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DYNAMIC FAIRLEAD FOR TOWING WINCH

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ABSRACT

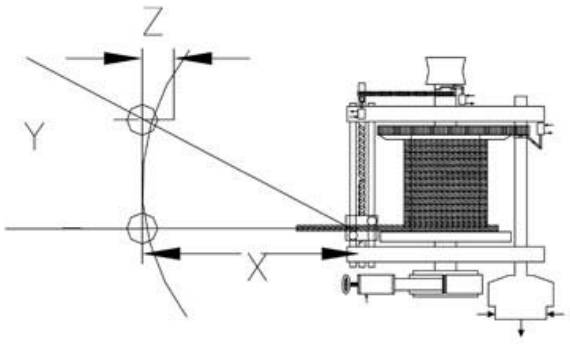
The patent deals with the problems existing between the towline and the fairlead and presents a dynamic variety of the last to compensate the lengthening of the towline and, therefore, reduce and even eliminate rope wear on abrasive surfaces. Tug stability will increase during tow operations**.** The system is composed of structural elements as well as hydraulic components.

Key words: Tug, fairlead, winch, stability, towing hook.

1. - INTRODUCTION

The fairlead dynamic in winch and towing hook *is* a system rail track. Rail track systems cause smaller heeling angles so higher athwartships towline forces can be applied, resulting in a increase in tug performance.

Figure 1.- Winch



The escort tugs for assistance and escort of potentially dangerous vessels are provided with several appliances which are currently under research and development.

It is well known that a great percentage of incidents during tug operations are due to the failure of the towing line, which forces rope and cable manufacturers to research to improve the quality of their products so that tug operations may be safer.

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Tug design has improved greatly. Usually, tug safety relies on systems duplication; their propellers can be azimuthal or cycloidal and tow power can be as three times greater when they use indirect pull. This variety uses engine power combined with hydrodynamic effects on the tug hull to increase pull. In this case, relative speed of water to the tug hull produces hydrodynamic forces which increase nearly as the square of the speed.

In practice, this pull increase during tow operations works much harder over the towline than with direct pull.

This capacity to produce greatly improved pull forces has lead to the development of different and modern varieties of an old device known as fairlead.

Let's analyze recent developments in towage equipment, which has focused mainly in tow winches and towlines, keeping the rest under minimal evolution. Such equipment comprises bitts, different types of fairleads, rollers, roller-heads, cat holes, bollards, tow pins, hold-down block, etc. which allow the tugboat to apply the pull force from a fixed point on the tug deck.

Therefore, the tug transmits all the required force to the assisted vessel via the towline – which as has been said can be a rope or a cable– and, when the pull is indirect, the towline goes trough a fairlead. This fairlead is the forced way between the winch or the hook and the towed vessel. This is the most critical point of the towline, since it supports there the greatest forces during towing operations.

This type of fairleads, also known as towing staples, serve several purposes: to maintain a fixed geometrical distance between the propeller and the towing point, to guide the towline to / from the winch so that its drum can stow the wire properly and to make sure that the towed ship doesn't tow the tug as result of a human error or an inadequate manoeuvre, avoiding therefore the risk of capsizing.

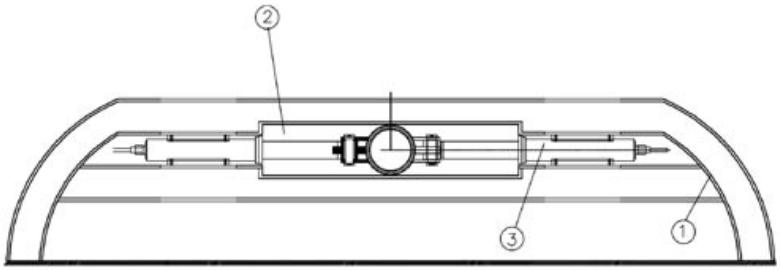
Current tug fairleads are fixed structures, usually formed by a stand welded to the deck with a couple of vertical or tilted cylinders which form a closed arch in their upper part. They are made of steel and located amidships, some times forward and some times aft, or even in both places. Their precise longitudinal positioning depends upon the shape of the hull, the deck and even propeller location. They can also be fixed to the deck with a variety of intermediate devices.

The stress produced over the towline can lead to its eventual failure, but even if it doesn't, it certainly produces a premature tensile stress and life shortening. The problem is that the lengthening produced between the winch and the staple is not balanced with that of the rest of the towline and, when it does, it produces sudden and violent slipping which frequently leads to towline failure.

We are proposing a new variety of dynamic fairlead between the winch and the tow, as we can see in Figure 1, which will compensate the above lengthening and protect the towline from unwanted and violent counter effects.

Up to now, we have usually found static towing gear. At most, we find rotating fairleads or ancillary elements to stabilize the path of the towline, but no one has proposed a dynamic device which will automatically adjust its movement as the pull changes, to avoid violent counter effects which can lead to towline failure.

Figure 2.- Fairlead



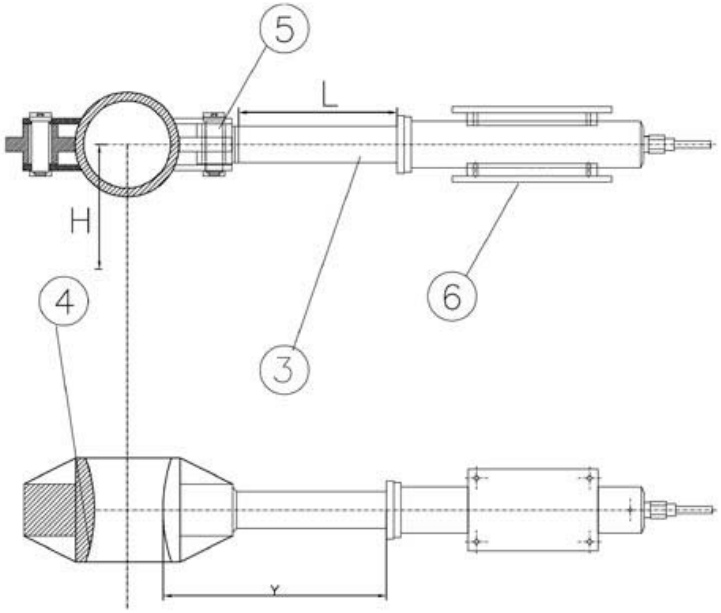
2. DESCRIPTION

The fairlead see figure 2. Usually, towing staples are fixed and welded to the deck, with a hole through which the towline goes. Our patent consists of the implementation of an auxiliary device which moves the fairlead to compensate the towline lengthening. Such movement equals the lengthening produced in the towline between the winch and the fairlead when it is under heavy stress. The movement of the fairlead bed is produced and controlled by a hydraulic system which can be seen in figures 3. The system regulation depends on the elasticity module of the working towline.

This device consists of the following parts, which are marked in the figure with the numbers shown below:

1. Arch structure.
2. Rail track
3. Two hydraulic cylinders.
4. Fairlead.
5. Crosshead
6. Bed.
7. Regulating valve.
8. Safety valves.
9. No-return valves.
10. Isolating valve.
11. Reversible pump.
12. Pump control.
13. Control box.
14. Oil tank.

Figure 3.- Two Hydraulic Cylinders



Hydraulic cylinders (3) are connected by pipes through the regulating valve (7), which limits oil flow depending on the characteristics of the towline. Therefore, this valve will be regulated as the lengthening expected in the towline. In figure 2, we can see opposite balanced cylinders with the fairlead in its resting position, amidships.

The hydraulic system which moves the basic fairlead is shown with greater detail in figure 2. We can see how the system recovers its resting position by means of two springs and a reversible engine.

This circuit is composed by a reversible hydraulic pump, two safety valves, two no-return valves, pump control and two isolating valves.

3. SYSTEM OPERATION

The patent system is aimed to be applied to any existing tug, no matter her size or power. The device can be accordingly dimensioned. Distances L and H in fig. 3 vary with the winch level and the expected lengthening of the towline.

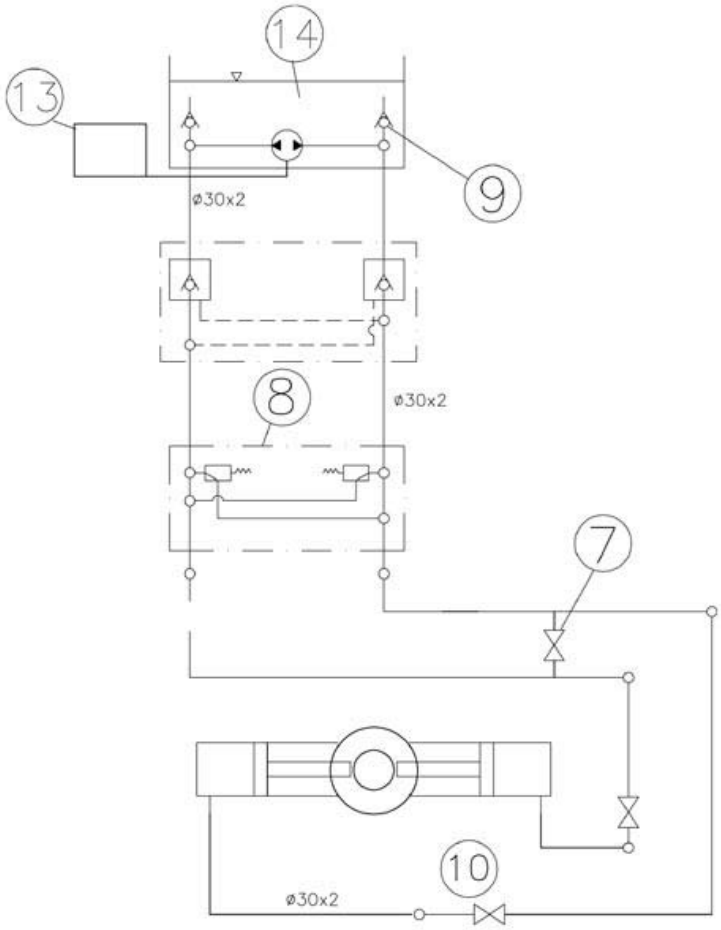
As we can see in figure 4, the device consists of two opposite cylinders with inner springs to recover the resting position. The towline goes from the winch through the hole in the lead up to the tow. When ordered to pull, the tug will manoeuvre as usual until the pull reaches higher values than those for which the control valve has been adjusted, the system will begin to operate moving the fairlead abeam to compensate the lengthening of the towline. Once the pull decreases below the calculated value, the system will come to a rest, with the fairlead amidships.

This abeam displacement of the fairlead has an additional benefit. As the fairlead pivot point moves abeam, the pulling forces work against the heeling moment, increasing tug stability.

When the system is intended for a tug of over 2.000 kW we propose a different design, which is shown in figure 5, where the resting position is reached by means of a hydraulic pump. This hydraulic equipment permits a better control of the fairlead displacement as the manoeuvre requires.

The system in designed to withstand failures, since the fairlead moves safely inside a track with a limited travel.

Figure 4.- Hydraulic System



4. APPLICATION

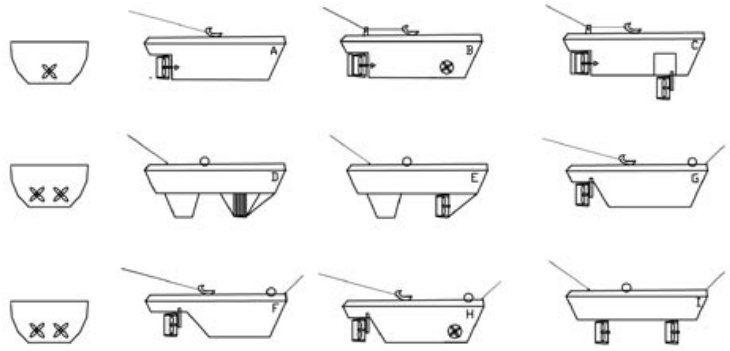
A study would be carried out for each tug, taking into consideration the need of specific manoeuvre capabilities, type of operations and pull required to determine the proper amount of displacement of the fairlead to compensate the expected lengthening and the overall design of the system. After the study is finished, the tug company can order the making of the device to any mechanical workshop in their area.

The device is compact and can integrate most of its elements, so that the fitting onboard can be achieved in a couple of working days. Figure 5 shows its position relative to the propellers. The types of tug for dynamic fairlead are: conventional tug, Azimuth Stern Tug, Combi-Tugs, Tractor-tugs and Reverse-Tractor Tugs and Rotor tug.

5. CONCLUSIONS

1. Indirect pull evolution creates the need of towing staples.
2. Combi-tugs, tractor-tugs and reverse-tractor tugs use fixed towing staples.
3. Failure usually takes place at the contact point between the towlines and the fairleads.
4. The use of bearings or grease doesn't reduce enough the risk of towline failure.
5. The dynamic fairlead proposed in this paper compensates the lengthening of the towline.
6. The dynamic fairlead avoids violent counter effects, minimizing the risk of breaking the towline.
7. Using dynamic fairleads increases safety in towing operations, especially during critical moments when towline lengthening can provoke its failure.
8. Dynamic fairlead fitting will increase towline life.
9. The device proposed is quite economically efficient. Its cost is moderate.
10. Tug stability will increase during tow operations when fitted with a dynamic fairlead.

Figure 5.- Tugs Types



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APENDICE: BITA GUÍA DINÁMICA PARA CHIGRES DE REMOLCADORES

RESUMEN

En los remolcadores tractor y acimutales, este mecanismo directamente, amortigua y compensa el alargamiento de la línea de remolque entre la maquinilla y la bita-guía, para evitar los estrincones, proteger la línea de remolque y aumentar sus horas de trabajo.

A su vez indirectamente aumenta la estabilidad del remolcador, durante las operaciones de remolque, cuando el tiro es de traves.

Este sistema esta compuesto por unos elementos hidráulicos.

Palabras clave: Remolcador, Bita, Chigre, Maquinilla, Gancho y Estabilidad.

INTRODUCCIÓN

Consiste en una máquina compuesta por dos cilindros situada en una estructura de arcos y con una pista por donde se desliza la guía, por la que pasará la línea de remolque del remolcador al buque remolcado, ésta guía permite trabajar a la línea de remolque sin problemas en las situaciones en que el tiro se eleva por encima de valores superiores al tiro a punto fijo del remolcador.

Las ventajas son:

- Compensar el alargamiento producido en las líneas de remolque entre el chigre y la bita-guía
- Amortiguar los efectos de la estrepada y reducir los estrincones.
- Aumentar la seguridad durante los remolques realizados con tiro indirecto
- Alarga la vida de las líneas de remolque
- Reducir el efecto de la fatiga a la que está sometida la línea de remolque.

INVESTIGACION DEL PROBLEMA

La bita-guía, también denominada bitón, está situada en la cubierta del remolcador y su trabajo esta reservado para las peores situaciones de tiro.

Conocido es, que entre el buque remolcado y el remolcador, como elemento de unión y transmisión de esfuerzos, está la línea de remolque que sale del chigre del remolcador hasta el buque remolcado, y que en los nuevos remolcadores, en caso de llegar el tiro a sobrepasar la carga de rotura del cable, del chigre se desvira para que el remolque no falte, pero cuando el trabajo obliga a que el remolque trabaje sobre la bita-guía, el rozamiento al desvirarse la maquinilla produce en la línea de remolque sobre la bita-guía un aumento de temperatura que produce la rotura.

La capacidad de desarrollar en los remolcadores actuales, un tiro muy superior a los obtenidos con tiro directo y que, dependiendo de la velocidad del buque remolcado, puede llegar a superar el doble del tiro realizado a punto fijo, hace que en la línea de remolque se produzcan solicitaciones en los cables o estachas de remolque como:

Tracción, Abrasión, Temperatura, Giro, Aplastamiento, Golpes, Efectos de Alargamiento y de Rozamiento, y Esfuerzos de Tracción y Flexión.

METODOLOGÍA DE LA INVESTIGACION

Varios métodos se han utilizado para reducir los efectos del contacto entre las líneas de remolque y las guías. Se usan los alavantes, las gateras, las guías de retorno, las guías panamá, los bitones y las bitas-guía, otros métodos son la lubricación de los elementos en contacto a base de grasas.

Las patentes relacionadas son:

- Sistemas de estibado de cadenas de maniobra, 435314
- Dispositivo para enganchar y desenganchar un cable 268143 - U2698143
- Mecanismo de retención y soltado rápido de cable y/o cadena, 547728.
- Mejoras de bitas giratorias con un mecanismo de bloqueo y frenado, 3555617
- Aparejo para maniobra y freno de embarcaciones, 950084
- Guía cabos en forma de cuadrante auto deslizante, US 904573, Europa87104203.2
- Bita telescópica para guiado de líneas de tipo de amarre en buques, 271.349
- Hasta ahora nos hemos encontrado que todos los sistemas de alavantes, guías, gateras, guías de retorno, guías panamá, bitas-guía y bitones son estáticos y sus desarrollos han llegado a hacerlos giratorios, otros han diseñado los elementos para que los cables sigan rutas fijas definidas, pero ninguno ha desarrollado una guía dinámica que se encuentra construida sobre una máquina que la moverá de acuerdo con el esfuerzo al que sea sometido la línea de remolque para evitar los estrincones sobre ella y la rotura por su efecto.

SISTEMA DE BITA GUIA DINÁMICA PARA CHIGRES DE REMOLCADORES

Las bitas-guía en los remolcadores son fijas y soldadas a la cubierta, tienen un orificio por donde pasa la línea de remolque, con la característica principal que este invento introduce una máquina que mueve la guía para compensar el alargamiento de la línea de remolque. El trabajo de la guía dinámica consiste en realizar un desplazamiento de la guía en dirección transversal, como demuestra la figura 1, cuya magnitud es igual al alargamiento sufrido por la línea de remolque entre la maquinilla y la guía, cuando ésta esté sometida a elevados esfuerzos.

El movimiento de la bancada de la guía es efectuado por medio de una máquina hidráulica, según las figuras 1, 2, 3 y 4, regulada de acuerdo con el módulo de elasticidad de la línea de remolque que esté trabajando.

Está máquina esta compuesta por los siguientes elementos, representados en las figuras por los números:

- Estructura de arcos (1)
- Pista con limitación de recorrido (2)
- Dos cilindros hidráulicos (3)
- Guía (4)
- Articulación de montaje rápido (5)
- Bancada (6)
- Válvula reguladora (7)
- Válvulas de seguridad (8)
- Válvulas anti-retorno (9)
- Válvula de incomunicación (10)
- Bomba reversible (11)
- Maniobra de la bomba (12)
- Caja de conexiones (13)
- Tanque de aceite (14)

- Los cilindros hidráulicos (3) están comunicados por unas tuberías a través de la válvula reguladora (7) que limita el paso del aceite en función de las características del material de la línea de remolque, por lo que la válvula se regulará de acuerdo al alargamiento que se produce en la línea de remolque, de acuerdo con el recorrido que deba realizar.

- En la figura están representados los dos cilindros opuestos compensados y la bita guía situada en posición de reposo, en la línea de crujía.

- En la figura (3) se aprecia el esquema hidráulico que maniobra la bita-guía básica, con unos resortes para recuperar la guía la posición de reposo o de la crujía.

- En la figura (4) tenemos el esquema hidráulico del equipo con recuperación de la posición de reposo por un motor reversible.

• Los elementos que componen este circuito son: una Bomba hidráulica reversible, dos válvulas de seguridad, dos válvulas anti-retorno, el cuadro de maniobra del motor hidráulico y dos válvulas de incomunicación.

DESCRIPCIÓN DE LOS DIBUJOS

Figura 1.- Principio básico del chigre

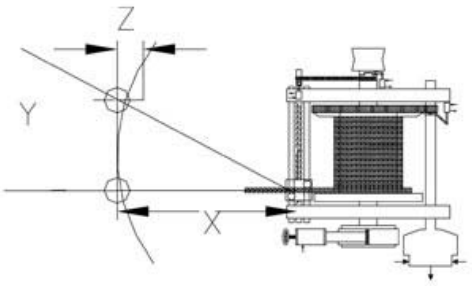


Figura 2.- Disposición Bita Dinámica

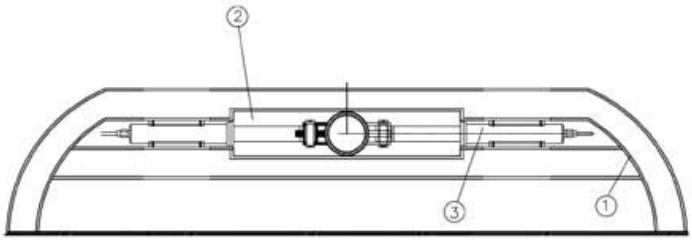


Figura 3.- Guía y Servomotor

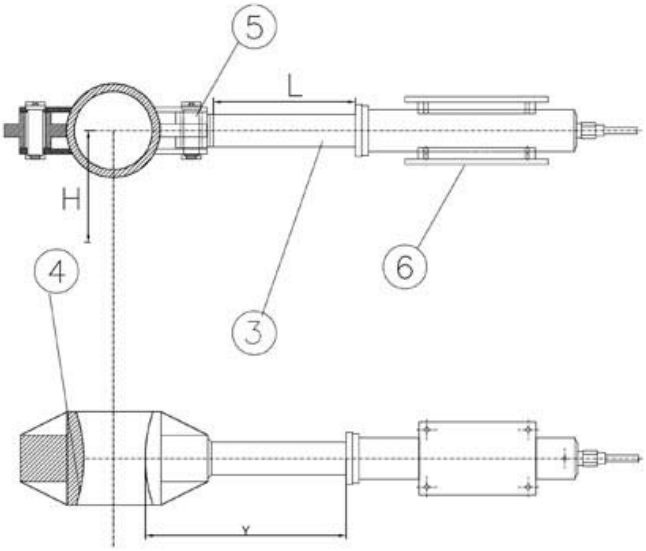


Figura 4.- Esquema hidráulico

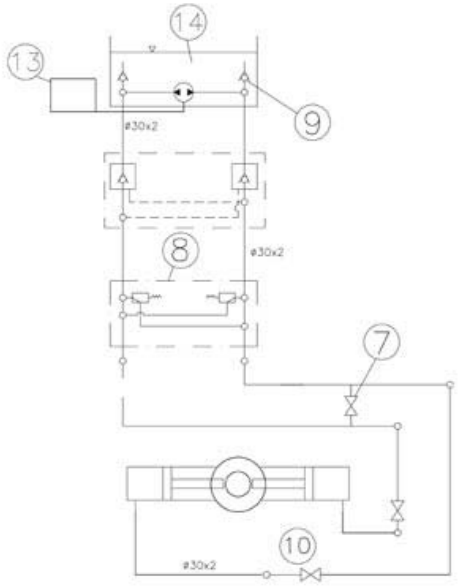
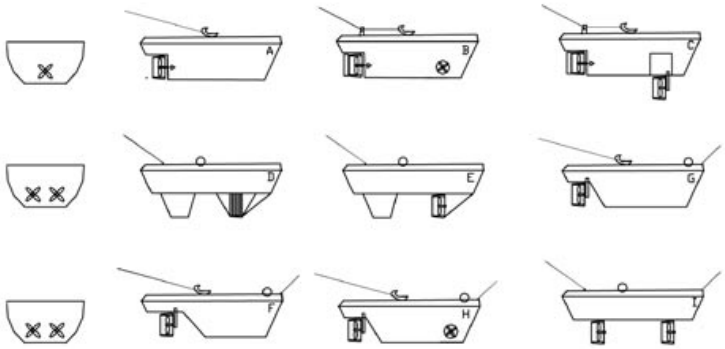
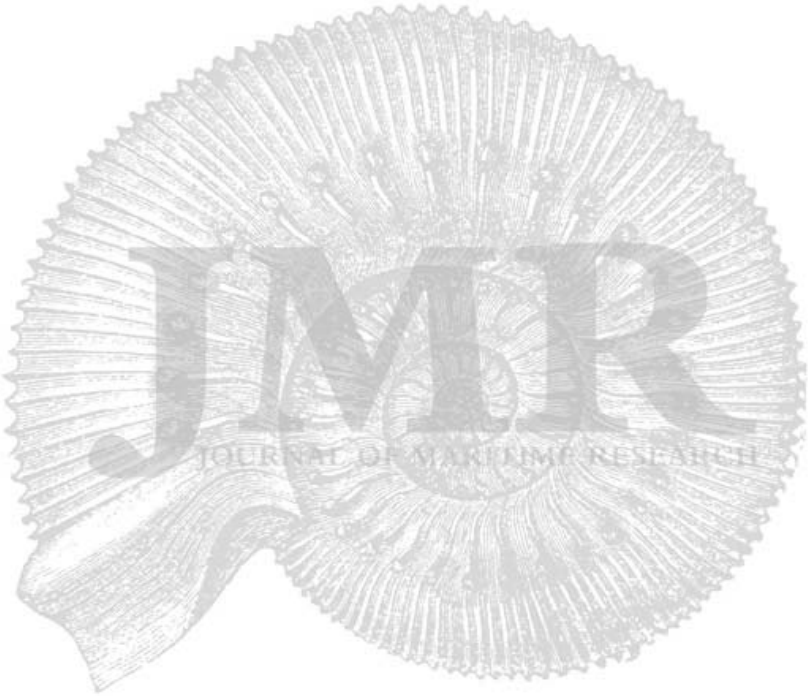


Figura 5.- Tipos de buques para la instalación de la Bita Dinámica



CONCLUSIONES

1.- El tiro indirecto necesita una guía sujeta a una estructura fija a la cubierta.
2.- Los remolcadores acimutales, tractor, combi y convencionales utilizan estas guías.
3.- Las roturas en las líneas de remolque se producen en el punto de contacto con la guía.
4.- La utilización de grasas y otros sistemas desarrollados no solucionan el problema.
5.- La Bita Dinámica, soluciona el problema de estrepada de las líneas de remolque.
6.- La Bita Dinámica amortigua los golpes del remolque.
7.- La Bita Dinámica, reduce el rozamiento de la línea del remolque con la guía.
8.- La Bita Dinámica incrementa el tiempo de utilización de la línea de remolque.
9.- La Bita Dinámica no supone un costo elevado entre la maquinaria del remolcador.
10.- Incremento de la estabilidad durante el tiro indirecto.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