

MOBILE GUN CARRIAGE AND GUN SYSTEM

Field Of The Invention

5 The present invention relates to the field of mobile gun carriages and gun systems, in particular for and to artillery pieces, such as howitzers.

Background

10 A conventional towed gun system, for instance a howitzer, has a carriage on which the gun itself (barrel and loading and firing mechanisms, etc.) is mounted. The carriage has a main body or chassis, with one or more pairs of driving wheels. A pair of elongate stabilising arms, so-called carriage trails, pivotally extend from the rear of the chassis and are able to splay apart to stabilise the howitzer during firing. A smaller
15 retractable support wheel is pivotally mounted on each of the carriage trails.

Such a gun system is usually towed (in a towing mode) to the vicinity of where it is to be fired and then propels itself (in a self-propelled mode) to its specific firing position and from one firing position to another nearby firing position. During towing
20 the carriage trails are together and are raised off the ground by the towing truck or tractor (or whatever is towing the howitzer) and the howitzer is towed by the carriage trails, with the retractable support wheels raised. During firing (in a firing mode), the carriage trails are splayed out on the ground, again with the retractable support wheels raised. In the self-propelled mode the retractable support wheels are extended. The carriage trails
25 are together and supported off the ground by the retractable support wheels. The gun system propels itself by the driving wheels and is steered by differential driving, with the support wheels pivoting in whatever direction is necessary.

The driving wheels are powered by an engine through gear train transmissions in
30 the self-propelled mode. A main driving pump coupled to the engine supplies hydraulic oil to drive a motor that is attached to a transmission gear housing in the wheel axle. Upon activating a hydraulic power clutch, the power of the drive motor is transmitted to the driving wheels to move the howitzer. Auxiliary hydraulic pumps are coupled to the

engine to power hydraulic cylinders to help ease deployment of the howitzer from a firing/towed position.

5 In the towing mode, the supporting wheels are retracted and raised above the ground, usually by means of hydraulic cylinders. The clutches are disengaged and the engine is shut down. This allows the driving wheels to be pulled along and rotate at different speeds to allow steering as the howitzer is being towed. In the towing mode configuration, the howitzer is being pulled along in a reverse direction close to the back of the tow tractor.

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In the firing mode, the engine is also shut down for gun laying. The supporting wheels are retracted and raised above the ground. The carriage trails are opened out and anchored to the ground to stabilise the gun during firing. A base plate, located below the gun is extended downwards to contact with the ground and to lift the driving wheels off the ground for the firing mode. In the firing mode configuration, the base plate and the ends of the carriage trails form a three-point triangular support for the howitzer.

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The gun is mounted on a main bearing above the base plate to allow the gun and its ordnance system to rotate relative to the base plate and the rest of the carriage, to allow the gun to be brought to bear to the desired position for firing. A person operating the gun rotates a hand wheel or a DC motor turns an equivalent gear wheel to traverse the gun barrel to the desired position. The movement of the hand or gear wheel turns a gear system which is housed above the main bearing.

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25 There are several drawbacks and limitations faced by a typical howitzer, with some or all also faced by other mobile gun systems.

A substantial amount of time is taken to deploy the howitzer. This is mainly due to the complex and time consuming operational procedures required for transforming the howitzer from one mode to another. Further, the clutching and de-clutching of the driving wheels when converting from the self-propelled mode to/from the towing or firing mode involves complex functions.

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In order to withstand the high firing load, there is a threshold as to the minimum size that the gear teeth in the traversing mechanism can have. This in turn limits the degree of fine adjustment that can be achieved. Further, the backlash in the inherent design of the gear system for rotating the gun limits the accuracy to which the gun barrel can be positioned to be in the line of target.

Since the howitzer is lifted off the ground during the firing mode, the centre of gravity of the howitzer is raised. This affects the stability of the gun system during firing.

The gun laying and drive systems are totally independent systems (i.e. the two systems operate independently of each other). The drive system is powered by a diesel engine while the gun laying system is operated manually, or using a large size DC motor powered by a separate battery. It is very difficult to integrate them together due to space constraints.

It would therefore be useful to alleviate one or more of the above-mentioned problems at least partially.

Summary

One aspect of the present invention provides a mobile gun carriage for mounting a gun, the carriage comprising: a chassis; and two first wheel assemblies mounted on the chassis at opposing sides of the chassis, wherein both of the first wheel assemblies comprises: a support member; and a first wheel rotatably mounted on the support member; wherein the support member is mounted on the chassis, with the first wheel spaced from the chassis; and the support member is mounted to pivot relative to the chassis in a first plane and in a second plane generally orthogonal to the first plane, to move the first wheel in the first and second planes and wherein the first wheel assemblies are operable to be positioned in at least two predetermined positions in the first plane, a first position for driving the gun carriage on the first wheels in a driving mode and a second position in which the chassis is operable to traverse on the first wheels, in a firing mode, for aiming a gun mounted on the gun carriage.

An alternate aspect of the present invention provides a method of transforming a mobile gun system from a driving mode to a firing mode, the gun system comprising a mobile gun carriage with a gun mounted thereon, the gun carriage comprising a chassis and two first wheel assemblies mounted on the chassis at opposing sides of the chassis, wherein
5 both of the first wheel assemblies comprises a support member; and a first wheel rotatably mounted on the support member; wherein the support member is mounted on the chassis, with the first wheel spaced from the chassis; and the support member is mounted to pivot relative to the chassis in a first plane and in a second plane generally orthogonal to the first plane, to move the first wheel in the first and second planes and
10 wherein the first wheel assemblies are operable to be positioned in at least two predetermined positions in the first plane, a first position for driving the gun carriage on the first wheels in the driving mode and a second position in which the chassis is operable to traverse on the first wheels, in the firing mode, for aiming a gun mounted on the gun carriage, the method comprising: raising the first wheels off the ground;
15 swinging the first wheel assemblies relative to the chassis to positions where the first wheels are angled relative to each other and relative to their direction in the driving mode; and lowering the first wheels to the ground.

A further aspect of the present invention provides a method of traversing a
20 mobile gun system in a firing mode, the gun system comprising a mobile gun carriage with a gun mounted thereon, the gun carriage comprising a chassis and two first wheel assemblies mounted on the chassis at opposing sides of the chassis, wherein both of the first wheel assemblies comprises a support member; and a first wheel rotatably mounted on the support member; wherein the support member is mounted on the chassis, with the
25 first wheel spaced from the chassis; and the support member is mounted to pivot relative to the chassis in a first plane and in a second plane generally orthogonal to the first plane, to move the first wheel in the first and second planes and wherein the first wheel assemblies are operable to be positioned in at least two predetermined positions in the first plane, a first position for driving the gun carriage on the first wheels in a driving
30 mode and a second position in which the chassis is operable to traverse on the first wheels, in the firing mode, for aiming a gun mounted on the gun carriage, the method comprising: traversing the gun and the gun carriage on said first wheels by driving said first wheels along the ground in the same rotational direction.

Embodiments of the invention are able to provide, for example, a mobile gun carriage for instance for a howitzer, having two drive wheel assemblies mounted at the front end of a chassis. Each drive wheel assembly has a drive wheel mounted rotatably on a support member. Each drive wheel assembly is mounted onto a wheel mounting frame at the front end of the chassis, by means of a wheel assembly mount. The wheel assembly mount allows the support member to pivot in a plane that is generally parallel to the plane of the chassis. A suspension cylinder extends between the wheel assembly mount and an end of the support member. The suspension cylinder extends and/or retracts to move the support member in a plane that is generally orthogonal to the plane of the chassis. This allows the carriage to be transformed from one operating mode to another by adjusting the position of the wheel assembly. The support member can be locked at various predetermined positions with respect to the wheel mounting frame corresponding to towing, self-propelled and firing modes. In the firing mode, the axis of each drive wheel extend generally in the radial direction relative to the centre of the rotation of the chassis about a base plate. A DC motor provides power to the drive wheels to provide fine adjustment in aiming the gun on the carriage in the firing mode.

Brief Description Of The Drawings

The invention will now be further described by way of non-limiting examples, with reference to the accompanying drawings, in which:-

Figure 1 is an isometric view of a mobile gun carriage according to an embodiment, with the wheels in a towing mode;

Figure 2 is a side view of the mobile gun carriage of Figure 1 in a complete towing mode, with a gun mounted;

Figure 3 is an isometric view of a main wheel assembly used on the mobile gun carriage of Figure 1;

Figure 4 is an isometric view of the main wheel assembly of Figure 3 in the towing mode;

Figure 5 is an isometric view of the mobile gun carriage of Figure 1 in a self-propelled mode;

5 Figure 6 is an isometric view of the main wheel assembly of Figure 3 in the self-propelled mode;

Figure 7 is an isometric view of the mobile gun carriage of Figure 1 in a firing mode;

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Figure 8 is an isometric view of the main wheel assembly of Figure 3 in the firing mode;

Figure 9 is a front end view of the mobile gun carriage of Figure 7 with the gun mounted;

Figure 10 is a flowchart showing the sequence of steps to transform the mobile gun carriage of Figure 1 from the self-propelled mode, as in Figure 5, to the firing mode, as in Figure 7; and

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Figure 11 is a schematic diagram of an integrated gun laying system of the mobile gun carriage of Figure 1.

Detailed Description

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A more complete appreciation of the invention and many of the attendant advantages thereof may be readily obtained by reference to the following detailed description of an embodiment, when considered with the accompanying drawings in which like reference characters indicate corresponding parts in the different views.

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The Figures show a mobile gun carriage 10 for a howitzer, and a howitzer. However, the invention is not limited thereto. The mobile gun carriage and the principles of the invention are readily usable for or with other artillery pieces.

Figure 1 is an isometric view of a mobile gun carriage 10 according to an embodiment of the invention, with the wheels in a towing mode.

5 A mobile gun carriage 10 has a main chassis 12, with a gun cradle 14 and a base plate 16 mounted on the main chassis 12. The main chassis 12 is a generally elongate frame, with two main arms 18 spaced apart and extending along its length, and braced together. The gun cradle 14 pivots at one end, at the rear of and on top of the main chassis 12. The gun cradle 14 pivots in the vertical plane to raise and lower the gun
10 barrel (not shown in Figure 1). The elevation of the gun cradle 14 is controlled by an hydraulic system (shown in Figures 2 and 9). The gun cradle 14 is shown in Figure 1 in a partially raised position, although normally in the towing mode it would be in the lowered position, as in Figure 2, lying between the two main arms 18 of the main chassis 12. The gun cradle 14 is mounted between two hydraulic cylinders 54, for elevate and
15 depressing a gun mounted thereon.

A pair of main wheel assemblies 20 is mounted at the front end of the main chassis 12, one main wheel assembly 20 on each side of the main chassis 12. The main wheel assemblies 20 are mounted on wheel mounting frames 22 which form part of the
20 main chassis 12 and extend a short distance sideways, out from the rest of the main chassis 12. The main wheel assemblies 20 each has a main wheel 24. The main wheel assemblies 20 are able to pivot on the wheel mounting frames 22 in two orthogonal planes, to change the height of the main chassis 12 relative to the main wheels 24 and the angles of the axes of the main wheels 24 relative to the main chassis 12. In the towing
25 mode, as shown in Figure 1, the main wheel assemblies 20 are shown with the axes of the main wheels 24 parallel, and indeed co-axial, and the main wheels 24 held rearward of the wheel mounting frames 22.

The base plate 16 is mounted at the rear end of and underneath the main chassis
30 12. The base plate 16 extends outwards from the rear end of the main chassis 12 and can rotate relative to and in the plane of the main chassis 12. The base plate 16 serves as a support for the chassis 12 during the firing mode. A pair of support wheel assemblies 30 is mounted on the sides of the base plate 16 towards the rear end of the base plate 16, one

support wheel assembly 30 on each side of the base plate 16. The support wheel assemblies 30 each has a support wheel 32. The support wheel assemblies 30 are pivotable, to be flipped between a raised position, as shown in Figure 1, and a lowered position (as shown in Figure 5). Further, a pair of spades 56 extend beyond the back of the base plate 16, for digging into the ground during firing, to reduce movement due to recoil. The spades 56 are pivotable between raised and lowered positions. The spades 56 are shown in Figure 1 in the lowered position, but are generally folded up to the raised position when the gun is not firing or being readied for firing. The spades are generally manually manoeuvrable between the raised and lowered positions.

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A driving position 40 is provided on one of the two main arms 18, at the front of the mobile gun carriage 10. The driving position 40 includes a seat and steering wheel and other controls for operating the mobile gun carriage 10. An engine and hydraulics controls 42 are provided on the other of the two main arms 18, at the front of the mobile gun carriage 10.

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Figure 2 is a side view of the mobile gun carriage of Figure 1, with a gun 48 mounted on the gun cradle 14. The mobile gun is in the towing mode, being towed from the front end, with the main chassis 12 and the gun barrel 50 generally horizontal. The gun barrel 50 has a towing eye 52 at its front end for the towing operation. The base plate 16 also has a main recoil plate 58, which digs into the ground, for transferring the recoil from the gun 48 to the ground.

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Figure 3 is an isometric view of a main wheel assembly 20 used on the mobile gun carriage of Figure 1, looking at the main wheel assembly 20 from the main chassis 12. Figure 4 is an isometric view of the wheel assembly of Figure 3 in the towing mode, as in Figure 1.

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The wheel assembly 20 has the main wheel 24 rotatably mounted on a wheel hub 60, which itself is mounted on a first end of an elongate support member 62. A wheel assembly mount 64 mounts the wheel assembly 20 to the main chassis 12 through the wheel mounting frame 22. The wheel assembly mount 64 is generally an L-shaped bracket, which is fairly short but quite thick and wide. The wheel assembly mount 64

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has a first and longer end 66 adapted to be pivotally mounted to the wheel mounting frame 22, and a second and shorter end 68 adapted to pivotally mount an actuator means, such as a suspension cylinder 70, and the support member 62.

5 The first end 66 of the wheel assembly mount 64 has a generally vertical bore 72 extending therethrough from a top edge to a lower edge. The bore 72 allows the wheel assembly mount 64 to be mounted to the wheel mounting frame 22 to pivot in a first plane, generally parallel with the main plane of the main chassis, and which is a generally horizontal plane. Figure 3 shows part of the first end 66 of the wheel assembly
10 mount 64 removed to show a swivel kingpin 74 extending through the bore 72.

 The second end of the wheel assembly mount 64 is a generally vertical support flange 68, with two generally horizontal bores 76, 78 therethrough. The support flange 68 is wider than the first end 66 of the wheel assembly mount 64. The first bore 76 has a
15 bearing 80 within it which mounts the second end of the support member 62. The second bore 78, has an actuator attachment pin 82 therethrough which mounts one end of the suspension cylinder 70. The second bore 78 is above the first bore 76, although not directly above, in this embodiment. The support flange 68 allows the support member 62 and the suspension cylinder 70 to pivot in a second plane, generally orthogonal to the
20 main plane of the main chassis, and which is a generally vertical plane.

 A hub motor (not shown) is housed within the wheel hub 60. The hub motor drives the wheel 24 when the mobile gun carriage is in the self-propelled and firing
25 modes.

 The actuator means in this exemplary embodiment is in the form of a suspension cylinder 70. The suspension cylinder 70 extends between the wheel assembly mount 64 and the support member 62. A first end of the suspension cylinder 70 is pivotally mounted to an extension arm 84. The extension arm 84 extends at an angle to the main
30 axis of the support member 62, extending from the first end of the support member 62, from the other side of the axis of the main wheel 24 from the second end of the support member 62. The second end of the suspension cylinder 70 is pivotally mounted to the support flange 68. The suspension cylinder 70 is operable to extend and retract, and at

the same time to pivot about the actuator attachment pin 82 of the wheel assembly mount 64 in the same first plane as the support member 62. Thus, when the suspension cylinder 70 extends, the support member 62 pivots about the support flange 68 and is pushed downwards. Consequently, the wheel 24 that is attached to the first end of the support member 70 also moves downwards relative to the wheel assembly mount 64, in a plane parallel to the second plane, due to the movement of the support member 62.

Conversely, when the suspension cylinder retracts, the support member 62 and the wheel 24 are simultaneously pulled upwards in a plane parallel to the second plane.

10 A flat locator plate 86 with a first locating hole 88 protrudes from the support flange 68, from a little below the actuator attachment pin 82. The locator plate 86 overlaps the top edge of the first end 66 of the wheel assembly mount 64 with a space left between the locator plate 86 and the top edge of the first end 66 of the wheel assembly mount 64. A corresponding second locating hole 90 on the top edge of the first end 66 of the wheel assembly mount 64 is positioned directly under the first locating hole 88 on the locator plate 86.

In this embodiment, the wheel mounting frame 22 has a first, upper frame plate 92 and a second, lower frame plate 94 extending sideways from the main chassis 12.

20 The first and second plates 92, 94 are positioned one above of the other, with a gap between them. The first end 66 of the wheel assembly mount 64 is placed in the gap between the upper and lower plates 92, 94 of the wheel mounting frame 22. The height of the gap is such as to allow the wheel assembly mount 64 to pivot freely about the wheel mounting frame 22. The swivel kingpin 74 is inserted through locating bores on the frame plates 92, 94 and the bore 72 on the wheel assembly mount 64 and secured in position with a nut at each end. This allows the wheel assembly mount 64 to pivot about the wheel mounting frame 22 in the first plane.

30 With the first end 66 of the wheel assembly mount 64 mounted between the first and second frame plates 92, 94, and the pivot pin 74 fixed in place, the locator plate 86 extends about the upper frame plate 92. Thus, the upper frame plate 92 fits in the space between the locator plate 86 and the top edge of the first end 66 of the wheel assembly

mount 64. The thickness of the upper frame plate 92 is such as to allow the wheel assembly mount 64 to pivot freely on the wheel mounting frame 22.

The upper frame plate 92 has first, second and third positioning holes 96, 98, 100 placed at predetermined positions around the swivel kingpin 74. The predetermined positions correspond to positions of the wheel assembly 20 for the towing, firing and self-propelled modes, respectively. To place the mobile gun carriage into a particular mode which it is not already in, for example into the towing mode (assuming it is not already in that mode), the wheel assembly mount 64 is rotated in the first plane until the first locating hole 88 on the locator plate 86 of the wheel assembly mount 64 is aligned with the first positioning hole 96 on the upper frame plate 92 of the wheel mounting frame 22. A self centring locking pin 102 is inserted through the first locating hole 88, the first positioning hole 96 and the second locating hole 90 to lock the wheel assembly mount 64 in the required position for the towing mode (Figure 4 – except that the locking pin 102 is not shown). In order to rotate the wheel assembly mount 64 to another predetermined position for another mode of operation, the locking pin 102 is removed. This allows the wheel assembly mount 64 to rotate to either the firing or self-propelled positions. Details of the transformation of the wheel assembly 20 from one mode to another is described in greater detail later.

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Figure 5 is an isometric view of the mobile gun carriage 10 of Figure 1 in a self-propelled mode. Figure 6 is an isometric view of the main wheel assembly of Figure 3 in the self-propelled mode.

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In Figure 5, the gun cradle 14 is lowered to between the two main arms 18 and the support wheel assemblies 30 are in the lowered positions to support the rear end of the mobile gun carriage 10 off the ground. The wheel assemblies 22 are rotated round such that the main wheels 24 are forwards of the front end of the mobile gun carriage 10, and are generally coaxial. For this, the first locating hole 88 on the locator plate 86 of the wheel assembly mount 64 is aligned with and locked into the third positioning hole 100 on the upper frame plate 92 of the wheel mounting frame 22. As the only points of contact between the mobile gun carriage 10 and the ground are the four wheels, in the

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self-propelled mode, the mobile gun carriage 10 can be driven and manoeuvred as desired.

It is also possible for the mobile gun carriage 10 to drive when the main wheel
5 assemblies 20 are in the towing position. However, in this position, the mobile gun carriage 10 is less stable. For instance with the added weight of a gun, if it is moving forward and suddenly hits an obstacle such as a rock, with stops the carriage 10, the whole gun and carriage could topple over. It is preferred to use a leading arm configuration for self-propelling and a trailing arm configuration for towing. This allows
10 towing at higher speeds. Speed is not so much of a concern in self-propelling.

Figure 7 is an isometric view of the mobile gun carriage 10 of Figure 1 in a firing mode. Figure 8 is an isometric view of the main wheel assembly of Figure 3 in the firing mode. Figure 9 is a front end view of the mobile gun carriage of Figure 7 with the gun
15 mounted.

In Figure 7, the gun cradle 14 is raised for the firing position, the main wheels 24 are raised relative to the main chassis 12 and the support wheel assemblies 30 are in the raised positions. With the support wheel assemblies 30 raised, the rear end of the base
20 plate 16 is on the ground. With the main wheels 24 raised relative to the main chassis 12, the rest of the base plate 16 of the mobile gun carriage is also on the ground. Thus when the gun is fired, the recoil passes directly through the base plate 16, more particularly through the recoil plate 58, into the ground. The wheel assemblies 22 are swung round such that they are angled backwards, and splayed outwards with main
25 wheels 24 rearwards of the front end of the mobile gun carriage 10 and not-coaxial. For this, the first locating hole 88 on the locator plate 86 of the wheel assembly mount 64 is aligned with and locked into the second positioning hole 98 on the upper frame plate 92 of the wheel mounting frame 22.

30 In Figure 9, the gun 48 is shown elevated to the firing position by the elevation hydraulic cylinders 44, with the spades 56 and the recoil plate 58 sunk into the ground.

In this embodiment, the main wheels 24 are angled out to about 57 degrees from the centre line of the main chassis 12, and to the centre line of the gun barrel when that is mounted. This angle varies according to the length of the mobile gun carriage 10 and the main wheel assemblies 20. It is generally between 45 and 90 degrees, most usually
 5 between 50 and 65 degrees. The ideal angle is one that puts the direction of the two main wheels 24 in a tangential direction for a circle, which is centred on the centre of rotation between the main chassis 12 and the base plate 16. Thus, ideally, the axes of the two main wheels 24 extend in a radial direction for this circle centred on the centre of rotation between the main chassis 12 and the base plate 16. With such an arrangement
 10 the main wheels 24 can rotate in an arc relative to the pivot point of the base plate, with minimum ground resistance. For a howitzer the main chassis 12 would typically turn through up to plus or minus 20 degrees relative to the base plate 16.

The gun 48 is mounted on the main chassis 12 and a change in the angle of the
 15 main body changes the angle of the gun by the same amount. The movement of the front main wheels 24 to the left or right causes the chassis 12 to rotate as it pivots about the base plate 16, both wheels rotating in generally the same direction, rather than counter-rotating. The movement of the main wheels 24 is thus the mechanism for traversing the gun. Because the wheels are further from the centre of the traverse than with the former
 20 gear driven traverse, the same distance of traverse for the wheels as for the gear mechanism translates into a smaller angle of traverse. Thus, finer adjustments are possible. Additionally, because the movement is achieved by way of hydraulics in-hub motors, the accuracy of movement of the wheels and especially of the minimum movement is good, thereby improving the possibility for fine adjustments of traverse yet
 25 further.

Moreover, because the front end of the mobile gun carriage 10 is closer to the ground and the rear end of the mobile gun carriage 10 is on the ground during firing, this results in a low centre of gravity, providing improved stability during firing.

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The wheel adjustment process of the wheel assemblies 20 to transform the mobile gun carriage 10 from one mode to another is now described with reference to Figures 4, 6, 8 and 10.

Figures 4 and 6 show the wheel assembly 20, with the wheel 24 in a towing and self-propelled mode respectively. Assuming the mobile gun carriage 10 is in the towing mode initially, the wheel assembly 20 is positioned such that the support member 62 and the suspension cylinder 70 extend generally parallel to and towards the rear end of the main chassis 12. In the towing mode configuration, the support wheels 32 are turned upwards away from the ground, such that, without outside forces, the rear end of the chassis 12 rests on the ground. When in the towing mode, the wheel assembly mount 64 is fixed at the towing position. This is achieved when the first locating hole 88 on the locator plate 86 of the wheel assembly mount 64 is aligned with the first positioning hole 96 on the upper plate 92, as shown in Figure 4, and is locked in place by the locking pin 102.

In order to transform the mobile gun carriage 10 from the towing mode to the self-propelled mode, the suspension cylinder 70 is retracted. This causes the wheel 24 to be pulled upwards relative to the chassis 12. The suspension cylinder 70 continues to retract until the wheel 24 is completely lifted off the ground and the front end of the main chassis rests on supports (not shown) on the ground. The locking pin 102 is then removed. This allows the wheel assembly mount 64 to pivot freely on the wheel mounting frame 22. The support member 62 and the wheel 24 are pushed round until the first locating hole 88 on the locator plate 86 of the wheel assembly mount 64 is aligned with the third (self-propelled) positioning hole 100. The locking pin 102 is inserted through the first locating hole 88 and the third positioning hole 100 as shown in Figure 6. This locks the wheel assembly 20 in the self-propelled position. The suspension cylinder 70 is then extended such that the wheel 24 is lowered onto the ground. The suspension cylinder 70 continues to extend lifting the front end of the main chassis 12 off the ground until the desired height for driving is obtained. The extension and retraction of the suspension cylinder 70 serves to adjust the height of the front end of the mobile gun carriage 10 as well as to lift the main wheel 24 above the ground. The rear support wheels 32 are rotated downwards until they touch the ground and lift the rear end of the base plate 16 and thereby the rear end of the main chassis 12 off the ground. The mobile gun carriage 10 is now in the self-propelled mode.

Figure 5 is an isometric view of the main chassis 12 in the self-propelled mode. The support member 62 and suspension cylinder 70 of each wheel assembly 20 extend generally parallel to and beyond the front end of the main chassis 12. In the self-propelled mode, the hub motors drive the main wheels 24, allowing the mobile gun carriage 10 to move on its own.

Figure 10 is a flowchart showing the sequence of steps to transform the mobile gun carriage 10 from the self-propelled mode to the firing mode. Initially at the start step, the mobile gun carriage 10 is in the self-propelled mode as shown in Figure 5. In a first step S202, the rear support wheels 32 are turned upwards away from the ground. As the rear wheels 32 are turned upwards, the rear end of the base plate 16 comes down onto the ground, in step S204. The pair of spades 56, each protruding from the rear end of the base plate 16 lodge themselves into the ground. The suspension cylinders 70 are retracted, in step S206, causing the front main wheels 24 to be pulled upwards relative to the main chassis 12. At step S208, the suspension cylinder 70 stops retracting when the front wheels 24 are completely lifted off the ground and the recoil plate 58, as well as the front end of the main chassis 12 rest on the ground.

At step S210, the locking pin 102 is removed. The wheel assembly mount 64 can now pivot freely on the wheel mounting frame 22. The support member 62 and the wheel 24 are pushed round to align the first locating hole 88 on the locator plate 86 with the second (firing) positioning hole 98 at step S212, as shown in Figure 8. The locking pin 102 is inserted into the first and second locating holes 88, 90 and the second positioning hole 98 to lock the wheel assembly 20 in place at step S214. The suspension cylinders 70 are then extended slightly, to lift the front end of the main chassis 12 off the ground, at step S216. At this point the mobile gun carriage 10 is now in the firing mode. The mobile gun carriage 10 can now be traversed to the required position and the gun itself raised to the required elevation, loaded and fired.

In the self-propelled mode and during transition to the firing mode, the power to the wheels and actuators is derived from the gun system engine. During gun laying the engine is still used to elevate the gun and may also be used for the initial traverse.

However, after elevating the gun and the initial traverse the engine is switched off and a DC motor is used to power the main wheels for fine adjustment.

Figure 11 is a schematic diagram of an integrated gun laying and driving system.

5 During gun laying in the firing mode, the rotation of the front main wheels 24 is controlled by shifting a variable speed joystick 104 to the left or right. The joystick 104 is electrically connected to a first, fine hydraulic pump 106 within the engine and the hydraulics controls 42, which is powered by the DC motor. Oil flowing from the first hydraulic pump 106 to first and second main wheel hub motors 108, 110 provides fine

10 adjustment rotation of the main wheels 24 during gun laying. The oil flow is distributed by an hydraulic manifold 112. During self-propelling, a second, coarse pump 114 is powered by the mobile gun carriage engine, within the engine and the hydraulics controls 42, under the control of the driver functions 116. Again the hydraulic oil is provided to the hub motors 108, 110 via the hydraulic manifold 112.

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The hydraulic manifold 112 has valves that interlock the function between self-propelling and gun laying and the provision of oil from the two pumps 106, 114. The wheel motors 108, 110, pumps 106, 114 and the hydraulic manifold 112 are connected to provide a hydrostatic drive function. Upon engaging a directional switch for either

20 forward or reverse, oil is directed from the pumps 106, 114 to the wheel motors 108, 110. There is no clutch in the system. The speed of driving is determined by depressing the accelerator pedal when self-propelling. The speed of the initial traverse using the engine is also determined in this way. The mobile gun carriage 10 comes to a halt by stepping on the brake pedal. The speed of the traverse using the DC motor is determined

25 by the degree of operation of the joystick 104. When the engine and DC motor are switched off, the oil pressure is released from the wheel motors, which automatically frees the main wheels 24 for towing.

In the above embodiment, the swinging of the main wheel assemblies 20 from

30 one position to the other is achieved manually. This is a preferred option where there are weight concerns. However, the operation can be achieved automatically, by way of additional actuators, for instance hydraulic cylinders, if so desired. Likewise, in the above embodiment, the flipping of the support wheel assemblies 30 from one position to

the other is achieved manually. This is a preferred option where there are weight concerns. However, it does require some man-handling of the gun system, for instance by pulling down on the gun barrel 50 to lift the base plate 16 off the ground to allow the support wheels 32 to move to the raised or lowered positions. Again, the operation of
5 these support wheels can be achieved automatically, by way of additional actuators, for instance hydraulic cylinders, if so desired.

In the above described embodiment, it is only the main wheels that are powered. The support wheels can also be powered if desired.

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In the above described embodiment, the front end of the main chassis 12 is lowered onto the ground to allow the main wheel assemblies 20 to be swung into different positions. In an alternative embodiment, jacks are provided below the front end of the main chassis 12. These are operated to keep the front end of the main chassis 12
15 off the ground during changing of the modes. In a further alternative embodiment, the wheel assemblies are provided without the actuators 70 and such jacks are used to lift the front end of the main chassis 12 off the main wheels, to allow hem to be swung between positions.

CLAIMS

1. A mobile gun carriage for mounting a gun, the carriage comprising:
 - 5 a chassis; and
 - two first wheel assemblies mounted on the chassis at opposing sides of the chassis, wherein both of the first wheel assemblies comprises:
 - a support member; and
 - a first wheel rotatably mounted on the support member; wherein
 - 10 the support member is mounted on the chassis, with the first wheel spaced from the chassis; and the support member is mounted to pivot relative to the chassis in a first plane and in a second plane generally orthogonal to the first plane, to move the first wheel in the first and second planes and wherein the first wheel assemblies are operable to be positioned in at least two predetermined
 - 15 positions in the first plane, a first position for driving the gun carriage on the first wheels in a driving mode and a second position in which the chassis is operable to traverse on the first wheels, in a firing mode, for aiming a gun mounted on the gun carriage.

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2. A mobile gun carriage according to claim 1 , wherein the driving mode is a self-propelling mode, in which the gun carriage is operable to propel itself.

3. A mobile gun carriage according to claim 1, or 2, wherein the gun carriage is operable in at least a third, further driving mode, which is a towing mode, in which the gun carriage is operable to be towed.

4. A mobile gun carriage according to claim 3, wherein the first wheel assemblies are further operable to be positioned in a third predetermined position relative to the chassis, for driving the gun carriage in the towing mode.

5. A mobile gun carriage according to claim 4, wherein the first wheels are turned around between the first and third predetermined positions.

6. A mobile gun carriage according to claim 1 or 2, wherein the driving mode is a towing mode, in which the gun carriage is operable to be towed.

7. A mobile gun carriage according to any one of claims 1 to 6, wherein the first wheels are generally parallel to each other in the driving mode.

8. A mobile gun carriage according to any one of claims 1 to 7, wherein the chassis has a main axis and the first wheel assemblies are generally parallel to the main axis in the first position.

9. A mobile gun carriage according to any one of claims 1 to 8, wherein the first wheels are at an angle to each other in the firing mode.

10. A mobile gun carriage according to any one of claims 1 to 9, wherein the chassis has a main axis and the first wheel assemblies are at an angle relative to the main axis in the second position.

5 11. A mobile gun carriage according to any one of claims 1 to 10, further comprising a plurality of second wheel assemblies, each second wheel assembly comprising at least one second wheel; and wherein the second wheel assemblies are operable to be positioned in at least two predetermined positions, a first position for driving the gun carriage on the second wheels in the driving mode and a second position in which the
10 second wheels are removed from contact with the ground in the firing mode.

12. A mobile gun carriage according to any one of claims 1 to 11, further comprising a base plate operable to be positioned in at least two predetermined positions, a first position raised above the ground in the driving mode and a second position in contact
15 with the ground in the firing mode.

13. A mobile gun carriage according to claims 11 and 12, wherein the plurality of second wheel assemblies are mounted on the base plate.

20 14. A mobile gun carriage according to claim 12 or 13, wherein the base plate is mounted beneath the chassis.

15. A mobile gun carriage according to any one of claims 12 to 14, wherein the base plate is rotatable relative to the chassis.

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16. A mobile gun carriage according to claim 15, wherein, in the firing mode, the axes of the first wheels lie substantially along radii extending out from the centre of rotation between the chassis and the base plate.

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17. A mobile gun carriage according to any one of claims 12 to 16, wherein in the firing mode the main points of contact between the ground and the gun carriage consist of the base plate and the first wheels.

5 18. A mobile gun carriage according to any one of the preceding claims, wherein the first wheels are powered.

19. A mobile gun carriage according to any one of the preceding claims, wherein the first wheels are powered by way of an engine in the driving mode and by way of a
10 separate motor in the firing mode.

20. A mobile gun carriage according to any one of the preceding claims, wherein the first wheel assemblies are operable to move the first wheels, relative to the chassis, in the second plane .

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21. A mobile gun carriage according to claim 20, wherein
each of the first wheel assemblies further comprises a support member,
with the first wheel rotatably mounted on the support member; wherein
the support member is mounted on the chassis, with the first wheel spaced
20 from the chassis; and
the support member is mounted to pivot relative to the chassis in the first
and second planes.

22. A mobile gun carriage according to any one of the preceding claims, wherein the
25 support members are elongate having a first end and a second end, and the first wheels
are mounted at the first ends of the support members.

23. A mobile gun carriage according to any one of the preceding claims, wherein
each first wheel assembly further comprises a first wheel assembly mount mounted on
30 the chassis to pivot in the first plane.

24. A mobile gun carriage according to claims 22 and 23, wherein the second ends of the support members are pivotally mounted on wheel assembly mounts to pivot in the second planes.

5 25. A mobile gun carriage according to any one of the preceding claims, wherein each wheel assembly further comprises an actuating means for pivoting the support member in a second plane.

10 26. A mobile gun carriage according to claims 24 and 25, wherein a first end of each actuating means is attached to a first end of a support member and a second end of each actuating means is pivotally mounted on a wheel assembly mount to pivot in a second plane.

15 27. A mobile gun carriage according to claim 25 or 26, wherein the actuating means retract or extend to move the support members in the second planes.

28. A mobile gun carriage according to any one the preceding claims, wherein the second planes are generally vertical.

20 29. A mobile gun carriage according to any one of the preceding claims, wherein the first plane is generally parallel to the plane of the chassis.

25 30. A mobile gun carriage according to any one of the preceding claims, wherein the first wheel assemblies further comprise locking means for locking the first wheel assemblies at selected ones of the at least two predetermined positions.

31. A mobile gun carriage according to any one of the preceding claims,

wherein the at least two predetermined positions are at predetermined angles relative to the main axis of the chassis, in the first plane.

32. A mobile gun carriage according to any one of the preceding claims, wherein the
5 first wheels support the main weight of the gun carriage in the driving mode.

33. A mobile gun carriage according to any one of the preceding claims, arranged
such that the first wheel assemblies are at the front end of the chassis, being the muzzle
end of the gun carriage when a gun is mounted thereon.

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34. A mobile gun carriage according to claim 33 when dependent on at least claim
12, wherein the base plate is provided at the rear end of the chassis.

35. A mobile gun carriage according to any one of the preceding claims, wherein, in
15 the driving mode, the first wheels are positioned in front of the front end of the chassis.

36. A mobile gun carriage according to claim 33 or 34 , wherein, in the towing mode
the first wheels are positioned to behind front end of the chassis.

20 37. A mobile gun carriage according to claim 36, wherein in the self-propelling
mode, the first wheels are positioned in front of the front end of the chassis.

38. A mobile gun carriage according to any one of claims 33 to 37, wherein in the
firing mode, the first wheels are positioned behind the front end of the chassis.

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39. A mobile gun carriage according to any one of the preceding claims, wherein, in
the firing mode, the first wheels are angled between 45 to 90 degrees relative to a main
axis of the chassis.

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40. A mobile gun system comprising a mobile gun carriage according to any one of the preceding claims, with a gun mounted thereon.

41. A mobile gun system according to claim 40, wherein said gun is a howitzer.

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42. A method of transforming a mobile gun system from a driving mode to a firing mode, the gun system comprising a mobile gun carriage with a gun mounted thereon, the gun carriage comprising a chassis and two first wheel assemblies mounted on the chassis at opposing sides of the chassis, wherein both of the first wheel assemblies comprises a support member; and a first wheel rotatably mounted on the support member; wherein the support member is mounted on the chassis, with the first wheel spaced from the chassis; and the support member is mounted to pivot relative to the chassis in a first plane and in a second plane generally orthogonal to the first plane, to move the first wheel in the first and second planes and wherein the first wheel assemblies are operable to be positioned in at least two predetermined positions in the first plane, a first position for driving the gun carriage on the first wheels in the driving mode and a second position in which the chassis is operable to traverse on the first wheels, in the firing mode, for aiming a gun mounted on the gun carriage, the method comprising:

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raising the first wheels off the ground;

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swinging the first wheel assemblies relative to the chassis to positions where the first wheels are angled relative to each other and relative to their direction in the driving mode; and

lowering the first wheels to the ground.

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43. A method according to claim 42, further comprising lowering the chassis to the ground prior to raising the first wheels.

44. A method of traversing a mobile gun system in a firing mode, the gun system comprising a mobile gun carriage with a gun mounted thereon, the gun carriage

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comprising a chassis and two first wheel assemblies mounted on the chassis at opposing

sides of the chassis, wherein both of the first wheel assemblies comprises a support member; and a first wheel rotatably mounted on the support member; wherein the support member is mounted on the chassis, with the first wheel spaced from the chassis; and the support member is mounted to pivot relative to the chassis in a first plane and in a second plane generally orthogonal to the first plane, to move the first wheel in the first and second planes and wherein the first wheel assemblies are operable to be positioned in at least two predetermined positions in the first plane, a first position for driving the gun carriage on the first wheels in a driving mode and a second position in which the chassis is operable to traverse on the first wheels, in the firing mode, for aiming a gun mounted on the gun carriage., the method comprising:

traversing the gun and the gun carriage on said first wheels by driving said first wheels along the ground in the same rotational direction.

45. A method according to any one of claims 42 to 44, wherein, in the firing mode, the first wheels are angled between 45 to 90 degrees relative to a main axis of the chassis.

46. A method according to any one of claims 42 to 45, wherein the gun system is as defined in claim 40 or 41.