Jan. 2, 1962 J. BELL ETAL 3,015,298

SHIP STABILIZERS

Filed May 4, 1961 3 Sheets-Sheet 1

Fig 1.

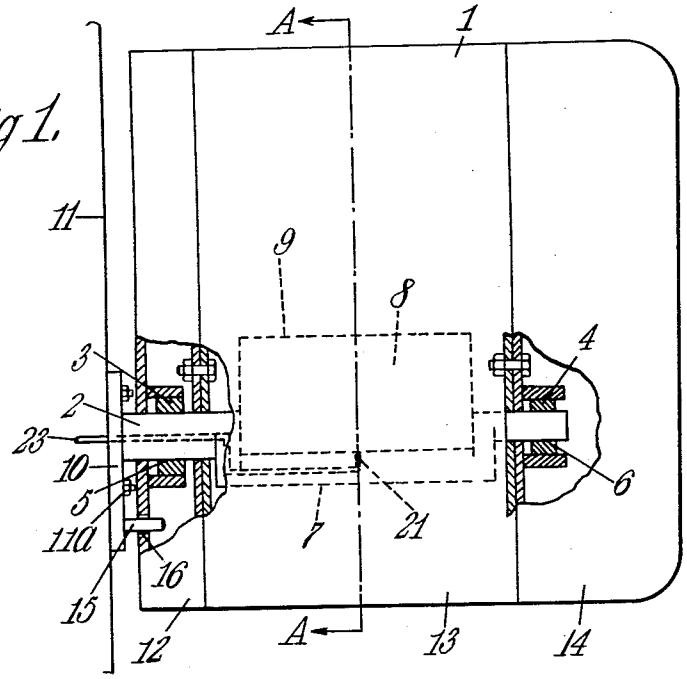


Fig 2.

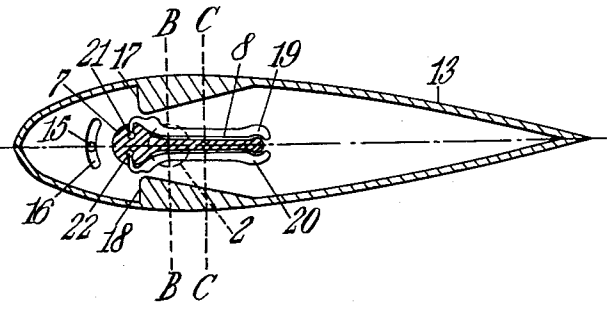
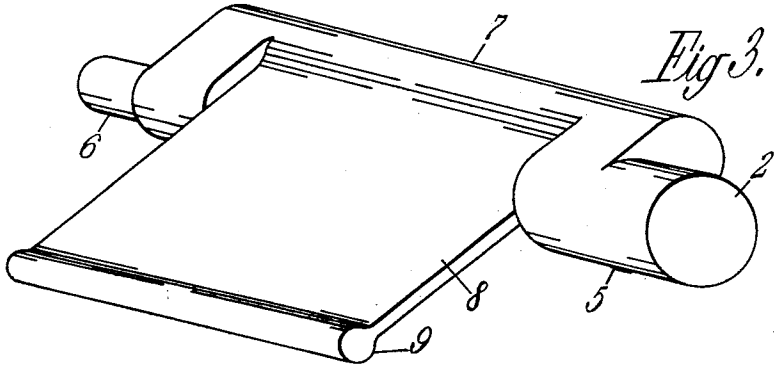


Fig 3.



SHIP STABILIZERS

Filed May 4, 1961 3 Sheets-Sheet 2

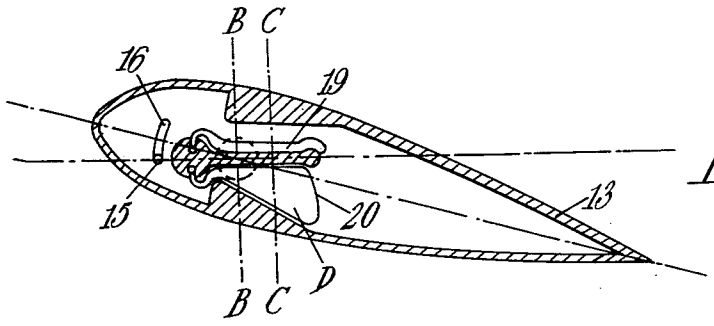


Fig 4.

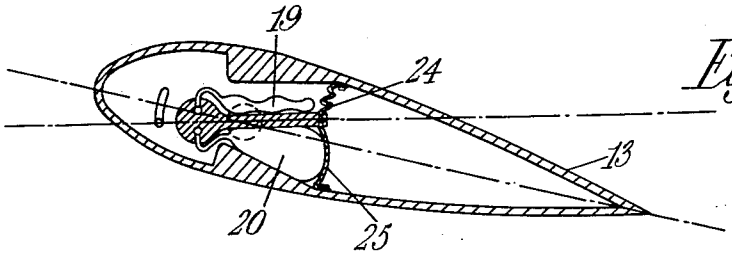


Fig 5.

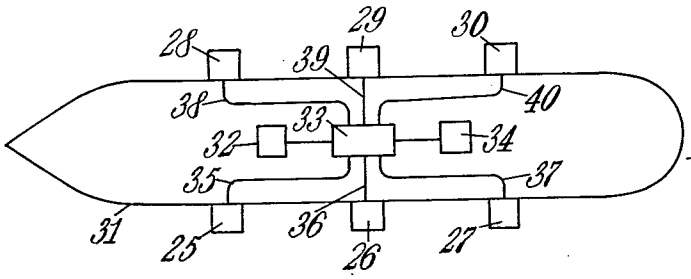


Fig 6.

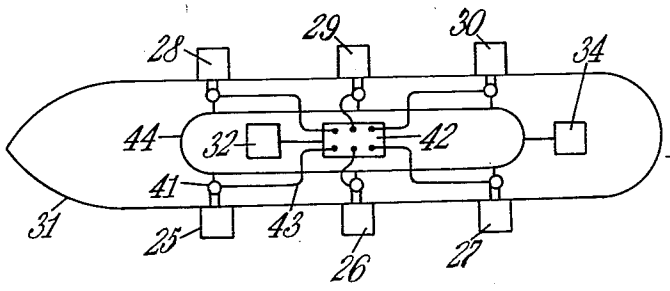


Fig 7.

Jan. 2, 1962 J. BELL ETAL 3,015,298

SHIP STABILIZERS

Filed May 4, 1961 3 Sheets-Sheet 3

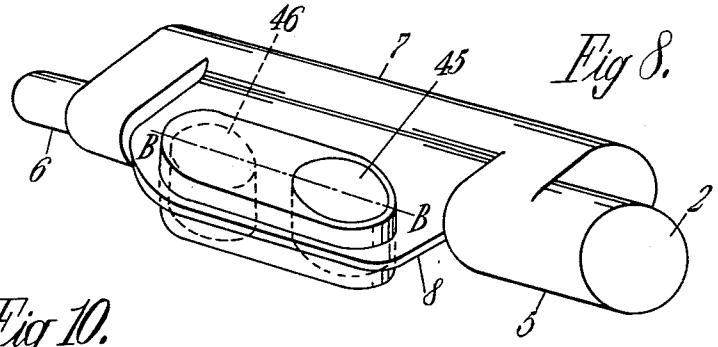


Fig 8.

Fig 10.

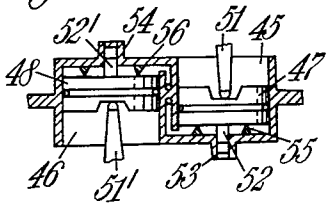
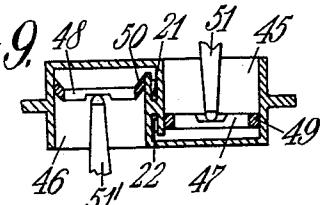


Fig 9.



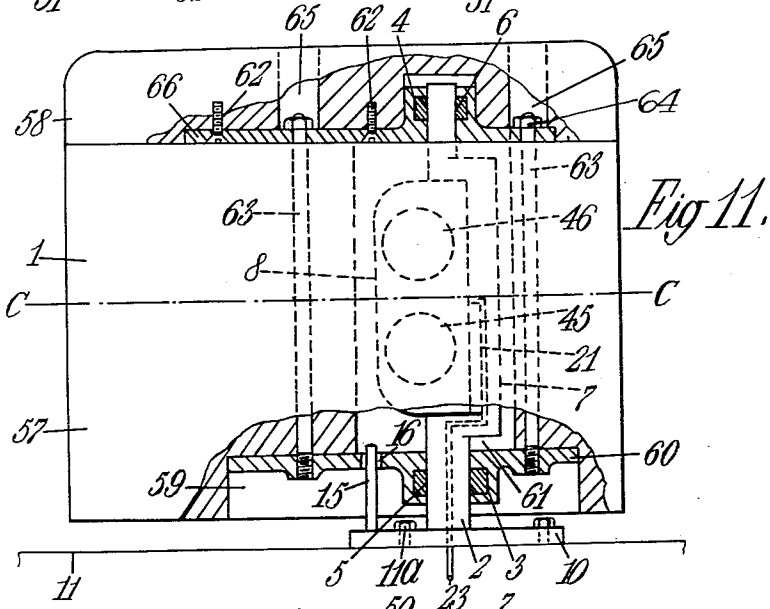


Fig 11.

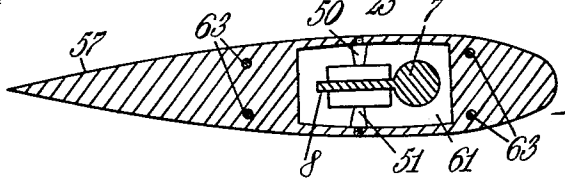


Fig 12.

United States Patent Office 3,015,298 Patented Jan. 2, 1962

3,015,298

SHIP STABILIZERS

John Bell, John Victor Foll, and Francis Heron Muirhead, all of Beckenham, England, assignors to Muirhead & Co. Limited, Beckenham, England

Filed May 4, 1961, Ser. No. 107,851
Claims priority, application Great Britain Mar. 23, 1961
4 Claims. (Cl. 114—126)

This invention relates to improvements in the actuating means for generating lift or torque by means, for example, of fins or hydrofoils for the purpose of controlling the motion of a vehicle, for example, a ship in the rolling or pitching sense.

Means for actuating stabilising fins are known in which the fin is fixed to a shaft which is caused to oscillate in a desired manner by power means within the ship. Other actuating means are known in which the fin is adapted for rotating or oscillating about a fixed shaft attached to the side of the ship by means of hydraulic jacks, rotary vane actuators and the like, these means being located within or adjacent to the fin and exterior to the ship.

The aforesaid actuating means are all characterised by a multiplicity of sliding surfaces to be found in the bearings, plungers, cylinders and the like, that are essential parts of such means. In fin systems actuated by power means within the ship, watertight glands are required where the fin shaft passes through the hull. In hydraulic fin systems in which the actuating means is external to the ship there is always the risk of water entering and contaminating the pressure fluid.

Moreover, by reason of the multiplicity of parts employed, the aforesaid systems are difficult and costly to manufacture.

An object of the present invention is to provide a simple design of actuating mechanism which is economical to make and has a minimum of parts.

A further object is to minimise the wear of surfaces that are in relative motion.

A still further object is to eliminate or partially eliminate the load on the bearings on the actuating member.

The invention consists of a movement control fin comprising a shaft for securing to the structure the movement of which is to be controlled, a fin element mounted on the shaft for oscillatory movement about the shaft axis, a web integral with the shaft and extending into the body of the fin element, inflatable means mounted one on each side of the flange between the flange and the fin element and fluid passage extending from within the inflatable means to outside the fin element.

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

FIGURE 1 is a partly sectional plan view of a fin;

FIGURE 2 is a cross-section of a fin in the neutral position.

FIGURE 3 is a three-dimensional drawing of a fin shaft.

FIGURE 4 is a cross-section of a fin in a tilted position.

FIGURE 5 is a cross-section of a fin showing an alternative actuating means.

FIGURE 6 is a diagrammatic representation of a complete ship stabilizer.

FIGURE 7 is another diagrammatic representation of a complete ship stabilizer.

FIGURE 8 is a three-dimensional drawing of a fin shaft embodying actuating cylinders.

FIGURE 9 is a cross-section of FIGURE 8 on the line B—B.

FIGURE 10 is a reproduction of FIGURE 9 showing alternative actuating means.

FIGURE 11 is a plan view partly sectioned of a fin embodying piston actuating means.

FIGURE 12 is a cross-section of FIGURE 11 on the line C—C.

In the figures like parts are indicated by like numerals where appropriate.

FIGURE 1 shows a view in plan of a fin and actuating means therefor according to the invention and FIGURE 2 is a cross-section of FIGURE 1 on the line A—A. In the figures, fin **1** which is of streamline section is mounted for rotation or oscillation on shaft **2**. The fin **1** is supported on shaft **2** by bearings **3** and **4** which engage journals **5** and **6** respectively on shaft **2**. The shaft **2** is displaced or cranked between the journalled parts in a forward direction as shown at **7** and web or plate **8** extends in a rearward direction. The rear edge **9** of web **8** is enlarged and rounded and the forward edge thereof is faired into shaft part **7**. FIGURE 3 is a general view of shaft **2**.

Bearings **3** and **4** may be fabricated conveniently from rubber or other material suitable for lubrication by water since the fin is not sealed against ingress of the sea. The inboard end of shaft **2** terminates in a flange plate **10** secured to the ship's side **11** by bolts **11***a*. Pin **15** cooperating with sector shaped slot **16** constitutes a device for limiting the movement of the fin.

The fin **1** is constructed in three parts, the inboard part **12** enclosing the bearing **3**, the central part **13** enclosing the web **8** and the outboard part **14** enclosing bearing **4**. These three parts may be conveniently joined by means of flanges and through-bolts as shown in the sectional parts of FIGURE 1. Alternatively part **12** may be inserted (embedded) in the central part **13**.

Referring to FIGURE 2, it is arranged that the axis of rotation of fin **1** is on the broken line B—B which is arranged to be forward of the centre of pressure of the fin indicated by broken line C—C. Thus, the horizontal axis of fin **1** will normally align itself with the streamline flow of water in which it is immersed. The internal surface of part **13** of fin **1** is provided with shaped parts **17**, **18** which, together with web **8**, form wedge or V-shaped spaces therebetween. Within these V-shaped spaces are placed inflatable flexible walled containers **19** and **20** respectively shown in FIGURE 2 in the deflated condition. The forward ends of containers **19** and **20** are connected over short tubes to ducts **21** and **22** respectively within shaft **2**, which ducts are continued through shaft **2** for the supply of pressure fluid over pipes **23** and **23'**, only pipe **23** being visible in FIGURE 1.

It can readily be seen that if pressure fluid is introduced into one of the containers, for example container **20** of FIGURE 4 causing it to inflate, the corresponding V-shaped space will be enlarged and since shaft **2** is fixed, fin **1** will be tilted upwards until arrested by stop pin **15**. Similarly, if container **19** is inflated while container **20** is allowed to deflate, the fin **1** will be urged to the downwardly tilted position.

It will be appreciated that containers **19** and **20** can be of such shape and be so disposed in relation to the centre of pressure of the fin that when the fin is tilted and a stabilizing force is thereby generated the internal force at D (FIGURE 4) due to the pressurised container and that acting externally on the fin can be arranged to be equal and opposite, and hence the load imposed on the fin bearings is cancelled or at least reduced to a minimum.

Friction of the fin movement is thus practically eliminated and a balance can therefore be obtained between fin lift and the applied internal pressure. Use can be

made of this balance in the control system for operating the fin if so desired. Alternatively, the fins may be operated in a purely On/Off manner by admitting through suitable valve means, sufficient pressure fluid to cause the fins of a stabilizer to execute the full movement allowed by the stops. Alternatively the fin lift provided is related to ship speed and consequently ensures smoother and sweeter action of the mechanism.

Alternatively, by suitably controlling the actuating pressure the lift obtained may be limited to a prescribed value despite an increase in ship speed.

FIGURE 5 shows an alternative embodiment in which pressure containers **19** and **20** are fabricated from elastic material, for example, rubber that is not reinforced. The elastic containers **19** and **20** are confined within their respective V-shaped cavities by flexible barriers **24** and **25** of flexible fabric or other suitable material which close the extremities of the two V-shaped cavities, and further barriers of the same material (not shown) which close each side of each cavity. Thus when a container is inflated, the aforesaid barriers restrain the container in the lateral and endwise directions while the force acting vertically is effective in actuating the fin as hereinbefore explained.

The figure shows the fin actuated to the upwards position by the inflated container **20** and it will be seen that barrier **25** is fully extended while because container **19** is deflated, barrier **24** is slack. The same conditions will obviously apply to the barriers adapted to resist lateral pressure.

When the ship is at rest, as when at anchor, however, it is desirable to prevent the fin from moving continually back and forth against the stop due to rolling, which may occur under such circumstances. To prevent this it is arranged that the two containers are each half-inflated or alternatively one is fully inflated with pressure fluid.

In the first case the fin will remain more or less central and move only a small amount of each successive roll, never reaching the stops. In the second case, the fin is held rigidly against one or other of the stops.

FIGURE 6 illustrates in diagrammatic form a ship stabilizer employing a plurality of fins according to the invention, in which by way of example fins **25**, **26** and **27** are disposed along one side of the ship **31** and fins **28**, **29** and **30** are similarly disposed along the other side. A roll sensing device **32**, which in known simple form may embody a rate gyroscope, produces a signal proprotional to the velocity of the rolling motion of the ship and operates control valve or valves **33** in known manner to regulate the flow of pressure fluid in each fin actuating means over their respective pipe lines **35**—**40** in any desired sequence, the pressure fluid being derived from pumping means **34**. Two pipe lines to each fin (only one being shown in the figure) are required, one for actuation in each direction.

FIGURE 7 illustrates an alternative arrangement to avoid long pipe runs with consequent inefficiency particularly when the operating fluid is a gas. In the figure which for the purpose of illustration is similar in many respects to FIGURE 6, the pumping means **34** supplies pressure fluid to a closed pipe line or ring main **44** conveniently located near the sides of the ship from which short branch pipes are taken to each fin. Interposed in each branch pipe is an electrically operated vlave **41** of which many types are known.

In this arrangement roll sensing device **32** controls switching means **42** which in turn operate the electrically operated valve **41** over electrical circuits **43**. It must be understood that the switching means **42** may be adapted to control the action of the fins in any desired sequence and alternately in either direction. The ring main **44** should be of sufficient cross sectional area to supply pressure fluid to all the fins without appreciable fall in pressure.

FIGURES 8 to 12 illustrate a fin and fin actuating means in which the actuating means comprises two pistons operating in corresponding cylinders. In order to provide adequate actuating force in the limited space within the fin which permits only a short stroke the cylinders are of large bore. FIGURES 8, 9 and 10 show the fin supporting shaft **2**, **7**, **6** which is of cranked form carrying a rearwards extending web or plate **8** and in these respects is similar to the fin supporting shaft shown in FIGURE 3. The web or plate **8** carries cylinder **45**, the open end facing upwards and cylinder **46** facing downwards. FIGURE 9 is a cross section of FIGURE 8 on the line B—B showing piston **47** located in cylinder **45** and piston **48** in cylinder **46**. Pistons **47** and **48** are bonded to the adjacent inside walls of cylinder **45** and **46** respectively with an elastic material such as rubber as shown at **49** and **50**.

It will be seen that if pressure fluid, for example oil, is introduced say to cylinder **46** over duct **21**, piston **48** will be forced outwards and the elastic bond **50** will be stretched or deformed as shown to permit this movement. When the pressure fluid is released the piston **48** will be returned to its normal position in cylinder **46** as the elastic bond **50** returns to the unstretched position. A similar motion will be imparted to piston **47** when pressure fluid is introduced into cylinder **45** over channel **22**. Push rods **51** and **51'** transmit the motion of pistons **47** and **48** respectively to the fin to cause it to tilt in one or other direction according to which push rod is actuated. This arrangement is best suited to a stabiliser operating with a liquid hydraulic fluid under relatively high pressure.

It is to be understood that the construction is not limited to bonding the piston to the cylinder using flexible rubber-like substances. It is equally effective to employ a flexible diaphragm which may be of corrugated metal for this purpose.

FIGURE 10 shows an arrangement of pistons and cylinders more suitable for pneumatic operation. Pistons **47** and **48** are free to move in cylinders **45** and **46** respectively and are given motional stability by the provision of cylindrical extension **52** and **52'** which are a sliding fit in extensions **53** and **54** to cylinders **45** and **46**. The pistons and cylindrical extensions are provided with O-rings as shown to form an effective seal. Circular rubber rings **55** and **56** of, for example, triangular cross-section are provided in the bases of cylinders **45** and **46** to cushion the inward motion of the pistons and provide additional means of centralising the fin. The effort required to move the piston itself is then relatively small and effective operation of the fin can be achieved using a compressible fluid such as air as the operating medium with pressure of the order of 30 p.s.i. to 150 p.s.i. depending on the diameter of the piston and the fin parameters.

FIGURE 11 is a plan in part section of a fin embodying the piston actuating means of FIGURES 8, 9 and 10 and FIGURE 12 is a section of the fin on the line C—C.

Conveniently the fin may be of moulded plastic construction and made in two parts; the main or inboard part **57** and the outboard part **58**. The main part **57** is provided with a recess **59** in the inboard face to locate the inboard bearing plate **60** (which is split along its longitudinal centre line) and a cavity **61** extending from the inboard face to the outboard face of part **57** to accommodate the central part of fin supporting shaft **2**, web **8** and cylinders **45** and **46**. The inboard face of the outboard fin part **58** is recessed to accommodate the outboard bearing plate **66** which is screwed or bonded to the fin part **58**, two screws being shown at **62**.

With the construction described above the assembly of the fin is relatively simple. The fin shaft **2** is rigidly attached to the ship's side **11** by bolts **12** passing through the flange plate **10**. The two halves of bearing plate **60** are assembled round the journalled part **5** of shaft **2** and the main fin part **57** is slid over the outboard end of shaft **2** until bearing plate **60** fits in the recess **59**. The outboard fin part **58** is then passed over the outboard end of

shaft **2** so that bearing **4** registers with journal **6**. Tie-rods **63** which are threaded at each end are passed through holes in the two fin parts, the inboard ends being screwed into bearing plate **60** as shown in FIGURE 11. Finally nuts **64** are placed on the outboard ends of tie-rods **63** and the fin parts **57** and **58** are rigidly clamped together. The enlarged holes **65** may conveniently be plugged with a suitable sealing compound. The lengths of push rods **50** and **51** may be adjustable.

Constructional limitations in a fin of normal proportions are such that the cylinders are displaced axially within the fin structure and perfect balance against the hydrodynamic pressure on the fin is not obtained, but an approximation to this balance is possible and the loading on the fin bearings, as described above is to a considerable extent relieved.

In the practical application of the invention thus set forth, various devices may be embodied in substitution for those which are herein shown as illustrating the principles involved, and variations may be made in many respects without departing from the scope of the invention.

We claim:

1. A movement control fin comprising a shaft for securing to the structure the movement of which is to be controlled, a fin element mounted on the shaft for oscillatory movement about the shaft axis, a web integral with the shaft and extending into the body of the fin element, inflatable means mounted one on each side of the web between the web and the fin element and fluid passages extending from within the inflatable means to outside the fin element.

2. A movement control fin as claimed in claim 1 in which the inflatable means are flexible walled containers.

3. A movement control fin as claimed in claim 1 in which the inflatable means are piston and cylinder combinations.

4. A movement control fin as claimed in claim 1 in which the shaft is cranked in one direction and the web extends from the cranked part in the opposite direction.

References Cited in the file of this patent

UNITED STATES PATENTS

2,628,684	Slatter et al.	Feb. 11, 1953
2,753,835	Gehrig	July 10, 1956
2,969,035	Foll	Jan. 24, 1961
2,991,748	Muirhead et al.	July 11, 1961