United States Patent

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[54] ELECTRICAL GROUND FILTER MEANS FOR BOATS SUPPLIED WITH A SHORE-BASED SOURCE OF ALTERNATING CURRENT POWER

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[52] **U.S. Cl.** .....**317/18 D**, 204/147, 204/196, 307/95, 317/20

[51] **Int. Cl.** **H01b 7/28**

[58] **Field of Search**.....307/95; 204/196, 147, DIG. 5, 204/DIG. 6; 136/163, 182; 317/10, 18 D, 20

[56] **References Cited**

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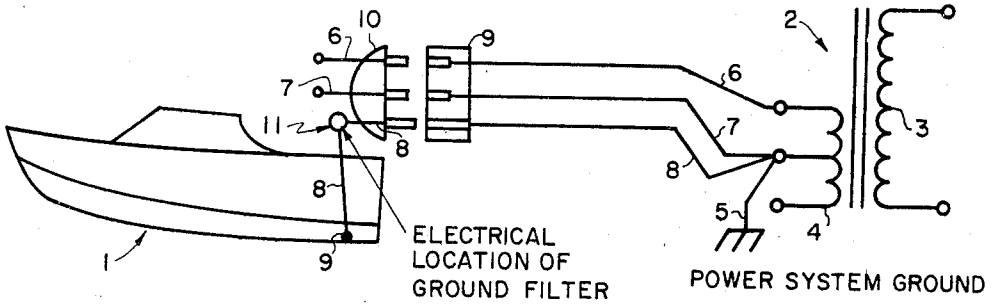
[57] **ABSTRACT**

An electrical ground filter means for boats or other vessels supplied with a shore-based source of alternating current power having current leads and an electrical grounding lead connected between the alternating current source and a boat, the ground filter means comprising a first pair of rectifiers in series with each other, a second pair of rectifiers in series with each other and of opposite polarity with the first pair, a capacitor means, the first and second pairs of rectifiers and the capacitor means being connected electrically in parallel of each other.

5 Claims, 5 Drawing Figures



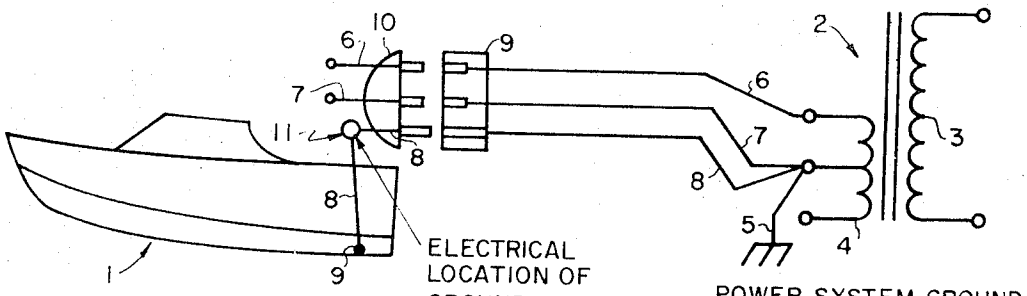


FIG. 1

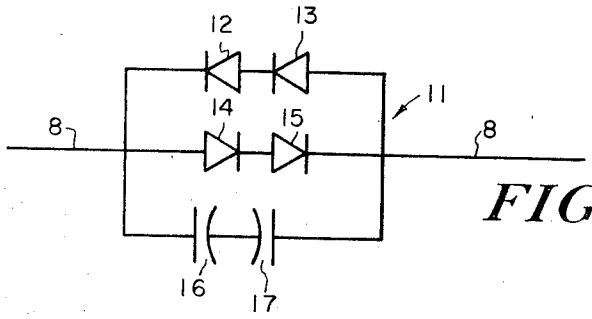


FIG. 2

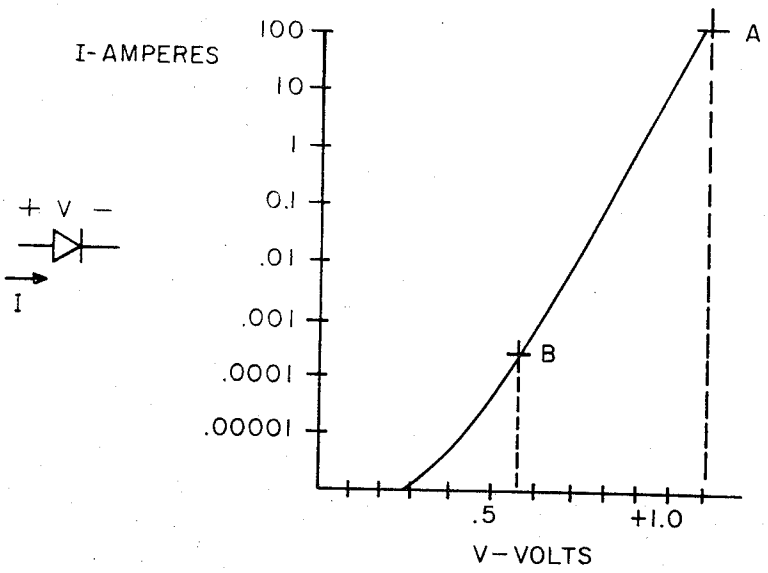


FIG. 3

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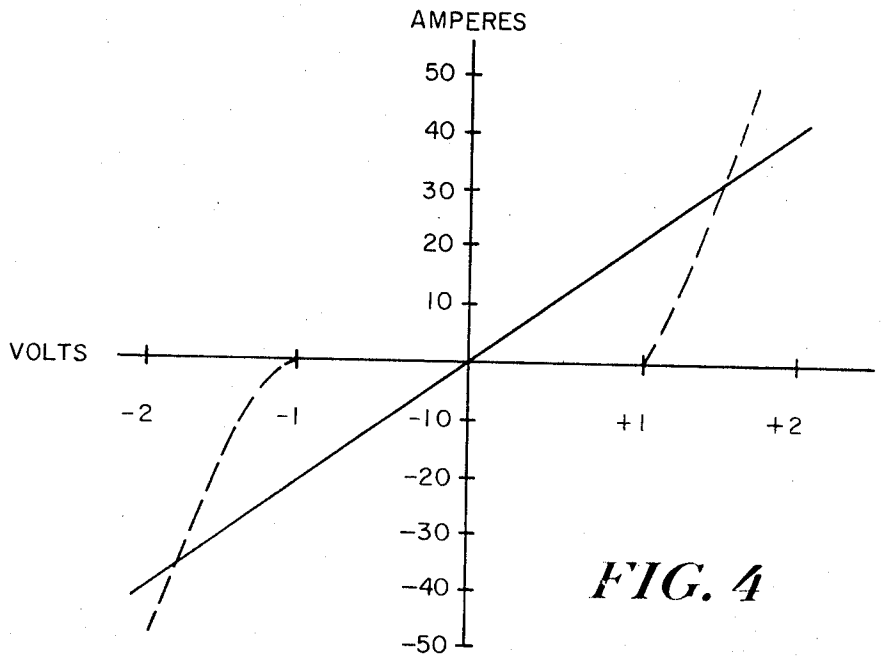
AMPERES
50
40
30
20
10
VOLTS
-2
-1
-10
+1
+2
-20
-30
-40
-50

FIG. 4

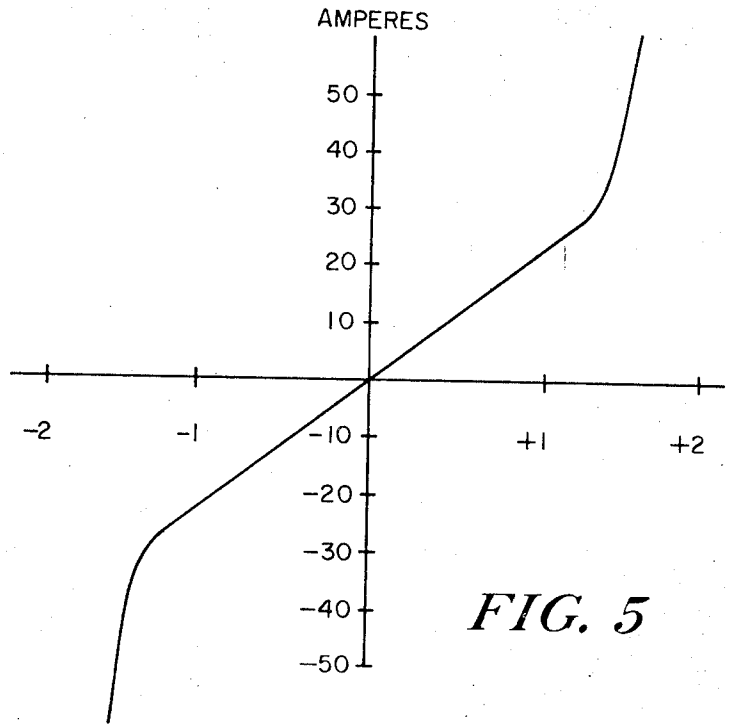
AMPERES
50
40
30
20
10
-2
-1
-10
+1
+2
-20
-30
-40
-50

FIG. 5

ELECTRICAL GROUND FILTER MEANS FOR BOATS SUPPLIED WITH A SHORE-BASED SOURCE OF ALTERNATING CURRENT POWER

BACKGROUND OF THE INVENTION

It is most practical for boats or other vessels to obtain electrical power from a shore-based source while the boat or vessel is at dock rather than from on-board electrical generation equipment. The wiring of this electricity aboard the vessel is often responsible for excessive corrosion of the water-immersed metal structure of the vessel.

Two corrosion promoting situations may exist in a boat wired for shore-based power. One situation is that when a third wire grounding conductor is used to ground a metal hull or metal underwater structures, a galvanic condition exists between the boat and shore-located metal structures. If the boat hull is an aluminum hull, or a fiber glass hull equipped with aluminum outdrives or outboard motors, the aluminum tends to become a sacrificial anode which will corrode away to protect shore-located iron structures. The other situation is that should a boat have a steel hull the galvanic action may not be as highly destructive as with aluminum, but the protection intended from cathodic protection devices with which the boat may be equipped can be seriously attenuated by a parasitic drain through the third wire ground.

Deterioration from these situations is costly since it causes structural weakness and surface roughness of the boat hull or its underwater metal structures. Corrosion so induced is most active in limited areas of the null and may promote water leakage. Also, a roughened surface increases resistance to the movement of the boat through water and thereby adversely affects the efficiency of boat operation.

It is the purpose of this invention to provide a means for eliminating the potential corrosion damage to boats or other vessels having electrically grounded metal hull structures, while at the same time to provide protection to personnel aboard the boat or vessel from electrical shock.

SUMMARY OF THE INVENTION

In accordance with the invention there is provided an electrical ground filter means for boats or other vessels supplied with a shore-based source of alternating current power, such as an appropriate transformer, having current leads and an electrical grounding lead connected between the source of current and a boat or vessels, the ground filter means being connected in series with the grounding lead, the filter means comprising a first pair of rectifiers in series with each other, a second pair of rectifiers in series with each other and of opposite polarity with the first pair, a capacitor or a pair of capacitors, the pair of capacitors being in series with each other and having opposite polarities, the first and second pairs of rectifiers and the capacitor or the pair of capacitors being connected electrically in parallel of each other. The parallel combination of the capacitor or the pair of capacitors and rectifiers provides low impedance under usual operating current conditions while simultaneously preventing the passage of direct current at low voltages inherent in the corrosion process.

DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates a schematic view of an electrical system for a boat supplied with a shore-based source of alternating current power including the filter means of the invention.

FIG. 2 illustrates a schematic circuit representation of the filter means of the invention,

FIG. 3 is a graphic representation of the volt-ampere characteristics of each series connected pair of the rectifier components of the ground filter means,

FIG. 4 is a graphic representation of the volt-ampere characteristics of the combined pairs of rectifiers in parallel arrangement including alternating current capacitor impedance, and

FIG. 5 is a graphic representation of a composite curve showing the volt-ampere characteristics and alternating current capacitor impedance of the parallel combination of rectifier pairs and capacitor means.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1, boat 1 is supplied with a shore-based source of alternating current power comprising a transformer 2 having a primary winding 3 and a secondary winding 4. The power system transformer output from the secondary winding is grounded by means of grounding lead 5 at the shore location. Current leads 6 and 7 and grounding lead 8 pass from the transformer secondary winding to a location on boat 1, preferably through a disconnectable means comprising a female socket 9 and male plug 10. The current leads 6 and 7 are connectable to a power outlet (not shown) on board the boat while the grounding lead 8 is grounded to the boat hull, as at 9, through an electrical ground filter means 11 preferably located on the boat. The ground filter means is connected is series in the grounding lead 8 as more particularly shown in FIG. 2. The filter means comprises a first pair of rectifiers 12 and 13 in series with each other, a second pair of rectifiers 14 and 15 in series with each other and of opposite polarity with the first pair of rectifiers, a capacitor means, for example a pair of capacitors 16 and 17 in series with each other and of opposite polarities, the first and second pairs of rectifiers and the capacitor means, e.g., capacitors 16 and 17, being connected in lead 8 in parallel with each other as shown.

The rectifiers are merely schematically shown since in practice the four rectifiers may be manufactured as a single-piece semiconductor device.

In order to prevent galvanic corrosion it is necessary to restrict the passage of low-voltage direct current between the boat and the shore. It is known that the maximum potential difference that will be generated between any two dissimilar metals (excepting when one metal is magnesium) immersed in a common sea water electrolyte is 1.1 volt. FIG. 3 shows that at this voltage a current of the order of 100 amperes will flow through a single rectifier (point A). When two such rectifiers are placed electrically in series and 1.1 volt is impressed across this combination, for example rectifiers 12 and 13, the voltage across each rectifier will be approximately 0.55 volt. FIG. 3 shows that at this voltage the current flowing will be less than 0.001 ampere (point B). When reverse polarity is applied to this rectifier combination essentially zero current flows. Since the voltage between the vessel and shore installations may be of either polarity depending on the metals encountered, it is necessary to employ rectifiers arranged with both polarities. This is shown in FIG. 2 where rectifiers 12 and 13 of one pair of rectifiers are connected in series with each other, rectifiers 14 and 15 of another pair of rectifiers are connected in series with each other and these pairs are connected electrically in parallel. The pairs of rectifiers are of opposite polarities relative to each other. The direct current volt-ampere characteristics of this arrangement is shown in FIG. 4 by the dashed curves. At low currents the combination of rectifiers has high impedance, e.g., at 1.1 volt at 0.001 ampere or an apparent resistance of 1,100 ohms, while at high currents a low impedance is observed, e.g., 1.8 volt at 40 amperes or an apparent resistance of 0.045 ohm. The combination of both these pairs of rectifiers performs the required function of a low impedance fault current path while simultaneously preventing the passage of direct current at the low voltages inherent in the corrosion processes. To further improve the performance of the filter a capacitor means constructed, for example, of a single nonpolar capacitor, or a pair of polarized electrolytic capacitors 16 and 17 which are connected in series with opposing polarities are employed. This capacitor means so arranged with the rectifiers reduces the alternating current terminal impedance of the filter means at potentials below that at which the rectifiers conduct. This type of capacitor means can be made to have a large capacitance at low volt-

ages, for example 0.14 farad at 3 volts. At a power line frequency of 60 hertz this capacitor means has an impedance of 0.04 ohm and is shown by the solid line in FIG. 4. This impedance is less than the apparent impedance of the rectifier system of rectifiers **12, 13, 14** and **15** at currents less than 30 amperes alternating current.

The parallel combination of capacitors and rectifiers provides low impedance under all current conditions at low power dissipation. The composite volt-ampere characteristics of the filter at a frequency of 60 hertz is illustrated by FIG. **5**.

The grounding lead **8** is installed to prevent serious electrical shock to the user of faulty electrical devices with shorts or leakage to their enclosure. It is necessary to preserve the electrical integrity of this grounding lead in the event of high short circuit currents which may exceed 1,000 amperes. The rectifiers employed are designed to meet this high fault current requirement.

The rectifiers **12, 13, 14** and **15** described each consist of a P- and N-doped silicon semiconductor junction. It is possible to fabricate these four junctions on a single piece of semiconductor material and provide the volt-ampere characteristics shown by the dashed line in FIG. **4**.

In a more generic sense, the invention comprises an electrical ground filter for the elimination of corrosive galvanic currents which is series connected between two dissimilar metals disposed in a common electrolyte, the filter having an impedance less than 0.1 ohm to alternating currents of 60 hertz and an impedance of at least 1,000 ohms at voltages of up to 0.9 volt direct current and the ability to pass fault currents in of at least 1,000 amperes.

Various modifications of the filter means of the invention is contemplated within the scope of the appended claims.

1. An electrical ground filter means for vessels supplied with a shore-based source of alternating current power, current leads and an electrical grounding lead connected between the power source and the vessel, the ground filter means being connected in series with the grounding lead, the filter means comprising a first pair of rectifiers in series with each other, a second pair of rectifiers in series with each other and of opposite polarity with the first pair of rectifiers, a capacitor means, the first and second pairs of rectifiers and the capacitor means being connected electrically in parallel with each other.

2. An electrical ground filter means according to claim **1**, wherein the capacitor means comprises a pair of capacitors in series with each other and of opposite polarities.

3. An electrical ground filter means according to claim **1**, wherein the first and second pairs of rectifiers are in the form of a single-piece semiconductor device.

4. An electrical ground filter means for the elimination of corrosive galvanic currents, the filter means being electrically series connected between two dissimilar metals disposed in a common electrolyte, the filter means having an impedance less than 0.1 ohm to alternating currents of 60 hertz and an impedance of at least 1,000 ohms at voltages of up to 0.9 volt direct current

5. An electrical ground filter means according to claim **4**, wherein the filter means is characterized by the passage of fault currents of at least 1,000 amperes.

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