

[54] ROLL COMPUTER

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[56] References Cited
UNITED STATES PATENTS

2,901,996 9/1959 Bell 114/122

3,045,630	7/1962	Foll et al.	114/122
3,557,734	1/1971	Tann et al.	114/122
3,604,386	9/1971	Turci 114/125	
3,727,572	4/1973	Nelson et al.	318/585 X
3,738,304	6/1973	Duberley 114/126	

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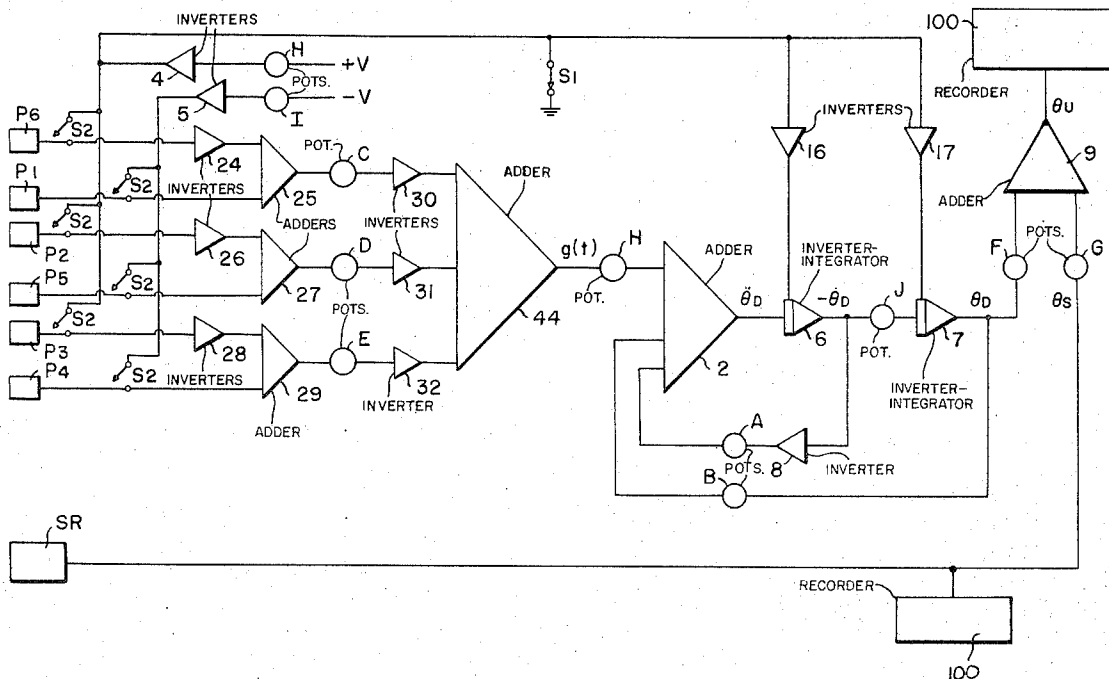
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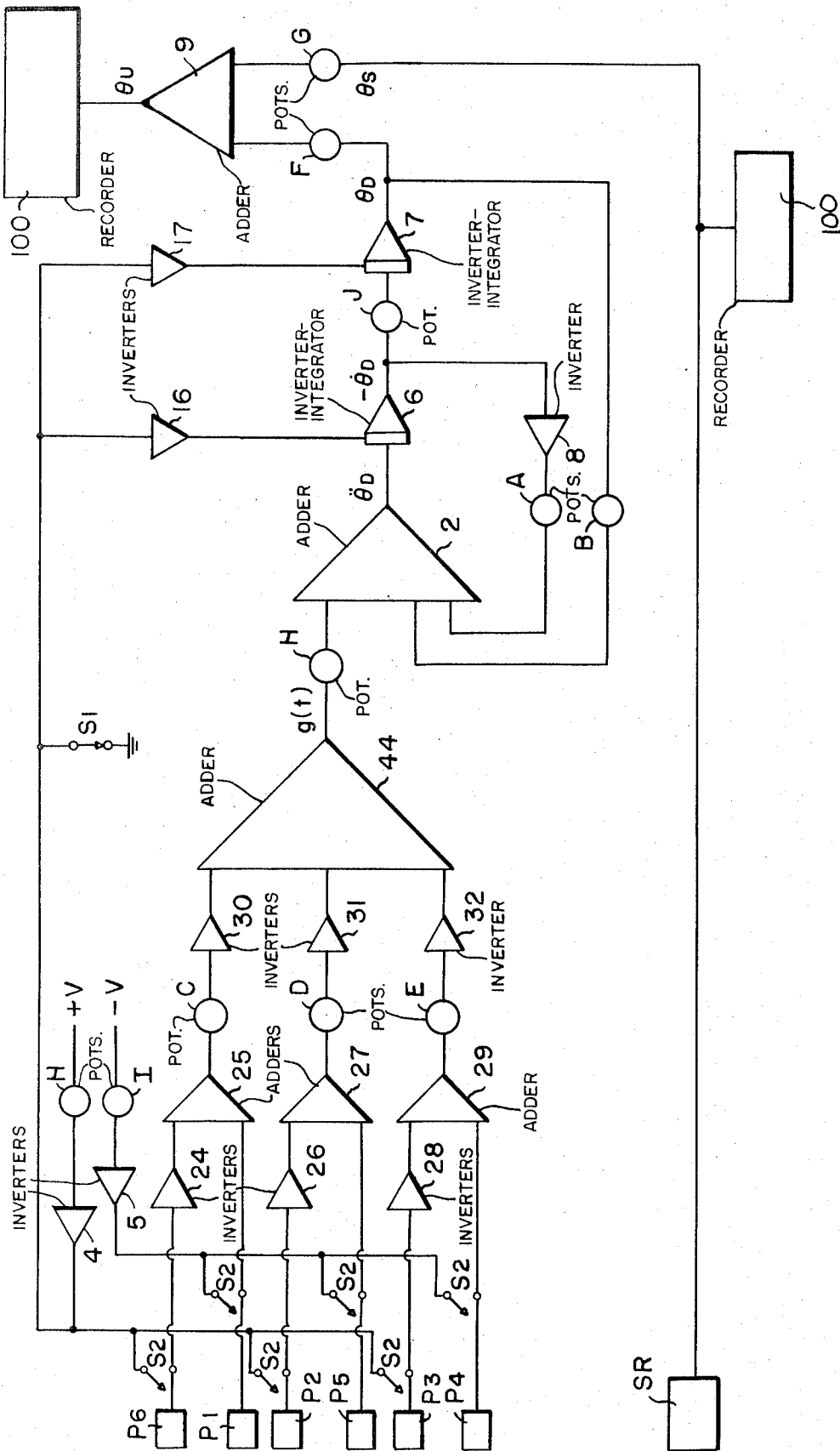
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[57] ABSTRACT

A ship mounted stabilizer roll tank is instrumented to generate signals indicative of the tank moment. The ship is also instrumented to generate signals indicative of its actual roll. The measured tank moment is weighted to yield a signal indicative of the difference between the actual stabilized roll and the estimated unstabilized roll.

6 Claims, 1 Drawing Figure





ROLL COMPUTER

The invention described herein may be manufactured and used by or for the Government of the United States of America for Governmental purposes without the payment of any royalties thereon or therefore.

BACKGROUND OF THE INVENTION

This invention generally relates to ships equipped with passive roll tanks. A roll tank is a fluid filled tank mounted in a ship and used to prevent undesired oscillations of the ship due to wave excitation. As the ship rolls, the fluid in the tank shifts in the direction of the roll and, in effect, changes the center of gravity of the ship thereby inhibiting the tendency of the ship to oscillate. The term passive is used herein to denote that type of tank in which the amount of fluid is held constant as opposed to other types of roll tanks in which the fluid level is changed as by pumping in response to signals from other shipboard systems as disclosed in prior art devices. The present invention is designed to test the efficiency of passive roll tanks while mounted on the ship under test. No such prior art device is believed to exist.

SUMMARY OF THE INVENTION

This invention relates to a device for determining the unstabilized roll of a ship equipped with a passive roll tank. Signals indicative of the stabilizer roll tank moment are generated by instruments mounted on the stabilizer roll tank. Another signal indicative of the actual roll of the ship is generated. The measured tank moment is then utilized to generate a signal which is indicative of the difference between the actual stabilized roll and the estimated unstabilized roll. The difference signal is then added with the actual roll signal to produce a signal indicative of the unstabilized roll of the ship.

OBJECTS OF THE INVENTION

The object of this invention is to provide a device for estimating the unstabilized roll of a ship which is equipped with a passive roll tank.

Another object of this invention is to avoid the necessity of making separate tests of the oscillatory behavior of a ship before and after the passive roll tank is mounted.

Other objects, advantages and novel features of the invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings wherein:

BRIEF DESCRIPTION OF THE DRAWINGS

The sole FIGURE is a detailed network diagram of the preferred embodiment of this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Generally, when a ship is unstabilized, i.e., not outfitted with a roll tank stabilizer

$$a\ddot{\theta}_u + b\dot{\theta}_u + c\theta_u \cong f(t) \quad (1)$$

where a , b , and c are constants of proportionality, $f(t)$ is the roll moment of the ship due to wave excitation and θ_u is the unstabilized roll angle of the ship. When the ship is stabilized

$$a\ddot{\theta}_s + b\dot{\theta}_s + c\theta_s \cong f(t) + g(t) \quad (2)$$

where $g(t)$ is the moment developed by the stabilizer tank and θ_s is defined as the stabilized roll angle. By definition herein

$$\theta_d = \theta_u - \theta_s \quad (3)$$

or

$$\theta_u = \theta_s + \theta_d \quad (4)$$

θ_d , therefore, represents the difference between the unstabilized roll angle and the stabilized roll angle. It follows from substitution of equation (4) into equation (1) that

$$a(\ddot{\theta}_s + \ddot{\theta}_d) + b(\dot{\theta}_s + \dot{\theta}_d) + c(\theta_s + \theta_d) \cong f(t) \quad (5)$$

Since the derivative of a sum is equal to the sum of the derivatives, it follows that

$$a\ddot{\theta}_s + a\ddot{\theta}_d + b\dot{\theta}_s + b\dot{\theta}_d + c\theta_s + c\theta_d \cong f(t) \quad (6)$$

Subtracting equation (2) from equation (6), gives

$$a\ddot{\theta}_d + b\dot{\theta}_d + c\theta_d \cong -g(t) \quad (7)$$

It is thus seen that θ_d is a function of the moment developed by the stabilizer tank.

In the drawing, P_1 , P_2 , P_3 , P_4 , P_5 , and P_6 each represent a pressure transducer mounted on the roll stabilizer tank and an amplifier to amplify the transducer signal output. The transducers are mounted at various locations on the stabilizer tank depending on the particular stabilizer tank configuration. A, B, C, D, E, F, G, H, and I denote potentiometers utilized at various locations in the roll computer to properly scale the signals passing therethrough. 24, 26, 28, 30, 31, 32, and 8 are inverter amplifiers for inverting signals at their inputs to provide the proper polarity signal at their outputs. 25, 27, 29, 44, 2, and 9 are adders. 6 and 7 are inverter integrating networks. SR denotes a unit for measuring the stabilized roll of the ship and for providing an electrical signal proportional to the stabilized roll angle θ_s . SR may be a gyroscope or an inclinometer with a potentiometer.

The signals developed by pressure transducers P_1 - P_6 and units 24-32 are supplied as inputs to adder 44 such that the output of adder 44 is representative of the total roll tank moment $g(t)$. The instant invention provides for sensing of the fluid pressure within the roll tank at six locations by the pressure transducers P_1 - P_6 shown in the drawing, the locations of the transducers being dependent upon the particular roll tank configuration. Inverter-amplifier 24 inverts the pressure indicative signal from transducer-amplifier P_6 so that the output of adder 25 is a measure of the difference between the pressures sensed by units P_1 and P_6 . Likewise the outputs of adders 27 and 29 are measures of the pressure differences sensed by transducers P_2 and P_5 and P_3 and P_4 respectively. Potentiometer C scales the pressure difference output of adder 25 and, thereby, produces a first contribution to the total tank moment. Similarly, potentiometers D and E scale the pressure difference outputs of adders 27 and 29, respectively, thereby producing second and third contributions to the total tank moment. These tank moment contributions are inverted by inverters 30, 31 and 32 to provide the proper sign and are then summed by adder 44. The output of 44 is, therefore, representative of the total stabilizer tank moment, $g(t)$. Solving equation (7) for the second order derivative, $\ddot{\theta}_d$, yields

$$\ddot{\theta}_d = -g(t)/a - b/a\dot{\theta}_d - c/a\theta_d \quad (8)$$

The purpose of adder 2 is to synthesize the right hand side of equation (8). The output of adder 44 supplies the first input, $g(t)$, to adder 2. The second input to adder 2 is supplied by a first feed back loop from the output of inverter integrator 6 since the output of 6 is proportional to the quantity $\dot{\theta}_u$. The third input to adder 2 is supplied by a second feedback loop from the output of inverter integrator 7 since the output of 7 is proportional to θ_u . Thus, each of the three quantities in the right hand side of equation (8) is present as one of the inputs to adder 2. Inverter integrators 6 and 7 then perform a double integration of the output from adder 2. The output of 7, therefore, is representative of θ_u , the difference between the unstabilized roll angle and the stabilized roll angle. Adder 9 adds to this signal the signal θ_s , the stabilized roll angle. Thus, as seen in equation (4), the output of adder 9 is θ_u . This unstabilized roll angle signal, θ_u , and θ_s are detected by some type of recording instruments, 100, which may take the form of a strip chart recorder, a tape recorder, a dial gauge, or any other form of suitable display means. θ_u may then be compared with θ_s to determine the effectiveness of the roll tank.

Static testing of the roll computer may also be performed by means of the test network provided. The test network comprises the voltage supplies +V and -V, potentiometers H and I, inverter amplifiers 4, 5, 16 and 17, and selectively actuable test switches S1 and S2. Switches S2 may be either ganged or independently operable. Opening of normally closed test switch S1 removes the shunt across the voltage supply, +V, whereby inverter amplifiers 16 and 17 are energized to supply test signals to inverter integrators 6 and 7. Similarly, closure of normally opened test switches S2 permits the voltage supplies +V and -V to energize the units 24-32 and, thereby, adder 44. Thus, the output of each of the units comprising the roll computer may be checked statically.

Thus, a roll computer has been disclosed for developing a signal which is an estimate of the unstabilized roll of a ship equipped with a stabilizer roll tank.

Obviously many modifications and variations of the present invention are possible in light of the above teachings. It is, therefore, to be understood that within the scope of the appended claims the invention may be

practiced otherwise than as specifically described.

What is claimed is:

1. A device for determining the unstabilized roll of a ship equipped with a roll tank comprising:

first means for developing a first electrical signal proportional to the difference between the unstabilized roll angle and the stabilized roll angle of the ship;

second means for developing a second electrical signal proportional to the stabilized roll angle of the ship;

third means for adding said first and second signals to produce a third electrical signal proportional to the unstabilized roll angle of the ship, whereby said third signal is indicative of the effectiveness of said roll tank when compared with said second signal.

2. The device according to claim 1 wherein:

said first means includes a plurality of pressure sensors mounted at various locations on said roll tank for producing pressure representative electrical signals.

3. The device according to claim 2 wherein said first means includes a first adder (44) connected to said pressure sensors, said first adder including an output, whereby the signal at the output of said first adder is representative of the instantaneous roll tank moment.

4. The device according to claim 3 wherein said first means includes a second adder connected to the output of said first adder said second adder including a second output;

first and second series connected integrators connected to said second output, each said integrator including an integrator output, whereby said first electrical signal is present at said output of said second integrator.

5. The device of claim 4 wherein said first means includes feedback means connecting each said integrator output to an input of said second adder.

6. The device of claim 1 further including selectively actuable test means for supplying voltage signals to said first means whereby said first means may selectively be tested for proper operation.

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