Sept. 5, 1961 W. R. HAWTHORNE ET AL 2,998,793

FLEXIBLE BARGES

Filed Sept. 10, 1958 2 Sheets-Sheet 1

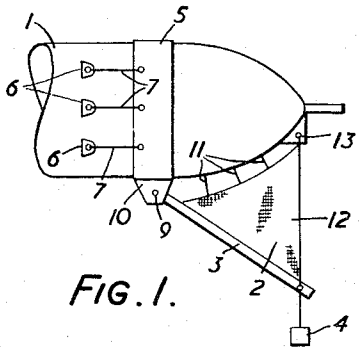

FIG. 1.

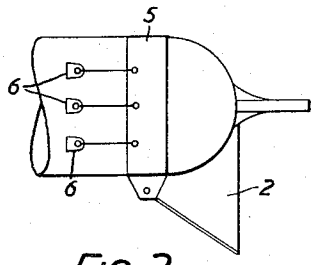

FIG. 2.

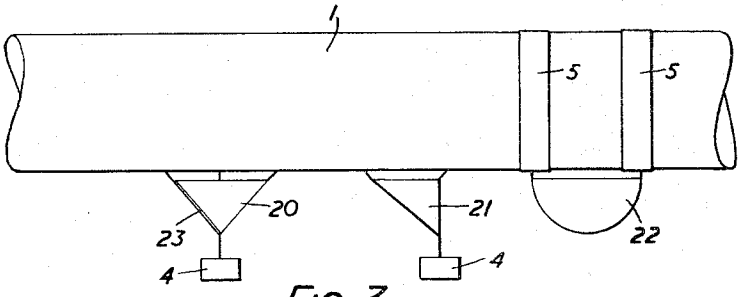

FIG. 3.

INVENTORS

William Reginald Hawthorne

John Christopher Shaldham Shaw

BY

Stevens, Davis, Miller & Mosher

their ATTORNEYS

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FLEXIBLE BARGES

Filed Sept. 10, 1958 2 Sheets-Sheet 2

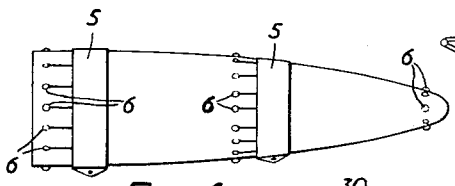

FIG. 4.

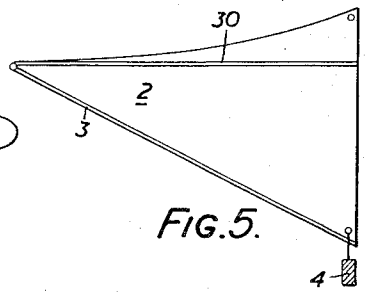

FIG. 5.

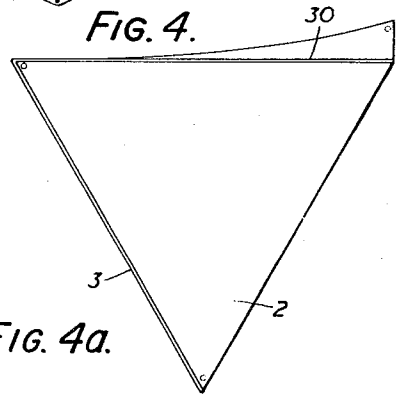

FIG. 4a.

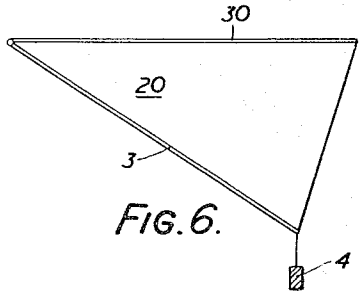

FIG. 6.

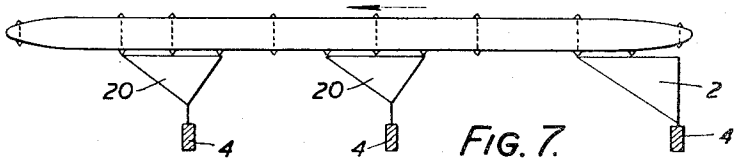

FIG. 7.

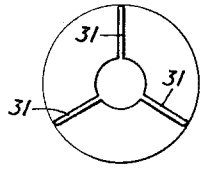

FIG. 9.

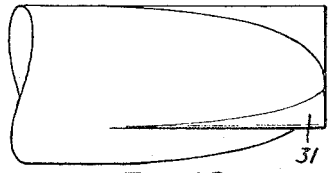

FIG. 10.

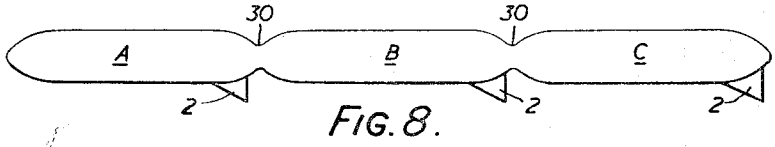

FIG. 8.

INVENTORS
William Ryde Hawthorne
John Christopher Shuldham-Shaw
BY
Stevens, Davis, Miller & Mosher
ATTORNEYS

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FLEXIBLE BARGES

William Rede Hawthorne and John Christopher Shuldham Shaw, Cambridge, England, assignors to Dracone Developments Limited, London, England

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9 Claims. (Cl. 114—74)

This invention relates to totally enclosed barges of flexible material for the transport of fluid or granular or like solid cargo by towing.

It has been found that there is a critical speed of towing above which the barge commences to flex and yaw or to oscillate flexurally.

It has been found that the force at the stern of the barge tending to produce such instability can be represented by the expression:

$$f\rho U^2 S\alpha$$

where S is the maximum cross-sectional area of a tubular barge, U is the towing velocity, ρ is the density of the fluid in which the barge is being towed, and α is the small angle of attack of the stern of the vessel relatively to the direction of tow, f being a factor dependent upon the presence of a fin and varying from a value of less than unity through zero to a negative value as the area of the fin is increased. While a value of fin area such as will give $f=0$ would be preferred, slightly negative values of f have been found to give stability over a wide range of speed.

According to the invention, therefore, a flexible barge has flexibly attached at or near its stern, a fin which is formed from flexible material such as fabric and which is weighted to hold it depending from the barge. The fin may be furnished at its leading edge with a stiffener and this preferably of material heavier than water so that the stiffener also acts as the weight. If desired, however, instead of or in addition to the heavy stiffener, a weight may be attached to the lower extremity of the fin.

It has also been found that the derivative of the normal force C_N acting on the remainder of the vessel, representing the rate of change of normal force with angle of attack, also has an effect on stability. Although with small areas of fin such as will give a slightly positive value to f, an increase in the normal force derivative tends to render the body unstable, the unexpected result has been found that when f is slightly negative an increase of the normal force derivative tends to improve the stability of the vessel, that is to say it raises the speed at which stability is achieved. If the normal derivative is high enough and the fin area of sufficient size, stability can be achieved at all speeds.

A fin having an area of three to five times the maximum cross-sectional area of the barge has been found to give adequate stability during towing. Preferably, the main points of attachment of the fin to the barge are at approximately the same radius from the axis of the barge.

The fin may consist of a flat, triangular piece of wood weighted at the tip and attached at various points to the fabric of the barge, or the fin may be of proofed or unproofed fabric and may have its edges weighted. Thus, the fin may be of triangular or other convenient shape to hang below the stern of the barge. The fin may be attached to the barge either by a strap or straps around the circumference of the barge or by suitable patches woven or stuck to the fabric of the barge, or a combination of both methods may be utilized with ropes connecting the patches to the strap or straps. The strap may have an eye for pivotal connection of a heavy rod let into the hem of the fabric fin along its leading edge. The lower end of the rod may carry a weight or kite to hold the fin extended during towing. The trailing edge of the fin may be stiffened by means of a rope or other means let into the hem. The edge of the fin next to the surface of the barge is attached to the barge at various points by ropes attached to flaps woven or stuck to the barge.

If desired, and particularly on large barges, means may be provided for increasing the normal force derivative C_N. This can be obtained by hanging below the barge at various intervals small amidships fins disposed uniformly along the length of the barge or arranged in such a way as to produce a uniform normal force derivative.

Fins may also be placed at the stern of the barge in a manner similar to the fins used conventionally on airships.

According to a further feature of the present invention, the barge is divided into sections each having a stabilizing fin at the rear end thereof.

Embodiments of the invention will now be described by way of example with reference to the accompanying diagrammatic drawings, in which

FIG. 1 is a side elevation of the stern of a barge according to the invention,

FIG. 2 is a similar view of a modified form of stern;

FIG. 3 is a side elevation of an amidships portion of a flexible barge in accordance with the invention;

FIG. 4 is a side elevation of a further modified form of stern and;

FIG. 4*a* is a side elevation of a rear fin for attachment to the stern;

FIG. 5 is a side elevation of a modified form of tail fin;

FIG. 6 is a similar view of an amidships fin as shown in FIG. 4;

FIG. 7 is a side elevation of a flexible barge according to the invention having a tail fin and amidships fins;

FIG. 8 is a similar view of a modified form of barge according to the invention;

FIGS. 9 and 10 are fragmentary views as will hereinafter appear.

Referring first to FIG. 1 of the drawings, a flexible barge 1 is furnished at the rear with a stabilising fin 2 of unproofed fabric such as that marketed under the registered trademark "Terylene," and having a heavy rod 3 let into a hem or a pocket of the fabric at the leading edge of the fin. A weight or kite 4 is attached to the lower extremity of the fin and the fin is attached to the barge by means of a fabric girdle 5 secured to flaps 6 by means of ropes 7, the stiffener 3 of the fin being pivotally attached at 9 to an eyeletted flap 10 on the girdle 5. The fin is additionally attached to the barge by local rope attachments 11 and a rope 12 let into the fabric hem at the trailing edge of the fin is attached to an eyeletted flap 13. The object of the girdle 5 is to distribute the stress so that not all the load is taken by one flap or eyelet. The girdle is provented from sliding backwards by the ropes 7 around its circumference and can be strengthened near the point of attachment of the fiin. It is easily replaceable when worn.

FIG. 2 illustrates a modified form of construction in which the stern of the barge is hemispherical and is provided with a fin 2 of smaller area than that shown in FIG. 1 where the stern of the barge is tapered. The stern may alternatively be of flat ellipsoidal form.

FIG. 3 shows amidships fins 20, 21, 22 hung below the barge at various intervals to increase the normal force derivative C_N. The fin 20 is provided at its leading edge with a stiffener 23 as described above and with a weight or kite 4. The fins 20 and 21 are attached to flaps whereas the fin 22 is shown attached to girdles 5 similar to that illustrated in FIG. 1. The fins are preferably of high aspect ratio and arranged in such a way that the orientation of the barge about its axis is unimportant so far as concerns the fin force. It has been found that a stabilis-

ing fin at the stern of between three and five times the maximum cross-sectional area of the barge gives satisfactory stability during towing. FIGURES 4 and 4*a* illustrate such an arrangement, the fin being constructed and attached similarly to the fin illustrated in FIG. 1 except that a stiffener **30** of wood or other convenient material is arranged to extend parallel to the axis of the barge and two girdles **5** are used. More girdles may be provided to suspend the fin if necessary.

A modified shape of tail fin is illustrated in FIG. 5 and a modified shape of amidships fin is illustrated in FIG. 6. FIG. 7 shows diagrammatically a barge fitted with two amidships fins **20**, similar to that illustrated in FIG. 6 and with a tail fin similar to that illustrated in FIG. 5.

The main points of attachment of the fin **2** are preferably at approximately the same radius from the axis of the barge. This can be done in practice by moving the fin forward and attaching its after end to the last girdle **5**.

FIG. 8 illustrates a barge which is divided into sections A, B, C by binding at **30**. Each section is provided with a tail fin **2**. A binding at **30** reduces the diameter of the barge to a small value such that oil or liquid cargo can pass from one part of the barge to another through the small hole left inside the cross-section of the reduced area.

Alternatively, the preferred shape may be obtained by working the fabric into reduced area portions. These shapes may be obtained by sewing fabric pieces together or by sticking rubberized portions of the fabric together.

A further method of obtaining reduced area portions is illustrated in FIG. 9 in which adjacent peripheral portions of the tube are first folded and adhesively secured, sewn or riveted together at three or more points around the circumference as indicated at **31** in FIG. 9 which is a transverse section through one of the reduced portions. The portions may also be trimmed off or trimmed into shapes suitable for fins. FIG. 10 shows a barge terminating at such a reduced portion so that the parts **31** constitute fins.

We claim:

1. A flexible barge having means for preventing unstable lateral motions thereof when under tow, said means comprising a fin formed of flexible material such as fabric and flexibly attached to the barge in the region of the stern thereof and weighted to hold the fin depending from the barge.

2. A flexible barge as claimed in claim 1, wherein the fin is furnished at its leading edge with a stiffener.

3. A barge as claimed in claim 2, wherein the stiffener is of material heavier than water.

4. A barge as claimed in claim 2, wherein the weighting of the fin is accomplished by a weight attached to the lower extremity of the fin.

5. A barge as claimed in claim 1 wherein the area of the fin is three to five times the maximum cross-sectional area of the barge.

6. A barge as claimed in claim 1, wherein the main points of attachment of the fin to the barge are at approximately the same radius from the axis of the barge.

7. A barge as claimed in claim 1 wherein at least one additional fin is provided along the underside of the barge forward of the main stabilizing fin.

8. A barge according to claim 1, in which the fin is attached to the barge by means of a fabric girdle around the barge.

9. A barge according to claim 8, in which the girdle is secured to the barge by means of flaps on the barge and ropes connected to the flaps.

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