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Davies et al.

[11] **3,841,250**

[45] **Oct. 15, 1974**

[54] **ELECTRICAL CHLORINATOR**

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[73] Assignee: **Morgen Berkeley & Company Limited**, Surrey, England

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[52] **U.S. Cl.** ..... **114/.5 R**, 204/149, 204/196, 204/270, 204/278

[51] **Int. Cl.** **B63b 35/00**

[58] **Field of Search** ..... 204/128, 149, 196, 269, 204/270, 278; 114/.5 R

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Assistant Examiner—W. I. Solomon
Attorney, Agent, or Firm—Wenderoth, Lind & Ponack

[57] **ABSTRACT**

An electrolytic chlorinator and a ship embodying the chlorinator. The chlorinator is suitable for fixing in a sea-water conduit without requiring a special recess and has elongate channels defined by upstanding vanes which are aligned with the direction of flow of the water. The sides of the vanes which define the channels are provided with electrolysing electrodes.

11 Claims, 8 Drawing Figures

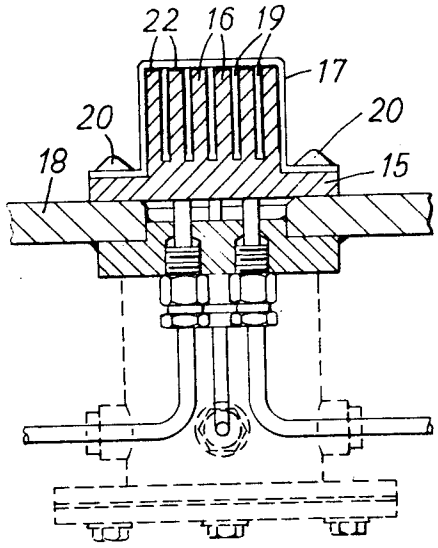


FIG. 1.

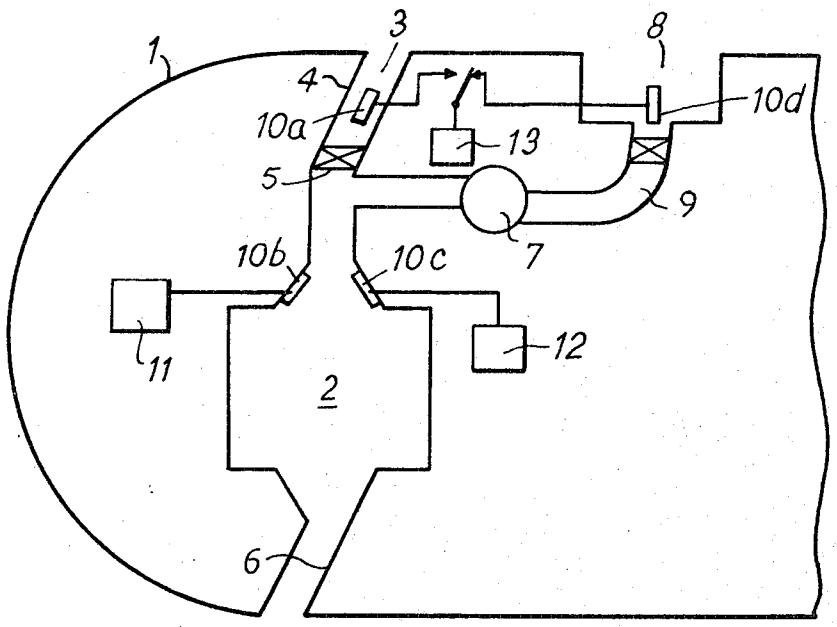

1
3
8
4
10a
10d
13
5
9
7
10b
10c
12
11
2
6

FIG. 4a.

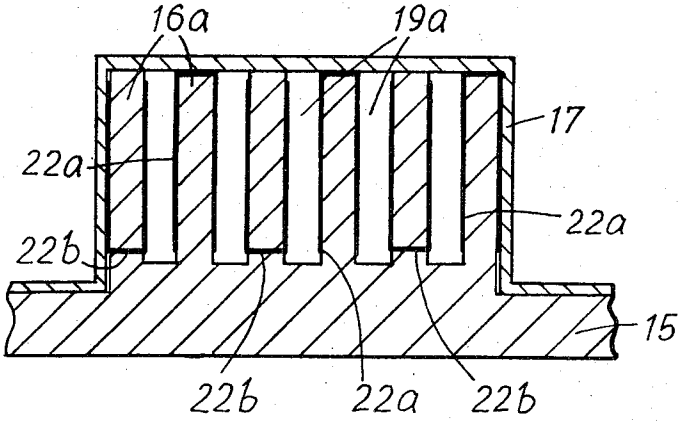

16a
19a
17
22a
22a
22b
15
22b
22a
22b

FIG. 2a.

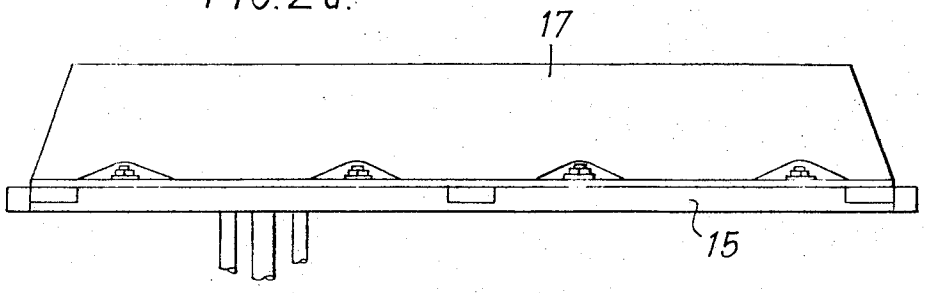


FIG. 2b.

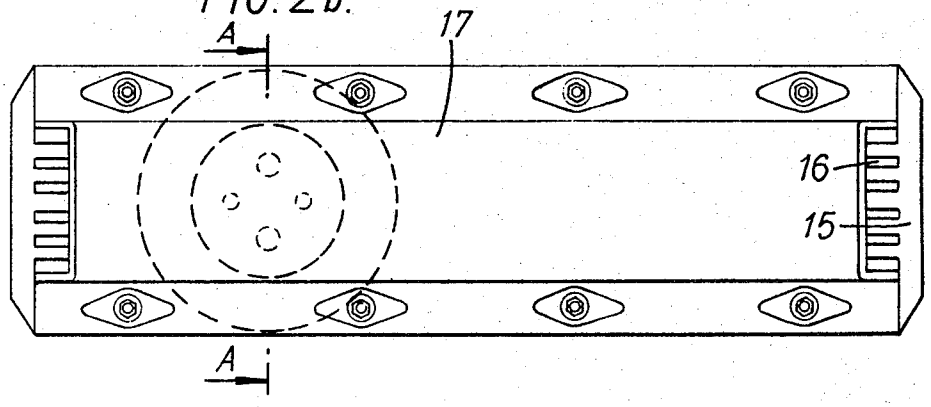


FIG. 2c.

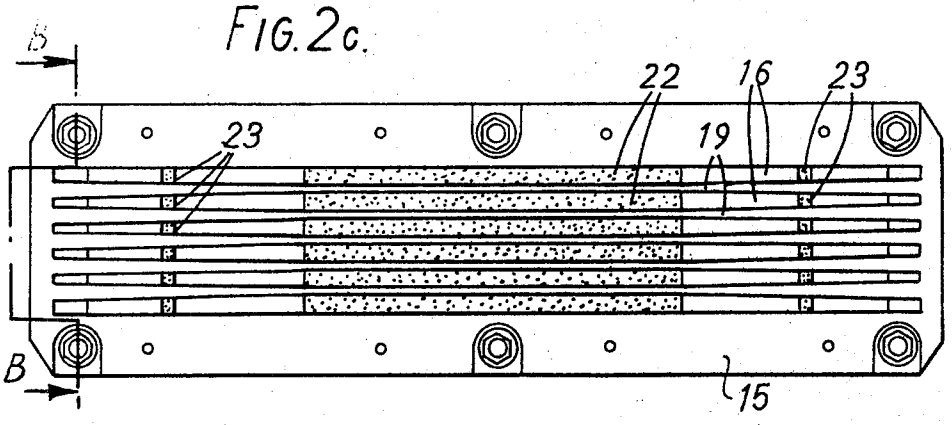


FIG. 3.

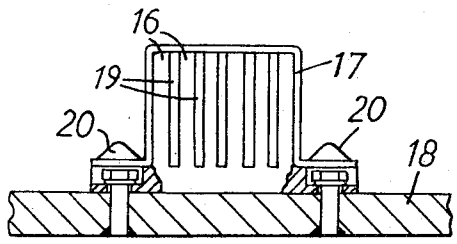
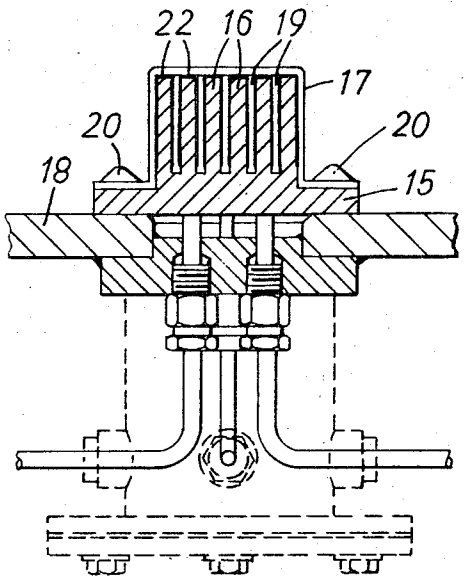


FIG. 4.



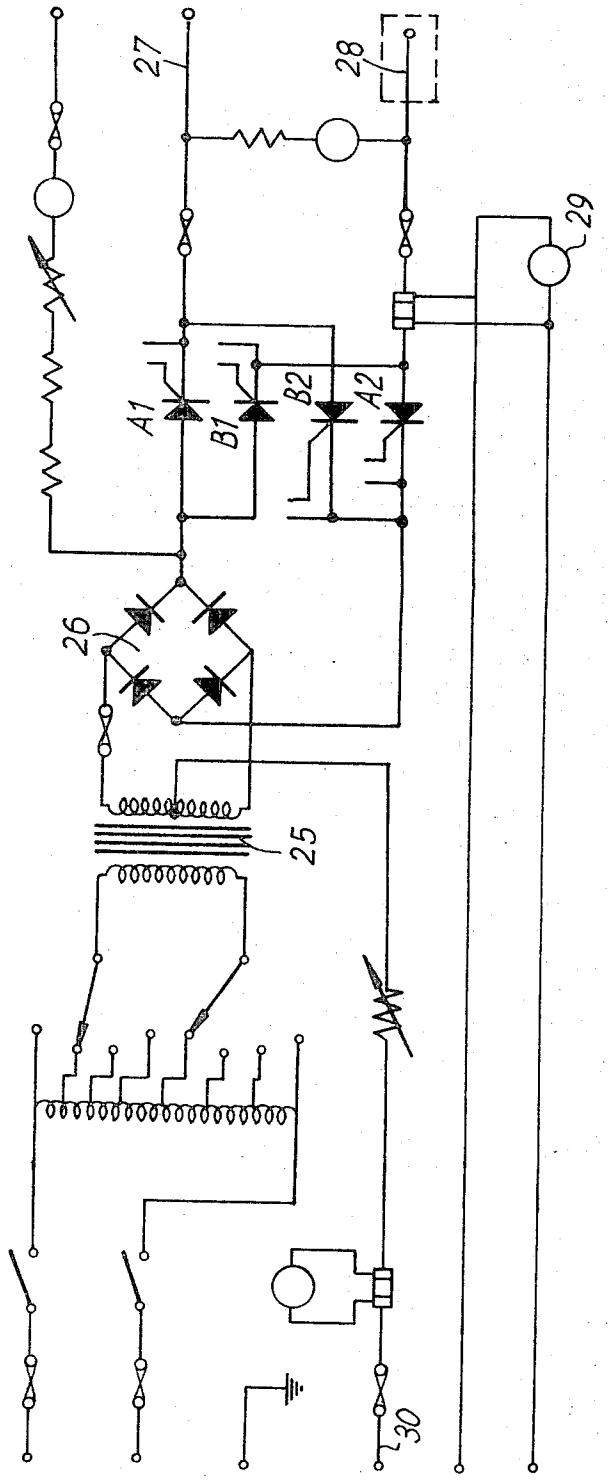


FIG. 5.

ELECTRICAL CHLORINATOR

The invention relates to an electrical chlorinator.

In large ships, particularly those which are driven by steam turbines, it is the practice to take in sea-water for the purpose of engine cooling and/or steam condensing. The water is taken in by a scoop, fed along a conduit to the cooling system or condenser and thereafter ejected. A disadvantage of such an arrangement is that organic growths such as weed or slimes and crustacia such as mussels are taken in with the water and may cling to the sides of the water passage ways in the system, so causing blockages and mal-functioning of valves and pumps. It has been proposed to kill such organisms by generating chlorine from the sea-water by electrolytic action. The present invention seeks to provide an improved electrolytic chlorinator for this purpose.

According to the invention there is provided an electrolytic chlorinator having an essentially flat rectangular base portion adapted to be fitted on the inside of the wall of a sea-water conduit in a ship; a plurality of vanes each extending from end to end of the base portion and upstanding therefrom, the space or spaces between the vanes constituting one or more elongate openended channels; and electrolysing electrodes extending over the major parts of the vane surfaces which bound the channel or channels. A chlorinator of this kind can be fixed directly to the wall of a sea-water conduit so that the vanes of the chlorinator are aligned with the direction of flow of the sea-water. The chlorinator does not require a special recess or cavity built into the side of the conduit within which to operate. Installation is thus simple and inexpensive.

Preferably there are three or more vanes which define a plurality of channels. In a preferred embodiment of the invention there are six vanes which define five channels. Preferably the channels are closed at their upper sides (the sides remote from the base portion). This closure may be effected by a cover which may be fixed to or integral with the vanes, but which is preferably removable.

The vanes are preferably of a plastics material, conveniently a glass-fibre reinforced resin. Preferably the vanes are moulded integrally of this material with the base portion. Alternatively, however, the vanes may be integral with and depending from the cover, being brought into position with respect to the base member by placement of the cover. The electrolysing electrodes are preferably of platinised titanium.

There is a danger that introduction and use of the chlorinator in a conduit of a ship may give rise to electrolytic corrosion of the conduit. In order to alleviate this problem a feature of the present invention provides guard electrodes of the vanes near their ends, the guard electrodes being insulated from the electrolysing electrodes so that in operation they can be maintained at a positive potential. It is found that this procedure allows adequate shielding of the electrolysing electrodes from the metal of the conduit.

The invention also includes within its scope a ship having a sea-water inlet conduit and fitted with one or more chlorinators as described above, the or each chlorinator being fitted by fixing the base portion to the wall of the conduit so that the channels of the chlorinator in and aligned with the sea-water flow through the conduit, the or each chlorinator being electrically connected to a power supply for applying electrolysing potentials to the electrolysing electrodes. Preferably the power supply applies positive potentials to the guard electrodes.

There is an alternative and simpler method of avoiding electrolytic corrosion. This does not require the provision of guard electrodes but instead requires the provision of a steady bias current to the vanes sufficient to ensure that all the plates in the chlorinator are maintained at potentials equal to or more positive than the surrounding metalwork. The vane system is designed to allow a controlled amount of current to flow out from the plate assembly and this current will at all times contribute to the cathodic protection of the pipework system.

The present invention further provides three important features which avoid practical disadvantages in the above-described arrangement. Firstly, if the electrolysing current passed between the electrolysing electrodes is a direct current, there will be a tendency for a calcerous film to be built up by decomposition of the sea-water, and this may well cause the equipment to fail through clogging. It is, therefore, a preferred feature of the invention that the potential between the main electrodes should be changed in direction periodically, but the guard electrodes are always at the potential of the most positive plates, or at more positive than the potential at the point in the electrolytic path where the guard electrodes are situated. This can be achieved in one form of the invention by the use of a potential dividing rheostat.

The periodicity of the switching of direction of the electrolysing current is limited by two factors. Firstly, there is a delay after switching to a new current direction before chlorine is generated in effective quantities. Secondly, if the current is maintained in a particular direction for too long scale builds up which is not readily removed on current reversal. Accordingly, a preferred but not exclusive period range for current in a particular direction is between 10 seconds and 10 minutes. This corresponds to a cyclic periodicity of 20 seconds to 20 minutes.

As far as the second important feature is concerned, in using noble metal electrodes even with a substantial substrate of titanium, it would be an advantage if thin electrodes could be used, as these are cheaper and lighter, and this could be done by using a folded electrode so that the electrode face is platinised on one side only and the electrode is folded about the vane to lie possibly in a small recess in the vane. It will be found that if this type of system is used, that the resistance of the thin plate would cause an uneven distribution of current between the electrodes, the current density being much greater at the point of fold. It is, therefore, a preferred feature of the present invention that the electrode plates are folded about the vanes so that the fold is about the tip of one vane and about the base of the adjacent vane or vanes. This brings about a great economy in the thickness of the electrode and it maintains an even current distribution.

A preferred circuit arrangement comprises a power source which supplies current to the electrolysing electrodes by way of a set silicon-controlled rectifiers effective, by switching, to control the direction of current applied to the electrodes. Switching of the rectifiers is effected by means of a control circuit which generates an appropriate timing waveform. Generally, such sea-

water cooling systems have incorporated a cathodic protection arrangement wherein there are provided a number of anodes spaced through the system and maintained at a positive potential. Typically the number of anodes may be **20.** In accordance with the third preferred feature of the present invention each chlorinator becomes an anode of the above system operating with a fixed current. To this end a direct bias current is provided to offset positively the average potential of the electrolysing electrodes. Such dual purpose operation offers particular advantage especially with a reversing gate electrode chlorinator.

The invention will further be described with reference to the accompanying drawings, of which:

FIG. **1** is a schematic illustration of a ship in accordance with the invention fitted with three chlorinators in accordance with the invention;

FIG. **2** shows at A, B and C respectively a side elevation, a plan view with the lid; and a plan view with the lid removed of a chlorinator in accordance with the invention;

FIG. **3** is a sectional view taken at BB of FIG. **2***c;*

FIG. **4** is a sectional view taken at AA of FIG. **2***b;*

FIG. **4***a* is a schematic sectional view showing a preferred electrode arrangement; and

FIG. **5** is a circuit diagram of part of a power source for supplying the chlorinators of FIG. **1.**

Referring to FIG. **1** part of the hull of a ship is shown at **1.** The ship has a steam driven turbine (not shown) and steam is condensed in a condenser **2** by means of sea-water which, when the vessel is in motion (the normal direction of motion being as shown by the arrow) is scooped into a scoop opening **3,** is fed along a conduit **4** past a scoop valve **5,** through the condenser and is passed out of the vessel through an exhaust conduit **6.** When the ship is not in motion the scoop valve **5** is shut down and an auxiliary pump **7** is operated, thus drawing sea-water through a sea-chest **8** and via conduits **9** through the condenser **2.**

In order to discourage crustacia and other organisms from establishing themselves in the system, chlorine is generated from the incoming sea-water by means of four chlorinators **10***a* to **10***d.* It will be seen that there is a chlorinator **10***a* on the outside of the scoop valve **5** and chlorinators **10***b* and **10***c* in the inlet water-box to the condenser. The fourth chlorinator **10***d* is situated in the sea-chest **8.**

Three power source circuits **11, 12** and **13** are provided to supply electrolysing power to the chlorinators. Source **11** is connected to chlorinator **10***b;* source **12** is connected to chlorinator **10***c* and source **13** is connected through a switch alternatively to chlorinators **10***a* or **10***d.* Only one of these latter two chlorinators will be operative at any time, depending upon whether sea-water is flowing through conduit **4** or conduit **9.**

Referring now to FIGS. **2** to **4** each chlorinator is moulded essentially of glass fibre reinforced resin and has an essentially flat rectangular base portion **15** and, extending therefrom, six vanes **16** extending from end to end of the base portion. The vanes **16** can be seen in plan view in FIG. **2***c.* FIG. **2***b* is a corresponding view but with a glass fibre reinforced resin lid **17** in place over the vanes.

In use, each chlorinator is fitted directly on the inside wall of a conduit. The steel conduit wall is shown in FIGS. **3** and **4** at **18.** The chlorinator is mounted so that the longitudinal channels **19** defined between the upstanding vanes **16** are directed in line with the direction of flow of the sea water in conduit. A small portion of the sea-water flowing through the conduit therefore flows through the channels **19.** Fixing of the chlorinator is effected by means of steel studs **20** welded into the wall of the conduit as shown in FIG. **4.** Electrical connections are taken from the chlorinator through the wall of the conduit and special precautions are taken to ensure a good water-tight seal at this point, a sealing steel plug being welded in place at the aperture.

As shown in FIG. **2***c* each vane **16** is provided over a substantial portion of its middle length with an electrolysing electrode **22** extending down both sides of the vane and across the top. In use, these electrolysing electrodes are polarised as shown alternatively positively and negatively with respect to each other and a heavy electrolysing current is passed between them. The current flows in the sea-water in channels **19** and electrolytic action generates chlorine therein which passes with the outgoing sea-water. The electrolysing electrodes are made of platinised titanium. Typically, an electrolysing current of 80 amps. is used with a voltage of 60v. With the dimensions shown in the drawings (the width of the channels **19** being about three-sixteenths of an inch) there is typically generated 0.46 kgs per hour of Cl_2. Three such units generate about 1.4 kgs per hour at Cl_2 and with a flow of water at about 6,200m^3 per hour the quantity of chlorine generated is about 0.2 part per million. This is sufficient for most purposes but clearly if more chlorine is required then more chlorinators can be used.

Referring again to FIG. **2***c* the vanes are provided at their ends with additional guard electrodes of platinised titanium shown at **23.** They are remote from the electrodes **22** and are provided in use with a high potential. It is found that this is instrumental in preventing electrolytic corrosion of the conduit which might otherwise occur because of the effect of the electrolysing electrodes.

Referring now to FIG. **4***a* there is shown schematically a sectional view illustrating an alternative and preferred manner of disposing the electrolysing electrodes with respect to the vanes of the chlorinator. In FIG. **4***a* there are again shown six vanes **16***a* defining five channels **19***a.* The electrolysing electrodes are made of titanium platinised on one surface only, the electrodes being disposed with the platinised surface outermost. Platinised titanium is expensive and difficult to bend so that it is an advantage to use thin sheet. However, this has a high electrical resistance, which with an electrode arrangement as shown in FIG. **4,** would give an undesirable current distribution. Thus, the electrode sheets of FIG. **4***a* are disposed differently, so that successive sheets are folded at opposite ends of the vanes. Electrodes **22***a* are folded over the tips of vanes **19***a* whereas electrodes **22***b* are formed in the plastics material during the moulding operation so that they are effectively folded around the bases of the vanes.

It will be seen that with the arrangement of FIG. **4***a* the voltage drop along electrodes **22***a* by virtue of passage of the electrolysing current is in the same direction to the voltage drop along electrodes **22***b.* The electrolysing current distribution is thereby more uniform than with an arrangement such as is shown in FIG. **4.**

Referring now to FIG. **5** there is shown part of a power source for applying electrolysing current to the chlorinators of FIG. **1.** Power is derived from the alter-

nating current ship's supply and applied through a transformer **25** to a full-wave rectifier **26.** The output from the rectifier is applied through **4** silicon controlled rectifiers A1, B2, A2 and B1 to two output lines **27** and **28.** A control circuit (not shown) is effective to switch the silicon controlled rectifiers in turn so that the electrolysing current supplied through lines **27** and **28** flows alternately in one direction and then the other. A centre-zero ammeter **29** is provided for monitoring the electrolysing current.

Although not shown in FIG. **1** the cooling system of the ship is provided with about **20** anodes of platinised titanium distributed throughout. These anodes are maintained at a positive potential in order to alleviate the effects of cathodic corrosion in the system. It is convenient to make use of the chlorinators **10** as some of the anodes of the cathodic protection system and in order to maintain these chlorinators at the appropriate positive voltage a cathodic protection current of some 3 amps is provided through a connection **30** to the centre tapping of the secondary of the transformer **25.** This maintains the mean level of the electrolysing electrodes at a positive value. The direct electrolysing current is periodically reversed in order to avoid problems associated with polarisation of the electrolysing system. Such problems are manifested particularly by a hard white deposit on the cathodes. Current is allowed to run in one direction for 1 minute or so and then after a rest period of a few seconds, during which the silicon controlled rectifiers are switched, the current flows for 1 minute or so in a reverse direction, and so on.

The control circuit referred to above is effective to time the trigger pulses for the silicon controlled rectifiers. The trigger electrodes of the silicon controlled rectifiers are connected to respective pairs of output terminals of the control circuit. The signals on these output terminals are high frequency repetitive triggering pulses generated at the appropriate time for triggering. Timing is effected by a capacitor timing circuit in which there are generated two waveforms, one appropriate to the conduction time for pair of rectifiers and the other appropriate to the conduction time for the other pair of rectifiers. The waveforms are combined and applied to a gate transistor which gates high frequency triggering pulses to the S.C.R.'s.

The invention is not restricted to the details of the foregoing description of one embodiment made with reference to the accompanying drawings. For example, it is found that in some situations adequate cathodic protection is possible without the provision the anodes **20,** merely by providing a bias current to the vanes of the chlorinator. Also, the use of guard electrodes **23** may be dispensed with.

We claim:

1. An electrolytic chlorinator having an essentially flat rectangular base portion of plastic material adapted to be fitted on the inside of the wall of a sea-water conduit in a ship; a plurality of vanes of plastic material moulded integrally with the base portion each extending from end to end of the base portion and upstanding therefrom, there being at least one space between the vanes constituting at least one elongate open-ended channel; and electrolysing electrodes extending over the major parts of the vane surfaces which bound the channel.

2. A chlorinator as claimed in claim **1** wherein there are at least three vanes which define a plurality of channels.

3. A chlorinator as claimed in claim **2** wherein there are six vanes which define five channels.

4. A chlorinator as claimed in claim **2** wherein the channels are closed at their upper sides by a removable cover.

5. A chlorinator as claimed in claim **1** wherein the electrolysing electrodes are plates having a noble metal deposit on one side only, the plates being folded about the vanes with the noble metal deposit outermost, each plate being folded about the tip or the base of the respective vane, the folds being alternated so that a vane with a fold about its base is flanked by vanes with folds about their tips and vice versa.

6. A chlorinator as claimed in claim **1** wherein there are provided guard electrodes on the vanes near their ends, the guard electrodes being insulated from the electrolysing electrodes so that in operation they can be maintained at a positive potential.

7. A ship having a sea-water inlet and fitted with at least one electrolytic chlorinator, said chlorinator having an essentially flat rectangular base portion of plastic material adapted to be fitted on the inside of the wall of a sea-water conduit in a ship; a plurality of vanes of plastic material moulded integrally with the base portion each extending from end to end of the base portion and upstanding therefrom, there being at least one space between the vanes constituting at least one elongate open-ended channel; and electrolysing electrodes extending over the major parts of the vane surfaces which bound the channel.

8. A ship as claimed in claim **7** wherein the chlorinator has guard electrodes on the vanes near their ends, the guard electrodes being insulated from the electrolysing electrodes, and the power supply is such that the potential between the electrolysing electrodes is changed in direction periodically, and the guard electrodes are always more positive than the potential at the point in the electrolytic path where the guard electrodes are situated.

9. A ship as claimed in claim **8** wherein the cyclic periodicity of the electrolysing current is between 20 seconds and 20 minutes.

10. A ship as claimed in claim **7** wherein a cathodic protection arrangement is provided and the chlorinator is made an anode of the cathodic protection system, means being provided to apply a direct bias current to offset positively the average potential of the electrolysing electrodes of the chlorinator which is an anode.

11. A ship as claimed in claim **7** wherein means are provided for supplying to the electrolysing electrodes a steady bias current sufficient to maintain the potential of the chlorinator vanes at potentials at least equal to, in the positive sense, the potential of surrounding metalwork.

* * * * *