Summary of the invention

In one aspect the present invention provides a marine fender for mounting to a structure, the marine fender including: a facing assembly for bearing against a vessel; a resilient fender element for absorbing forces on the facing assembly, the fender element being mounted between the facing assembly and the structure; and one or more load sensing elements being positioned to measure forces applied to the facing assembly and outputting force data relating to the measured forces~~.~~, wherein

~~T~~ the one or more load sensing elements ~~may be~~ are load bearing.

The marine fender may further include a first mounting assembly for mounting the facing assembly to the fender element and a second mounting assembly for mounting the fender element to the structure, and the one or more load sensing elements may form part of the first or second mounting assembly.

The one or more load sensing elements may provide a coupling arrangement for coupling together the first or second mounting assemblies.

The first mounting assembly may include a first mounting bracket carried by the facing assembly and a second mounting bracket carried by the fender element, and the first and second brackets may be coupled together by the one or more load sensing elements.

The second mounting assembly may include a first mounting bracket connected to the fender element and a second mounting bracket connected to the structure, and the first and second brackets may be coupled together by the one or more load sensing elements.

The first and second mounting brackets may be complementarily shaped.

The first and second mounting brackets may be coupled together by load ~~sensors~~ sensing elements passing through apertures carried by the first and second mounting brackets.

The first mounting bracket may include a first annular flange for mounting the first mounting bracket and a first set of radially extending apertured lugs spaced around the circumference of the first annular flange, the second mounting bracket may include a second annular flange for

mounting the second mounting bracket and a second set of radially extending apertured lugs spaced around the circumference of the second annular flange, and ~~———~~lugs of the first set of radially extending apertured lugs may inter-engage with corresponding lugs of the second set of radially extending apertured lugs, apertures of the first set of radially extending apertured lugs may align with corresponding apertures of the second set of radially extending apertured lugs, and load ~~sensors may~~ sensing elements in the form of load pins extend through correspondingly aligned apertures, thereby coupling the first and second mounting brackets together.

The first and second sets of radially extending apertured lugs may be equiangularly positioned around the circumferences of the first and second annular flanges respectively.

Each apertured lug in the first set of apertured lugs may inter-engage with a pair of corresponding apertured lugs in the second set of apertured lugs.

The number of load sensing elements may be selected from a group including 3 load sensing elements, 4 load sensing elements, 5 load sensing elements, and more than 5 load sensing elements.

The marine fender may further include a fender memory for storing the data output from the one or more load ~~sensors~~sensing elements.

The marine fender may further include a communications interface for sending the data output from the one or more load ~~sensors~~ sensing elements to a networked location.

In a second aspect the present invention provides a mounting assembly for mounting a marine fender facing assembly to a resilient fender element, the mounting assembly including: a first mounting bracket adapted to be secured to the facing assembly; and a second mounting bracket adapted to be secured to the fender element; and one or more load sensing elements for, in use, coupling together the first and second mounting brackets, measuring forces applied to the ~~facing~~ fender element assembly, and outputting force data relating to the measured forces~~.~~, wherein the one or more load sensing elements are load bearing.

In a third aspect the present invention provides a mounting assembly for mounting a resilient marine fender element to a structure, the mounting assembly including: a first mounting bracket adapted to be secured to the fender element; and a second mounting bracket adapted to be secured to the

structure; and one or more load sensing elements for, in use, coupling together the first and second mounting brackets, measuring forces applied to the facing assembly, and outputting force data relating to the measured forces~~.~~, wherein

~~In use~~ the one or more load sensing elements ~~may be~~ are load bearing.

The first and second mounting brackets may be complementarily shaped.

In use the load ~~sensors~~ sensing elements may couple the first second mounting brackets together by passing through apertures carried by the first and second mounting brackets.

The first mounting bracket may include a first annular flange for mounting the first mounting bracket and a first set of radially extending apertured lugs spaced around the circumference of the first annular flange, the second mounting bracket may include a second annular flange for mounting the second mounting bracket and a second set of radially extending apertured lugs spaced around the circumference of the second annular flange, and in use lugs of the first set of radially extending apertured lugs may inter-engage with corresponding lugs of the second set of radially extending apertured lugs, apertures of the first set of radially extending apertured lugs may align with corresponding apertures of the second set of radially extending apertured lugs, and load ~~sensors~~ sensing elements may extend through correspondingly aligned apertures, thereby coupling the first and second mounting brackets together.

The first and second sets of radially extending apertured lugs may be equiangularly positioned around the circumferences of the first and second annular flanges respectively.

Each apertured lug in the first set of apertured lugs may inter-engage with a pair of corresponding apertured lugs in the second set of apertured lugs.

The number of load sensing elements may be selected from a group including 3 load sensing elements, 4 load sensing elements, 5 load sensing elements, and more than 5 load sensing elements.

The resilient fender element may comprise a resilient rubber compound.

In yet another aspect the present invention provides a load monitoring system including: a plurality of marine fenders, each marine fender including: a communications interface for transmitting force data output from the plurality of fenders to a networked location, the networked location including: a receiver for receiving data output from the one or more load sensing elements of each marine fender; a networked location memory for storing the data output from the one or more load sensing elements of each marine fender; and a processor for processing the data.

The claims defining the invention are as follows:

1. A marine fender for mounting to a structure, the marine fender including:

a facing assembly for bearing against a vessel;

a resilient fender element for absorbing forces on the facing assembly, the fender element being mounted between the facing assembly and the structure; and

one or more load sensing elements being positioned to measure forces applied to the facing assembly and outputting force data relating to the measured forces~~.~~

~~2. A marine fender according to claim 1~~, wherein the one or more load sensing elements are load bearing.

~~3~~2. A marine fender according to claim 1~~ or claim 2~~, wherein the marine fender further includes a first mounting assembly for mounting the facing assembly to the fender element and a second mounting assembly for mounting the fender element to the structure, and wherein the one or more load sensing elements form part of the first or second mounting assembly.

~~4~~3. A marine fender according to claim ~~3~~2, wherein the one or more load sensing elements provides a coupling arrangement for coupling together the first or second mounting assemblies.

~~5~~4. A marine fender according to claim ~~3~~ 2 or claim ~~4~~3, wherein the first mounting assembly includes a first mounting bracket carried by the facing assembly and a second mounting bracket carried by the fender element, and wherein the first and second brackets are coupled together by the one or more load sensing elements.

~~6~~5. A marine fender according to claim ~~3~~ 2 or claim ~~4~~3, wherein the second mounting assembly includes a first mounting bracket connected to the fender element and a second mounting bracket connected to the structure, and wherein the first and second brackets are coupled together by the one or more load sensing elements.

~~7~~6. A marine fender according to claims ~~5~~ 4 or claim ~~6~~5, wherein the first and second mounting brackets are complementarily shaped.

~~8~~7. A marine fender according to any one of claims ~~5~~ 4 to ~~7~~6, wherein the first and second mounting brackets are coupled together by load ~~sensors~~ sensing elements passing through apertures carried by the first and second mounting brackets.

~~9~~8. A marine fender according to any one of claims ~~5~~ 4 to ~~8~~7, wherein

the first mounting bracket includes a first annular flange for mounting the first mounting bracket and a first set of radially extending apertured lugs spaced around the circumference of the first annular flange,

the second mounting bracket includes a second annular flange for mounting the second mounting bracket and a second set of radially extending apertured lugs spaced around the circumference of the second annular flange, wherein

lugs of the first set of radially extending apertured lugs inter-engage with corresponding lugs of the second set of radially extending apertured lugs,

apertures of the first set of radially extending apertured lugs align with corresponding apertures of the second set of radially extending apertured lugs, and

load ~~sensors~~ sensing elements in the form of load pins extend through correspondingly aligned apertures, thereby coupling the first and second mounting brackets together.

~~10~~9. A marine fender according to claim ~~9~~8, wherein the first and second sets of radially extending apertured lugs are equiangularly positioned around the circumferences of the first and second annular flanges respectively.

~~11~~10. A marine fender according to claim ~~9~~ 8 or claim ~~10~~9, wherein each apertured lug in the first set of apertured lugs inter-engages with a pair of corresponding apertured lugs in the second set of apertured lugs.

~~12~~11. A marine fender according to any one of claims 1 to ~~11~~10, wherein the number of load sensing elements is selected from a group including 3 load sensing elements, 4 load sensing elements, 5 load sensing elements, and more than 5 load sensing elements.

~~13~~12. A marine fender according to any one of claims 1 to ~~12~~11, further including a fender memory for storing the data output from the one or more load ~~sensors~~sensing elements.

~~14~~13. A marine fender according to any one of claims 1 to ~~13~~12, further including a communications interface for sending the data output from the one or more load ~~sensors~~ sensing elements to a networked location.

~~15~~14. A mounting assembly for mounting a marine fender facing assembly to a resilient fender element, the mounting assembly including:

a first mounting bracket adapted to be secured to the facing assembly; ~~and~~

a second mounting bracket adapted to be secured to the fender element; and

one or more load sensing elements for, in use, coupling together the first and second mounting brackets, measuring forces applied to the facing assembly, and outputting force data relating to the measured forces~~.~~, wherein the one or more load sensing elements are load bearing.

~~16~~15. A mounting assembly for mounting a resilient marine fender element to a structure, the mounting assembly including:

a first mounting bracket adapted to be secured to the fender element; ~~and~~

a second mounting bracket adapted to be secured to the structure; and

one or more load sensing elements for, in use, coupling together the first and second mounting brackets, measuring forces applied to the ~~facing~~ fender element assembly, and outputting force data relating to the measured forces~~.~~, wherein the one or more load sensing elements are load bearing.

~~17. A mounting assembly according to claim 15 or claim 16, wherein in use the one or more load sensing elements are load bearing.~~

~~18~~16. A mounting assembly according to any one of claims ~~15~~ 14 to ~~17~~15, wherein the first and second mounting brackets are complementarily shaped.

~~19~~17. A mounting assembly according to any one of claims ~~15~~ 14 to ~~18~~16, wherein in use the load ~~sensors~~ sensing elements couple the first second mounting brackets together by passing through apertures carried by the first and second mounting brackets.

~~20~~18. A mounting assembly according to any one of claims ~~15~~ 14 to ~~19~~16, wherein

the first mounting bracket includes a first annular flange for mounting the first mounting bracket and a first set of radially extending apertured lugs spaced around the circumference of the first annular flange,

the second mounting bracket includes a second annular flange for mounting the second mounting bracket and a second set of radially extending apertured lugs spaced around the circumference of the second annular flange, wherein in use

lugs of the first set of radially extending apertured lugs inter-engage with corresponding lugs of the second set of radially extending apertured lugs,

apertures of the first set of radially extending apertured lugs align with corresponding apertures of the second set of radially extending apertured lugs, and

the load ~~sensors~~ sensing elements extend through correspondingly aligned apertures, thereby coupling the first and second mounting brackets together.

~~21~~19. A mounting assembly according to claim ~~20~~18, wherein the first and second sets of radially extending apertured lugs are equiangularly positioned around the circumferences of the first and second annular flanges respectively.

~~22~~20. A mounting assembly according to claim ~~20~~ 18 or claim ~~21~~19, wherein each apertured lug in the first set of apertured lugs inter-engages with a pair of corresponding apertured lugs in the second set of apertured lugs.

~~23~~21. A mounting assembly according to any one of claims ~~15~~ 14 to ~~22~~20, wherein the number of load sensing elements is selected from a group including 3 load sensing elements, 4 load sensing elements, 5 load sensing elements, and more than 5 load sensing elements.

22. A marine fender according to any one of claims 1 to 13 wherein the resilient fender element comprises a resilient rubber compound.

~~24~~23. A load monitoring system including:

a plurality of marine fenders ~~for mounting to a structure~~according to any one of claims 1 to 12 or 22, each marine fender including:

~~a facing assembly for bearing against a vessel;~~

~~a resilient fender element for absorbing forces on the facing assembly, the fender element being mounted between the facing assembly and the structure;~~

~~one or more load sensing elements being positioned to measure forces applied to the facing assembly and outputting force data relating to the measured forces; and~~

a communications interface for transmitting the force data ~~output~~ to a networked location,

the networked location including:

a receiver for receiving the force data ~~output~~ from the ~~one or more load sensing elements of each~~ plurality of marine fenders;

a networked location memory for storing the force data ~~output~~ from the one or more load sensing elements of each marine fender; and

a processor for processing the data.