis moves~~ in a direction indicated by said pilot-controlled steering.

3. A towbarless airplane tug comprising:

a chassis mounted on a plurality of tug wheels, at least some of said plurality of tug wheels being steerable tug wheels;

an airplane nose wheel support turret assembly, rotatably mounted on said chassis, for supporting rotatable wheels of a nose landing gear of an airplane;

at least one rotation detector operative to sense rotation of said airplane nose wheel support assembly relative to said chassis, resulting at least from pilot-controlled ground steering of said airplane;

at least one tug wheel driver operative to drive said plurality of tug wheels in rotation to provide displacement of said chassis;

at least one tug wheel steering mechanism operative to steer said steerable tug wheels; and

at least one tug controller operative to control operation of at least said at least one tug wheel steering mechanism, said at least one tug controller being operative at least partially in response to an output of said at least one rotation detector indicating airplane pilot-controlled steering of said airplane to operate said at least one tug wheel steering mechanism so as to steer said steerable tug wheels such that said chassis moves in a direction indicated by said pilot-controlled steering.

4. A towbarless airplane tug according to any of claims 1 - 3 and wherein said airplane nose wheel support turret assembly is rotatably mounted on said chassis by bearings.

5. A towbarless airplane tug according to any of claims 1 - 4 and also comprising at least one energy absorber assembly mounted between said airplane nose wheel support turret assembly and said chassis for absorbing energy resulting from inertial forces of the tug which would otherwise be applied to said nose landing gear of ~~said airplane.~~

~~6. A towbarless airplane tug according to any of claims 1 - 5 and also~~, comprising at least one airplane wheel engagement assembly for placement of said airplane wheels on said airplane nose wheel support turret assembly such that a center of horizontal rotation of said nose landing gear of said airplane lies at a center of rotation of said airplane nose wheel support turret assembly relative to said chassis.

7. A towbarless airplane tug according to claim 6 and wherein said at least one airplane wheel engagement assembly is also operative for retaining said airplane nose landing gear wheels in place at a location such that a center of horizontal rotation of said nose landing gear wheels of said airplane lies at said center of rotation of said airplane nose wheel support turret assembly relative to said chassis.

8. A towbarless airplane tug according to claim 6 or claim 7 and wherein said at least one airplane wheel engagement assembly is adaptive to airplane wheel size for placement of said airplane wheels on said airplane wheel support assembly and retaining said airplane wheels in place at said location such that said nose landing gear wheels of said airplane lie at said center of rotation of said airplane nose wheel support turret assembly relative to said chassis.

9. A towbarless airplane tug according to any of claims 1 - 8 and wherein said airplane nose wheel support turret assembly is pivotably mounted relative to said chassis, for accommodating tilt of said airplane nose landing gear wheels during airplane movement.

10. A towbarless airplane tug according to any of claims 1 - 9 and having a tug driver-controlled mode of operation for airplane pushback and an airplane pilot-controlled mode of operation for airplane movement during taxiing following at least one ~~of pushback and landing.~~

~~11. A towbarless airplane tug according to any of claims 1 - 10 and having an~~ autonomous mode of operation for airplane movement during taxiing following at least one of pushback and landing.

12. A towbarless airplane tug according to claim 11 and wherein in said autonomous mode of operation, said tug controller is responsive to commands received from an airport command and control center.

13. A towbarless airplane tug according to claim 11 or claim 12 and wherein in said autonomous mode of operation, said tug controller is responsive to pre-programmed driving pathways and speed limits and to tug location information received from tug mounted tug location functionality.

14. A towbarless airplane tug according to any of claims 1 - 13 and having an autonomous mode of operation for tug return from a take-off area to a pre-pushback location.

15. A towbarless airplane tug according to any of claims 1 - 14 and having tug speed control functionality allowing said tug to travel at speeds up to different speed limits at different locations in the airport.

16. A towbarless airplane tug according to any of the preceding claims 1, 2 and 4 - 15 and wherein said at least one tug controller is operative to control acceleration and deceleration of said tug, thereby to limit the force applied to said nose landing gear of said airplane, said at least one tug controller employing at least one force feedback loop utilizing an input from said at least one force sensor and at least one of the following inputs:

an indication of known slopes at various locations along an airplane travel surface traversed by said tug, said locations being identified to said at least one tug controller by tug location and inclination sensing functionality;

~~an indication of wind forces applied to said airplane;~~

an indication of known airplane and tug rolling friction force at various locations along airplane travel surface traversed by said tug, said locations being identified to said at least one tug controller by location sensing functionality; and

an obstacle detection indication.

17. A towbarless airplane tug according to claim 16 and wherein said at least one force feedback loop utilizes an input from said at least one force sensor and at least two of the following inputs:

an indication of known slopes at various locations along an airplane travel surface traversed by said tug, said locations being identified to said at least one tug controller by tug location and inclination sensing functionality;

an indication of wind forces applied to said airplane;

an indication of known airplane and tug rolling friction force at various locations along airplane travel surface traversed by said tug, said locations being identified to said at least one tug controller by location sensing functionality; and

an obstacle detection indication.

18. A towbarless airplane tug according to claim 17 and wherein said at least one force feedback loop utilizes an input from said at least one sensor and at least three of the following inputs:

an indication of known slopes at various locations along an airplane travel surface traversed by said tug, said locations being identified to said at least one tug controller by tug location and inclination sensing functionality;

an indication of wind forces applied to said airplane;

an indication of known airplane and tug rolling friction force at various locations along airplane travel surface traversed by said tug, said locations being identified to said at least one tug controller by location sensing functionality; and

an obstacle detection indication.

~~19. A towbarless airplane tug according to claim 18 and wherein said at least~~ one force feedback loop utilizes an input from said at least one sensor and the following inputs:

an indication of known slopes at various locations along an airplane travel surface traversed by said tug, said locations being identified to said at least one tug controller by tug location and inclination sensing functionality;

an indication of wind forces applied to said airplane;

an indication of known airplane and tug rolling friction force at various locations along airplane travel surface traversed by said tug, said locations being identified to said at least one tug controller by location sensing functionality; and

an obstacle detection indication.

20. A towbarless airplane tug according to any of claims 1 - 19 and wherein said at least one tug controller is operative to control speed of said tug and employs at least one speed feedback loop utilizing at least one of the following inputs:

an indication of known desired speed at various locations along an airplane travel surface traversed by said tug, obtained by said at least one tug controller using tug location sensing functionality and a predetermined map of said airplane travel surface indicating speed limits therealong; and

desired speed information supplied to said at least one tug controller from an airplane main controller.

21. A towbarless airplane tug according to any of the preceding claims 2 - 19 and wherein said at least one tug controller is operative to control steering of said tug by employing at least one position feedback loop utilizing at least an indication of rotation of said airplane nose landing gear wheels provided by said at least one rotation detector.

22. A towbarless airplane tug comprising:

a chassis mounted on a plurality of tug wheels, at least some of said ~~plurality of tug wheels being steerable tug wheels;~~

~~an airplane wheel support assembly, mounted on said chassis, for~~ supporting rotatable wheels of a nose landing gear of an airplane;

at least one force sensor operative to sense force applied to said nose landing gear of said airplane in at least one generally horizontal direction;

at least one tug wheel driver operative to drive said plurality of tug wheels in rotation to provide displacement of said chassis;

at least one tug controller operative to control acceleration and deceleration of said tug thereby to limit the force applied to said nose landing gear of the said airplane, said at least one tug controller employing at least one force feedback loop utilizing an input from said at least one force sensor and at least one of the following inputs:

an indication of known slopes at various locations along an airplane travel surface traversed by said tug, said locations being identified to said at least one tug controller by tug location and inclination sensing functionality;

an indication of wind forces applied to said airplane;

an indication of known airplane and tug rolling friction force at various locations along airplane travel surface traversed by said tug, said locations being identified to said at least one tug controller by location sensing functionality; and

an obstacle detection indication.

23. A towbarless airplane tug according to claim 22 and wherein said at least one tug controller employs at least one feedback loop utilizing an input from said at least one force sensor and at least two of the following inputs:

an indication of known slopes at various locations along an airplane travel surface traversed by said tug, said locations being identified to said at least one tug controller by tug location and inclination sensing functionality;

an indication of wind forces applied to said airplane;

an indication of known airplane and tug rolling friction force at various locations along airplane travel surface traversed by said tug, said locations being identified to said at least one tug controller by location sensing functionality; and

~~an obstacle detection indication.~~

~~24. A towbarless airplane tug according to claim 22 and wherein said at least~~ one tug controller employs at least one feedback loop utilizing an input from said at least one force sensor and all of the following inputs:

an indication of known slopes at various locations along an airplane travel surface traversed by said tug, said locations being identified to said at least one tug controller by tug location and inclination sensing functionality;

an indication of wind forces applied to said airplane;

an indication of known airplane and tug rolling friction force at various locations along airplane travel surface traversed by said tug, said locations being identified to said at least one tug controller by location sensing functionality; and

an obstacle detection indication.

25. A towbarless airplane tug according to any of claims 22 - 24 and also comprising:

at least one energy absorber assembly mounted on said chassis for absorbing forces resulting from inertia of the tug which would otherwise be applied to said nose landing gear of said airplane.

26. A towbarless airplane tug according to any of claims 22 - 25 and wherein said airplane nose wheel support turret assembly is rotatably mounted on said chassis by bearings.

27. A towbarless airplane tug according to any of claims 22 - 26 and also comprising at least one airplane wheel engagement assembly for placement of said airplane wheels on said airplane wheel support assembly such that said nose landing gear of said airplane lies at a center of rotation of said airplane wheel support assembly relative to said chassis.

28. A towbarless airplane tug according to claim 27 and wherein said at least ~~one airplane wheel engagement assembly is also operative for retaining said airplane~~

~~wheels in place at a location such that said nose landing gear wheels of said airplane lie at~~ a center of rotation of said airplane wheel support turret assembly relative to said chassis.

29. A towbarless airplane tug according to either of the preceding claims 27 and 28 and wherein said at least one airplane wheel engagement assembly is adaptive to airplane wheel size for placement of said airplane wheels on said airplane wheel support assembly and retaining said airplane wheels in place at said location such that said nose landing gear of said airplane lies at said center of rotation of said airplane wheel support assembly relative to said chassis.

30. A towbarless airplane tug according to any of claims 5 - 21 and 25 - 29 and wherein said at least one energy absorber assembly comprises multiple pistons which absorb energy upon acceleration or deceleration of said tug relative to said airplane.

31. A towbarless airplane tug according to any of claims 1 - 30 and wherein said at least one tug controller is responsive to input signals from an airport command and control system.

32. A towbarless airplane tug comprising:

a chassis mounted on a plurality of tug wheels, at least some of said plurality of tug wheels being steerable tug wheels;

an airplane wheel support assembly, mounted on said chassis, for supporting rotatable wheels of a nose landing gear of an airplane;

at least one tug wheel driver operative to drive said plurality of tug wheels in rotation to provide displacement of said chassis;

at least one tug controller operative to control speed of said tug, said at least one tug controller employing at least one feedback loop utilizing a mapping of speed limits along a travel path traversed by said tug and said airplane at said airport as well as an indication of the instantaneous location of said tug and said airplane along a travel ~~path.~~

CLAIMS

1. A towbarless airplane tug comprising:

   (a) a chassis mounted on a plurality of tug wheels, at least some of said tug wheels being steerable tug wheels and at least some of said tug wheels being drivable tug wheels;

   (b) an airplane wheel support turret assembly, rotatably mounted in connection with said chassis and operative to support at least one wheel of a nose landing gear of an airplane;

   (c) at least one rotation sensor connected to said wheel support turret assembly and operative to sense rotation of said wheel support turret assembly relative to said chassis, said rotation resulting at least from steering control induced movement of the nose landing gear caused by pilot-controlled ground steering of said airplane, and to generate an output indicating a direction of said pilot-controlled ground steering of said airplane;

   (d) at least one tug wheel driver unit operative to drive said drivable tug wheels;

   (e) at least one tug wheel steering mechanism operative to steer said steerable tug wheels thereby providing steering of said chassis; and

   (f) at least one tug controller operative to control operation of at least said tug wheel steering mechanism at least in response to said output of said rotation sensor, so as to cause steering said steerable tug wheels such that said chassis moves in the direction indicated in said output of said rotation sensor.

2. The towbarless airplane tug of Claim 1 further comprising at least one first force sensor operative in engagement with at least one nose landing gear wheel so as to sense forces applied to said nose landing gear wheel in at least one generally horizontal direction, and further operative to generate an output indicating a difference in acceleration and/or deceleration of said airplane tug relative to acceleration and/or deceleration of the airplane being towered thereby, said difference caused, at least, by pilot-controlled deceleration of the airplane; and

wherein said tug controller is further operative to control, responsive at least to said output of said first force sensor, said tug driver unit so as to maintain the forces applied to said nose landing gear of said airplane within predefined limits.

3. The towbarless airplane tug of Claim 1 further comprising a horizontal base assembly supporting said wheel support turret assembly, engaged to said chassis by at least one energy absorber assembly mounted between said horizontal base assembly and said chassis and operative to absorb energy resulting from a difference in acceleration and/or deceleration of said airplane tug relative to the airplane.

4. The towbarless airplane tug of Claim 3 further comprising at least one second force sensor positioned in engagement with said energy absorber so as to sense forces applied to said energy absorber and operative to generate an output indicating a difference in acceleration and/or deceleration of said airplane tug relative acceleration and/or deceleration of the airplane being towered thereby, said difference caused, at least, by pilot-controlled deceleration of the airplane and a tug traction force applied to the tug; and

wherein said tug controller is further operative to control, responsive at least to said output of said second force sensor, said tug driver unit so as to maintain forces applied to said nose landing gear of said airplane within predefined limits.

5. The towbarless airplane tug of Claim 1 further comprising:

(a) a horizontal base assembly supporting said wheel support turret assembly, engaged to said chassis by at least one energy absorber assembly mounted between said horizontal base assembly and said chassis and operative to absorb energy resulting from a difference in acceleration and/or deceleration of said airplane tug relative to acceleration and/or deceleration of the airplane being towered thereby; and

(b) at least one second force sensor positioned in engagement with said energy absorber so as to sense forces applied to said energy absorber and operative to generate an output indicating a difference in acceleration and/or deceleration of said airplane tug relative to the airplane, said difference caused, at least, by pilot-controlled deceleration of the airplane and a tug traction force applied to the tug; and

wherein said tug controller is operative to control, responsive at least to said output of said second force sensor, said tug driver unit so as to maintain the forces applied to said nose landing gear of said airplane within predefined limits.

6. The towbarless airplane tug of Claim 5 wherein said tug controller is operative to maintain the forces applied to said nose landing gear of said airplane within predefined limits by employing at least one force feedback loop characterized by the following inputs: output generated by at least one of said force sensors and at least one input selected from a group comprising:

(a) an indication of known slopes at various locations along an airplane travel surface traversed by said tug;

(b) an indication of wind forces applied to said airplane; and

(c) an indication of known airplane and tug rolling friction force at various locations along airplane travel surface traversed by said tug.

7. The towbarless airplane tug of Claim 5 wherein said predefined limits is sufficiently below an acceptable nose landing gear force limit, so as to leave a margin for unexpected accelerations or decelerations of either the airplane or the airplane tug.

8. The towbarless airplane tug of Claim 1 wherein said tug controller is further operative to control speed of said tug and is adapted to employ at least one speed feedback loop utilizing at least one of the following inputs:

(a) an indication of known desired speed at various locations along an airplane travel surface traversed by said tug, obtained by said tug controller using tug location sensing functionality and a predetermined map of said airplane travel surface indicating speed limits there along;

(b) an indication of known desired speed obtained by said tug controller from an airplane main pilot controller;

(c) a mapping of speed limits along a travel path traversed by said tug and said airplane at an airport according to road and environment conditions;

(d) an indication of an instantaneous location of said tug and said airplane along a travel path; and

(e) an indication of obstacles along a travel path traversed by said tug.

9. The towbarless airplane tug of Claim 1 further comprising at least one front airplane wheel engagement assembly for placement of said airplane wheels on said airplane wheel support turret assembly such that a vertical axis of rotation of said nose

landing gear of said airplane passes through a center of rotation of said airplane wheel support turret assembly relative to said chassis.

10. The towbarless airplane tug of Claim 9 wherein said airplane wheel engagement assembly is adaptive to airplane wheel size for placement of said airplane wheels on said airplane wheel support assembly such that a vertical line of rotation of said airplane wheel lies along a vertical axis of rotation of said airplane wheel support turret assembly.

11. The towbarless airplane tug of Claim 1 wherein said airplane wheel support turret assembly mounted on a horizontal base assembly which is pivotably connected to said chassis, thereby accommodating tilt of said airplane nose landing gear wheels during airplane movement.

12. The towbarless airplane tug of Claim 1 wherein said tug controller is further responsive to commands received from an airport command and control center.

13. The towbarless airplane tug of Claim 1 wherein said tug controller is further responsive preprogrammed driving pathways and speed limits.

14. The towbarless airplane tug of Claim 1 wherein said tug controller is operative to control steering of said tug by employing at least one position feedback loop utilizing at least an indication of rotation of said airplane nose landing gear wheels clamped in the airplane wheel support turret assembly, said indication provided by said rotation sensor.

15. A towbarless airplane tug comprising:

(a) a chassis mounted on a plurality of tug wheels, at least some of said tug wheels being steerable tug wheels and at least some of said tug wheels being drivable tug wheels;

(b) an airplane wheel support turret assembly, rotatably mounted in connection with said chassis and operative to support at least one wheel of a nose landing gear of an airplane;

(c) a horizontal base assembly supporting said wheel support turret assembly and engaged to said chassis by at least one energy absorber assembly mounted between said horizontal base assembly and said chassis;

(d) at least one rotation sensor connected to said wheel support turret assembly and operative to sense rotation of said wheel support turret assembly relative to said chassis, said rotation resulting at least from

steering control induced movement of the nose landing gear caused by pilot-controlled ground steering of said airplane, and further operative to generate an output indicating a direction of said pilot-controlled ground steering of said airplane;

(e) at least one first force sensor operative in engagement with at least one nose landing gear wheel so as to sense forces applied to said nose landing gear wheel in at least one generally horizontal direction, and further operative to generate an output indicating a difference in acceleration and/or deceleration of said airplane tug relative to acceleration and/or deceleration of the airplane being towered thereby, said difference caused, at least, by pilot-controlled deceleration of the airplane;

(f) at least one second force sensor positioned in engagement with said energy absorber so as to sense forces applied to said energy absorber and operative to generate an output indicating a difference in acceleration and/or deceleration of said airplane tug relative to acceleration and/or deceleration of the airplane being towered thereby, said difference caused, at least, by pilot-controlled deceleration of the airplane;

(g) at least one tug controller operative to control operation of said tug in response to at least one output among the outputs generated by said sensors.

16. A towbarless airplane tug comprising:

(a) a chassis mounted on a plurality of tug wheels, at least some of said tug wheels being steerable tug wheels and at least some of said tug wheels being drivable tug wheels;

(b) an airplane wheel support turret assembly, rotatably mounted in connection with said chassis and operative to support at least one wheel of a nose landing gear of an airplane;

(c) a horizontal base assembly supporting said wheel support turret assembly and engaged to said chassis by at least one energy absorber assembly mounted between said horizontal base assembly said chassis;

(d) at least one tug wheel driver unit operative to drive said drivable tug wheels;

(e) at least one second force sensor positioned in engagement with said energy absorber so as to sense forces applied to said energy absorber and

operative to generate an output indicating a difference in acceleration and/or deceleration of said airplane tug relative to acceleration and/or deceleration of the airplane being towered thereby, said difference caused, at least, by pilot-controlled deceleration of the airplane; and

(f) at least one tug controller operative to control, responsive at least to said output of said second force sensor, said tug driver unit so as to maintain the forces applied to said nose landing gear of said airplane within predefined limits.

17. The towbarless airplane tug of Claim 16 further comprising at least one first force sensor operative in engagement with said nose landing gear wheel so as to sense forces applied to said nose landing gear wheel in at least one generally horizontal direction, and further operative to generate an output indicating a difference in acceleration and/or deceleration of said airplane tug relative to acceleration and/or deceleration of the airplane being towered thereby, said difference caused, at least, by pilot-controlled deceleration of the airplane; wherein said tug controller is operative to control said tug driver unit so as to maintain the forces applied to said nose landing gear of said airplane within predefined limits responsive at least to one output among said outputs of said first force sensor and said second force senor.

18. The towbarless airplane tug of Claim 16 wherein said predefined limits is sufficiently below an acceptable nose landing gear force limit, so as to leave a margin for unexpected accelerations or decelerations of either the airplane or the airplane tug.

19. The towbarless airplane tug of Claim 17 wherein said tug controller is operative to maintain the forces applied to said nose landing gear of said airplane within predefined limits by employing at least one force feedback loop characterized by the following inputs: output generated by at least one of said force sensors and at least one input selected from a group comprising:

(a) an indication of known slopes at various locations along an airplane travel surface traversed by said tug;

(b) an indication of wind forces applied to said airplane; and

(c) an indication of known airplane and tug rolling friction force at various locations along airplane travel surface traversed by said tug.

20. A towbarless airplane tug comprising:

(a) a chassis mounted on a plurality of tug wheels, at least some of said tug wheels being steerable tug wheels and at least some of said tug wheels being drivable tug wheels;

(b) an airplane wheel support turret assembly, rotatably mounted in connection with said chassis and operative to support at least one wheel of a nose landing gear of an airplane;

(c) at least one tug wheel driver unit operative to drive said drivable tug wheels thereby providing a tug traction force;

(d) at least one first force sensor operative in engagement with said nose landing gear wheel so as to sense forces applied to said nose landing gear wheel in at least one generally horizontal direction, and further operative to generate an output indicating a difference in acceleration and/or deceleration of said airplane tug relative to the airplane, said difference caused, at least, by pilot-controlled deceleration of the airplane; and

(e) at least one tug controller operative to control, responsive at least to said output of said first force sensor, said tug driver unit so as to maintain the forces applied to said nose landing gear of said airplane within predefined limits.

21. A method of operating a towbarless airplane tug comprising a chassis mounted on a plurality of tug wheels, an airplane wheel support turret assembly mounted in connection with said chassis and operative to support at least one wheel of a nose landing gear of an airplane, at least one tug wheel driver unit operative to drive drivable tug wheels among said plurality of tug wheels, and at least one tug wheel steering mechanism operative to steer steerable tug wheels among said plurality of tug wheels, the method comprising:

(a) sensing rotation of said airplane wheel support turret assembly relative to said chassis with the help of at least one rotation sensor connected to said wheel support turret assembly, said rotation is resulted at least from steering control induced movement of nose landing gear caused by pilot-controlled ground steering of said airplane;

(b) generating an output of said rotation sensor indicative of direction of pilot-controlled ground steering of said airplane;

(c) controlling, responsive at least to said generated output of said rotation sensor, said tug wheel steering mechanism so as to cause steering said tug

wheels such that said chassis moves in direction indicated in said output of said rotation sensor.

22. The method of Claim 21 further comprising:

(a) sensing, with the help of at least one first force sensor positioned in engagement with said nose landing gear wheel, forces applied to said nose landing gear wheel in at least one generally horizontal direction;

(b) generating an output of said first force sensor indicative of a difference in acceleration and/or deceleration of said airplane tug relative to acceleration and/or deceleration of the airplane being towed thereby, said difference caused, at least, by pilot-controlled deceleration of the airplane; and

(c) controlling, responsive at least to said generated output of said first force sensor, said tug driver unit so as to maintain the forces applied to said nose landing gear of said airplane within predefined limits.

23. The method of Claim 21 wherein the towbarless airplane tug further comprises a horizontal base assembly supporting said wheel support turret assembly and engaged to said chassis by at least one energy absorber assembly mounted between said horizontal base assembly and said chassis, the method further comprising:

(a) sensing force applied to said energy absorber, said sensing provided with the help of at least one second force sensor positioned in engagement with said energy absorber;

(b) generating an output of said second force sensor indicating a difference in acceleration and/or deceleration of said airplane tug relative to acceleration and/or deceleration of the airplane being towed thereby, said difference caused, at least, by pilot-controlled deceleration of the airplane;

(c) controlling, responsive at least to said output of said second force sensor, said tug driver unit so as to maintain the forces applied to said nose landing gear of said airplane within predefined limits.

24. A method of operating a towbarless airplane tug comprising a chassis mounted on a plurality of tug wheels, an airplane wheel support turret assembly mounted in connection with said chassis and operative to support at least one wheel of a nose landing gear of an airplane, and at least one tug wheel driver unit operative to drive drivable tug wheels among said plurality of tug wheels, the method comprising:

(a) sensing, with the help of at least one first force sensor positioned in engagement with said nose landing gear wheel, forces applied to said nose landing gear wheel in at least one generally horizontal direction;

(b) generating an output of said first force sensor indicative of a difference in acceleration and/or deceleration of said airplane tug relative to acceleration and/or deceleration of the airplane being towed thereby, said difference caused, at least, by pilot-controlled deceleration of the airplane; and

(c) controlling, responsive at least to said generated output of said first forse sensor, said tug driver unit so as to maintain the forces applied to said nose landing gear of said airplane within predefined limits.

25. The method of Claim 24 wherein the towbarless airplane tug further comprises a horizontal base assembly supporting said wheel support turret assembly and engaged to said chassis by at least one energy absorber assembly mounted between said horizontal base assembly and said chassis, the method further comprising:

(a) sensing forces applied to said energy absorber, said sensing provided with the help of at least one second force sensor positioned in engagement with said energy absorber;

(b) generating an output of said second force sensor indicating a difference in acceleration and/or deceleration of said airplane tug relative to acceleration and/or deceleration of the airplane being towed thereby, said difference caused, at least, by pilot-controlled deceleration of the airplane; and

(c) controlling said tug driver unit responsive at least to one output among said outputs of said first force sensor and said second force senor so as to maintain the forces applied to said nose landing gear of said airplane within predefined limits.

26. The method of Claim 24 further comprising:

(a) sensing rotation of said airplane wheel support turret assembly relative to said chassis with the help of at least one rotation sensor connected to said wheel support turret assembly, said rotation is resulted at least from steering control induced movement of nose landing gear caused by pilot-controlled ground steering of said airplane;

(b) generating an output of said rotation sensor indicative of direction of pilot-controlled ground steering of said airplane;

(c) controlling, responsive at least to said generated output of said rotation sensor, said tug wheel steering mechanism so as to cause steering said tug wheels such that said chassis moves in direction indicated in said output of said rotation sensor.

27. The method of Claim 25 wherein said predefined limits are sufficiently below an acceptable nose landing gear force limit, so as to leave a margin for unexpected accelerations or decelerations of either the airplane or the airplane tug.

28. A method of operating a towbarless airplane tug comprising a chassis mounted on a plurality of tug wheels, an airplane wheel support turret assembly mounted in connection with said chassis and operative to support at least one wheel of a nose landing gear of an airplane, a horizontal base assembly supporting said wheel support turret assembly and engaged to said chassis by at least one energy absorber assembly mounted between said horizontal base assembly and said chassis, at least one tug wheel driver unit operative to drive drivable tug wheels among said plurality of tug wheels, and at least one tug wheel steering mechanism operative to steer steerable tug wheels among said plurality of tug wheels, the method comprising:

(a) sensing rotation of said wheel support turret assembly relative to said chassis with the help of at least one rotation sensor connected to said wheel support turret assembly, said rotation resulting at least from steering control induced movement of the nose landing gear caused by pilot-controlled ground steering of said airplane, and generating an output of said rotation sensor indicating a direction of said pilot-controlled ground steering of said airplane;

(b) sensing forces applied to said nose landing gear wheel in at least one generally horizontal direction with the help of at least one first force sensor operative in engagement with said nose landing gear wheel, and generating an output of said first force sensor indicating a difference in acceleration and/or deceleration of said airplane tug relative to acceleration and/or deceleration of the airplane being towed thereby, said difference caused, at least, by pilot-controlled deceleration of the airplane;

(c) sense forces applied to said energy absorber with the help of at least one second force sensor positioned in engagement with said energy absorber, and generating an output of said second force sensor indicating a difference in acceleration and/or deceleration of said airplane tug relative

to acceleration and/or deceleration of the airplane being towed thereby, said difference caused, at least, by pilot-controlled deceleration of the airplane;

(d) controlling operation of said tug with the help of at least one tug controller operative to in response to at least one output among the outputs generated by said sensors.