

Apparatus and method for immediate emergency disconnection of a load

The invention is particularly useful for cutting wire or chain during a towing or lifting
5 operation, as for instance, an anchor wire or an anchor chain in an anchor handling situation.

In connection with offshore operations that involve towing or anchor handling, it could happen that the tow or the anchor that is handled has made unexpected or unintended
10 manoeuvres which may entail the risk of damage to or loss of a vessel that is involved in the towing activity or the anchor handling. However, dangerous situations have usually been averted by "winching out" the wire or chain connecting the vessel to the uncontrolled tow or the anchor, or by more drastic measures such as cutting the wire or the chain. Unfortunately, serious incidents nevertheless have occurred in similar
15 situations where the tow or the anchor has made unexpected or unintended manoeuvres at such a speed that it has not been possible to remove the uncontrolled load on the wire or the chain quickly enough, which has then resulted in grave risk or serious damage to vessels or crew, and in the worst cases shipwreck and loss of vessel or lives.

Similar problems have been addressed in connection with trawlers, and the published
20 international patent application PCT/EP2007/051518 describes a system for preventing accidents, such as capsize, which may happen as a result of high tension in trawler cables. The system comprises a tension detecting means for a trawler cable, means for detecting trim of the vessel, an alarm system and a cable cutter. The cable cutter is of a
25 pyrotechnic type, with a housing that surrounds the cable in its peripheral direction. A hollow charge which partially surrounds the cable is arranged in the housing. The system is designed to detect abnormal tension in the trawler cable which may lead to capsize, and, on detonation of the hollow charge, to cause a point on the cable to be struck by a jet and/or be subjected to heat and/or pressure which will result in the cable
30 being cut.

The published international patent application PCT/EP2007/051572 describes a cable cutter of the pyrotechnic type, with a hollow charge arranged in a housing through which the cable is passed. The hollow charge is given a V-shaped cross-section, is
35 formed as a part of a circular arc, and thus partly surrounds the cable. By the hollow charge being shaped as a part of a circular arc, the output from its detonation will be

focused towards a focal point. The housing comprises a device for positioning a part of the cable that is to be cut centrally in relation to the focal point.

The patent document US3089417 describes a pyrotechnic cable cutter for use in aircraft with an emergency release cockpit for cutting of control cables between the cockpit and the control surfaces of the aircraft. The cable cutter comprises a device for fastening an explosive to the cable at the point on the cable at which, in an emergency situation, it is to be cut to ensure that the cockpit will be released from the rest of the aircraft body. In one embodiment, the cable cutter is formed of an annular holder which surrounds the cable in its circumferential direction, and a substantially rectilinear, elongate hollow charge explosive with a detonator secured to the fastening device in immediate proximity of and tangential to the cable.

The patent document US 2920532 describes a cable cutter with a V-shaped hollow charge explosive located in a housing, and an arrangement for holding a cable against an open end of the housing from where the material from the explosive will stream out on detonation. The V-shaped surface of the explosive is covered with a layer.

The patent document US 2185303 describes a pyrotechnic cable cutter wherein a piston is located in a cylinder and wherein the cylinder at a first end has inserted an explosive which, when detonated, drives the piston to move through the cylinder. At the second end of the cylinder there is located a cutting device in a housing which in a portion thereof also surrounds the cable. When the cutting device is struck by the piston, it is driven towards the cable so that the cable is weakened or cut.

The known cable cutters of pyrotechnic type comprise a fully encircling casing or sleeve designed to prevent substantially all movement of the cable transverse to the longitudinal direction of the cable so that it is at all times in the point of action of the hollow charge explosive, or they are constructed to act on a specific point on the cable and are unsuitable for installation or use on vessels that are lifters, towing vessels or anchor handling vessels where the wire, cable or chain must be guided and winched over an open deck and where there is no suitable location for the mounting of such encasing installations or cable-mounted devices.

By way of solution to the aforementioned and other problems, the present invention provides an apparatus for immediate cutting of a cable or the like according to

independent claim 1, a wire cutter apparatus according to claim 17 and a vessel according to claim 18.

Additional advantageous features of the present inventive apparatus for immediate
5 cutting of a cable or the like are set forth in attached dependent claims 2-16.

The apparatus of the invention is adapted for installation in or under a deck of a vessel participating in a towing or lifting operation, such as in a towing or anchor handling vessel that is used in offshore activities, immediately below a deck plate in a part of the
10 deck over which chain, wire or the like is run. The apparatus installed under the vessel's deck works in that it produces a cutting effect that penetrates and cuts the chain, wire or the like at a point or location at which it is passed over the deck. The apparatus of the invention is preferably dimensioned so that it can effect cutting or substantial
weakening of cable, wire, or the like, in particular a wire with dimensions of up to $\varnothing =$
15 110mm or a chain with dimensions of up to $\varnothing = 130\text{mm}$. When installed under the deck plate, the apparatus of the invention also effects a penetration of the ship's deck, is preferably dimensioned to penetrate deck plates of a thickness of about or a little more than 40 mm, and has a capacity for cutting or weakening wire or chain of the
aforementioned dimensions.

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In an advantageous embodiment of the inventive apparatus, it comprises an active part formed of a high-velocity (i.e., rapid reacting) thermally reactive material, as, for example, a blasting agent or explosive, which on initiation (detonation) produces the desired penetration and cutting effect, this taking place at extremely high speeds and for
25 the purposes of the invention is to be considered as instantaneous.

The mode of operation of the inventive apparatus is as follows:

The thermally reactive material is shaped and positioned such that on thermal reaction it
30 generates a pressure in the direction of the said chain, wire or the like, and, if installed under a deck plate, also the deck plate, which typically results in such tensions in the target material, and partly also such thermal impact that the yield limit of the target material is exceeded. As a result of this effect, the target material disintegrates so that, in the case of the said chain, wire or the like, the said cable, chain, wire or the like is cut
35 almost immediately.

The thermal rapid-reacting material is so arranged that during the reaction it provides a geometric focusing towards a convergence point, a convergence line or a convergence plane, of pressure, and possibly also material and heat, which are ejected during the reaction. The individual explosive unit has a thermally reactive material with a V-shaped, pyramid-shaped or conical surface on the ejection side and is arranged so as to eject a shock wave, material or heat in a unified stream towards a convergence region, which, for example, is adapted so that the convergence point lies in or close to the centre of the object that is to be cut. To strengthen the aforementioned effect, metallic additives are added so as to obtain a substantial strengthening of the effect at the convergence point of the geometric focus in the thermally reactive material. One example of such a strengthening is described in the following text. In what follows, the term "explosive" is basically used as a generic term for such thermal materials that are well suited for the performance of the invention.

The invention will be described in more detail below with the aid of different exemplary embodiments and with reference to the attached drawings, wherein:

Figure 1A is a side view illustrating a typical vessel for raising, lifting, towing or anchor handling;

Figure 1B is a perspective view showing a part of a stern of the vessel illustrated in Figure 1A and a below-deck installed wire or chain cutter apparatus according to the present invention;

Figure 1C is a longitudinal sectional view of a part of the stern illustrated in Figure 1B which illustrates the below-deck installed wire or chain cutter apparatus according to the present invention;

Figure 2 is a perspective view showing an enlarged part of the illustration in Figure 1B of the below-deck installed wire or chain cutter apparatus according to the present invention;

Figure 3 is a longitudinal section of the stern showing an enlarged part of the illustration in Figure 1C of the below-deck installation of the wire or chain cutter apparatus according to the present invention;

Figure 4A is a schematic cross-sectional view of an installation with a first embodiment of a wire or chain cutter apparatus according to the present invention;

Figure 4B is a schematic longitudinal section of an installation with the first
5 embodiment of a wire or chain cutter apparatus according to the present invention;

Figure 5 is a schematic cross-sectional view of an installation with a second embodiment of a wire or chain cutter apparatus according to the present invention;

10 Figure 6 is a schematic longitudinal section of an installation with the second embodiment of a wire or chain cutter apparatus according to the present invention;

Figure 7 is a schematic cross-sectional view of an installation with a third embodiment of a wire or chain cutter apparatus according to the present invention;

15 Figure 8 is a schematic longitudinal section of an installation with the third embodiment of a wire or chain cutter apparatus according to the present invention;

Figure 9A is a schematic illustration of a cross-sectional view of a first arrangement of
20 individual explosives in the third embodiment of a wire or chain cutter apparatus according to the present invention; and

Figure 9B is a schematic illustration of a cross-sectional view of a second arrangement of individual explosives in the third embodiment of a wire or chain cutter apparatus
25 according to the present invention.

Figure 1A illustrates a typical vessel for raising, lifting, towing or anchor handling. The vessel has a large open afterdeck which typically has a winch arrangement on the end facing the bow, and the end that faces astern is open so that objects which are handled,
30 such as anchor chain or an anchor can be winched up over the stern and optionally up onto the deck.

Figure 1B illustrates in more detail, by means of an example, the stern of the vessel with a cable, wire or chain 1 that is about to be raised, lowered or taken in tow and run over
35 the afterdeck 2 towards the winch arrangement (not shown), and manipulating devices 3 which typically are in the form of shark jaw and/or towing pins for securing cable, wire or chain or for guiding them. The broken lines illustrate a wire and chain cutter 100

according to the present invention as installed under the deck 3, or as incorporated in the deck 3.

Figure 1C shows in a longitudinal section through the vessel's stern cable, wire or chain 1, manipulating devices 3 for locking or guiding said cable, wire or chain 1, the deck 2 and also, in cross-section, a wire or chain cutter 100 according to the present invention as installed below the deck 3 or as incorporated in the deck 3.

In an enlarged view, Figure 2 illustrates in perspective the vessel deck with manipulating devices, and in a broken line indicates an advantageous location of a wire and chain cutter according to the present invention, as installed below the deck or as incorporated in the deck. The invention thus meets the need for and requirement that the deck should be free of installations other than the manipulating devices which are necessary to hold or guide the actual cable, wire or chain that is handled, but at the same time ensures that there are means for at all times being able, in an emergency situation, to immediately cut the cable, wire or chain concerned. As shown in the broken line, in one advantageous embodiment of the installation of a wire and chain cutter according to the present invention, as installed below the deck or as incorporated in the deck, the inventive apparatus on the vessel is immediately astern of the manipulating devices, and is provided with a longitudinal extent transverse to the vessel's longitudinal direction which corresponds to at least the largest possible displacement of wire or chain across the longitudinal direction of the vessel at the installation site of the apparatus.

The enlarged view in Figure 3 also illustrates, in a longitudinal section through the stern of the vessel, the vessel deck with manipulating means, and individual details of a pyrotechnic cutter apparatus in an advantageous location according to the present invention, as installed below the deck or as incorporated in the deck. Reference is made in particular to the trapeziform section of the inventive apparatus where diagonal hatching indicates a housing part of the apparatus, and an area of chequered hatching within indicates the active parts of the apparatus according to the invention.

For the further detailed description, the term "wire" will be used to refer to a cable, wire, chain or the like that is to be immediately cut in an emergency situation by using the invention.

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Reference is made to Figures 4A, 5 and 4B, as an illustrative cross-section and top view, respectively, for the following explanation of a first embodiment of the wire

cutter apparatus 100 according to the invention, and moreover its installation or location below the deck of a vessel in the area over which the wire is run. The first embodiment of the inventive wire cutter 100 is an elongate assembly comprising an elongate, external housing 10 of a rigid and robust structure formed of a bottom 11, four side walls 12, 13, 14, 15, preferably made of steel, a layer of damping material 20, preferably of polyurethane of uniform thickness, as a layer which substantially covers the inside of the bottom and the side walls of the external housing 10, thereby constituting a damping intermediate housing consisting of a bottom 21, four side walls and end walls 22, 23 and 24, 25, respectively, an internal housing 30 formed of a bottom 31 and side walls and end walls 32, 33 and 34, 35, respectively, which are shape-adapted to the internal form of the damping material layer formed by the intermediate housing, and which preferably are of steel or other strong material which may be of uniform thickness, and an explosive member 40 which is formed of an elongate explosive element that has a bottom face 41, side faces and end faces 42, 43 and 44, 45 respectively, and is shaped to fill the internal housing wholly or partly and has first and second surfaces 46, 47 in a V-shape, whereby the first and second V-shaped surfaces 46, 47 provide a V-shaped cavity 60 above the explosive for formation of a hollow charge explosive which will cause the shock wave, the material and the heat from the detonated explosive to be ejected in a concentrated manner out of the V-shaped cavity. Arranged on the V-shaped surfaces 46, 47 is preferably a layer 50 of a material that is well suited, on detonation of the explosive, to provide a jet of material in the area of concentration for a detonation shock wave which can cause a weakening or cutting of a wire that is immediately at or above the V-shaped open area. It is envisaged that this layer will be formed of copper. The V-shape is presented clearly in the sectional view in Figure 4A, whilst the top view in Figure 4B, by means of the line 48 in the centre of the drawing, indicates the bottom line of the V-shape. Thus, what is involved is a simple, elongate explosive element with a longitudinal V-shaped upper portion. The terms 'upper' and 'lower' refer in this description to the directions that apply in the illustrations when observed normally.

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Figure 4A also illustrates a fastening device 70, for securing the inventive apparatus 100 to the underside of the deck plate 2. The fastening device 70 may be made in the form of a rectangular assembly of a total of four side walls and end walls 71, 72 and 73, 74, respectively, which by the use of, for example, bolt fasteners or a welding method are connected to the upper edges of respective sidewalls and end walls 11, 12 and 13, 14, respectively, of the external housing 10 and to the underside of the deck plate 2 with sufficient holding power to ensure the external housing 10 remains in its position and

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connected to the deck 2 also after the explosive has been detonated and thus ensures a sealing of openings which will be cut in the deck by the detonation against the remaining volume or space that is found below the deck 2. A rigid and solid anchoring of the external housing to the underside of the deck plate 2 also maintains the integrity of the deck structure even when the apparatus 100, on detonation, has created a substantial elongate opening in the deck. The height of the fastening device 70, that is to say, the distance that is established by the fastening device between the deck plate 2 and the external housing 10 when the apparatus 100 is below the deck plate 2 is determined partly on the basis of selected shape and configuration of the explosive member 40 and the type of wire the vessel is to handle. In some cases, the fastening device 70 can therefore be omitted and the external housing 10 is then mounted directly on the means for fastening the apparatus 100 to the deck plate 2.

Reference will now be made to Figures 5 and 6 for the following detailed explanation of a second embodiment of the present invention. In the second embodiment, the special features of which can be seen in particular from Figure 6, the apparently continuous elongate V-shaped explosive is formed of a plurality of sections or shorter individual explosives which each have basically the same V-shape in cross-section and which have V-shape bottom lines 48 that are essentially coincident or at least substantially parallel. The illustrative example shown in Figure 6 is formed of eight sections or juxtaposed individual explosives which are provided with a respective detonator or a detonator arrangement that gives a controlled detonation of each section or of each individual explosive at different times. The sections or individual explosives are preferably separated from each other by devices 80 which ensure that detonation of one explosive does not cause detonation of a neighbouring explosive, such as a plate or similar dividing wall which diverts or damps a shock wave and/or heat generation.

With V-shaped explosives, the shock wave, the generated heat and the accompanying material from each individual detonated section or individual explosive will travel from the wire cutter apparatus 100 essentially in a common convergence plane 4 that lies in the longitudinal direction of the bottom line 48 of the V-shape, which is indicated in the broken, thick line denoted by reference numeral 4 in Figure 5.

Reference will now be made to Figures 7, 8, 9A and 9B for the following detailed explanation of a third embodiment of the present invention. In the third embodiment, the explosive member 40 of the wire cutter apparatus 100 is formed of a larger number of elongate substantially circular-cylindrical or conical individual explosive units 90,

each of which comprises an associated explosive 91 which in an upper part, in a longitudinal section, has an essentially V-shaped contour that is produced by a cavity 60 which is conical in the upper part of the individual explosive. In the illustrative example shown in Figure 6, the explosive member 40 of the wire cutter apparatus 100 is formed of eighty-eight (88) individual explosive units 90, each of which is provided with a detonator or a detonator arrangement which gives a controlled detonation of each individual explosive at different times. The individual explosive units 90 each comprise a cylindrical or conical housing 92 which houses the actual explosive 91, and which also forms a partition between them. The individual explosive units 90 are also separated by devices 80 which ensure that detonation of one explosive does not cause detonation of a neighbouring explosive, as, for example, an arrangement of plates or similar dividing walls, or a filler material that essentially fills the space between the explosive units 90, and which are provided to divert or damp a shock wave and/or heat generation from a detonating neighbouring explosive unit 90 in a degree sufficient to prevent the detonating explosive from detonating a neighbouring explosive unit.

In an alternative variant (not shown in the figures) of the third embodiment of the inventive wire cutter apparatus 100, at least a plurality of the elongate individual explosive units 90 are not circular-cylindrical, but each is cylindrical with a rectangular or square shape seen in section transverse to its longitudinal direction, and has a uniform width along its length, or they are tapered towards the bottom in a pyramid shape, and are then provided with an explosive formed to produce a V-shaped cavity with a respective bottom line, and where this plurality of individual explosive units 90 is installed in the internal housing with the bottom lines of the V-shaped cavities directed in the longitudinal direction of the apparatus 100.

The exemplary constellation of individual explosive units 90, which is illustrated in cross-section in Figure 7 and in longitudinal section in Figure 8, indicates for an advantageous embodiment of the inventive apparatus 100 that the elongate individual explosive units 90 are uniform, circular-cylindrical housings 92 that are arranged side by side with essentially parallel longitudinal axes, and that they have uniform explosives 91. By virtue of its V-shaped or conical recess in the upper part, each individual explosive unit 90, on detonation, ejects a respective shock wave, material and heat essentially together along and in a direction which is illustrated by the thick broken ejection line indicated by the reference numeral 5. With the exemplary constellation that is illustrated as an example in Figures 7 and 8, a greater length of the wire can advantageously be struck when the individual explosive units 90 in the explosive

member 40 are detonated together or successively for vessels that handle wires which, with greatest safety, can be cut or weakened until they break by application of force at several points along a part of their length, the ejection lines 5 for the respective individual explosive units 90 being essentially parallel in the sense that they do not
5 result in a significant and intended gathering or concentration of ejected pressure waves, material or heat in an area where the deck plate or wire will be located.

For vessels or work operations where wires are to be handled which in an emergency situation, with greater safety, can be cut or weakened until they break by a unified or
10 concentrated application of force on a smaller part of the wire that can be regarded as a single point along the length of the wire, there is used a constellation of individual explosive units 90 in the explosive member 40 like the constellation examples which in Figures 9A and 9B are illustrated by a cross-sectional view, and where it is shown that transverse to the longitudinal direction of the apparatus there is mounted at most five (5)
15 individual explosive units 90. The number five which applies in particular in the illustrated examples is not limiting for similar constellations, but it is required that the number is at least two (2). Each of the individual explosive units 90 in these constellations is mounted in the wire cutter apparatus 100 according to the invention at different angles with an angle between them as indicated by the reference numeral 7 in a
20 plane lying essentially transverse to the longitudinal direction of the elongate wire cutter apparatus 100, and in such manner that the respective ejection lines 5 of these five individual explosive units 90 are gathered in a convergence point in an area at the point or points of intersection of the ejection lines as one common point of action or several common points of action for the shock waves, the material and the heat which, on
25 detonation, are ejected from each of the individual explosive units 90. The indicated angles 7 between the ejection lines 5 in the illustrative examples which are outlined in Figures 9A and 9B are thus different, the angle 7 in Figure 9A being smaller than the angle 7 in Figure 9B.

30 In the case of the second and third embodiment, the inventive apparatus 100 may advantageously further comprise a detonation control device or a detonator arrangement which effects a controlled detonation of the explosive sections of the explosive member 40 or of individual explosives 90 at different times. One of the advantages obtained by timewise-separated detonation of the explosive sections or the individual explosives in
35 both the second and third embodiments is that the recoil impulse has a lower peak value than the peak value produced by detonating the one individual explosive which in the first embodiment is the whole explosive member. A timewise-spread detonation can be

used to reduce the requirement of the strength of the housing structure 10, intermediate housing 20 and associated damping material of the apparatus 100, and the fastening device 70. Seen in terms of the cutting effect, this can nevertheless be maintained by sufficiently short intervals between the times for detonating the individual explosive units or the individual explosives. Time control of the detonation times, especially in the case of the third embodiment, may be favourable by combining detonation time sequence, alignment angle of the direction of ejection, V-shaped variants and coating variants for formation of a so-called "metal storm" directed towards deck plate and wire, where, by means of the time control, the metal storm is established in several time phases, the deck and the outer parts of the wire being struck in a first phase, and the inner parts or core parts of the wire being struck in one or more immediately timewise subsequent phases. The time control is advantageously programmable, a detonation sequence that is determining for the time relation between the phases being programmed by distinct programs for each type of wire the vessel may have to handle, and is then selected and made ready for instantaneous activation before the handling operation in question is started.

For damping by, for example, absorption, by-products of the sudden reaction in the thermally reactive material of the explosive, which, for instance, are in the form of heat and pressure, the apparatus 100, as mentioned above, is advantageously provided with a single-layer or multilayer absorbent material that is adapted to absorb some or most of the by-products. The apparatus advantageously also comprises, as mentioned, a casing arranged such that a penetration of the target material does not reduce the remaining structural integrity of the invention's structure or other parts of the surrounding structure, preferably also such that an initiation of the rapid thermal reaction, for example, detonation, does not result in any other effect that constitutes a danger for nearby objects.

Through the installation of the inventive apparatus, a new arrangement is provided in a vessel deck with a simple installation of the inventive wire cutter apparatus for immediate cutting of a weight-loaded or tension-loaded wire that can effectively prevent or avert a case of vessel damage, crew injury, capsize or other loss of vessel or crew as a result of the weight or tension loading of the wire.

The condition or structure of the deck 2 may, however, have to be taken into account in connection with location or installation in the vessel. The problems that are seen to have to be solved may be related to structural elements in or immediately below the

deck or structural factors in connection with the deck plate itself, which do not permit a single wire cutter apparatus 100 as described herein to safely provide the required emergency cutting effect. In an inventive application of the inventive wire cutter apparatus, there is provided in or under the deck plate a group arrangement of a plurality of wire cutter apparatuses arranged essentially parallel as regards their longitudinal axes, which are advantageously angled about their longitudinal axes in relation to each other, and which by detonation control are arranged to be triggered for detonation wholly or partly simultaneously or in an advantageous sequence, in order to penetrate the deck plate simultaneously with the strike against the wire, or in order first to penetrate the deck plate and immediately after strike the wire itself. Figure 9A or 9B may, with a view to such a group arrangement of a plurality of elongate wire cutter apparatuses 100 as provided by this invention, also be used to illustrate in a sectional plane transverse to the longitudinal direction of the wire cutter apparatuses, examples of group arrangements of five (5) elongate wire cutter apparatuses which are in that case indicated in this connection by the reference numeral 90, with their respective ejection planes indicated in section by the lines that are pointed to by the arrow linked to the reference numeral 5, and where the reference numeral 7 in this particular connection indicates the angle of each individual apparatus about its longitudinal axis in relation to one or more of the other wire cutter apparatuses that are included in the group arrangement. Here it should be pointed out that in the group arrangement proposed by the invention there is no limit as regards the individual wire cutter apparatus having to be of the same design or embodiment, but that in an advantageous group arrangement there may be included different embodiments of the elongate wire cutter apparatus 100 with respective different constellations of explosive units or explosive sections. For example, in one group arrangement of a total of three (3) elongate wire cutter apparatuses 100, it is intended that the central one of the three is accordance with the first or the second embodiment as described above and especially adapted for penetration of the deck plate, and that the two others are in accordance with the third embodiment and especially adapted for concentration of their respective and joint cutting effect on the wire. The detonation sequence is thus adapted to the configuration of the group arrangement and is also intended to be arranged such that the sequence timewise takes into account a lifting of the wire from the deck as a result of the deck penetration which runs ahead of the actual application of force against the wire.

According to the invention, the attachment means 70 for coupling the wire cutter apparatus 100 or a group arrangement thereof may comprise or be constituted by a deck plate part of a structure and/or a condition that provides or has the same strength and

holding power as also specified for the open deck in the area which, here, has been designated by the invention for installation of the wire cutter apparatus 100 or a group arrangement thereof. For example, for the purpose of the attachment means, an elongate part of a deck of ordinary deck plate of the aforementioned type may be
5 replaced by a sandwich structure, preferably of steel and adapted to be welded in place as a deck part, which in the installation area concerned gives the deck the required impact strength and load holding power and moreover makes minimum demands on the undermounted wire cutter apparatus or apparatuses which are installed there primarily for penetrating the deck or for effecting both penetration of the deck and cutting of the
10 wire.

The inventive apparatus is primarily intended to be adapted for permanent installation, but can alternatively be realised as a separate mobile unit.

15 For permanent installation, the inventive apparatus is advantageously sunk into, or as indicated above and shown in some of the attached drawings, mounted immediately below the afterdeck of an anchor handling (AH) vessel, but may alternatively or additionally be included as attached to or an integral part of a hydraulic AH unit or similar apparatus.

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The external housing is internally coated preferably with one or more layers of a shock absorbing or deformable material that may be a material which, due to material properties or design, has large deformation energy.

25 Internally and over the layer, or the several layers, of shock absorbing or deformable material, the apparatus is further preferably coated with a layer of shock resistant material, as, for instance steel, which constitutes the internal housing and which in turn supports an additional internal layer in the apparatus of the thermal rapid-reacting material, which typically is a blasting agent or explosive. Internally in the apparatus
30 100, the blasting agent or explosive has a depression, which advantageously in the case where the housing is of an elongate form, also is correspondingly elongate. The advantageous depression form, when the apparatus is illustrated in section transverse to the longitudinal direction as illustrated in some of the attached figures, is a V-shape where the bottom of the V-shape is located centrally in the said direction.

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The aforementioned inner covering layer or coating of, for example, Cu, for strengthening the directed explosive effect that the invention will provide, can be placed

against the surface of the V-shaped depression, and is so formed that it preferably follows and reproduces on the inside of the apparatus the inner V-shape of the blasting agent.

- 5 The second or third embodiment of the apparatus 100 according to the invention preferably comprises a rail or bracket arrangement designed to hold the individual explosive units 90, which in turn are secured to the internal housing.

10 An installation of the apparatus 100 according to the invention is made preferably transversely below deck, preferably as far back in the ship as possible.

The cavity pos. 6 above the charge pos. 4 forms a "standoff" to obtain the desired acceleration and form of the "projectile" that perforates the deck and the object to be cut.

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The charges are dimensioned in relation to the deck thickness that is found on the various types of ship.

The ship's structure is not significantly weakened transversely because the strength of the structure is not borne by the damaged deck plates, but by the underlying structure
20 that consists of strong beams which are not damaged to any appreciable extent. Water penetration is limited by the volume that the steel housing pos. 1 can hold. After detonation has been triggered, it is supposed that the ship terminates the operation and goes to dock for repair and recharging. One method of the invention comprises making the inventive apparatus by assembling the elements of the invention in the assembly as
25 explained above.

One method of the invention comprises using the inventive apparatus by equipping a vessel with the inventive apparatus as explained above.

- 30 Activation of the inventive apparatus, which comprises initiating (detonating) the thermal rapid reaction will, when the apparatus is installed in or immediately below the afterdeck of an anchor handling vessel (AH vessel), provide a safety barrier that acts to avoid loss of crew or ship in a case where a load connected to said chain, wire or the like goes out of control in such manner that there is a danger to the ship or crew, and
35 where cutting the said chain, wire or the like can help to avoid or reduce such danger.

The inventive apparatus has such structural features that it is safe to handle and can withstand huge mechanical and temperature stresses.

The invention may comprise one or more initiating mechanisms, preferably of the type
5 that have two or more firing barriers to eliminate unintentional activation.

CLAIMS

1. A vessel provided to tow or lift a load using a cable, wire or chain by running the cable, wire or chain over a part of a vessel deck adapted for the running operation, characterised in that the vessel has installed in or immediately below the part of the vessel deck adapted for the running operation, a disconnecting apparatus (100) for immediate disconnection of the load connected to the vessel by the wire, cable, chain or the like (1) which is run on an upper side of the adapted part of the vessel deck (2), the disconnecting apparatus (100) comprising an elongate and, in its longitudinal direction, substantially rectilinear outer housing (10) which houses an elongate and, in its longitudinal direction, substantially rectilinear explosive member (40), which explosive member comprises at least one explosive unit formed as a directed charge with an ejection side, and an apparatus coupling area on the ejection side for coupling the elongate outer housing to the vessel deck in or below the adapted part of the vessel deck.
2. The vessel according to claim 1, wherein the explosive unit comprises an explosive element which in an upper part thereof has, in a section transverse to the longitudinal direction of the housing, an essentially V-shaped contour for formation of an essentially V-shaped or conical cavity (60) immediately above the essentially V-shaped contour.
3. The vessel according to claim 2, wherein the explosive unit is arranged such that the symmetry plane or symmetry axis of the essentially V-shaped or conical cavity in the opening direction of the cavity determines a direction of ejection for a shock wave, material or heat.
4. The vessel according to any one of the preceding claims, wherein in the coupling area, it has a coupling device (70) for bolting or welding the apparatus in or to the vessel deck.
5. The vessel according to claim 4, wherein the coupling device is formed of a rectangular assembly of four side wall elements (71, 72, 73, 74).
6. The vessel according to any one of the preceding claims, wherein the disconnecting apparatus comprises an intermediate housing formed of a layer of shock or heat absorbing material disposed between the outer housing and the explosive member.
7. The vessel according to claim 6, wherein the disconnecting apparatus comprises an inner housing protective layer of a substantially shock or heat resistant material between the layer of shock or heat absorbing material and the explosive element that forms the directed charge.
8. The vessel according to any one of the preceding claims, wherein the explosive unit in a section has a V-shaped contour formed of a surface that forms a V-shaped or conical cavity.
9. The vessel according to claim 8, wherein the surface is covered by an active layer.
10. The vessel according to claim 9, wherein the active layer is formed of Cu.
11. The vessel according to any one of the preceding claims, wherein the explosive member is formed of multiple explosive units arranged side by side.

12. The vessel according to claim 11, wherein the disconnecting apparatus comprises a barrier arranged to damp propagation of shock wave, material or heat between respective neighbouring explosive units of the multiple explosive units.
- 5 13. The vessel according to claim 11, wherein the explosive member with multiple explosive units is formed with only one single explosive unit in the transverse direction of the apparatus (100) and a plurality of essentially uniform explosive units with elongate V-shaped surfaces in the longitudinal direction of the apparatus (100), and wherein the bottom lines of the V-shaped surfaces are essentially coincident or parallel.
- 10 14. The vessel according to claim 11, wherein the explosive member with multiple explosive units is formed with a plurality of explosive units in both the transverse direction and the longitudinal direction of the apparatus (100), and wherein all of the multiple units are elongate explosive units with a respective cylindrical housing comprising an explosive that has a V-shaped or conical cavity.
- 15 15. The vessel according to claim 14, wherein the disconnecting apparatus comprises rows of the elongate explosive elements arranged side by side in the longitudinal direction of the apparatus, and the longitudinal axes, which correspond to the direction of ejection, of the explosive units in one row are angled in relation to the longitudinal axes of the explosive units in a second row, so that these longitudinal axes intersect each other in an area above the ejection side.
- 20 16. The vessel according to any one of the preceding claims, wherein the explosive unit comprises a detonator arranged to be controlled by a detonation signal from a double-secured control means provided on the command bridge of the vessel.