(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 391 380 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
25.02.2004 Bulletin 2004/09

(51) Int Cl.[7]: **B63H 25/38**

(21) Application number: **03077326.1**

(22) Date of filing: **24.07.2003**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IT LI LU MC NL PT RO SE SI SK TR
Designated Extension States:
AL LT LV MK

(30) Priority: **22.08.2002 IT GE20020077**

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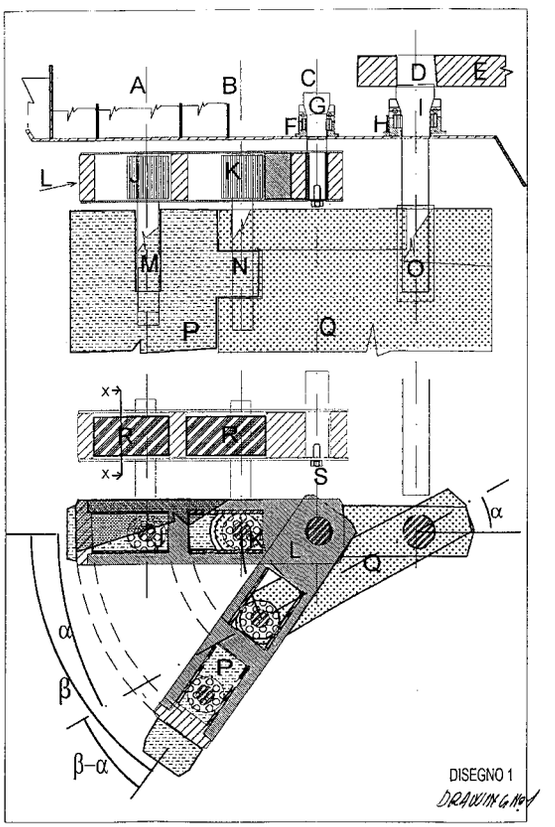
(54) Mechanical device for torque transmision from rudder to a flap by means of a bearings guide

(57) The solved problem regarding the transmission of torque at low speed from a steering rudder (Q) to a flap (P), blade hinged to the rudder blade aft edge, all mounted on the aft side of a hull floating and moving in water.
With a reduction of friction and so of wear, this mechanical device solves the above problem without using any other active steering gear (E) than the one of the rudder. This mechanical device functioning space portion is horizontal between the hull and vertical blades of the steering system.
It is built up by: a rollers bearing (K) on the upper edge of the rudder blade with its vertical axis coincident with flap rotation axis (N), a rollers bearing (J) on the upper edge of the flap with its vertical axis positioned at about one third to the aft edge of the flap blade, a grooved beam guide (L) with the fore end constrained (keyed) to a vertical guide stock (G), after than the rudder stock (I). Part of the torque of the rudder stock is transmitted to the flap blade, it happens with the use of said two rollers bearings (K e J) with vertical axis, which shift into the grooved guide (L). During the rudder rotation the grooved guide, pulled by bearing (K), with rotation around (C), acts and pushes on (J) that get rotation to the flap blade. The rotation angle of the flap blade "Beta" is aparametric function of the "Alfa" angle of rotation of the rudder blade and parameters are the rotation arms (a,b,c) of rotation of the same mechanical torque transmission device.



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Description

[0001] With reference to the actual development of technology and to previous solutions applied to solve the problem of the transmission of the torque to a flap hinged on the aft side of a rudder blade only from the rudder steering actuator; the real news which distinguish this simple invention from previous ones, are connected with the strong decrease of frictions and the elimination of the risk of permanent block of the steering system.

[0002] It is realised with two roller bearings (with their shafts integrated in the upper edge of the flap/rudder blades) which roll alternatively to one or to the other internal lateral sides of a grooved guide bar (L) with fore-end constrained to a vertical rotating shaft (G) similar to common naval rudder stock.

[0003] The guide works in the best way like a beam by bending with three loads at optimum distances. "Thrust pins (C, J, K)" are free to turn on itselves, they cancel negative effect of relative rotation between hull, rudder, flap, pins, guide, then the efficiency of mechanical device increases. Loads parallel to the guide are negligible than those normal to the guide.

[0004] **Functioning:** Rudder tiller (E) applies torque to the rudder stock (I) which swings the rudder blade (Q) of an angle of α. This rotation moves the axis (B) of the bearing (K) and also of the hinge (N) of the flap (P) which also shift along the guide (L), that displaces of an angle β around its axis (C). During this rotation the guide (L) pull the bearing (J) with flap driving stock (M) and then the flap blade (P) shifts along the guide to outside and displaces of the same angle β. The rotation angle between flap and rudder blades will be equal to β- α. Fore roller bearing (K) and aft roller bearing (J) shift on the internal walls of the grooved guide; in the specific case of drawings, the bearing (K) rolls on the internal vertical right wall of the guide and the bearing (J) rolls on the internal vertical left wall of the guide, otherwise when opposite rotation occurs it happens the contrary.

[0005] With reference to construction details drawings for cutting and grinding mechanical parts of this mechanism it is strongly raccomended to avoid sharping edges on mechanical components in way to limit notching. With reference to the mounting of all components, retainers are recommended.

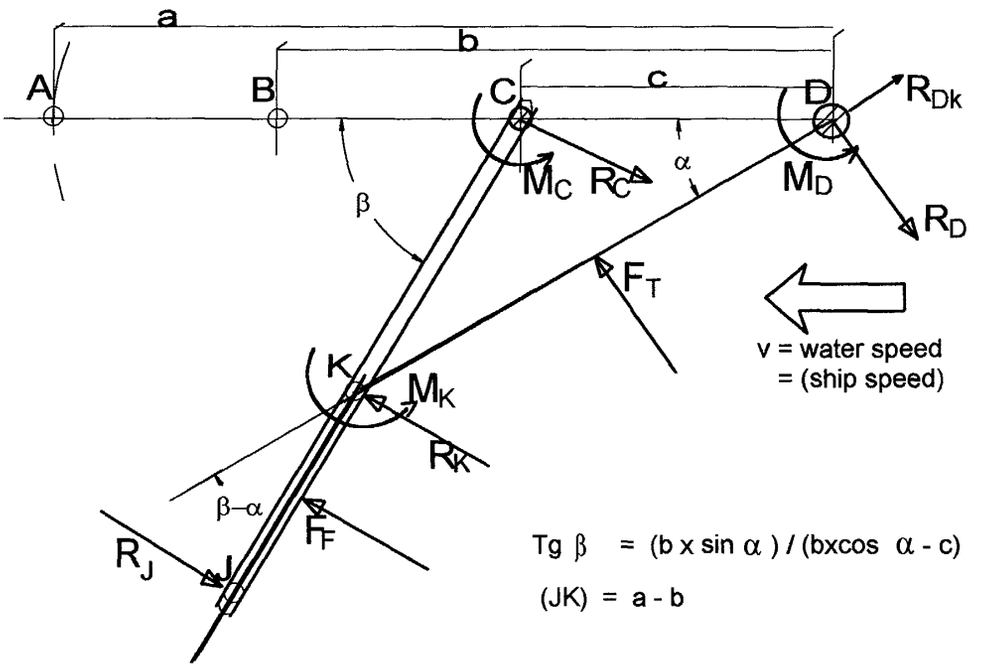
With reference to the desmounting procedure of the grooved guide bar, at first the bolt (S) is to be *detightned* then the guide support (T) and rotating part disassembled when the shaft (G) upwithdrawn; after rotation of the rudder enough to deconstrain the guide (L) from the stock, but to let it connected with bearings to the flap and the aft side of the rudder blades; then it could be laterally moved and after retainers dismounting it could also deconstrained from spacers , bearings and plates.

In the case of application for a vessel rudder in sea water , with v = maximum speed of the ship, the positive evaluation about realibility of this mechanical device is strictly connected with the dimensioning and admeasurement of its mechanical components and of the rudder parts; this starts from the specific ratio Flap Blade Area / Rudder Blade Area, ship speed, hull streamline, flap and rudder blades streamlines and areas, for every single ship.

With reference to the above, Static Balance Draft follows (next page) for this Torque Transmission Mechanical Device.

Static Balance Draft for the Torque Transmission Mechanic Device.

Fixed values a, b, c,
Mt = F(Alfa; ship speed; rudder blade area, ...) and
Mf = F(Beta ; ship speed; flap blade area, ...)



Tg β = (b x sin α) / (bxcos α - c)

(JK) = a - b

Both rotating axis of bearings, with flap blade, shift along the grooved guide, for a lenght of:

(KC - BC) = b^2 -2 x b x c x cos α + c^2 - b + c

IF:

Mt = Rudder Stock Torque (no flap) = Ft x b/2

Mf = Flap Torque = Ff x (a-b)/2

Md = Ft x b/2 + Rk x cos (β–α) x b Eq. Rudder Rotation

Mc = 0 = Rk x (KC) + Rj x (JC) Eq. Grooved Guide Rotation

Mk = 0 = Ff x (a-b)/2 + Rj x (a-b) Eq. Flap Rotation

To find Md; Rk; Rj.

Then also :

Rc + Rk + Rj = 0 Transl. Eq. normal to the Guide

Rk x cos (β–α) + Ft + Rd = 0 Transl. Eq. normal to the rudder blade

Rk x sin(β–α) + Rdk = 0 Transl Eq. straight the rudder blade

To Find : Rc = tot. reaction at guide stock, and Rt = tot reaction of rudder stock = Rd + Rdk
with Rd = reaction at guide stock normal to the rudder blade
and Rdk= reaction at guide stock straight to the rudder blade

Caption also for Drawings n° 1 and n°2 (DISEGNI 1 E 2)

[0006]

A : Axis of: Roller Bearing (J), Stock pocket (M) when $\alpha = 0$;
B : Axis of: Roller Bearing (K) and Flap Pintle/Gudgeon (N); when $\alpha = 0$;
C : Axis of: Grooved Guide Stock (G);
D : Axis of: Rudder Stock (I) and Rudder Pintle/Gudgeon (O);
E : Rudder Tiller;
F : Thrust Bearing and Sealing of grooved guide stock (G) ;
G : Rotational Stock keyed to Groveed Guide(L);
H : Thrust Bearing and Sealing of rudder stock (I);
I : Rudder Stock (Q);
J : Aft Roller bearing; K : Fore Roller Bearing;
L : Grooved Guide for bearings (J and K);
L1: Aft End Spacer - L2: Medium Spacer - L3:Fore End Spacer Holed Round Bar ;
L4a, L4b steel plates respectively resting on and down to the profile of the grooved guide;
L5a, L5b steel plates respectively adjacent to internal upper and lower sides of profile of the grooved guide; M : Flap Stock;
N : Flap Pintle/Gudgeon;
O : Rudder Pintle/Gudgeon;
P : Rudder Flap;
Q : Rudder Blade;
R : Rolling plates for bearings (J e K), fitted on the internal grooved guide walls;
S : Assembling Bolt for Stock (G) and grooved guide (L) ; T: Guide Support Cup;
Description Ref.:Right (Port) , Left (starboard), Fore, Aft: verse and direction of the hull into the fluide.

Claims

1. **Claim: Rotation Grooved Guide (L)** will be constructed as follows and proportioned to the other components of the mechanical device. This component could be constructed (i.e.) in several subcomponents (Drawing 2) and easily demountable: starting from HR ((Yield Strenght)Rp0,2 > 315 N/mmh ^2) steel beams with C (or double L) sections] [, with two steel demountable proper spacers, one at aft end (L1), one medium (L2) and one other fixed (welded) spacer (L3) of proper height and holed properly for keying connection to the vertical stock (G).
   Upper side closed with an horizontal dimensioned steel plate (L5a) adjacent to the upper side of the internal profiles and one other (L4a) resting on the same profile, furthermore corresponding same plates for the lower side (L5b - L4b), but also holed with proper openings to let the relative guide translation of those shafts of bearings which are integral to the flap. The guide stock (G) is keyed to the grooved guide (L) for all the height of the hole of the relative guide beam end, then they are also bolted together with a lower cup (T) as support of the weight of the same guide beam and to maintain it in horizontal position. Internal walls of the grooved guide are parallel and four plates (R) are applied on, two for each side, with an harder surfaces proper to support the higher pressure on bearing areas , with a lenght bit more than the shift contact lenght (KC-BC) of bearings on.
   Internal surfaces of these plates, built with hardened steel material, have a divergency angle of about 1° straight after, so that, while the rudder plate is turning, the shift of bearings (J), (K) and of the flap (P) is easier, furthermore the risk of a block between walls is almost reduced .

2. **Claim: Rollers Bearing J**
   With vertical axe positioned on the flap blade at about one third from the aft border, its height will be proper for utilisation with the grooved guide, completed with the vertical shaft integrated inside the flap blade which will be reinforced properly against concentrated loads.
   The height of the reinforced pocket for fitting the bearing shaft inside the flap blade is the height of upper hingers to the upper blade edge.
   The reinforcement of the upper bands of rudder and flap blades could be easily realised , in fact both cave structures could be overdimensioned, as frames and central girder, without change the external shell thicknesses and profiles of blades.
   Furthermore please note that the verse of rotation of this roller bearing is always opposite then the flap.

3. **Claim: Rollers Bearing K**

On the upper edge of the rudder blade with vertical axis coincident with the flap blade rotation axis, its height will be proper for utilisation with the grooved guide, completed with the vertical shaft integrated inside the flap blade which will be reinforced properly against concentrated loads.

The height of the reinforced pocket for fitting the bearing shaft inside the flap blade is the upper hingers to the upper blade edge.

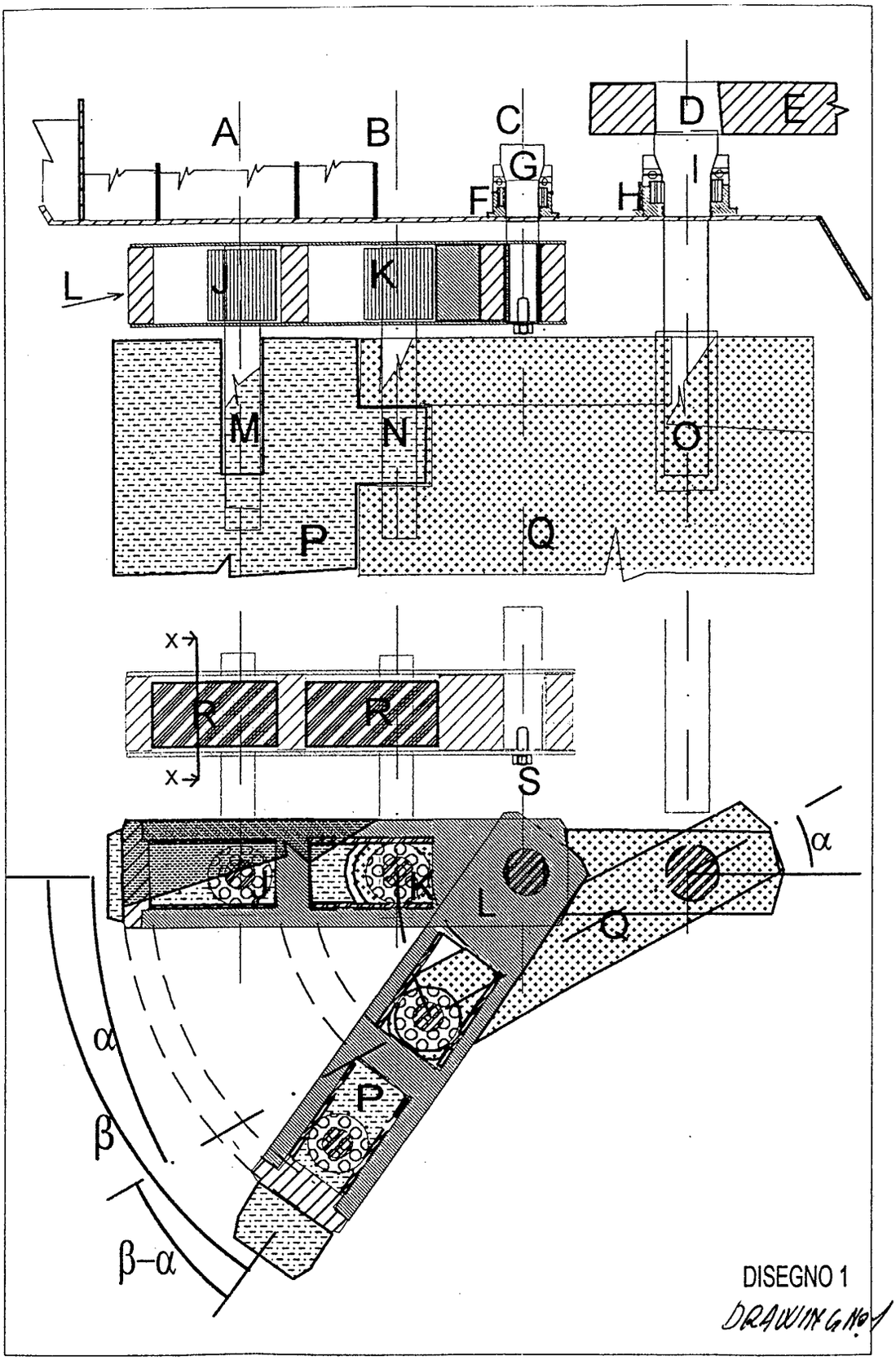
The reinforcement of the upper bands of rudder and flap blades could be easily realised , in fact both cave structures could be overdimensioned, as frames and central girder, without change the external shell thicknesses and profiles of blades.

4. **Claim: Guide Rotation Stock (G) di rotazione e sostegno guida (L)**

Usually, naval rudder stocks are provided with thrust bearings inside the hull to permit rotation and proper sealing at the hull passage.

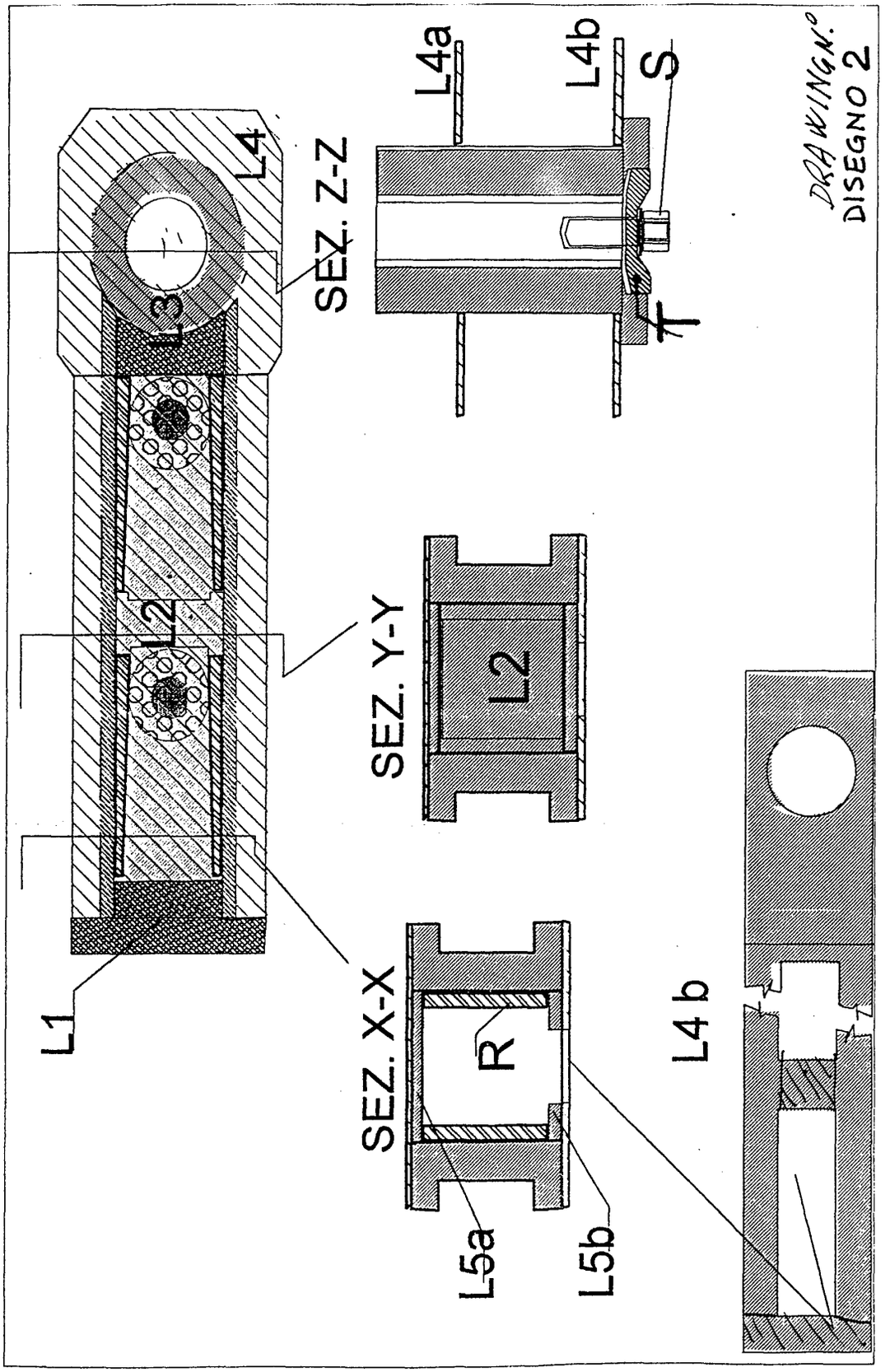
The upper side of the guide stock (G) will be the same of the above described common naval rudder stocks with the difference that above inside the hull will not be any tiller(E) of the steering gear.

The lower side of the guide stock (G) is complementary to to the described grooved guide (L) end to which is keyed with also a lower cup (T) as support of the weight of the same guide beam: lateral key pocket, threaded hole at bottom for the proper bolt (S).



DISEGNO 1

DRAWING No 1


DRAWING N.°
DISEGNO 2
L4
L3
L2
L1
SEZ. Z-Z
L4a
L4b
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SEZ. Y-Y
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SEZ. X-X
R
L5a
L5b
L4 b

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EUROPEAN SEARCH REPORT

Application Number
EP 03 07 7326

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X	DE 38 14 943 A (BECKER INGBUERO W) 29 December 1988 (1988-12-29) * abstract; figure 4 *	4	
X	DE 947 949 C (ERNST MURAWSKI) 23 August 1956 (1956-08-23) * page - *	4	
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A	DE 572 422 C (ERNST ROGGE) 16 March 1933 (1933-03-16) * page - *	1-4	
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	10 November 2003	Moya, E

CATEGORY OF CITED DOCUMENTS

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 03 07 7326

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