Claims

1. A ~~M~~mobile active heave compensator provided with a~~n~~ first attachment device for suspending the compensator from a load bearing device and a~~n~~ second attachment device for carrying a payload, the mobile active heave compensator~~-~~ comprise~~s~~ing a passive heave compensation part and an active heave compensation part, and being associated with a sensor arrangement producing input signals for a control unit and a power source,
characterized in that wherein the compensator incorporates a hydraulic fluid pump and/or a motor device, affecting the active heave compensation~~g~~ part, producing output signal(s) to the hydraulic fluid pump and/or the motor device, based on input signals received from the sensor arrangement.

2. The ~~M~~mobile active heave compensator according to claim 1, wherein the power source and/or the control unit form an integral part of the compensator.

3. The ~~M~~mobile active heave compensator according to claim 1 or 2, wherein the mobile active heave compensator is self supported without any external electric or fluid connection to a surface vessel or a connection to an externally arranged high pressure unit.

4. The ~~M~~mobile active heave compensator according to any one of ~~the~~ claims 1 to 3, wherein the compensator comprises at least a~~n~~ first actuator and a~~n~~ first gas accumulator and ~~that~~ wherein the hydraulic fluid ~~transportation device~~pump ~~affects~~ directly or indirectly affects pressures appearing in the first actuator and/or the first gas accumulator.

5. The ~~M~~mobile active heave compensator according to any one of ~~the~~ claims 1 to 4, ~~provided with~~further comprising a conduit system including a by-pass line, enabling by-passing the pump and/or the motor device operating in a passive modus.

~~6. Mobile active heave compensator according to one of the claims 1 to 5, comprising an actuator provided with a first cylinder (11,91) and a reciprocating piston (12) reciprocating inside the cylinder (11,91) and with a piston rod (13) extending through an end wall of the cylinder, the piston (12) dividing the cylinder (11,91) into an enclosed first volume (V1) on one side of the piston (12), and a second enclosed volume (V2) on the opposite side, one end of the actuator being provided with a first and a second connection device (14), at least one accumulator (40) in the form of a cylinder provided~~

with an internally arranged reciprocating piston (44), configured to move inside the accumulator (40), dividing the accumulator into a third enclosed volume (V3) on one side of the piston (44) and a fourth enclosed volume (V4) on the opposite side; and fluid communicating line system extending between the actuator and the at least one cylinder, wherein the mobile heave compensator is provided with a device for hydraulic fluid transportation (151) affecting a pressure in one of the actuator volumes (V1,V2) or one of the volumes in accumulator (V6-V8).

7. Mobile active heave compensator according to claim 6, wherein the device for hydraulic fluid transportation communicates hydraulic fluid between an enclosed volume on one side of the actuator piston and an enclosed volume on one side of the piston in another cylinder, directly or indirectly is affecting the pressure in one of the volumes.

8. Mobile active heave compensator according to claim 6 or 7, wherein the heave compensator is provided a first and a second sensing device for controlling the hydraulic fluid communicated by the device for hydraulic fluid transportation.

9. Mobile active heave compensator according to one of the claims 6 to 8, wherein one of the sensors used may be chosen from the group of an internal accelerometer, water pressure measuring device, or a device for measuring the difference on position between the compensator and the payload.

10. Mobile active heave compensator according to one of the claims 6 to 9, wherein the actuator (10) and/or the accumulator (40,100), are provided with one additional separated volume (V20,V8).

11. Mobile active heave compensator according to claim 10, wherein the accumulator being a double acting gas accumulator with a reciprocating piston, provided with a fourth separated volume, the piston being provided with two piston rods (105,106), configured to run with their ends in two (V21,V24) of the four separated volumes (V21-V24).

12.6. The Mmobile active heave compensator (1000) according to any one of the claims 1 to 65, comprisingwherein:

athe passive heave compensation device part(1001), is adapted for linear reciprocating motion;

the sensor device (120),arrangement is adapted for giving an output signal to an active element, based on payload (1004) motion and/or crane hook (1006) motion and/or vessel (1008) motion and/or crane tip (1009) motion; and

anthe active element (1002),is adapted for manipulating the linear reciprocating motion in such a way that the motion of the payload (1004) relative to the seabed (1007) is minimized when desired;

characterized in that wherein the mobile active heave compensator (1000) is connected between the crane hook (1006) and the payload (1004).

13.7. The Mmobile active heave compensator (1000), according to claim to 126, comprising any number of and any functional combination elements selected from the group of elements consisting of:

athe first actuator (10), consisting of a first cylinder (11) having an upper end and a lower end, a connection device (14) mounted at the upper end of the first cylinder (11), a first piston (12) located within the first cylinder (11) and adapted for reciprocation with respect thereto, a first piston rod (13) connected to the first piston (12) and extending downwardly therefrom through the lower end of the first cylinder (11), a connector device (14) located at the lower end of the first cylinder (11), a first volume (V1) located between the first piston (12) and the lower end of the first cylinder (11), a second volume (V2) located between the first piston (12) and the upper end of the first cylinder (11);

a second actuator (20), consisting of a second cylinder (21) having an upper end and a lower end, a second piston (22) located within the second cylinder (21) and adapted for reciprocation with respect thereto, a second piston rod (23) connected to the second piston (22) and extending downwardly therefrom through the lower end of the second cylinder (21), a third volume (V3) located between the second piston (22) and the lower end of the second cylinder (21), a fourth volume (V4) located between the second piston (22) and the upper end of the second cylinder (21);

a third actuator (30), consisting of a third cylinder (31) having an upper end and a lower end, a rod (32) adapted for reciprocation with respect to the third cylinder and extending downwardly therefrom through the lower end of the third cylinder (31), a fifth volume (V5) inside the third cylinder (21) displaced by the rod (32);

a pressure intensifier (40), consisting of a fourth cylinder (41), a fifth cylinder (42), a third piston rod (43) and a third piston (44), forming a sixth volume (V6) between one end of the fourth cylinder (41) and the third piston (44), a seventh volume (V7) between the other end of the fourth cylinder (41) and the third piston (44), and an eighth volume (V8), between the ends of the fifth cylinder (42);

a depth compensator (50), consisting of a sixth cylinder (51), a fourth piston rod (52) exposed to external pressure and a fourth piston (53), forming a ninth volume (V9) between one end of the sixth cylinder (51) and the fourth piston (53), a tenth volume (V10) between the other end of the sixth cylinder (51) and the fourth piston (53);

a first gas accumulator (60), consisting of a seventh cylinder (61) and a fifth piston (62) forming an eleventh volume (V11) between one end of the seventh cylinder (61) and the fifth piston (62), a twelfth volume (V12) between the other end of the seventh cylinder (61) and the fifth piston (62);

a second gas accumulator (70), consisting of an eighth cylinder (71) and a sixth piston (72) forming a thirteenth volume (V13) between one end of the eighth cylinder (71) and the sixth piston (72), a fourteenth volume (V14) between the other end of the eighth cylinder (71) and the sixth piston (72);

a ring based depth compensator (80), consisting of a ninth cylinder (81), a first ring piston (82), a first ring piston rod (83) exposed to external pressure, forming a fifteenth volume (V15) between one end of the ninth cylinder (81) and the first ring piston (82), a sixteenth volume (V16) between the other end of the ninth cylinder (81) and the first ring piston (82), the inner diameter of the first ring piston rod (83) and the outer diameter of the inner cylinder (can be any cylinder, shown with dashed lines in figures), a seventeenth volume (V17) between the other end of the ninth cylinder (81) and the first ring piston (82), the outer diameter of the first ring piston rod (83) and the inner diameter of the ninth cylinder (81);

a hollow rod actuator (90), consisting of a tenth cylinder (91) having an upper end and a lower end, a connection device (94) mounted at the upper end of the tenth cylinder (91), a second ring piston (92) located within the tenth cylinder (91) and adapted for reciprocation with respect thereto, a second ring piston rod (93) connected to the second ring piston (92) and extending downwardly therefrom through the lower end of the tenth cylinder (91) with a sealed lower end, a connector device (94) located at the end of the second ring piston rod (91), an eleventh cylinder (95) mounted concentric with the tenth cylinder (91) at one end of the tenth cylinder (91) and with the other end inside the inner volume of the second ring piston rod (93), an eighteenth volume (V18) located between the second ring piston (92), the outer diameter of the eleventh cylinder (95) and the lower end of the tenth cylinder (91), a nineteenth volume (V19) located between the second ring piston (92), the outer diameter of the ring piston rod (93) and the lower end of the tenth cylinder (91), a twentieth volume (V20) located between the inner diameter of the eleventh cylinder (95), the inner diameter of the ring piston rod (93), one end of the tenth cylinder (91) and one end of the ring piston rod (93);

a double acting pressure intensifier (100), consisting of a twelfth cylinder (101) mounted concentric between a thirteenth cylinder (102) at the upper end of the twelfth cylinder (101) and a fourteenth cylinder (103) at the lower end of the twelfth cylinder (101), a seventh piston (104), a fifth piston rod (105) connected to the lower end of the seventh piston (104) and a sixth piston rod (106) connected to the upper end of the seventh piston (104), forming a twenty-first volume (V21) between one end of the fourteenth cylinder (103) and the lower end of the twelfth cylinder (101) displaced by the fifth piston rod, a twenty-second volume (V22) between the lower end of the twelfth cylinder (101), the lower end of the seventh piston (104) and the outer diameter of the fifth piston rod (105), a twenty-third volume (V23) between the upper end of the twelfth cylinder (101), the upper end of the seventh piston (104) and the outer diameter of the sixth piston rod (106), a twenty-fourth volume (V24) between one end of the thirteenth cylinder (102) and the upper end of the twelfth cylinder (101) displaced by the sixth piston rod (106); and

a second pressure intensifier (110), consisting of a fifteenth cylinder (111), a sixteenth cylinder (112), a seventh piston rod (113), an eighth piston (114) and a ninth piston (115), forming a twenty-fifth volume (V25) between one end of the fifteenth cylinder (111) and the eighth piston (114), a twenty-sixth volume (V26) between the other end of the fifteenth cylinder (111) and the eighth piston (114), a twenty-seventh volume (V27) between the upper end of the sixteenth cylinder (112) and the ninth piston (115) and a twenty-eighth volume (V28), between the lower end of the sixteenth cylinder (112) and the ninth piston (115);

a second double acting pressure intensifier (130), consisting of a seventeenth cylinder (131) mounted concentric between a eighteenth cylinder (132) at the upper end of the seventeenth cylinder (131) and a nineteenth cylinder (133) at the lower end of the seventeenth cylinder (131), a tenth piston (134), an eight piston rod (135) connected to the lower end of the seventh piston (134) and a ninth piston rod (136) connected to the upper end of the tenth piston (134), an eleventh piston (137) connected to the upper end of the ninth piston rod (136), a twelfth piston (138) connected to the lower end of the eighth piston rod (135), forming a twenty-ninth volume (V29) between one end of the nineteenth cylinder (133) and the lower end of the twelfth piston (138), a thirtieth volume (V30) between the upper end of the nineteenth cylinder (133) and the upper end of the twelfth piston (138) displaced by the eight piston rod (135), a thirty-first volume (V31) between the lower end of the seventeenth cylinder (131) and the lower end of the tenth piston (134) displaced by the eight piston rod (135), a thirty-second volume (V32) between the upper end of the seventeenth cylinder (131) and the upper end of the tenth piston (134) displaced by the ninth piston rod (136), a thirty-third volume (V33) between

the lower end of the eighteenth cylinder (132) and the lower end of the eleventh piston (137) displaced by the ninth piston rod (136), a thirty-fourth volume (V34) between the upper end of the eighteenth cylinder (132) and the upper end of the eleventh piston (137)any functional combinations thereof.

14. Mobile active heave compensator (1000) according to claim 12 or 13, comprising:
a first actuator (10), where the first volume (V1) is filled with oil and the second volume (V2) is under vacuum;
a pressure intensifier (40), where the sixth volume (V6) is filled with gas, the seventh volume (V7) is filled with oil and the eighth volume (V8) is filled with oil;
conduit device connecting the seventh volume (V7) to the first volume (V1);
conduit device connecting the first volume (V1) to the eighth volume (V8) via a device for hydraulic fluid transportation (151).

15. Mobile active heave compensator (1000) according to claim 12 or 13, comprising:
a first actuator (10), where the first volume (V1) is filled with oil and the second volume (V2) is filled with oil;
a depth compensator (50), where the tenth volume (V10) is filled with oil, and the ninth volume (V9) is either filled with gas or under vacuum;
a pressure intensifier (40), where the sixth volume (V6) is filled with gas, the seventh volume (V7) is filled with oil and the eighth volume (V8) is filled with oil;
conduit device connecting the seventh volume (V7) to the first volume (V1);
conduit device between the second volume (V2) and the tenth volume (V10);
conduit device connecting the first volume (V1) to the eighth volume (V8) via a device for hydraulic fluid transportation (151).

16. Mobile active heave compensator (1000) according to claim 12 or 13, comprising:
a hollow rod actuator (90), where the eighteenth volume (V18) is filled with oil, the nineteenth volume (V19) is filled with oil and the twentieth volume (V20) is filled with oil;
a depth compensator (50), where the tenth volume (V10) is filled with oil, and the ninth volume (V9) is either filled with gas or under vacuum;
a first gas accumulator (60), where the eleventh volume (V11) is filled with oil and the twelfth volume (V12) is filled with gas;
a second gas accumulator (70), where the thirteenth volume (V13) is filled with oil and the fourteenth volume (V14) is filled with gas;
conduit device connecting the eleventh volume (V11) to the nineteenth volume (V19);

conduit device between the eighteenth volume (V18) and the tenth volume (V10);

conduit device connecting the twentieth volume (V20) to the thirteenth volume (V13) via a device for hydraulic fluid transportation (151).

17. Mobile active heave compensator (1000) according to claim 12 or 13, comprising:

a hollow rod actuator (90), where the eighteenth volume (V18) is filled with oil, the nineteenth volume (V19) is filled with oil and the twentieth volume (V20) is filled with oil;

a depth compensator (50), where the tenth volume (V10) is filled with oil, and the ninth volume (V9) is either filled with gas or under vacuum;

a first gas accumulator (60), where the eleventh volume (V11) is filled with oil and the twelfth volume (V12) is filled with gas;

conduit device connecting the eleventh volume (V11) to the nineteenth volume (V19);

conduit device between the eighteenth volume (V18) and the tenth volume (V10);

conduit device connecting the twentieth volume (V20) to the nineteenth volume (V19) via a device for hydraulic fluid transportation (151).

18. Mobile active heave compensator (1000) according to claim 12 or 13, comprising:

a hollow rod actuator (90), where the eighteenth volume (V18) is under vacuum or filled with gas, the nineteenth volume (V19) is filled with oil and the twentieth volume (V20) is filled with oil;

a first gas accumulator (60), where the eleventh volume (V11) is filled with oil and the twelfth volume (V12) is filled with gas;

a second gas accumulator (70), where the thirteenth volume (V13) is filled with oil and the fourteenth volume (V14) is filled with gas;

conduit device connecting the eleventh volume (V11) to the nineteenth volume (V19);

conduit device connecting the twentieth volume (V20) to the thirteenth volume (V13) via a device for hydraulic fluid transportation (151).

19. Mobile active heave compensator (1000) according to claim 12 or 13, comprising:

a hollow rod actuator (90), where the eighteenth volume (V18) is under vacuum or filled with gas, the nineteenth volume (V19) is filled with oil and the twentieth volume (V20) is filled with oil;

a first gas accumulator (60), where the eleventh volume (V11) is filled with oil and the twelfth volume (V12) is filled with gas;

conduit device connecting the eleventh volume (V11) to the nineteenth volume (V19);

conduit device connecting the twentieth volume (V20) to the nineteenth volume (V19) via a device for hydraulic fluid transportation (151).

208. The Mmobile active heave compensator (1000) according to claim 12 or 136, comprising:

athe first actuator (10), consisting of a first cylinder having an upper end and a lower end, a connection device mounted at the upper end of the first cylinder, a first piston located within the first cylinder and adapted for reciprocation with respect thereto, a first piston rod connected to the first piston and extending downwardly therefrom through the lower end of the first cylinder, a connector device located at the lower end of the first cylinder, a first volume located between the first piston and the lower end of the first cylinder, a second volume located between the first piston and the upper end of the first cylinder, where the first volume (V1) is filled with oil and the second volume (V2) is filled with gas or is under vacuum;

at least one second gas accumulator(s) (70), consisting of an eighth cylinder and a sixth piston forming a thirteenth volume between one end of the eighth cylinder and the sixth piston, a fourteenth volume between the other end of the eighth cylinder and the sixth piston, where the thirteenth volume (V13) is filled with oil and the fourteenth volume (V14) is filled with gas;

a double acting pressure intensifier (100), consisting of a twelfth cylinder mounted concentric between a thirteenth cylinder at the upper end of the twelfth cylinder and a fourteenth cylinder at the lower end of the twelfth cylinder, a seventh piston, a fifth piston rod connected to the lower end of the seventh piston and a sixth piston rod connected to the upper end of the seventh piston, forming a twenty-first volume between one end of the fourteenth cylinder and the lower end of the twelfth cylinder displaced by the fifth piston rod, a twenty-second volume between the lower end of the twelfth cylinder, the lower end of the seventh piston and the outer diameter of the fifth piston rod, a twenty-third volume between the upper end of the twelfth cylinder, the upper end of the seventh piston and the outer diameter of the sixth piston rod, a twenty-fourth volume between one end of the thirteenth cylinder and the upper end of the twelfth cylinder displaced by the

sixth piston rod, where the twenty-fourth volume (V24) is filled with oil, the twenty-third volume (V23) is filled with gas, the twenty-second volume (V22) is filled with oil and the twenty-first volume (V21) is filled with oil;

a first conduit device connecting the twenty-second volume (V22) to the first volume (V1);

a second conduit device connecting the twenty-fourth volume (V24) to at least one of the oil filled volumes (V13) of the at least one second gas accumulator(s) (70);

a third conduit device connecting the twenty-first volume (V21) to at least one of the oil filled volumes (V13) of the at least one second gas accumulator(s) (70); and

a fourth conduit device connecting the twenty-first volume (V21) and the twenty-fourth volume (V24) via a device for hydraulic fluid transportation (151).

219. The Mmobile active heave compensator (1000) according to claim 12 or 136, comprising:

athe first actuator (10), consisting of a first cylinder having an upper end and a lower end, a connection device mounted at the upper end of the first cylinder, a first piston located within the first cylinder and adapted for reciprocation with respect thereto, a first piston rod connected to the first piston and extending downwardly therefrom through the lower end of the first cylinder, a connector device located at the lower end of the first cylinder, a first volume located between the first piston and the lower end of the first cylinder, a second volume located between the first piston and the upper end of the first cylinder, where the first volume (V1) is filled with oil a first fill substance and the second volume (V2) is filled oilwith a second fill substance;

a depth compensator (50), consisting of a sixth cylinder, a fourth piston rod exposed to external pressure and a fourth piston, forming a ninth volume between one end of the sixth cylinder and the fourth piston, a tenth volume between the other end of the sixth cylinder and the fourth piston, where the tenth volume (V10) is filled with oila third fill substance, and the ninth volume (V9) is either filled with gas or under vacuuma fourth fill substance;

at least one second gas accumulator, consisting of an eighth cylinder and a sixth piston forming a thirteenth volume between one end of the eighth cylinder and the sixth piston, a fourteenth volume between the other end of the eighth cylinder and the sixth piston, where the thirteenth volume is filled with a fifth fill substance and the fourteenth volume is filled with a sixth fill substance;

a double acting pressure intensifier (100), consisting of a twelfth cylinder mounted concentric between a thirteenth cylinder at the upper end of the twelfth cylinder and a fourteenth cylinder at the lower end of the twelfth cylinder, a seventh piston, a fifth piston rod connected to the lower end of the seventh piston and a sixth piston rod connected to the upper end of the seventh piston, forming a twenty-first volume between one end of the fourteenth cylinder and the lower end of the twelfth cylinder displaced by the fifth piston rod, a twenty-second volume between the lower end of the twelfth cylinder, the lower end of the seventh piston and the outer diameter of the fifth piston rod, a twenty-third volume between the upper end of the twelfth cylinder, the upper end of the seventh piston and the outer diameter of the sixth piston rod, a twenty-fourth volume between one end of the thirteenth cylinder and the upper end of the twelfth cylinder displaced by the sixth piston rod, where the twenty-fourth volume (V24) is filled with oil, gas or is under vacuuma seventh fill substance, the twenty-third volume (V23) is filled with gasan eighth fill substance, the twenty-second volume (V22) is filled with oil a ninth fill substance and the twenty-first volume (V21) is filled with oila tenth fill substance;

a first conduit device connecting the second volume to the tenth volume;

a second conduit device connecting the twenty-second volume (V22) to the first volume (V1);

conduit device connecting the second volume (V2) to the tenth volume (V10);

a third conduit device connecting the twenty-fourth volume to at least two one of the following volumes via a device for hydraulic fluid transportation (151): the twenty-fourth volume (V24), the first volume (V1), the twenty-first volume (V21) of the at least one second gas accumulator, wherein the at least one of the volumes of the at least one second gas accumulator is filled with oil;

a fourth conduit device connecting the twenty-first volume to at least one of the volumes of the at least one second gas accumulator, wherein the at least one of the volumes of the at least one second gas accumulator is filled with oil; and

a fifth conduit device connecting the twenty-first volume and the twenty-fourth volume via a device for hydraulic fluid transportation; wherein the first, second, third, fourth, fifth, sixth, seventh, eighth, ninth, and tenth fill substances are selected from the group of fill substances consisting of any fluid, oil, gas, vacuum, and combinations thereof.

10. The mobile active heave compensator according to claim 9, wherein:

the first fill substance comprises oil;

the second fill substance comprises oil;

the third fill substance comprises oil;

the fourth fill substance comprises gas or vacuum;

the fifth fill substance comprises oil;

the sixth fill substance comprises gas;

the seventh fill substance comprises oil

the eighth fill substance comprises gas;

the ninth fill substance comprises oil; and

the tenth fill substance comprises oil.

~~22. Mobile active heave compensator (1000) according to claim 12 or 13, comprising:~~

~~a first actuator (10), where the first volume (V1) is filled with oil and the second volume (V2) is filled oil;~~

~~a depth compensator (50), where the tenth volume (V10) is filled with oil, and the ninth volume (V9) is either filled with gas or under vacuum;~~

~~at least one second gas accumulator(s) (70), where the thirteenth volume (V13) is filled with oil and the fourteenth volume (V14) is filled with gas;~~

~~a double acting pressure intensifier (100), where the twenty-fourth volume (V24) is filled with oil, the twenty-third volume (V23) is filled with gas, the twenty-second volume (V22) is filled with oil and the twenty-first volume (V21) is filled with oil;~~

~~conduit device connecting the second volume (V2) to the tenth volume (V10);~~

~~conduit device connecting the twenty-second volume (V22) to the first volume (V1);~~

~~conduit device connecting the twenty-fourth volume (V24) to at least one of the oil filled volumes (V13) of the second gas accumulator(s) (70);~~

~~conduit device connecting the twenty-first volume (V21) to at least one of the oil filled volumes (V13) of the second gas accumulator(s) (70);~~

~~conduit device connecting the twenty-first volume (V21) and the twenty-fourth volume (V24) via a device for hydraulic fluid transportation (151).~~

~~23. Mobile active heave compensator (1000) according to one of the claims 12 to 22, wherein oil is replaced by any fluid and/or gas is replaced by any fluid and/or vacuum is replaced by any fluid/gas.~~

~~24~~11. The ~~M~~mobile active heave compensator ~~(1000)~~ according to ~~one of the~~ claim~~s 12 to 23~~10, wherein the effective size of any of the numbered volumes is expanded by connecting tanks or other devices to any of the numbered volumes.

~~25~~12. The ~~M~~mobile active heave compensator ~~(1000)~~ according to ~~one of the~~ claim~~s 12 to 24~~11, wherein the device for hydraulic fluid transportation ~~(151)~~ is controlled based on measurements from at least one position sensor ~~(121)~~ and/or one motion sensor ~~(122)~~.

~~26. Mobile active heave compensator (1000) according to one of the claims 12 to 25, wherein the pressure intensifier (40) is replaced by a second pressure intensifier (110), the twenty-fifth volume (V25) will be filled with the same fluid as the sixth volume (V6) and connected to the same volume as the sixth volume (V6), the twenty-sixth volume (V26) will be filled with the same fluid as the seventh volume (V7), the twenty-seventh volume (V27) will be under vacuum or gas pressure, the twenty eight volume (V28) will be filled with the same fluid as the eighth volume (V8) and connected to the same volume as the eighth volume (V8).~~

~~27. Mobile active heave compensator (1000) according to one of the claims 12 to 26, wherein the double acting pressure intensifier (100) is replaced by a second pressure intensifier (130), the thirty-fourth volume (V34) will be filled with the same fluid as the twenty-fourth volume (V24) and connected to the same volume as the twenty-fourth volume (V24), the twenty-ninth volume (V29) will be filled with the same fluid as the twenty-first volume (V21) and connected to the same volume as the twenty first volume (V21), the thirty-first volume (V31) will be filled with the same fluid as the twenty-second volume (V22) and connected to the same volume as the twenty-second volume (V22), the thirtieth volume (V30) is either connected to the thirty-first volume (V31) or filled with gas or under vacuum, the thirty-second volume (V32) is filled with the same fluid as the twenty-third volume (V23), the thirty-third volume (V33) is either connected to the thirty-second volume (V32) or filled with gas or under vacuum.~~

~~28~~13. The ~~M~~mobile active heave compensator ~~(1000)~~ according to ~~one of the~~ claim~~s 12 to 27~~7, ~~wherein~~ further comprising ~~a device for hydraulic fluid transportation (151) is~~

separated into at least two devices for hydraulic fluid transportation (151).

2914. The Mmobile active heave compensator (1000) according to one of the claims 12 to 2813, wherein any two adjoining of the numbered volumes that are adjacent in any type ofthe pressure intensifier is are connected together.

3015. The Mmobile active heave compensator (1000) according to one of the claims 12 to 2914, wherein a device for gas transportation is used to transport gas between at least one gas of the numbered volumes and another gas of the numbered volumes and/or to the surroundings.

3116. The Mmobile active heave compensator (1000) according to one of the claims 12 to 3015, wherein athe sensoring arrangement for theadapted to directly or indirectly position measureing the position of the first piston (12) is further adapted for measuring the equilibrium position of the first piston (12) and/or the first piston rod (13) relative to the ends of the first cylinder (11).

3217. The Mmobile active heave compensator (1000) according to one of the claims 12 to 3116, wherein two the first gas accumulators and the second gas accumulator are used wherein these are replaced by a third gas accumulator with comprising two oil volumes filled with oil and one gas volume filled with gas.

33. Mobile active heave compensator according to one of the claims 1 to 6, wherein the first volume (V1), filled with hydraulic fluid, located between the first piston (12) and a lower end of the first cylinder (11,91);
a second volume (V2), filled with gas at any pressure including zero, located between the first piston (12) and an upper end of the first cylinder (11,91);
a double acting gas accumulator (40), comprising of a fourth cylinder (41), provided with a piston (44) and a piston rod (43), where the end of the piston rod ((43) is configured to reciprocate in a fourth cylinder 42 with an enclosed volume V8), wherein the device for fluid transportation (151) transports hydraulic fluid between the volumes (V1) and (V8) .

3418. The Mmobile active heave compensator according to claim 335, wherein a third inner cylinder (33) mounted concentrically within the fourth cylinder (31) and fixed to the upper end of the fourth cylinder (31) with a leak tight connection,

a fourth inner cylinder (35) mounted concentrically inside the fourth cylinder (31) and connected to the upper end of the ring shaped piston (32) with a leak tight connection, a cylinder end (34) mounted concentrically with the fourth cylinder (31) at the upper end of the fourth inner cylinder (35) with a leak tight connection,

a fifth inner cylinder (36) mounted concentrically with the fourth cylinder (31) at the lower end of the fourth cylinder (31) in a leak tight manner, where the assembly consisting of the ring shaped piston (32), the fourth inner cylinder (35) and the cylinder end (34) is adapted to reciprocate inside the fourth cylinder (31), inside the third inner cylinder (33) and outside the fifth inner cylinder (36) in a leak tight manner further comprising:

a hydraulic actuator, comprising a first cylinder having an upper end and a lower end, a first piston rod connected to a first piston and extending downwardly therefrom through the lower end of the first cylinder, adapted for reciprocation with respect thereto, a connection device mounted at the upper and lower end of the hydraulic actuator adapted for connecting the active heave compensator to a floating object, and a payload;

a first volume, filled with hydraulic fluid, located between the first piston and the lower end of the first cylinder;

a second volume, filled with gas at any pressure including zero, located between the first piston and the upper end of the first cylinder;

a double acting gas accumulator, comprising a fourth cylinder, a ring shaped piston mounted concentrically within the fourth cylinder and adapted for reciprocation with respect thereto, where the lower end of the ring shaped piston is on the same side as the lower end of the fourth cylinder when the ring shaped piston is at zero stroke, a third inner cylinder mounted concentrically within the fourth cylinder and fixed to the upper end of the fourth cylinder with a leak tight connection, a fourth inner cylinder mounted concentrically inside the fourth cylinder and connected to the upper end of the ring shaped piston with a leak tight connection, a cylinder end mounted concentrically with the fourth cylinder at the upper end of the fourth inner cylinder with a leak tight connection, a fifth inner cylinder mounted concentrically with the fourth cylinder at the lower end of the fourth cylinder in a leak tight manner, where the assembly consisting of the ring shaped piston, the fourth inner cylinder and the cylinder end is adapted to reciprocate inside the fourth cylinder, inside the third inner cylinder and outside the fifth inner cylinder in a leak tight manner;

a sixth volume (V6), filled with hydraulic fluid, located between the cylinder end (34), the inside of the fourth inner cylinder (35), the fifth inner cylinder (36) and the lower end of the first cylinder (31);

a seventh volume (V7), filled with hydraulic fluid, located between cylinder end (34), the outside of the fourth inner cylinder (35), the inside of the third inner cylinder (33) and the upper end of the first cylinder (31);
an eighth volume (V8), filled with hydraulic fluid, located between the ring shaped piston (32), the outside of the fifth inner cylinder (36) and the lower end of the first cylinder (31);
a ninth volume (V9), filled with gas at any pressure, located between the inside the fourth cylinder (31), the upper end of the fourth cylinder (31), the outside of the third inner cylinder (33), the outside of the fourth inner cylinder (35) and the upper end of the ring shaped piston (32);
a second gas accumulator (60), consisting of a seventh cylinder (61) and a fifth piston (62), adapted for reciprocation with respect thereto;
a seventeenth volume (V14), filled with hydraulic fluid, located between the upper end of the seventh cylinder (61) and the upper end of the fifth piston (62);
an eighteenth volume (V15), filled with gas at any pressure, located between the lower end of the seventh cylinder (61) and the lower end of the fifth piston (62);
a first conduit device between the first volume (V1) and the eighth volume (V8);
a second conduit device between the sixth volume (V6) and the seventh volume, (V7) the second conduit device adapted with having a first hydraulic pump (P1) adapted to transport oil under pressure between the respective sixth and seventh volumes;
a third conduit device between the seventeenth volume (V14) and the seventh volume, (V7) the third conduit device having adapted with a third device control valve (CV3);
a fourth conduit device between the seventeenth volume (V14) and the sixth volume (V6), the fourth conduit device having adapted with a second control valve (CV2);
a first sensing device adapted for measuring the position of the first piston (12);
a second sensing device adapted for measuring the motion of the active heave compensator (100);
one or more third sensing devices adapted for measuring the pressure in one or more of the numbered volumes;
a computer adapted for controlling the first hydraulic pump (P1) and the control valves based on input from the sensing devices.

35. Mobile active heave compensator (100) according to claim 33 or 34, comprising:
a first cylinder (1) having an upper end and a lower end;
a first connection device (5) mounted at the upper end of the first cylinder (1) and adapted for connecting the first cylinder (1) to at least one of: a vessel (102) at sea surface and a payload (101);

a first piston (2) located within the first cylinder (1) and adapted for reciprocation with respect thereto;

a first piston rod (3) connected to the first piston (2) and extending downwardly therefrom through the lower end of the first cylinder (1);

a second connector device (4) adapted for securing the first piston rod (3) at least one of: the vessel (102) at the sea surface and the payload (101), and located at the lower end of the first cylinder (1);

a first volume of hydraulic fluid located between the first piston (2) and the lower end of the first cylinder (1);

a second volume of hydraulic fluid located between the first piston (2) and the upper end of the first cylinder (1);

a second cylinder (8) containing a second piston (9);

a third volume of hydraulic fluid located between the lower end of the second cylinder (8) and the second piston (9);

a third cylinder (22) containing a third piston (20);

a fourth volume of hydraulic fluid located between the third piston (20) and the upper end of the third cylinder (22);

a device for hydraulic fluid transportation (17) adapted for transporting hydraulic fluid between the second volume of hydraulic fluid in the first cylinder (1) and the fourth volume of hydraulic fluid in the third cylinder (22);

wherein the hydraulic fluid is transported between the second volume of hydraulic fluid in the first cylinder (1) and the device for hydraulic fluid transportation (17) via a sixth conduit device (21) connected to the upper side of the first cylinder (1);

wherein the hydraulic fluid is transported between the fourth volume of hydraulic fluid in the third cylinder (22) and the device for hydraulic fluid transportation (17) via a fifth conduit device (18) connected to the upper side of the third cylinder (22);

wherein the hydraulic fluid is transported between the first volume of hydraulic fluid located at the lower side of the first cylinder (1) and the third volume of hydraulic fluid located at lower side of the second cylinder (8) via a first conduit device (7) connecting the lower sides of the first (1) and the second (8) cylinder; and

a sensing arrangement (6, 10, 19, 30 - 36) adapted for direct or indirect measuring an equilibrium position of at least one of: the first piston (2) and the first piston rod (3), relative to at least one of: the lower and upper ends of the first cylinder (1),

where the device for hydraulic fluid transportation (17) is controlled based on the direct or indirect measurements from the sensing arrangement.

36. Mobile active heave compensator (100) according to claim 33, further comprising:

an accelerometer (29) integrated into the compensator (100) and adapted to measure movement of the compensator (100);

where the decide for hydraulic fluid transportation (17) is controlled based on the direct or indirect measurements from both the sensing arrangement and the accelerometer (29).

37. Mobile active heave compensator (100) according to claim 33 or 34, further comprising:

a first volume of gas located between the upper end of the second cylinder (8) and the second piston (9), where the gas pressure in the first gas volume in the second cylinder (8) effectively pressurizes the first hydraulic fluid volume in the first cylinder (1) via the first conduit device (7), as well as the third hydraulic fluid volume in the second cylinder (8);

a third gas volume located between the third piston (20) and the lower end of the third cylinder (22), where the gas pressure in the third gas volume in the third cylinder (22) effectively pressurizes the fourth hydraulic fluid volume in the third cylinder (22);

a fourth cylinder (14);

a second gas volume located in the fourth cylinder (14);

a fifth cylinder (24);

a fourth gas volume located in the fifth cylinder (24);

a device for gas transportation (12) used to transport gas between any combination of: the first gas volume, the second gas volume, the third gas volume and the fourth gas volume, where the device for gas transportation (12) is adapted to expel gas to the surroundings from any of: the first gas volume, the second gas volume, the third gas volume and the fourth gas volume;

a second conduit device (11) is used to transport gas between the first gas volume in the second cylinder (8) and the device for gas transportation (12);

a third conduit device (13) is used to transport gas between the second gas volume in the fourth cylinder (14) and the device for gas transportation (12);

a fourth conduit device (15) is used to transport gas between the third gas volume in the third cylinder (22) and the device for gas transportation (12);

a ninth conduit device (28) is used to transport gas between the fourth gas volume in the fifth cylinder (24) and the device for gas transportation (12);

a valve (26) is used to separate the first gas volume in the second cylinder (8) and the fourth gas volume in the fifth cylinder (24);

an eighth conduit device (27) is used to transport gas between the first gas volume in the second cylinder (8) and the valve (26);

a seventh conduit device (25) is used to transport gas between the fourth gas volume in the fifth cylinder (24) and the valve (26).

38. Mobile active heave compensator (100) according to any one of claims 22 to 37, wherein the pressure in the second hydraulic fluid volume in the first cylinder (1) is not necessarily equal to the pressure of the fourth hydraulic fluid volume in the third cylinder (22), because the device for hydraulic fluid transportation (17) is adapted to transport hydraulic fluid between the two volumes and to create a positive or negative pressure deviation between them.

39. Mobile active heave compensator (100) according to one of claims 33 to 38, further comprising a first MRU (105) placed in a crane tip; and a second MRU (104) placed in the vicinity of the payload (101).

40. Mobile active heave compensator (100) according to one of claims 33 to 39, wherein the sensing arrangement (6, 10, 19) for the direct or indirect position measuring of the first piston (2) is at least one of: a first piston position sensor (6) arranged in the first cylinder (1) and adapted for direct measuring the equilibrium position of the first piston (2) and/or the rod (3); a second piston position sensor (10), in a second cylinder (8), being adapted for indirect measuring the equilibrium position of the first piston (2) and/or the rod (3); and a third piston position sensor (19), in a third cylinder (22), being adapted for indirect measuring the equilibrium position of the first piston (2) and/or the rod (3).

41. Mobile active heave compensator (100) according to one of claims 33 to 40, wherein the device for gas transportation (12) is one of: at least one pressure intensifier and at least one gas compressor, being driven by one of: an electric motor and hydraulics.

42. Mobile active heave compensator (100) according to one of claims 33 to 41, wherein the device for hydraulic fluid transportation (17) is at least one reversible hydraulic pump being driven by an electric motor.

43. Mobile semi active heave compensator (100) according to one of the claims 1 to 6, comprising:

a first cylinder (1) having an upper end and a lower end;

a first connection device (5) mounted at the upper end of the first cylinder (1) and adapted for connecting the first cylinder (1) to at least one of: a vessel (102) at sea surface and a payload (101);

a first piston (2) located within the first cylinder (1) and adapted for reciprocation with respect thereto;

a first piston rod (3) connected to the first piston (2) and extending downwardly therefrom through the lower end of the first cylinder (1);

a second connector device (4) adapted for securing the first piston rod (3) to at least one of: the vessel (102) at the sea surface and the payload (101), and located at the lower end of the first cylinder (1);

a first volume, filled with hydraulic fluid, located between the first piston (2) and the lower end of the first cylinder (1);

a second volume, located between the first piston (2) and the upper end of the first cylinder (1);

a second cylinder (8) containing a second piston (9);

a third volume of hydraulic fluid located between the lower end of the second cylinder (8) and the second piston (9);

a sensing arrangement (6 or 10 or 19) adapted for direct or indirect measuring the position of at least one of: the first piston (2) and the first piston rod (3), relative to at least one of: the lower and upper ends of the first cylinder (1);

a device for hydraulic fluid transportation (17) adapted for transporting hydraulic fluid between two volumes;

an accelerometer (29) integrated into the compensator (100) and adapted to measure movement of the compensator (100);

where the device for hydraulic fluid transportation (17) is controlled based on the direct or indirect measurements from both the sensing arrangement (6 or 10 or 19) and the accelerometer (29).

44. Mobile semi active heave compensator (100) according to claim 43, where the second volume is under vacuum;

a device for hydraulic fluid transportation (17) adapted for transporting hydraulic fluid between the first and third volume, using conduit devices (7, 28), and create a positive or a negative pressure deviation between the two volumes; and

valves may also be present in the conduit device (7, 28), to bypass the device for hydraulic fluid transportation (17) or to block it off.

45. Mobile semi active heave compensator (100) according to claim 43 or 44, where the second volume is filled with hydraulic fluid.

46. Mobile semi active heave compensator (100) according to claim 43 to 45, further comprising:

a third cylinder (25) contains a third piston (26) and a fifth volume, filled with hydraulic fluid, located between the third piston (26) and the upper end of the third cylinder (25), as well as a sixth volume, filled with low pressure gas, located between the third piston (26) and the lower end of the third cylinder (25);

the fifth volume is connected to the second volume via conduit device (21), and they have the same pressure;

a second piston rod (26) is connected to the third piston (26) and extends through the lower end of the third cylinder (25) into a fourth cylinder (24);

a fourth cylinder (24) contains a seventh volume, filled with hydraulic fluid, located around the second piston rod (26) and the fourth cylinder (24);

a fifth cylinder (22) contains a fourth piston (20);

a fifth cylinder (22) contains an eighth volume, filled with gas, located between the fourth piston (20) and the lower end of the fifth cylinder (22), as well as a ninth volume, filled with hydraulic fluid, located between the fourth piston (20) and the upper end of the fifth cylinder (22);

the gas pressure in the eighth volume in the third cylinder (22) effectively pressurizes hydraulic fluid in the ninth volume in the fifth cylinder (22);

a device for hydraulic fluid transportation (17) can transport hydraulic fluid between the seventh and ninth volume, via conduit device (18, 23) and create a positive or a negative pressure deviation between them;

valves may also be present in the conduit device (18, 23), to bypass the device for hydraulic fluid transportation (17) or to block it off.

47. Mobile semi active heave compensator (100) according to any one of claims 43 to 46, further comprising:

a motion reference unit (MRU) placed in a crane tip (not shown);

a device for distance measurement (31), adapted for measuring distance between the compensator (100) and the seabed (106);

a device for communication (30), adapted for providing MRU data to the compensator (100).

48. Mobile semi active heave compensator (100) according to one of claims 43 to 47, wherein the device for hydraulic fluid transportation (17) is at least one reversible hydraulic pump being driven by an electric motor.

49. Mobile semi active heave compensator (100) according to one of claims 43 to 48, further comprising an energy source (16) being at least one battery pack within the compensator (100).

50. Mobile semi active heave compensator (100) according to one of claims 43 to 49, wherein an energy source (16) on the vessel (102) is connected to the compensator (100) via an umbilical.

51. Mobile semi active heave compensator (100) according to one of claims 43-50, wherein at least one of the cylinders is constituted of a predetermined number of cylinders arranged in a parallel connection in order to increase the effective volume of at least one volume of the gas and/or hydraulic fluid volumes.

52. Mobile depth compensated active heave compensator (100) according to one of the claims 1 to 6, comprising:

a first cylinder (11) having an upper end and a lower end;

a first connection device (15) mounted at the upper end of the first cylinder (11) and adapted for connecting the first cylinder (11) to at least one of: a vessel (102) at sea surface or a payload (101);

a first piston (12) located within the first cylinder (11) and adapted for reciprocation with respect thereto;

a first piston rod (13) connected to the first piston (12) and extending downwardly therefrom through the lower end of the first cylinder (11);

a second connector device (14) adapted for securing the first piston rod (13) to at least one of: a vessel (102) at the sea surface or a payload (101), and located at the lower end of the first cylinder (11);

a first volume of hydraulic fluid (V1) located between the first piston (12) and the lower end of the first cylinder (11);

a second volume of hydraulic fluid (V2) located between the first piston (12) and the upper end of the first cylinder (11);

a second cylinder (21) containing a second piston (22);

a third volume (V3), containing hydraulic fluid, located between the lower end of the second cylinder (21) and the second piston (22);

a fourth volume (V4), containing gas, located between the upper end of the second cylinder (21) and the second piston (22), effectively pressurizing the third volume (V3) and the first volume (V1) via conduit device;

a sensor (105), adapted for directly or indirectly measuring movement of the mobile depth compensated active heave compensator (100);

a position sensor (16, 23), adapted for measuring the position of a piston (12, 22);

a device for fluid transportation (70) adapted for applying fluid pressure to the second volume (V2), where the device for fluid transportation (70) is controlled based on sensor (105, 16, 23) measurements;

a device for depth compensation, by increasing the pressure in the second volume (V2), where the pressure increase is proportional to the external pressure.

53. Mobile depth compensated active heave compensator (100) co according to one of the claims 1 to 6 or 52,comprising:

a first cylinder (11) having an upper end and a lower end;

a first connection device (15) mounted at the upper end of the first cylinder (11) and adapted for connecting the first cylinder (11) to at least one of: a vessel (102) at sea surface or a payload (101);

a first piston (12) located within the first cylinder (11) and adapted for reciprocation with respect thereto;

a first piston rod (13) connected to the first piston (12) and extending downwardly therefrom through the lower end of the first cylinder (11);

a second connector device (14) adapted for securing the first piston rod (13) to at least one of: a vessel (102) at the sea surface or a payload (101), and located at the lower end of the first cylinder (11);

a first volume of hydraulic fluid (V1) located between the first piston (12) and the lower end of the first cylinder (11);

a second volume of hydraulic fluid (V2) located between the first piston (12) and the upper end of the first cylinder (11);

a second cylinder (21) containing a second piston (22);

a third volume (V3), containing hydraulic fluid, located between the lower end of the second cylinder (21) and the second piston (22);

a fourth volume (V4), containing gas, located between the upper end of the second cylinder (21) and the second piston (22), effectively pressurizing the third volume (V3) and the first volume (V1) via conduit device;

a sensor (105), adapted for directly or indirectly measuring movement of the mobile depth compensated active heave compensator (100);

a position sensor (16, 23), adapted for measuring the position of a piston (12, 22);

a device for fluid transportation (70) adapted for applying fluid pressure to the second volume (V2), where the device for fluid transportation (70) is controlled based on sensor (105, 16, 23) measurements;

a device for depth compensation, by increasing the pressure in the second volume (V2), where the pressure increase is proportional to the external pressure.

54. Mobile depth compensated active heave compensator (100) according to claim 52 or 53, further comprising:

a depth compensator (40) is the specific device for depth compensation, consisting of a fifth cylinder (41), a third piston rod (42) exposed to external pressure and a fourth piston (43), forming an eighth volume (V8) between one end of the fifth cylinder (41) and the fourth piston (43), filled with oil, a ninth volume (V9) between the other end of the fifth cylinder (41) and the fourth piston (43), filled with oil;

a pressure intensifier (30), consisting of a third cylinder (31), a fourth cylinder (32), a second piston rod (33) and a third piston (34), forming a fifth volume (V5) between one end of the third cylinder (31) and the third piston (34), filled with oil, a sixth volume (V6) between the other end of the third cylinder (31) and the third piston (34), filled with gas and a seventh volume (V7), between the ends of the fourth cylinder (32), filled with oil;

a conduit device between the second volume (V2) and the ninth volume (V9), allowing fluid communication between the respective volumes;

a conduit device between the eighth volume (V8) and the fifth volume (V5), allowing fluid communication between the respective volumes;

wherein the device for fluid transportation (70) is connected between the first volume (V1) and the seventh volume (V7) in such a way that the pressure in the seventh volume (V7) exerted on the second piston rod (33) is converted to a lower pressure in the fifth volume (V5) via the third piston (34);

a position sensor (16, 23, 35, 44), adapted for measuring the position of a piston (12, 22, 34, 35).

55. Mobile depth compensated active heave compensator (100) according to claim 52, further comprising:

a depth compensator (40) is the specific device for depth compensation, consisting of a fifth cylinder (41), a third piston rod (42) exposed to external pressure and a fourth piston (43), forming an eighth volume (V8) between one end of the fifth cylinder

(41) and the fourth piston (43), filled with gas, a ninth volume (V9) between the other end of the fifth cylinder (41) and the fourth piston (43), filled with oil;

a pressure intensifier (30), consisting of a third cylinder (31), a fourth cylinder (32), a second piston rod (33) and a third piston (34), forming a fifth volume (V5) between one end of the third cylinder (31) and the third piston (34), filled with oil, a sixth volume (V6) between the other end of the third cylinder (31) and the third piston (34), filled with oil and a seventh volume (V7), between the ends of the fourth cylinder (32), filled with oil;

a conduit device between the second volume (V2) and the fifth volume (V5), allowing fluid communication between the respective volumes;

a conduit device between the ninth volume (V9) and the sixth volume (V6), allowing fluid communication between the respective volumes;

wherein the device for fluid transportation (70) is connected between the first volume (V1) and the seventh volume (V7) in such a way that the pressure in the seventh volume (V7) exerted on the second piston rod (33) is converted to a lower pressure in the fifth volume (V5) via the third piston (34);

a position sensor (16, 23, 35, 44), adapted for measuring the position of a piston (12, 22, 34, 35).

56. Mobile depth compensated active heave compensator (100) according to claim 52, further comprising:

a depth compensator (40) is the specific device for depth compensation, consisting of a fifth cylinder (41), a third piston rod (42) exposed to external pressure and a fourth piston (43), forming an eighth volume (V8) between one end of the fifth cylinder (41) and the fourth piston (43), filled with gas, a ninth volume (V9) between the other end of the fifth cylinder (41) and the fourth piston (43), filled with oil;

a pressure intensifier (30), consisting of a third cylinder (31), a fourth cylinder (32), a second piston rod (33) and a third piston (34), forming a fifth volume (V5) between one end of the third cylinder (31) and the third piston (34), filled with oil, a sixth volume (V6) between the other end of the third cylinder (31) and the third piston (34), filled with oil and a seventh volume (V7), between the ends of the fourth cylinder (32), filled with oil;

a second gas accumulator (60), consisting of a seventh cylinder (61) and a fifth piston (62) forming a tenth volume (V10) between one end of the seventh cylinder (61) and the fifth piston (62), filled with oil, an eleventh volume (V11) between the other end of the seventh cylinder (61) and the fifth piston (62), filled with gas;

a conduit device between the second volume (V2) and the fifth volume (V5), allowing fluid communication between the respective volumes;

a conduit device between the ninth volume (V9) and the sixth volume (V6), allowing fluid communication between the respective volumes;

wherein the device for fluid transportation (70) is connected between the tenth volume (V10) and the seventh volume (V7) in such a way that the pressure in the seventh volume (V7) exerted on the second piston rod (33) is converted to a lower pressure in the fifth volume (V5) via the third piston (34);

a position sensor (16, 23, 35, 44, 63), adapted for measuring the position of a piston (12, 22, 34, 35, 63).

57. Mobile depth compensated active heave compensator (100) according to claim 52, further comprising:

a depth compensator (40) is the specific device for depth compensation, consisting of a fifth cylinder (41), a third piston rod (42) exposed to external pressure and a fourth piston (43), forming an eighth volume (V8) between one end of the fifth cylinder (41) and the fourth piston (43), filled with oil, a ninth volume (V9) between the other end of the fifth cylinder (41) and the fourth piston (43), filled with oil;

a pressure intensifier (30), consisting of a third cylinder (31), a fourth cylinder (32), a second piston rod (33) and a third piston (34), forming a fifth volume (V5) between one end of the third cylinder (31) and the third piston (34), filled with oil, a sixth volume (V6) between the other end of the third cylinder (31) and the third piston (34), filled with gas and a seventh volume (V7), between the ends of the fourth cylinder (32), filled with oil;

a second gas accumulator (60), consisting of a seventh cylinder (61) and a fifth piston (62) forming a tenth volume (V10) between one end of the seventh cylinder (61) and the fifth piston (62), filled with oil, an eleventh volume (V11) between the other end of the seventh cylinder (61) and the fifth piston (62), filled with gas;

a conduit device between the second volume (V2) and the ninth volume (V9), allowing fluid communication between the respective volumes;

a conduit device between the eighth volume (V8) and the fifth volume (V5), allowing fluid communication between the respective volumes;

wherein the device for fluid transportation (70) is connected between the tenth volume (V10) and the seventh volume (V7) in such a way that the pressure in the seventh volume (V7) exerted on the second piston rod (33) is converted to a lower pressure in the fifth volume (V5) via the third piston (34);

a position sensor (16, 23, 35, 44, 63), adapted for measuring the position of a piston (12, 22, 34, 35, 63).

58. Mobile depth compensated active heave compensator (100) according to claim 52, further comprising:

a ring based depth compensator (50) is the specific device for depth compensation, consisting of a sixth cylinder (51), a ring piston (52), a ring piston rod (53) exposed to external pressure, forming a twelfth volume (V12) between one end of the sixth cylinder (51) and the ring piston (52), filled with oil, a thirteenth volume (V13) between the other end of the sixth cylinder (51) and the ring piston (52), the inner diameter of the ring piston rod (53) and the outer diameter of the first cylinder (11), filled with oil or gas, a fourteenth volume (V14) between the other end of the sixth cylinder (51) and the ring piston (52), the outer diameter of the ring piston rod (53) and the inner diameter of the sixth cylinder (51), filled with oil or gas;

a conduit device between the second volume (V2) and the twelfth volume (V12), allowing fluid communication between the respective volumes;

wherein the device for fluid transportation (70) is connected between the thirteenth volume (V13) or the fourteenth volume (V14) and the first volume (V1) in such a way that the pressure in thirteenth volume (V13) or the fourteenth volume (V14) exerted on the ring piston (52) is converted to a lower pressure in the twelfth volume (V12) via the ring piston (52);

a position sensor (16, 23), adapted for measuring the position of a piston (12, 22).

59. Mobile depth compensated active heave compensator (100) according to claim 52, further comprising:

a ring based depth compensator (50) is the specific device for depth compensation, consisting of a sixth cylinder (51), a ring piston (52), a ring piston rod (53) exposed to external pressure, forming a twelfth volume (V12) between one end of the sixth cylinder (51) and the ring piston (52), filled with oil, a thirteenth volume (V13) between the other end of the sixth cylinder (51) and the ring piston (52), the inner diameter of the ring piston rod (53) and the outer diameter of the first cylinder (11), filled with oil or gas, a fourteenth volume (V14) between the other end of the sixth cylinder (51) and the ring piston (52), the outer diameter of the ring piston rod (53) and the inner diameter of the sixth cylinder (51), filled with oil or gas;

a pressure intensifier (30), consisting of a third cylinder (31), a fourth cylinder (32), a second piston rod (33) and a third piston (34), forming a fifth volume (V5) between one end of the third cylinder (31) and the third piston (34), filled with oil, a sixth volume (V6) between the other end of the third cylinder (31) and the third piston (34), filled with gas and a seventh volume (V7), between the ends of the fourth cylinder (32), filled with oil;

a conduit device between the second volume (V2) and the twelfth volume (V12), allowing fluid communication between the respective volumes;

a conduit device between the thirteenth volume (V13) or the fourteenth volume (V14) and the fifth volume (V5), allowing fluid communication between the respective volumes;

wherein the device for fluid transportation (70) is connected between the first volume (V1) and the seventh volume (V7) in such a way that the pressure in the seventh volume (V7) exerted on the second piston rod (33) is converted to a lower pressure in the fifth volume (V5) via the third piston (34);

a position sensor (16, 23), adapted for measuring the position of a piston (12, 22).

60. Mobile active heave compensator (100) according to one of the claims 1 to 6, comprising:

a hydraulic actuator (10) according to one of the claims 1 to 6, comprising of a first cylinder (1) having an upper end and a lower end, a first piston rod (13) connected to a first piston (12) and extending downwardly therefrom through the lower end of the first cylinder (11), adapted for reciprocation with respect thereto, connection device (14) mounted at the upper and lower end of the hydraulic actuator (10) adapted for connecting the active heave compensator (100) to a floating object, like a vessel (102) mounted crane, and a payload (101);

a first volume (V1), filled with hydraulic fluid, located between the first piston (12) and the lower end of the first cylinder (11);

a second volume (V2), filled with gas at any pressure including zero, located between the first piston (12) and the upper end of the first cylinder (11);

a double acting gas accumulator (30), comprising of a fourth cylinder (31), a ring shaped piston (32) mounted concentrically within the fourth cylinder (31) and adapted for reciprocation with respect thereto, where the lower end of the ring shaped piston (32) is on the same side as the lower end of the fourth cylinder (31) when ring shaped piston (32) is at zero stroke, a third inner cylinder (33) mounted concentrically within the fourth cylinder (31) and fixed to the upper end of the fourth cylinder (31) with a leak tight connection, a fourth inner cylinder (35) mounted concentrically inside the fourth cylinder (31) and connected to the upper end of the ring shaped piston (32) with a leak tight connection, a cylinder end (34) mounted concentrically with the fourth cylinder (31) at the upper end of the fourth inner cylinder (35) with a leak tight connection, a fifth inner cylinder (36) mounted concentrically with the fourth cylinder (31) at the lower end of the fourth cylinder (31) in a leak tight manner, where the assembly consisting of the ring shaped piston (32), the fourth inner cylinder (35) and the cylinder end (34) is adapted to

reciprocate inside the fourth cylinder (31), inside the third inner cylinder (33) and outside the fifth inner cylinder (36) in a leak tight manner;

a sixth volume (V6), filled with hydraulic fluid, located between the cylinder end (34), the inside of the fourth inner cylinder (35), the fifth inner cylinder (36) and the lower end of the first cylinder (31);

a seventh volume (V7), filled with hydraulic fluid, located between cylinder end (34), the outside of the fourth inner cylinder (35), the inside of the third inner cylinder (33) and the upper end of the first cylinder (31);

an eighth volume (V8), filled with hydraulic fluid, located between the ring shaped piston (32), the outside of the fifth inner cylinder (36) and the lower end of the first cylinder (31);

a ninth volume (V9), filled with gas at any pressure, located between the inside the fourth cylinder (31), the upper end of the fourth cylinder (31), the outside of the third inner cylinder (33), the outside of the fourth inner cylinder (35) and the upper end of the ring shaped piston (32);

a second gas accumulator (60), consisting of a seventh cylinder (61) and a fifth piston (62), adapted for reciprocation with respect thereto;

a seventeenth volume (V14), filled with hydraulic fluid, located between the upper end of the seventh cylinder (61) and the upper end of the fifth piston (62);

an eighteenth volume (V15), filled with gas at any pressure, located between the lower end of the seventh cylinder (61) and the lower end of the fifth piston (62);

a conduit device between the first volume (V1) and the eighth volume (V8);

conduit device between the sixth volume (V6) and the seventh volume (V7) adapted with a first hydraulic pump (P1) adapted to transport oil under pressure between the respective volumes;

a conduit device between the seventeenth volume (V14) and the seventh volume (V7) adapted with a third device control valve (CV3);

a conduit device between the seventeenth volume (V14) and the sixth volume (V6) adapted with a second control valve (CV2);

a sensing device adapted for measuring the position of the first piston (12);

a sensing device adapted for measuring the motion of the active heave compensator (100);

one or more sensing device adapted for measuring the pressure in one or more volume;

a computer adapted for controlling the first hydraulic pump (P1) and the control valves based on input from the sensing device.

6119. The Mmobile active heave compensator (100) according to claim 6018, further comprising:

a set ofone or more tanks (T1, T2, …,TN), adapted for gas storage, where the number of tanks is minimum one;

a set of one or more fifth conduit devices between each of the one or more tanks (T1, T2, …,TN) and the ninth volume (V9), with a set ofwherein each of the one or more fifth conduit devices includes a fourth control valve devices (CVA1, CVA2, …,CVAN) in each conduit device being, wherein each of the one or more fifth conduit devices is adapted for connecting each of the one or more tanks (T1, T2, …,TN) individually to the ninth volume (V9).device

6220. The mobile Aactive heave compensator (100) according to claim 60 or 6119, further comprising:

a gas booster (40), consisting of a fifth cylinder (41) and third piston (42), adapted for reciprocation with respect thereto;

a first third gas accumulator (50), consisting of a sixth cylinder (51) and fourth piston (52), adapted for reciprocation with respect thereto;

a tenth volume (V10), filled with gas under any pressure, located between the upper end of the fifth cylinder (41) and the upper end of the third piston (42);

an eleventh volume (V11), filled with hydraulic fluid, located between the lower end of the fifth cylinder (41) and the lower end of the third piston (42);

a twelfth volume (V12), filled with hydraulic fluid, located between the lower end of the sixth cylinder (51) and the lower end of the fourth piston (52);

a thirteenth volume (V13), filled with hydraulic fluid, located between the upper end of the sixth cylinder (51) and the upper end of the fourth piston (52);

a sixth conduit device between the eleventh volume (V11) and the twelfth volume (V12) adapted with a second hydraulic pump (P2) adapted for transporting hydraulic fluid under pressure between the respective eleventh and twelfth volumes.

63. Mobile active heave compensator (100) according to at least one of claim 60-62, further comprising:

a set of conduit device between each tank (T1, T2, …,TN), the ninth volume (V9) and the surroundings, with a set of control valve devices (CV4, CV5, CV6, CVB1, CVB2, …,CVBN) in each conduit device adapted for individually adjusting the pressure in all gas volumes, except the second volume (V2), the thirteenth volume (V13) and the fifteenth volume (V15).

64. Mobile active heave compensator (100) according to at least one of claim 60-63, further comprising:

a set of conduit devices between each tank (T1, T2, …,TN) and the second volume (V2), with a set of control valve devices (CVC1, CVC2, …,CVCN) in each conduit device adapted for individually connecting any tank to the second volume (V2);

a set of conduit devices between each tank (T1, T2, …,TN), the ninth volume (V9) and the surroundings, with a set of control valve devices (CV4, CV5, CV6, CV7, CVB1, CVB2, …,CVBN) in each conduit device adapted for individually adjusting the pressure in all gas volumes, except the thirteenth volume (V13) and the fifteenth volume (V15).

65<u>21</u>. <u>The</u> Mmobile active heave compensator (100) according to at least one of claim 60-64<u>20</u>, further comprising:

a <u>fifth</u> control valve device (CV1) in the <u>first</u> conduit device between the first volume (V1) and the eighth volume (V8), <u>the fifth control valve device</u> adapted for manipulating the flow area from zero to free flow.

<u>22. The mobile active heave compensator according to claim 21, further comprising:
the one or more fifth conduit devices between each of the one or more tanks and the ninth volume further disposed between each of the one or more tanks and the surroundings, the fourth control valve device disposed in each of the one or more fifth conduit devices and adapted for individually adjusting the pressure in the numbered volumes excluding the second volume, the thirteenth volume and the fifteenth volume.</u>

<u>23. The mobile active heave compensator according to claim 22, further comprising:
one or more sixth conduit devices between each of the one or more tanks and the second volume, one or more fifth control valve devices disposed in each of the one or more sixth conduit devices and adapted for individually connecting any of the one or more tanks to the second volume;
the one or more fifth conduit devices between each of the one or more tanks, the ninth volume and the surroundings, the fourth control valve device disposed in each of the one or more fifth conduit devices and adapted for individually adjusting the pressure in the numbered volumes, excluding the thirteenth volume and the fifteenth volume.</u>

66<u>24</u>. <u>The</u> Mmobile active heave compensator (100) according to at least one of claim 60-65<u>23</u>, wherein

a first inner cylinder (15) is mounted concentrically inside the first cylinder (11) and connected with a leak tight connection to the upper end of the first cylinder;

the first piston rod ~~(13)~~ is hollow and has a sealing surface ~~towards~~ facing the first inner cylinder ~~(15)~~;

a third volume ~~(V3)~~ is formed, filled with hydraulic fluid, located inside the first piston rod ~~(13)~~, the first inner cylinder ~~(15)~~ and the upper end of the first cylinder;

~~further~~ wherein the mobile active heave compensator ~~(100)~~ further comprises:

a depth compensator ~~(20)~~ consisting of a second cylinder ~~(21)~~, a second inner cylinder ~~(26)~~ mounted concentrically with the second cylinder ~~(21)~~, connected to the upper end of the second cylinder ~~(21)~~ in a leak tight fashion, a second piston ~~(22)~~ located inside the second inner cylinder ~~(26)~~, a second piston rod ~~(23)~~ connected to the second piston ~~(22)~~ and adapted for reciprocation within the second inner cylinder ~~(26)~~, a third cylinder ~~(24)~~ mounted concentrically within the second cylinder ~~(21)~~ and connected to the second piston rod ~~(23)~~ via a cylinder-rod connector ~~(25)~~;

a~~n~~ fourth volume ~~(V4)~~, filled with hydraulic fluid, located between the upper end of the second piston ~~(22)~~, the inside of the second inner cylinder ~~(26)~~ and the upper end of the second cylinder ~~(21)~~; and

a fifth volume ~~(V5)~~, filled with gas under any pressure, located between the inside of the first cylinder ~~(21)~~, the inside of the third cylinder ~~(24)~~, the inside of the second inner cylinder ~~(26)~~, the lower side of the second piston ~~(22)~~ and the rod-cylinder connector ~~(25)~~;

wherein the rod-cylinder connector ~~(25) as well as~~and the third cylinder ~~(24) is~~are exposed to external pressure which will generate a higher pressure in the fourth volume ~~(V4)~~.

~~67~~25. The ~~M~~mobile active heave compensator ~~(100)~~ according to ~~at least one of~~ claim ~~60-66~~18, further comprising:

a communication device adapted to transfer signals between the vessel ~~(102)~~ and the mobile active heave compensator ~~(100)~~, ~~preferably with~~ wherein the communication device utilizes acoustic communication.

~~68~~26. The ~~M~~mobile active heave compensator ~~(100)~~ according to ~~at least one of~~ claim ~~60-67~~18, further comprising:

at least one wireless MRU ~~(104, 105)~~ adapted for transferring motion data to the active heave compensator ~~(100)~~.

~~69~~27. The ~~M~~mobile active heave compensator ~~(100)~~ according to ~~at least one of~~ claim ~~60-68~~18, wherein the mobile active heave compensator ~~(100)~~ is powered ~~either~~ by a battery pack or by power delivered through an umbilical.

~~70. Mobile active heave compensator (100) according to any one of claims 60-69, wherein at least one of the components is constituted of a predetermined number of components arranged in a parallel or series connection in order to increase the effective capacity of that component of any type.~~