Aug. 20, 1968 J. J. SLAGER ET AL 3,397,664

VESSEL STABILIZER

Filed Sept. 16, 1966 2 Sheets-Sheet 1

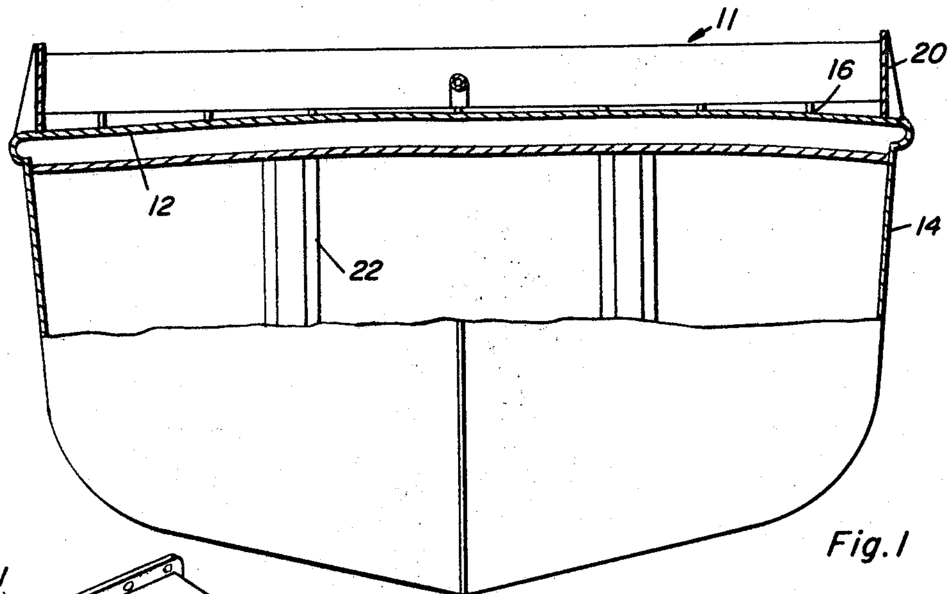


Fig. 1

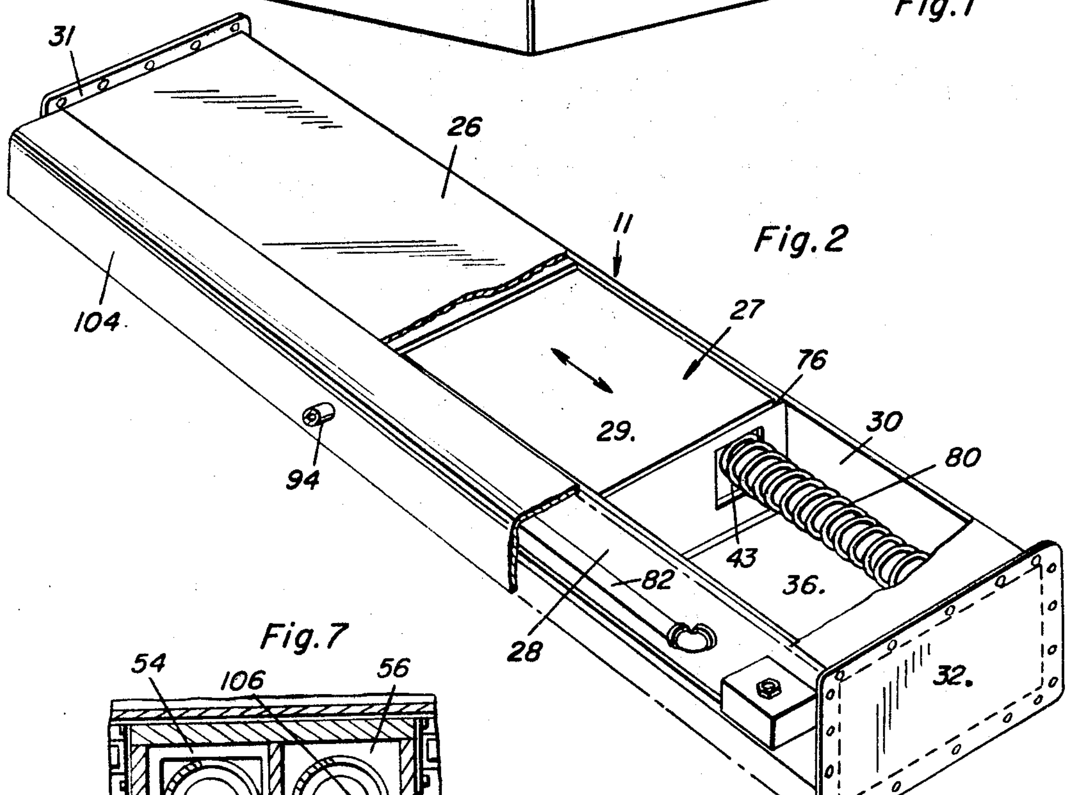
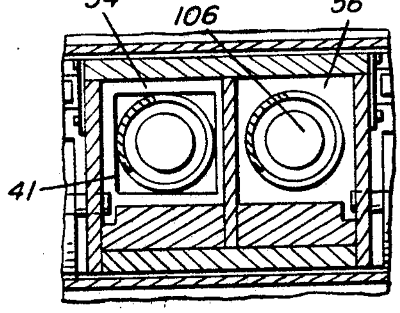


Fig. 7



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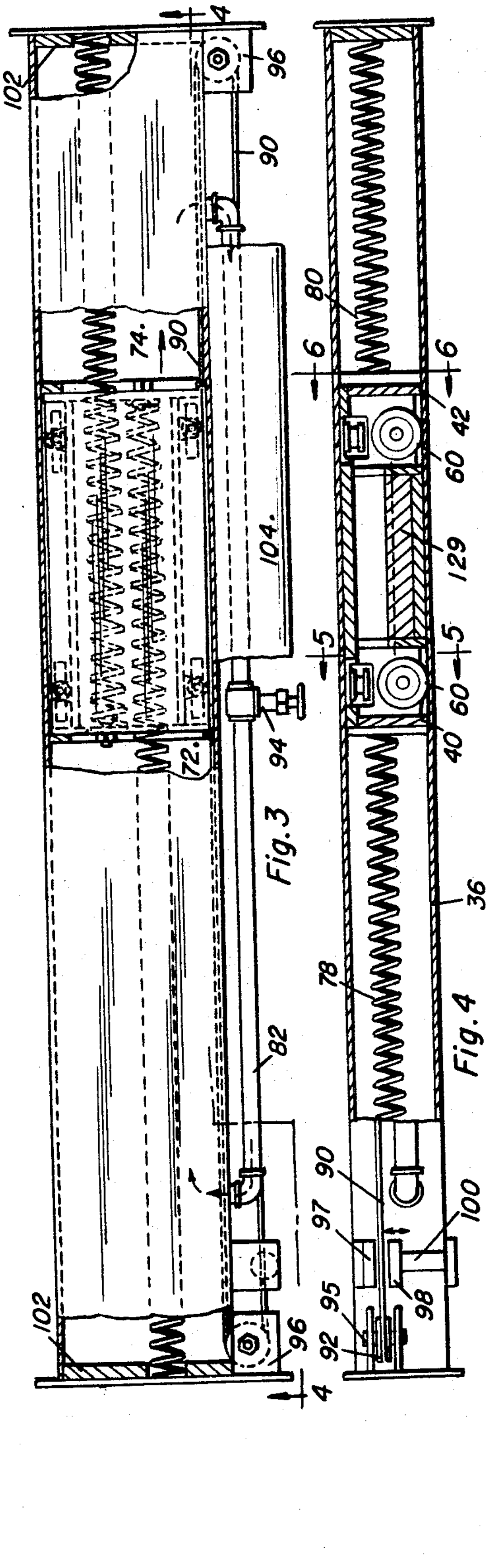

Fig. 3 Fig. 4

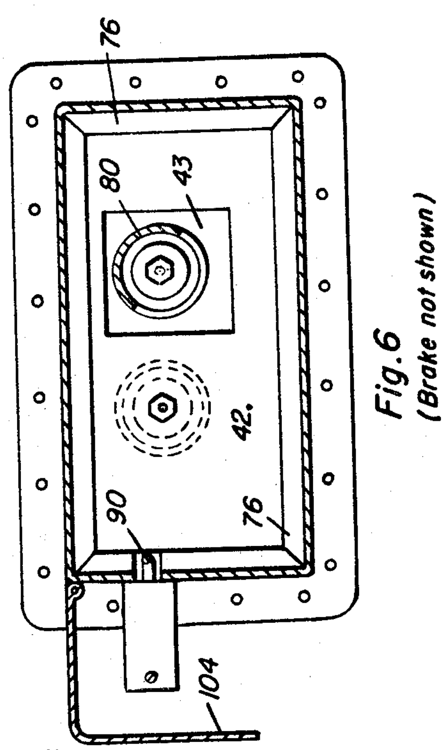

Fig. 6 (Brake not shown)

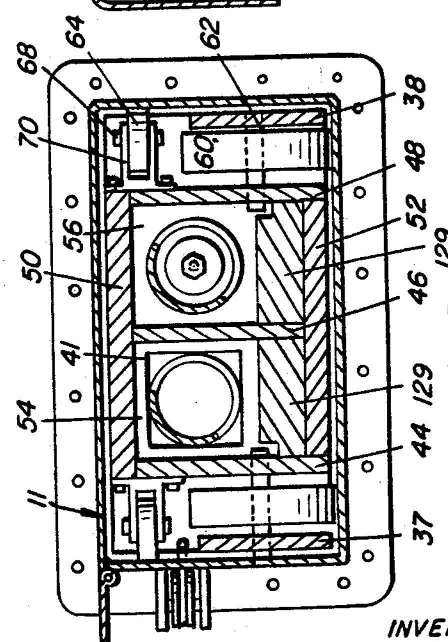

Fig. 5

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1

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VESSEL STABILIZER

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ABSTRACT OF THE DISCLOSURE

A vessel stabilizer including a mass movable within a substantially gastight tube and dividing it into left and right pressure chambers, resonant spring tuning means normally maintaining the mass centered relative to the pressure chambers, the mass upon movement from center compressing the gas in the chamber in the direction of movement to establish a dampening pressure resisting further movement of the mass.

The invention disclosed herein relates to a vessel stabilizer, and more particularly to a unitary self-contained, movable weighted mass stabilizer.

It is recognized that both active and passive stabilizers are well known in the art. In recent years considerable development has been pursued in passive type stabilizers, wherein fluid-containing wing tanks are interconnected by a cross-over conduit generally of a particular configuration to cause damping. The work of Frahm on passive stabilizers is well known. The Ripley patents disclose later developments. Ripley U.S. Patent No. 3,083,671 discloses a passive wing-type system and inserts into the cross-over conduit a solid mass of greater density than the water which would otherwise remain in the cross-over.

The development of active systems has not been extensively pursued in recent years. This type of system requires control means, which must be very sensitive to ship motion in order to rapidly activate the mechanical anti-roll means. The control problems inherent in such systems, their cost and maintenance, led to the further development of the passive means.

The stabilizer disclosed herein may be considered passive, in that it is activated by the application of an external force, namely the roll of the vessel. As the roll continues, the stabilizer will be inclined in an oscillatory manner, and the moving weight will oscillate. Associated with the weight are spring means tuned to cause resonant oscillation of the weight at or near the frequency of oscillation of the unstabilized vessel. Also associated with the weight is a closed system pressure establishing damping means to resist the weight movement and maintain it out of phase with the vessel oscillation. Herein both the tuning and damping means are operably connected to and activated by movement of the weighted mass. Power driven electric, hydraulic, or other control means are thereby eliminated.

The object of the invention is to provide a stabilizer of the above described type, having a minimum number of parts, which is entirely mechanical in operation, and which may be fabricated as a unitary structure for installation aboard a vessel. The unit may be positioned on the main deck, where it will be readily available for adjusting purposes and does not occupy valuable cargo or storage space. The change required in ship construction is the provision of additional structural strength which may be readily accomplished in new construction, as well as in vessels in service, again without sacrificing space.

Another object is a stabilizer of small volume and weight, as compared to passive liquid type stabilizers, making the stabilizer particularly suitable for small craft

2

and vessels up to one thousand tons displacement, wherein space is at a premium and added weight undesirable. For example, in a craft displacing approximately sixty-seven tons, the weight of water required in a passive wing-type stabilizer would be approximately double that of the weight herein, and with a movable weight such as is disclosed herein, the space occupied is approximately 10% of the volume require by water.

The foregoing and other objects and advantages will be apparent from the description herein when read in conjunction with accompanying drawings, wherein:

FIGURE 1 is a diagrammatic view of a vessel, partly in section, with the stabilizer mounted athwart the main deck;

FIGURE 2 is a perspective view of the stabilizer, partly in section;

FIGURE 3 is a plan view, also partly in section;

FIGURE 4 is a view taken on line **4—4** of FIGURE 3;

FIGURE 5 is a view taken along line **5—5** in FIGURE 4;

FIGURE 6 is a view taken along line **6—6** in FIGURE 4;

FIGURE 7 is a view similar to FIGURE 5 as modified, when the closed system pressure establishing means is wholly within the stabilizer casing.

As seen in FIGURES 1 and 2, the preferred embodiment of the stabilizer **10** includes an elongated tube or casing **11** of rectangular cross-section and of substantial length relative to its width and height. The stabilizer is positioned lengthwise athwart the main deck **12** of the hull **14**, and is secured to the deck by spaced depending foot members **16** and end brackets **20**, which may be welded to the stabilizer and bolted to the deck to permit removal of the stabilizer. The only installation requirements are that the transverse center line of the stabilizer be aligned with the longitudinal center line of the vessel, and the stabilizer be rigidly secured to the vessel to roll therewith. Suitable stanchions **22** may be installed between decks to give additional support, if needed.

As the stabilizer **10** may be turned end for end, it will be described as viewed in the drawings rather with relation to its onboard installation. More particularly, the tube **11** is preferably made of suitable metal, having a top **26**, front and rear side walls **28** and **30** and a bottom **36**. Each end of tube **11** has an outer peripheral flange **31** to which left and right end closures **32** are respectively secured. For reasons hereinafter apparent, the tube is substantially gastight and has a smooth interior surface.

Movable within the tube is a weighted mass **27** comprising an elongated rectangular carrier **29** having front and rear side walls **37** and **38** (FIG. 5) interconnected to left and right end walls **40** and **42**. The end walls **40** and **42** are also interconnected by a front partition wall **44**, a center partition wall **46**. and a rear partition wall **48**. Top and bottom members **50** and **52** complete the carrier, and with the parallel partition walls define a pair of adjacent longitudinal compartments **54** and **56** within. Carried on the bottom of each compartment is a lead weight **129** of the compartment. The front compartment **54** (left as seen in FIGURE 5) has an opening **41** thereto through the carrier left end wall **40**, and the rear compartment **56** has an opening **43** thereto through the carrier right end wall **42** (FIG. 2), the openings being above the weight, the compartments being otherwise substantially gastight.

The carrier **29** is supported for movement on anti-friction devices here shown as four rollers **60**, one at each corner of the carrier. Each roller is mounted on an axle **62** horizontally supported between the adjacent side and partition walls and so positioned that a small, peripheral portion extends through a slot in the carrier bottom and engages the interior surface of tube bottom **36**. Positioned above each roller is a centering caster **64**, rotatable on a pin **68** vertically supported between the arms of a U-bracket **70** which is secured to the adjacent partition wall. The adjacent side walls are cut away to permit the casters to engage the adjacent interior wall surfaces of tube **11**. The carrier **29** and lead weights **129** make up the movable weight mass **27**.

The carrier is approximately one-third the length of tube **11**, and divides the tube into left- and right-hand pressure chambers **72** and **74**. To establish pressure within the chambers, the left and right end walls **40** and **42** of the carrier each have a sealing gasket **76** (FIGS. 4 and 6) secured around the outer periphery thereof, the sealing gasket being in light rubbing engagement with the interior surface of the tube, and the carrier ends act as a piston upon movement of the carriage, to compress the gas or air in the direction of movement, as more fully explained hereinafter. A single seal could be used midway between the ends of the carrier, but for convenience in manufacture, the end seals are preferred.

When so constructed, when the weighted mass **27** moves upon inclination of the stabilizer by the roll of the vessel, the mass will therefore oscillate with the roll. As the oscillation must be at resonant frequency, as explained above, there is associated with the mass **27**, opposed left and right tuned spring damping means **78** and **80**. The spring **78** extends from the tube left closure member, to which its outer end is secured in any suitable way, and extends through the opening **41** in carrier left end wall **40**, into the compartment **54**, and has its inner end secured to the carrier right end wall **42** (FIG. 3). The right-hand spring **80** is similarly mounted, but in reverse manner, in that it extends from right end tube closure member, extends through the opening **43** in the carrier right end wall **42**, into the compartment **56** and is secured to the carrier left end wall **40**. The axis of each spring is equidistant to each side of the longitudinal center line of the tube, and in the same horizontal plane.

The spring means **78** and **80** are spiral, have the same physical characteristics, are tuned to the proper resonant frequency, are under compression and exert equal and opposite forces on the mass **27** when the latter is centered. The construction shown offers distinct advantages. By providing the carrier **29** with the longitudinally extending spring receiving compartments, the length of the spring is increased by the length of the carrier compartment. In the embodiment shown, when the carrier is centered, each spring is more than one-half the length of the stabilizer, thus permitting the use of long, light, sensitive springs. Additionally, as the mass **27** moves toward one end of the tube, as the spring is shortened, it, in effect, is swallowed within the compartment allowing maximum movement of the mass.

As previously stated, the mass **27** divides the tube into left and right pressure chambers, and as the tube is substantially gastight, movement of the mass operates the pressure establishing damping means. If the movement is to the right, the air or gas within chamber **74** will be compressed in the direction of movement and establish a pressure which resists further movement of the weight. The air or gas in the left chamber **72** is simultaneously expanding. Regulation of the damping may be accomplished by bleeding air between the chambers thus reducing the resisting force in the direction of movement. This is accomplished by providing a control means, comprising a tubular bypass **82** (FIG. 3) interconnecting the two pressure chambers. A throttle valve **94** is installed in the bypass **82**, permitting regulation of the flow between chambers. The bypass openings into the chambers are each positioned about one-half a carrier length from the end of tube, whereby the carrier will close off the bypass opening in the direction of movement, and the remaining air will be rapidly compressed to establish a rapid rise in pressure and provide additional resistance to cushion the mass as it approaches the end of the tube. As the weight of the gas is inconsequential, the mass and springs constant, the variable is the changing pressure force. By the use of air or other suitable gas, disturbance due to a sloshing of free water surface, is eliminated.

With the bypass throttle valve **94** exterior of the stabilizer, the damping may be readily adjusted. The ready rapid adjustment is highly desirable as it allows operation at maximum effectiveness over a range of metacentric heights. For instance, after discharge of cargo, the stabilizer may be quickly tuned to the changed ship condition.

As there are occasions when it may be necessary to move the mass within the tube without inclining the vessel, means are provided for moving it manually and means to lock it in a set position. These means include a cable **90** which is attached to the left front wall **40** of the carrier adjacent the inner side wall of the tube **11**, it then parallels the tubing front wall **28** to a horizontally arranged sheave **92** rotatable on a vertical pin **95**, positioned in a box casing **96** projecting outwardly from the front wall of the tube **11**. Cable **90** makes a reverse turn around the sheave **92** and exits from the casing through a suitable packing gland, then runs parallel to the exterior of the tube and enters a box casing **96** at the right end of tube, again making a reverse turn around a sheave **92**, and parallels the inner wall of the tube and is connected to the right end wall **42** of the carrier. The exterior run of the cable may be marked to show the interior position of the mass, as by a slack take-up turn buckle positioned to show when the mass is centered. The cable **90** may be secured in position by clamping the cable between members **97** and **98**, one of which may be operated by a screw jack **100**, diagrammatically shown, as any suitable type will do. A power drive means could be associated with the cable **90** for moving it, but it is apparent that a seaman could take a purchase thereon and utilize a block and tackle to accomplish the result.

Numerous other refinements may be made. For example, the interior ends of tube **11** may be covered with a cushioning material **102** to act as a shock absorber, should a spring break. Also, to protect the bypass **82** and cable **90**, a hinged cover **104** is provided, the cover having a suitable slot therein through which the throttle valve **94** stem projects, permitting access to it at all times.

It is apparent that the tube **11** could be circular in cross-section; and the mass could be cylindrical, with oppositely disposed open end chambers to receive the springs. The interior surfaces of the tube and exterior surface of the weight may be highly polished, coated with suitable lubricating substances or provided with radially disposed rollers or other means, to permit ready movement. From a practical standpoint, the high cost involved, gives preference to the embodiments hereon.

For small craft, where little change in draft occurs between light and heavy conditions, the exterior bypass **82** between the pressure chambers **72** and **74** may be eliminated, and one or both of the carrier compartments **54**, **56**, may have an opening **106** in the end wall opposite the spring entrance opening (FIG. 7), through which air may pass, whereby the pressure build-up to one side of the mass is controlled by the constant release of air to the other. This simplifies the structure, for small craft wherein displacement is relatively constant. Minor air or gas leakage either from the tube or past the carrier does not adversely affect the operation.

From the foregoing, it will be seen that the mass is the motivating force and becomes operable upon inclusion of the stabilizer. The spring resonant tuning means are operably connected between the stabilizer casing and the mass and are activated upon movement of the mass. The pressure establishing means become activated upon the movement of the mass and the pressure established is the variable force in that the mass and spring means are constant. Pressure adjustment is accomplished by a single throttle valve in the pressure establishing means.

The stabilizer having been described, the patentable subject matter is set forth in the following claims.

We claim:

1. A unitary self-contained vessel stabilizer including:
(a) an elongated closed airtight tube;
(b) a weighted mass of lesser length than the tube movable longitudinally of the tube;
(c) resonant spring tuning means operably connected between the mass and the tube and applying equal and opposite forces on the mass when the mass is centered in the tube and activated by movement of the mass; and
(d) pressure establishing means associated with the weighted mass and operably responsive to the mass upon movement thereof to compress the air in the direction of movement to establish pressure dampening the movement of the mass as the latter moves from center.

2. The stabilizer defined in claim 1 including bleeder control means for adjusting the pressure established by the pressure establishing damping means.

3. The stabilizer defined in claim 1 wherein the tube is rectangular in cross-section, and including an elongated rectangular weighted movable carrier, and said resonant spring tuning means comprises a pair of springs, one connected between one end of the tube and one end of the carrier, and the other connected between the other end of the tube and the other end of the carrier.

4. The stabilizer defined in claim 3 wherein each spring extends into the carrier and connects to the end of the carrier remote from the end of the tube to which it is connected.

5. The stabilizer defined in claim 3 wherein the carrier includes sealing means dividing the tube into left and right dashpots, said means compressing the air in the direction of movement of the carrier to establish pressure resisting the movement of the carrier.

6. The stabilizer defined in claim 5 including a bypass between the dashpots.

7. The stabilizer defined in claim 6 wherein the bypass is an opening through the carrier.

8. The stabilizer defined in claim 6 wherein the bypass is a conduit exterior of the tube and having its ends respectively opening into the opposite dashpots, and a throttle valve in the conduit.

9. The stabilizer defined in claim 3 including means connected to the carrier and extending exterior of the tube for manually moving the carrier.

10. The stabilizer defined in claim 9 including means for securing said last named means.

11. The stabilizer defined in claim 2 wherein said bleeder means is closed by the weighted mass after predetermined movement of the mass.

12. A vessel stabilizer including
(a) left and right gastight pressure chambers;
(b) a weighted means movable in said chambers to compress the gas in the chamber in the direction of movement of the mass whereupon the gas in the other chamber may expand;
(c) bleeder means interconnecting the chambers to control the pressure therebetween;
(d) and resonant spring tuning means normally acting to maintain the weighed mass centrally of the chambers.

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