RETRACTABLE HYDROFOIL SYSTEM FOR WATER CRAFT

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FIG. 1

FIG. 2

FIG. 6

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The invention relates to a water-craft provided with a retractable hydrofoil system, which in passage raises the hull above the water level, and which at rest can be retracted and folded up on either side of the hull. This arrangement has the advantage that the folded up foils are not reaching further down than the keel of the hull and protect the deck-line, such that the craft is able to operate in shallow waters and to go along the piers and other ships without any difficulties.

The present invention is distinguished by the fact that supporting fins are turnably mounted about a longitudinal and horizontal axis on either side of the hull, these fins being connected pivotally to the outer parts of laterally separated foils, spaced downwardly from the hull and extending transverse to the hull. The inner part of each foil portion is pivotally connected to a strut which is turnably joined with its other end to a downwardly projecting portion of the hull. The strut is forming a link which guides the inner part of the foil towards the sides of the hull when the fins are swung upwardly and folded up on either sides of the hull.

In order to adapt the lift of the described foil system to alterations of speed or load, the fins and struts can be connected to a stiff girder extending transversely from the hull and mounted turnable thereon about its horizontal axis for changing the angle of attack of the foils.

As actuating means for the retraction of the two foil parts, a hydraulic ram is provided which acts on a lever connected with the fins and projecting into the hull. To lock the foil system in its operating and retracting position, the hydraulic ram is provided with terminal position locking means.

For small craft a hydraulic actuation of the retraction is dispensible and the foils can be folded up manually. In order to facilitate such handling the invention applies resilient means which produce a fin-lifting moment about the fin-axis of such a magnitude that the moment keeps the foils at their folded up position. While lowering the foils to their operation position, the weight of the foil system parts overcomes the action of the resilient means so that the foils fall into the operational position, where they can be locked. For this purpose the fins are provided with a downwardly projecting lever, which joins a part of the hull in operating position of the foil system for locking purposes.

Two forms of the invention are illustrated by way of example in the accompanying drawings, in which:

FIG. 1 is a schematic front view of a craft provided with a retractable foil system according to one embodiment of the invention;

FIG. 2 is a fragmentary front view illustrating the embodiment of FIG. 1 with the foil system in a retracted inoperative position;

FIG. 3 is a schematic front view illustrating another embodiment of a retractable foil system according to the invention;

FIG. 4 is a fragmentary view illustrating the foil system of the embodiment of FIG. 3 in a retracted inoperative position;

FIG. 5 is a fragmentary plan view illustrating the foil system of the embodiment of FIG. 3 in the operative position; and

FIG. 6 is a fragmentary plan view illustrating the foil system of the embodiment of FIG. 3 in the operative position.

Referring first to the embodiment of FIGS. 1, 2, and 6, the hull 1 of the craft has a means 3 supporting a fin portion 2 for turning movement about a horizontal axis extending in longitudinal direction of the hull. Another means 6a is secured to a bracket 6 downwardly projecting from hull 1 to support a strut 5 for turning movement about a longitudinal horizontal axis. The strut is located lower than the axis at 3. A foil means 4 is articulated to the outer end of fin portion 2 by a pivot means or joint 2a, and to the lower end of strut 5 by a joint or pivot means 5a.

A lever 10 is fixedly connected to fin portion 2 so as to turn with the same, and is articulated to a connecting rod 9a of the piston of a hydraulic motor 9.

When the operating means 9, 9a is actuated, piston rod 9a moves downwardly and turns lever 10 with fin portion 2 so that fin portion 2, strut 5, and foil means 4 move to the higher inoperative position shown in FIG. 2 in which fin portion 2 is located directly adjacent the side of hull 1, strut 5 is also closely adjacent hull 1, and foil means 4 is located adjacent fin portion 2 and strut 5, and flatly folded against the side of the hull.

It will be understood that fin portion 2 and strut 5 constitute link means linking the foil means 4 to the hull 1. In the higher position of FIG. 2, the entire foil system is folded to assume the least possible space, while the inner and lower end of foil means 4 is located above the bottom portions of hull 1. Consequently, the craft can move in shallow waters in the position of FIG. 2, while very little lateral space is taken up by the folded foil system since the foil means 4 lies flat on the side of the hull.

The foil system of the embodiment of FIGS. 3 and 4 is constructed in a manner similar to the foil system of FIGS. 1 and 2, and includes on either side of hull 1, a fin portion 2, a strut 5, and foil means 4. A rigid connecting member 7 extends transversely through hull 1 and has supporting end portions 7a of circular cross-section. End portions 7a are turnably mounted in bearing means 8 on the hull for turning movement about a transverse horizontal axis. Bracket portions 6 extend downwardly from the end portions 7a of connecting member 7 and have at the free ends thereof, pivot means 6a for supporting the struts 5. Struts 5 are articulated to foil means 4 by pivot joints 5a. End portions 7a carry other brackets 16 which support the pivot means 3 on which the fin portions 2 are mounted for turning movement. Pivot joints 2a connect fin portions 2 with foil means 4.

A lever means 17 is secured to connecting member 7 so that the same can be turned in bearings 8 whereby both foil systems are simultaneously turned for varying their angle of attack when the foil means are in the operative position shown in FIG. 3. Each foil system may be raised and lowered by manual operation, or by actuating means of the type described with reference to FIGS. 1 and 2, but not shown in FIGS. 3 and 4. For example, a hydraulic motor 9 may be connected by a rod 9a to a lever 10 secured to fin portion 2. In the embodiment of FIGS. 3 and 4, the foil means are counterbalanced, which facilitates a manual operation. Lever 10 is secured to fin portion 2, and bracket means 7b is secured to connecting member 7. A spring means 11 connects the brackets 2b and 7b. In the higher position of the foil system shown in FIG. 4, the center of gravity of the foil system has a smaller effective lever arm than in the position of FIG. 3 so that the turning moment exerted by the foil means in the position of FIG. 4 is smaller than in the position of FIG. 3. On the other hand, the effective lever arm of spring 11 is greater in the position of FIG. 4, than in the position of FIG. 3. The arrange-
ment is such that the turning moment exerted by spring means 11 in the position of FIG. 4 is greater than the opposing turning moment exerted by the weight of the foil system so that the foil system tends to stay in the folded position shown in FIG. 4.

When the foil system is turned by manual operation, or by operating means 9, 16, not shown in FIGS. 3 and 4, from the higher position to the lower position, the center of gravity of the foil system moves away from the turning axis, and in the lower operative position of FIG. 3, the turning moment exerted by the weight of the foil system is greater than the countering moment of the spring means 11 so that the foil system tends to remain in the lower position until raised again by the operator. However, locking means are provided for rigidly locking the foil system in the operative position.

A transverse shaft 12 is mounted for turning movement in corresponding bearing bores 12a in end portions 7a of connecting member 7. Shaft 12 also passes through a bore in lever 17. The ends of shaft 12 have hammer heads 13 which pass in vertical position through vertically elongated slots in locking arms 14 of fin portions 2 when the foil systems are in the lower position shown in FIG. 3. A locking arm 14a is about the end faces of end members 7a. A lever 15 is secured to shaft 12, so that shaft 12 can be turned to a position in which the hammer heads 13 extend in horizontal direction and transverse to the vertical slots in locking arms 14 so that the foil systems are locked against movement to the higher folded position.

When lever 15 is turned from its horizontal position of FIG. 3 to the vertical position shown in FIG. 4, the hammer heads 13 extend in vertical direction so that they can pass through the vertical slots in locking arms 14 when the foil systems are swung upwardly, assisted by the action of spring means 11. When the foil system arrives in the higher position shown in FIG. 4, the turning moment produced by spring means 11 is sufficient to hold the foil systems in the folded inoperative position.

What we claim is:

1. A retractable hydrofoil system comprising, in combination, an elongate hull having lateral wall means and a bottom wall; an upper link having an inner end mounted on said lateral wall means of said hull for turning movement about a first horizontal axis between a lower position projecting from said bottom wall and a higher position retracted close to the side of said hull; a lower link having an inner end mounted on said hull for turning movement about a second horizontal axis located in the region of the lower part of said lateral wall means and the outer part of said bottom wall and lower on said hull than said first axis between a lower position downwardly projecting from said hull and a higher position retracted close to said hull extending from said second axis upwardly along said lateral wall means; and foil means having an outer portion pivotally connected to the other end of said upper link and an inner portion pivotally connected to the other end of said lower link, said links and foil means being arranged and constructed so that said foil means is located lower than said hull when said links are in said lower positions, and is located closely adjacent said links and flatly folded against said lateral wall means and above said bottom wall of said hull when said links are in said upper positions thereof.

2. A retractable hydrofoil system comprising, in combination, an elongate hull; a rigid connecting member extending transversely through said hull and being mounted thereto for turning movement about a horizontal axis, said connecting member having supporting end portions located on the sides of said hull; a pair of upper supporting fin portions having inner ends respectively mounted on said supporting end portions for turning movement about a pair of first horizontal longitudinal axes between lower positions projecting from said hull and higher positions retracted close to the sides of said hull; a pair of struts having inner ends respectively mounted on said supporting end portions for turning movement about a pair of second longitudinal horizontal axes located lower than said first axes and between lower positions downwardly projecting from said hull and higher positions retracted to said hull; and a pair of upper supporting fin portions pivotally connected to the ends of said struts, respectively, said fin portions, struts and foil means being arranged and constructed so that said foil means are in a lower position located lower than said struts and positions of said struts and struts are in said lower position, and are located in a higher position closely adjacent to said fin portions and struts and flatly folded against the sides of said hull when said fin portions and struts are in said higher positions, said fin portions, struts and foil means being turnable with said rigid connecting member for varying the angle of attack of said foil means in said lower position of said foil means.

3. A retractable hydrofoil system comprising, in combination, an elongate hull having lateral wall means and a bottom wall; a pair of upper supporting fin portions having inner ends respectively mounted on said lateral wall means of said hull for turning movement about a pair of first longitudinal horizontal axes between lower positions projecting from said hull and higher positions retracted close to the sides of said hull; a pair of struts having inner ends respectively mounted on said lower ends projecting from said hull for turning movement about a pair of second longitudinal horizontal axes located in the region of the lower part of said lateral wall means and the outer part of said bottom wall and lower on said hull than said first axes and between lower positions downwardly projecting from said hull and higher positions retracted close to the sides of said hull; and lock
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ing means located at said supporting end portions, respectively, and being operable to lock said rigid arms to said supporting end portions, respectively, whereby movement of said fin portions to said higher positions is prevented; a pair of struts having inner ends respectively mounted on said supporting end portions for turning movement about a pair of second longitudinal horizontal axes located lower than said first axes and between lower positions downwardly projecting from said hull and higher positions retracted to said hull; and a pair of foil means having outer portions pivotally connected to the other ends of said fin portions, respectively, and inner portions pivotally connected to the other ends of said struts, respectively, said fin portions, struts and foil means being arranged and constructed so that said foil means are in a lower position located lower than said hull when said fin portions and struts are in said lower positions, and are located in a higher position closely adjacent to said fin portions and struts and flatly folded against the sides of said hull when said fin portions and struts are in said higher positions thereof, said fin portions, struts and foil means being turnable with said rigid connecting member for varying the angle of attack of said foil means.

6. A retractable hydrofoil system comprising, in combination, an elongate hull; a rigid connecting member extending transversely through said hull and being mounted thereon for turning movement about a horizontal axis, said connecting member being supporting end portions located on the sides of said hull; a pair of upper supporting fin portions having inner ends respectively mounted on said supporting end portions for turning movement about a first pair of longitudinal horizontal axes located lower than said first axes and between lower positions downwardly projecting from said hull and higher positions retracted to said hull; a pair of foil means having outer portions pivotally connected to the other ends of said fin portions, respectively, and inner portions pivotally connected to the other ends of said struts, respectively, said fin portions, struts and foil means being arranged and constructed so that said foil means are in a lower position located lower than said hull when said fin portions and struts are in said lower positions, and are located in a higher position closely adjacent to said fin portions and struts and flatly folded against the sides of said hull when said fin portions and struts are in said higher positions thereof, said fin portions, struts and foil means being turnable with said rigid connecting member for varying the angle of attack of said foil means; and spring means connected to said fin portions and said struts and biasing said fin portions, struts and foil means to move to said higher positions, the effective lever arm of said spring means being smaller in said lower positions of said fin portions than in said higher positions of said fin portions so that said fin portions, struts and foil means are counterbalanced and held in said higher positions.

7. A retractable hydrofoil system comprising, in combination, an elongate hull; a rigid connecting member extending transversely through said hull and being mounted thereon for turning movement about a horizontal axis, said connecting member having supporting end portions located on the sides of said hull; a pair of upper supporting fin portions having inner ends respectively mounted on said supporting end portions for turning movement about a pair of second longitudinal horizontal axes located lower than said first axes and between lower positions downwardly projecting from said hull and higher positions retracted to said hull; a pair of foil means having outer portions pivotally connected to the other ends of said fin portions, respectively, and inner portions pivotally connected to the other ends of said struts, respectively, said fin portions, struts and foil means being arranged and constructed so that said foil means are in a lower position located lower than said hull when said fin portions and struts are in said lower positions, and are located in a higher position closely adjacent to said fin portions and struts and flatly folded against the sides of said hull when said fin portions and struts are in said higher positions thereof, said fin portions, struts and foil means being turnable with said rigid connecting member for varying the angle of attack of said foil means; and spring means connected to said fin portions and to said hull and biasing said fin portions, struts and foil means to move to said higher positions, the effective lever arm of said spring means being smaller in said lower positions of said fin portions than in said higher positions of said fin portions so that said fin portions, struts and foil means are counterbalanced and held in said higher positions thereof; spring means connected to said fin portions and to said hull and biasing said fin portions, struts and foil means to move to said higher positions, the effective lever arm of said spring means being smaller in said lower positions of said fin portions than in said higher positions of said fin portions so that said fin portions, struts and foil means are counterbalanced and held in said higher positions thereof; and locking means for locking the assemblies comprising said fin portions, said struts and said foil means in said lower positions.

8. A retractable hydrofoil system comprising, in combination, an elongate hull; a pair of upper supporting fin portions having inner ends respectively mounted on the sides of said hull for turning movement about a pair of first longitudinal horizontal axes between lower positions projecting from said hull and higher positions retracted close to the sides of said hull; a pair of struts having inner ends respectively mounted on the sides of said hull for turning movement about a pair of second longitudinal horizontal axes located lower than said first axes and between lower positions downwardly projecting from said hull and higher positions retracted to said hull; a pair of foil means having outer portions pivotally connected to the other ends of said fin portions, respectively, and inner portions pivotally connected to the other ends of said struts, respectively, said fin portions, struts and foil means being arranged and constructed so that said foil means are in a lower position located lower than said hull when said fin portions and struts are in said lower positions, and are located in a higher position closely adjacent to said fin portions and struts and flatly folded against the sides of said hull when said fin portions and struts are in said higher positions thereof, said fin portions, struts and foil means being turnable with said rigid connecting member for varying the angle of attack of said foil means; and spring means connected to said fin portions and to said hull and biasing said fin portions, struts and foil means to move to said higher positions, the effective lever arm of said spring means being smaller in said lower positions of said fin portions than in said higher positions of said fin portions so that said fin portions, struts and foil means are counterbalanced and held in said higher positions thereof; and locking means for locking the assemblies comprising said fin portions, said struts and said foil means in said lower positions.

9. A retractable hydrofoil system comprising, in combination, an elongate hull having a longitudinal axis, lateral wall means, and a bottom wall; link means mounted on said hull for turning movement about a pair of pivot axes in the region of the lower part of said lateral wall means and the outer part of said bottom wall and in a plane transverse to the longitudinal axis of said hull between a lower position projecting from said hull and a higher position extending from said pivot axis upwardly along said lateral wall means of said hull; and foil means including two spaced joint means articulated to said link means and
moving with the same, said link means and foil means being arranged and constructed in such a manner that said foil means is located lower than said hull when said link means is in said lower position, and is located in a higher position closely adjacent said link means and flatly folded against said lateral wall means and above said bottom wall of said hull when said link means is in said higher position.

10. A retractable hydrofoil system, comprising, in combination, an elongate hull having a longitudinal axis; a rigid connecting member extending transversely through said hull and being mounted thereon for turning movement about a transverse horizontal axis, said connecting member having supporting end portions located on opposite sides of said hull; link means mounted on each of said supporting end portions for turning movement in a plane transverse to the longitudinal axis of said hull between a lower position projecting from said hull and a higher position retracted close to the side of said hull; foil means including two spaced joint means articulated to said link means and moving with the same, said link means and foil means being arranged and constructed in such a manner that said foil means are located lower than said hull when said link means are in said lower position, and are located in a higher position closely adjacent said link means and flatly folded against said hull when said link means are in said higher position, said link means and foil means being turnable with said connecting member for varying the angle of attack of said foil means; and means for turning said connecting member.

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