

PATENT SPECIFICATION

(11) 1 533 960

1 533 960

- (21) Application No. 10945/77 (22) Filed 15 Mar. 1977
(31) Convention Application No. 688014 (32) Filed 19 May 1976 in
(33) United States of America (US)
(44) Complete Specification Published 29 Nov. 1978
(51) INT. CL.² B63B 3/38
(52) Index at Acceptance
B7A ED

(19)



(54) IMPROVEMENTS IN OR RELATING TO BARGES

(71) We, SEASpan DEVELOPMENT CO. LTD., a Corporation of British Columbia, Canada, of 10 Pemberton Avenue, North Vancouver, British Columbia, Canada V7P 2R1, do hereby declare the invention, for which we pray that a Patent may be granted to us, and the method by which it is to be performed to be particularly described in and by the following statement:-

This invention relates to skegs for barges to stabilize towed barges directionally by deterring yawing.

Skegs are customarily provided on the raked counter of the stern overhang of barges to deter yawing of a barge when towed by a towline trailing a towboat. Such skegs extend fore and aft over substantially the entire fore-and-aft extent of the barge stern counter, and their lower edges are at approximately the same elevation as the bottom of the barge. Such skegs are of low aspect ratio have no leading edge portion spaced from the stern counter of the barge and such skegs are in the form of flat or cambered plates as distinguished from being of airfoil cross section. Usually two of such skegs are provided, arranged symmetrically at opposite sides of the longitudinal vertical central plane of the barge.

Such conventional skegs are not very efficient in deterring yaw of a barge which is not self-propelled but is towed by a towline connected to its bow, and they do increase the drag of the barge a substantial amount over the drag of a similar barge having no skegs.

It is a principal object of this invention to provide skegs for a barge which are more effective than conventional skegs in producing directional stability and which reduce drag.

More specifically, it is an object to provide skegs for a barge which not only will not produce drag, such as produced by conven-

tional skegs, but which will reduce the wake and/or the turbulence of the barge wake so as actually to reduce the drag normally produced by the barge hull.

The foregoing objects can be accomplished according to the invention by a barge comprising a nonpowered, nonsteered hull for towing by a towline trailing a towboat, said hull having a substantially flat bottom and a raked stern counter, a plurality of skegs projecting downward from the aft portion of said stern counter at each side of the hull longitudinal center line and directionally fixed relative to said stern counter for effecting yaw stability of said hull, the lower end of each skeg being higher than the barge bottom, and each skeg having a height greater than its maximum chord.

The invention will now be described with reference to the accompanying drawings in which:-

Figure 1 is a bottom perspective of the stern portion of a barge showing an arrangement of skegs according to the present invention projecting downward from the barge counter.

Figure 2 is a side elevation, Figure 3 is a stern elevation and Figure 4 is a bottom plan of the starboard stern portion of a barge equipped with skegs according to the present invention.

Figure 5 is a detail horizontal section through a skeg taken on line 5-5 of Figure 2.

Figure 6 is a bottom perspective of the stern portion of a barge equipped with a modified skeg construction according to the present invention.

Figure 7 is a side elevation, Figure 8 is a rear elevation and Figure 9 is a bottom plan of the starboard stern portion of a barge equipped with skeg construction of the type shown in Figure 6.

Figure 10 is an enlarged fragmentary vertical section through a portion of the skeg structure taken along 10-10 of Figure 9.

50

55

60

65

70

75

80

85

90

Two benefits which are interrelated may be obtained by utilization of the present invention, namely, an increase in effectiveness of the skeg structure to improve the directional stability of the barge by deterring yaw and a decrease in the drag of the barge which reduces the power necessary to propel the barge, or which results in an increase in speed of the barge if the same propulsive power is used. Increase in the effectiveness of the skeg structure to improve directional stability is obtained by locating the skeg structure substantially as far aft as possible, by the skeg structure having a high aspect ratio, by the skeg structure being of airfoil cross section, by arranging the skeg elements at desirable angles of incidence, by minimizing tip loss resulting from connecting the tips by a bridging plate and by spacing adjacent skeg elements at a sufficient interval to minimize flow interference between them. Reduction in drag is accomplished by utilizing skegs of airfoil cross section arranged advantageously, by minimizing tip loss and by spacing adjacent skeg elements at a sufficient interval to minimize flow interference.

Two representative skeg installations according to the present invention are shown in the drawings, one being shown in Figures 1 to 5 inclusive and a modification being shown in Figure 6 to 10 inclusive. The second form of the invention includes the components shown in the first form of the invention, and such components are numbered correspondingly in such second form. The skeg structure is applied to the conventional raked stern counter C of a conventional barge B having a flat bottom b. The principle of the invention is applicable to barges of all sizes but is more beneficial when used on barges of medium size, 250 feet to 350 feet (76.200 meters to 106.680 meters) in length, or large barges, 350 feet to 450 feet (106.680 meters to 137.160 meters) in length, rather than to small barges, 150 feet to 250 feet (45.720 meters to 76.200 meters) in length.

The degree of the rake of counter C is not critical and may be within the range of 10° to 40° to the horizontal, but it is preferred that the rake be within the range of 15° to 20° to the horizontal. Also, the height of the transom T of the barge is not critical but preferably is from 20% to 35% of the total depth of the barge. In the representative barge shown in the drawings, the rake angle is approximately 15° and the height of the transom is approximately 28% of the total depth of the barge.

The dagger skegs of the present invention are in two sets arranged symmetrically at opposite sides of the longitudinal vertical central plane of the barge. Each set includes a plurality of dagger skegs, three skegs being shown in each set illustrated in the drawings.

The port set includes an outboard skeg 1p and an inboard skeg 2p, and may include one or more intermediate skegs 3p. Correspondingly, the starboard set of dagger skegs includes an outboard skeg 1s and an inboard skeg 2s and may include one or more intermediate skegs 3s. The skegs in each set are arranged in a row extending athwartships of the barge and preferably the skegs are of substantially the same height, chord and spanwise taper.

Each skeg element is preferably of airfoil cross section, as shown in Figure 5, a typical suitable cross section being a Clark Y section or a NASA 22012 section established by criteria of the National Aeronautics and Space Administration. Each dagger skeg element includes a root end 4 suitably secured to the aft portion of the barge counter C. The trailing edge 5 preferably is vertical, and the leading edge 6 preferably is swept back a moderate amount from the root end 4 to the bottom tip 7.

As shown in Figure 5, the airfoil section forms a cambered side 8 and a side 9 which may be cambered to the same or a lesser degree, or which may be flat. If the opposite sides of the skeg elements have different degrees of camber, it is preferred that the outboard skegs 1p and 1s have the greatest difference in camber, that the inboard skegs 2p and 2s have the next greatest difference in camber, and that the intermediate skegs 3p and 3s have the least difference in camber. It would not be objectionable for all of the dagger skeg elements to be of symmetrical airfoil cross sections, and the difference in action of the skegs be effected by selecting proper angles of incidence for the skeg elements.

Where the inboard and outboard skeg elements are of nonsymmetrical cross section, the most highly cambered side of the outboard skeg elements 1s and 1p should face inward and the most highly cambered sides of the inboard skeg elements 2p and 2s may face outward or inward. The cambered inner side of the outboard skeg in each set and the cambered outer side of the inboard skeg of each set will then cooperate to provide a venturi passage between the inboard skeg and the outboard skeg of each set which will guide the wake of the barge between such skeg elements and reduce the turbulence in such portion of the wake, thus correspondingly reducing the drag on the barge. If the intermediate skeg elements 3p and 3s are of symmetrical airfoil cross section, they will not interfere with the flow. If their sides are cambered unequally, it is preferred that the side having the greater camber be on the inner side of the skeg element, as shown in Figure 4, to form the venturi passage nearer the center of the barge.

Each dagger skeg element is of high aspect ratio, as shown in Figure 2. Such aspect ratio should be within the range between and including 2 to 1 and 8 to 1 and preferably is within the range between and including 2 to 1 and 4 to 1. The aspect ratio of the dagger skegs shown in Figure 2 is approximately 2-1/2 to 1. The tip 7 of the dagger skeg should not project below and preferably should be slightly above the bottom *b* of the barge *B*, as shown in Figure 2. The sweptback leading edge 6 of the skeg is spaced a substantial distance aft of barge bottom *B*. Also the fore and aft extent or chord of the root 4 is a small fraction of the fore and aft extent or run of the counter *C*.

The average chord of each dagger skeg element is selected so that the total area of all of the skeg elements in each set will be less than the substantially triangular area formed by the raked surface of counter *C* as one side, the fore and aft extent or run of the counter *C* as a second side, and the elevation between the bottom of the transom *T* and the elevation of the barge bottom *b* as the third side. Thus combined fin areas of all the dagger skegs in each set will be less than the area of the corresponding single conventional substantially triangular skeg.

The efficiency of the dagger skegs in providing directional stability for the barge depends not only on the total fin area, but also on the location of the skeg elements and their angles of incidence. To be most effective, the dagger skeg elements should be located as far aft as possible, as shown in Figures 1 and 2. Also, the outboard skeg elements 1*p* and 1*s* should be toed out in the direction of travel of the barge at an angle *i* of 2° to 10°. The inboard skegs 2*p* and 2*s* may be toed in to some extent, such as 2° to 10°. Intermediate skegs 3*p* and 3*s* should have 0° angle of incidence, or a small angle of incidence in one direction or the other, depending on the camber of such intermediate skeg elements and the flow pattern preferred. Also, the angles of incidence of the port skeg elements and of the starboard skeg elements need not be identical if a difference in such angles of incidence will cause the barge to follow a straighter course by reducing yaw.

Both to reduce the wake of the barge and the turbulence of the wake and to increase the effectiveness of the skeg elements in controlling directional stability, the adjacent skeg elements in a set should not be placed too close together, nor should the sets of elements at opposite sides of the longitudinal vertical central plane of the barge be placed too close together. It is preferred that the spacing between adjacent skeg elements be at least twice the mean chord of the skeg elements, as shown in Figure 4. While two skeg elements could be used in each set, or

more than three could be used, it is preferred that there be three skeg elements in each set. If there are more than three, the aspect ratio of the skeg elements should be increased by reducing the mean chord of each element. Consequently, adjacent skeg elements could be located closer together, but they should not be closer than 1-1/2 times the mean chord to provide the best yaw-detering performance and the greatest reduction in drag.

The individual cantilever dagger skegs shown in Figures 1 to 4, inclusive, are somewhat vulnerable to being struck by floating objects over which the barge *B* may be towed. The skegs can be unified and strengthened by connecting the lower portions of the skegs in each set at opposite sides of the longitudinal center line with an elongate bridging plate member extending athwartships, preferably substantially horizontally and located at least as high as the bottom of the barge. The bridging member 10*p* is shown in Figure 6 as connecting the tips of the port skegs 1*p*, 3*p* and 2*p*, and the bridging member 10*s* is shown as connecting the tips of the starboard skegs 1*s*, 3*s* and 2*s*. Each of the elongate bridging members is of airfoil cross section and is shown in Figure 10 as including a trailing edge 5', a leading edge 6', an upper cambered side 8', and a lower side 9' which either is of lesser camber than the upper side 8' or is flat.

The cambered upper side 8' of the bridging member cooperates with the cambered sides of the inboard and outboard skegs of the set to confine a venturi flow of the wake to a greater extent than the wake would be confined without such bridging member. Also, it is preferred that the skeg bridging members have a negative angle of incidence that is, that the bridging member chords slope forward and downward within the range of 2° to 10° to provide a forward hydrodynamic reaction component for reducing or offsetting drag.

Not only does the horizontal bridging member reduce turbulence by its cambered upper side promoting venturi flow, and reduce drag because of its forward hydrodynamic reaction component, but the fact that such bridging member covers the tips of the dagger skegs reduces the turbulence around such tips and decreases drag. The interconnection of the individual skegs by the bridging member also deters possible tendency of an individual skeg to vibrate and generally increases the strength of each set of skegs as a composite structure.

WHAT WE CLAIM IS:-

1. A barge comprising a nonpowered, nonsteered hull for towing by a towline trailing a towboat, said hull having a substantially flat bottom and a raked stern



(17)

Each dagger skeg element is of high aspect ratio, as shown in Figure 2. Such aspect ratio should be within the range between and including 2 to 1 and 8 to 1 and preferably is within the range between and including 2 to 1 and 4 to 1. The aspect ratio of the dagger skegs shown in Figure 2 is approximately 2-1/2 to 1. The tip 7 of the dagger skeg should not project below and preferably should be slightly above the bottom *b* of the barge *B*, as shown in Figure 2. The sweptback leading edge 6 of the skeg is spaced a substantial distance aft of barge bottom *B*. Also the fore and aft extent or chord of the root 4 is a small fraction of the fore and aft extent or run of the counter *C*.

The average chord of each dagger skeg element is selected so that the total area of all of the skeg elements in each set will be less than the substantially triangular area formed by the raked surface of counter *C* as one side, the fore and aft extent or run of the counter *C* as a second side, and the elevation between the bottom of the transom *T* and the elevation of the barge bottom *b* as the third side. Thus combined fin areas of all the dagger skegs in each set will be less than the area of the corresponding single conventional substantially triangular skeg.

The efficiency of the dagger skegs in providing directional stability for the barge depends not only on the total fin area, but also on the location of the skeg elements and their angles of incidence. To be most effective, the dagger skeg elements should be located as far aft as possible, as shown in Figures 1 and 2. Also, the outboard skeg elements 1*p* and 1*s* should be toed out in the direction of travel of the barge at an angle *i* of 2° to 10°. The inboard skegs 2*p* and 2*s* may be toed in to some extent, such as 2° to 10°. Intermediate skegs 3*p* and 3*s* should have 0° angle of incidence, or a small angle of incidence in one direction or the other, depending on the camber of such intermediate skeg elements and the flow pattern preferred. Also, the angles of incidence of the port skeg elements and of the starboard skeg elements need not be identical if a difference in such angles of incidence will cause the barge to follow a straighter course by reducing yaw.

Both to reduce the wake of the barge and the turbulence of the wake and to increase the effectiveness of the skeg elements in controlling directional stability, the adjacent skeg elements in a set should not be placed too close together, nor should the sets of elements at opposite sides of the longitudinal vertical central plane of the barge be placed too close together. It is preferred that the spacing between adjacent skeg elements be at least twice the mean chord of the skeg elements, as shown in Figure 4. While two skeg elements could be used in each set, or

more than three could be used, it is preferred that there be three skeg elements in each set. If there are more than three, the aspect ratio of the skeg elements should be increased by reducing the mean chord of each element. Consequently, adjacent skeg elements could be located closer together, but they should not be closer than 1-1/2 times the mean chord to provide the best yaw-detering performance and the greatest reduction in drag.

The individual cantilever dagger skegs shown in Figures 1 to 4, inclusive, are somewhat vulnerable to being struck by floating objects over which the barge *B* may be towed. The skegs can be unified and strengthened by connecting the lower portions of the skegs in each set at opposite sides of the longitudinal center line with an elongate bridging plate member extending athwartships, preferably substantially horizontally and located at least as high as the bottom of the barge. The bridging member 10*p* is shown in Figure 6 as connecting the tips of the port skegs 1*p*, 3*p* and 2*p*, and the bridging member 10*s* is shown as connecting the tips of the starboard skegs 1*s*, 3*s* and 2*s*. Each of the elongate bridging members is of airfoil cross section and is shown in Figure 10 as including a trailing edge 5', a leading edge 6', an upper cambered side 8', and a lower side 9' which either is of lesser camber than the upper side 8' or is flat.

The cambered upper side 8' of the bridging member cooperates with the cambered sides of the inboard and outboard skegs of the set to confine a venturi flow of the wake to a greater extent than the wake would be confined without such bridging member. Also, it is preferred that the skeg bridging members have a negative angle of incidence that is, that the bridging member chords slope forward and downward within the range of 2° to 10° to provide a forward hydrodynamic reaction component for reducing or offsetting drag.

Not only does the horizontal bridging member reduce turbulence by its cambered upper side promoting venturi flow, and reduce drag because of its forward hydrodynamic reaction component, but the fact that such bridging member covers the tips of the dagger skegs reduces the turbulence around such tips and decreases drag. The interconnection of the individual skegs by the bridging member also deters possible tendency of an individual skeg to vibrate and generally increases the strength of each set of skegs as a composite structure.

WHAT WE CLAIM IS:-

1. A barge comprising a nonpowered, nonsteered hull for towing by a towline trailing a towboat, said hull having a substantially flat bottom and a raked stern

(18)
4

1,533,960



4

- counter, a plurality of skegs projecting downward from the aft portion of said stern counter at each side of the hull longitudinal center line and directionally fixed relative to said stern counter for effecting yaw stability of said hull, the lower end of each skag being higher than the barge bottom, and each skag having a height greater than its maximum chord. 45
- 5 2. A barge as claimed in claim 1, the outboard skag of the plurality of skegs at each side of the hull longitudinal center line having an inboard cambered side. 50
- 10 3. A barge as claimed in claim 1 or 2, corresponding skegs at opposite sides of the hull longitudinal center line having their chords toed out in the direction of travel of the barge. 55
- 15 4. A barge as claimed in any preceding claim, having elongate bridging members at opposite sides of the hull longitudinal center line at least as high as the hull bottom, having their lengths extending transversely of the barge and each bridging member connecting the lower portions of the plurality of skegs at one side of such line. 60
- 20 5. The barge as claimed in claim 4, the elongate bridging members including plate means having at least one cambered side. 65
- 25 6. A barge as claimed in claim 5, the plate means having its cambered side facing upward. 70
- 30 7. A barge as claimed in claim 4, each of the elongate bridging members including plate means having a negative angle of incidence. 75
- 35 8. A barge as claimed in any of claims 4 to 7, skegs at each side of the hull longitudinal center line connected by each elongate bridging member having cambered sides facing each other. 80
- 40 9. A barge as claimed in any of claims 4 to 8, inclusive, skegs at one side of the hull longitudinal center line connected by an elongate bridging member being toed out in the direction of travel of the barge.
10. A barge as claimed in any of claims 4 to 9, inclusive, at least three skegs projecting downward from the stern counter at each side of the hull longitudinal center line.
11. A barge as claimed in any preceding claim, adjacent skegs being spaced apart transversely of the barge a distance at least as great as the mean chord of one of such skegs.
12. A barge comprising a nonpowered, nonsteered hull for towing by a towline trailing a towboat, said hull having a substantially flat bottom and a raked stern counter, a plurality of skegs projecting downward from the aft portion of said stern counter at each side of the hull longitudinal center line and directionally fixed relative to said stern counter for effecting yaw stability of said hull, the lower end of each skag being higher than the barge bottom, and each skag having a substantially vertical trailing edge, having a height greater than its maximum chord and having a root attached to said stern counter of substantially less extent fore and aft than the fore-and-aft extent of said stern counter.
13. A barge having a raked stern counter and a skag installation substantially as described hereinbefore with reference to the accompanying drawings and as illustrated in Figures 1 to 5 or Figures 6 to 10 of the accompanying drawings.

For the Applicants
F.J. CLEVELAND & COMPANY,
Chartered Patent Agents
40-43 Chancery Lane,
London, WC2A 1JQ.