DATA FILE:

CAPAC MANUAL FOR MODEL 10A12D

CAPAC® MANUAL

ENGELHARD
INDUSTRIES INC.
INSTRUMENTS AND SYSTEMS DIVISION
850 PASSAIC AVENUE • EAST NEWARK, NEW JERSEY

ADDENDA TO
OPERATING INSTRUCTIONS PAGE 7

The 10A12D controller is designed to maintain a hull potential reading of 1.0 to 8.0 on the CAPAC meter. If at any time the readings fall outside this range, the system should be disconnected by removing the fuse until the reason for failure can be determined and the fault corrected.

We have experienced an occasional owner who has felt that if a little protection is good – a lot would be better! This is not so. Over-protection can cause paint damage and also result in calcareous deposits which, on aluminum hulls, can result in alkaline attack of the hull. Use the adjustment screw to obtain the proper reading for your type of hull, as shown on page 4.

Readings in excess of 8.0 can be caused by a fault in the controller, anode, reference electrode or wiring.

Readings of less than 1.0 can be caused by a fault in the controller, a shorted reference electrode or improper wiring.

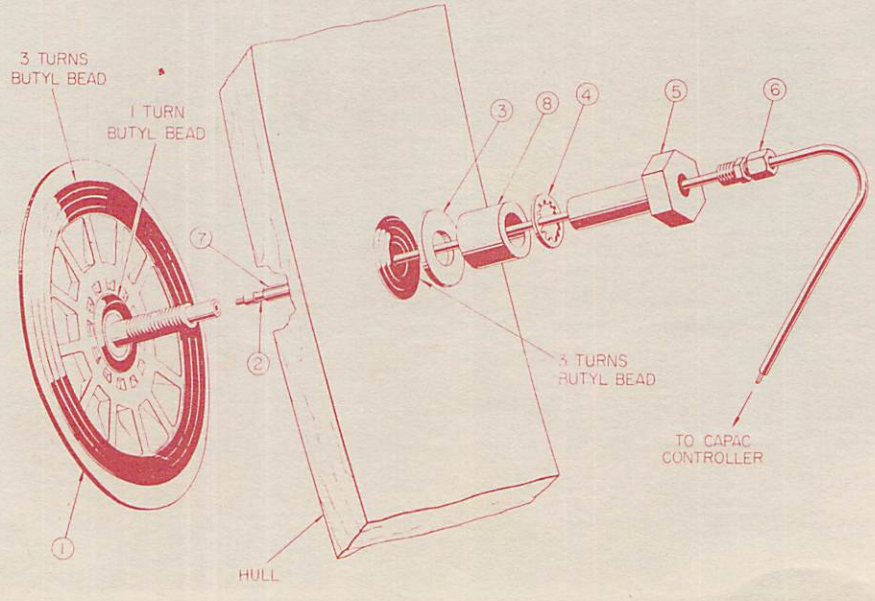
A properly operating system will show a stationary or slightly pulsating CAPAC meter reading, although a sudden drop may occur when paint is scraped off or the boat moves into water with a lower salinity.

ADDENDA TO
INSTALLATION INSTRUCTIONS AND FIGURE 4 PAGE 13

Neoprene Putty has been replaced with Butyl Bead, which has an indefinite shelf life.

The Neoprene Mat has been eliminated, and the anode or reference electrode is attached directly to the hull.

Place Butyl Bead as per drawing below.



Addenda
10A12D
P/N 34940
Rev. 12/62

CAPAC

OWNER'S MANUAL FOR MODEL 10A12D CAPAC SYSTEM

PRICE
$1.00

Part # Ref Electrode 37800
Controller — 37810-1 (SIZE L)

Electro Catalytic Services
908-851-2277

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201-589-7800
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Rev. 12/62

INTRODUCTION

Corrosion is banished from your craft by CAPAC, an electrical system which immunizes metal against attack.

Basically, this is the same CAPAC which protects the enormous investments in many of the new tankers, passenger ships, and even aircraft carriers and atomic submarines.

Automatically the protection required is adjusted to suit the circumstance of operation. This feature, retained from the large boat system, has made it practical and economically sound for use in small craft.

Patents Pending

MODEL 10A12D SYSTEM

Section 1

Controller

Description

The controller, Figure 1, consists of a panel on which are mounted a meter, name plate, automatic adjustment set-point, a 10 ampere fuse, and a component board mounting the transistor circuitry. The meter serves two purposes. Pointer deflection indicates that the Capac equipment is functioning and the degree of protection being provided to the hull (see Figure 2). The controller is designed to operate from 12v DC on hulls where the negative (–) terminal of the battery is connected to the hull.

Location

The side of the instrument control panel at the helm, Figure 3, commonly serves as a convenient location for the controller. This location is reasonably sheltered from excessive spray and is convenient for observation. The unit, however, should be located at least three feet from the magnetic compass if one is onboard. This will eliminate interaction between the compass and the Capac meter.

Other suitable locations in the bilge or in various places in the cabin may be considered as alternates.

Installation

After a location has been selected for the unit and an inspection has been made to ascertain that no interference with existing installations will be encountered, proceed to install the controller as follows:

(1) Using the template supplied in this manual, locate the corners of the cutout and the centers of the four mounting holes.

(2) With a straightedge and pencil or scriber complete the outline of the cutout.

(3) Drill a pair of holes within the rectangle and with a keyhole saw complete the cutout.

(4) Pass all the cables to be connected to the controller, Figure 4, up through the cutout.

(5) Cut the cables so that approximately one foot of each protrudes from the helm.

(6) Strip the cables and crimp the terminals to the leads as follows:

(a) Terminal for no. 6 screw to the reference electrode lead

(b) Terminal for no. 8 screw to the anode lead

(c) Terminals for no. 10 screw to the remaining leads

NOTE: The various sized terminal lugs and terminal studs are provided to protect against reversing the anode and reference electrode connections. Such a reversal will destroy the reference electrode.

(7) Connect the wires to the controller as per the wiring diagram, Figure 4. Make sure the terminals are tightly secured and do not short together. When more than one anode is installed it is advisable to tape or otherwise insulate the wires attached to terminal No. 2.

(8) Push the cables back into the cutout and set the controller in place.

(9) Secure the controller with the cup-washers and phillips head wood screws supplied.

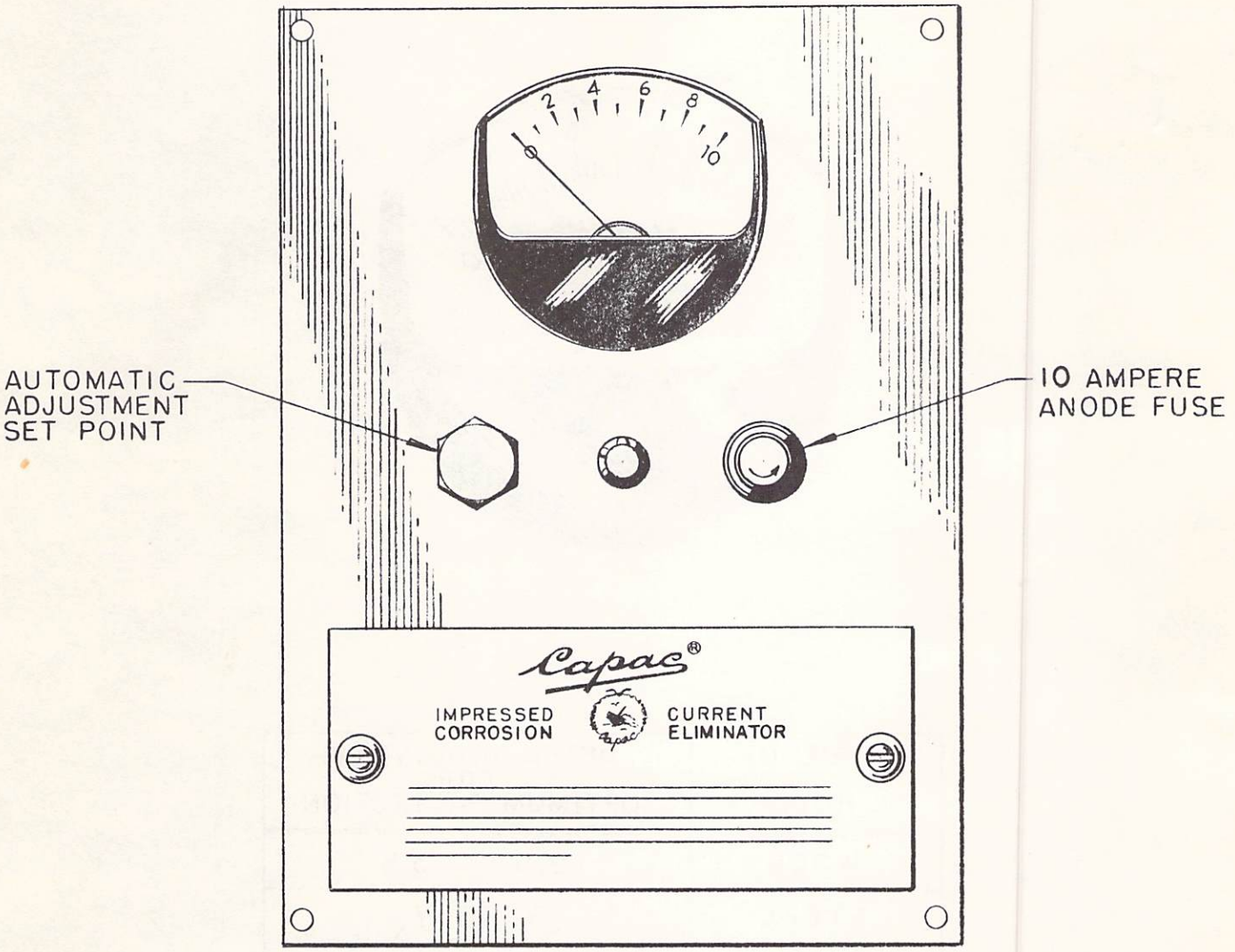
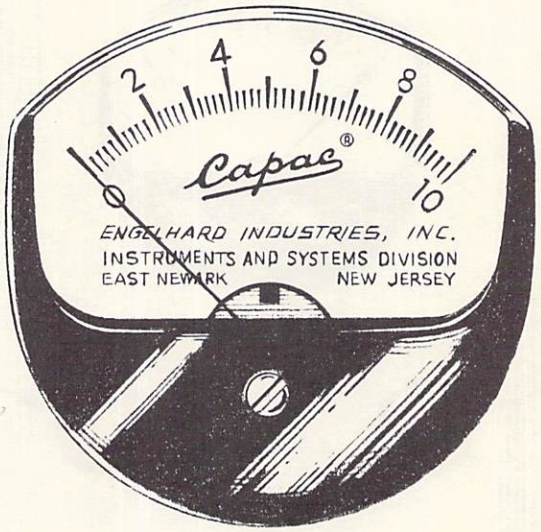


FIG. 1 - CONTROLLER



TYPE OF HULL	METER INDICATION FOR OPTIMUM PROTECTION
WOOD	2.5 TO 3.5
STEEL	6 TO 7
ALUMINUM	7 TO 7.5

FIG. 2 - METER

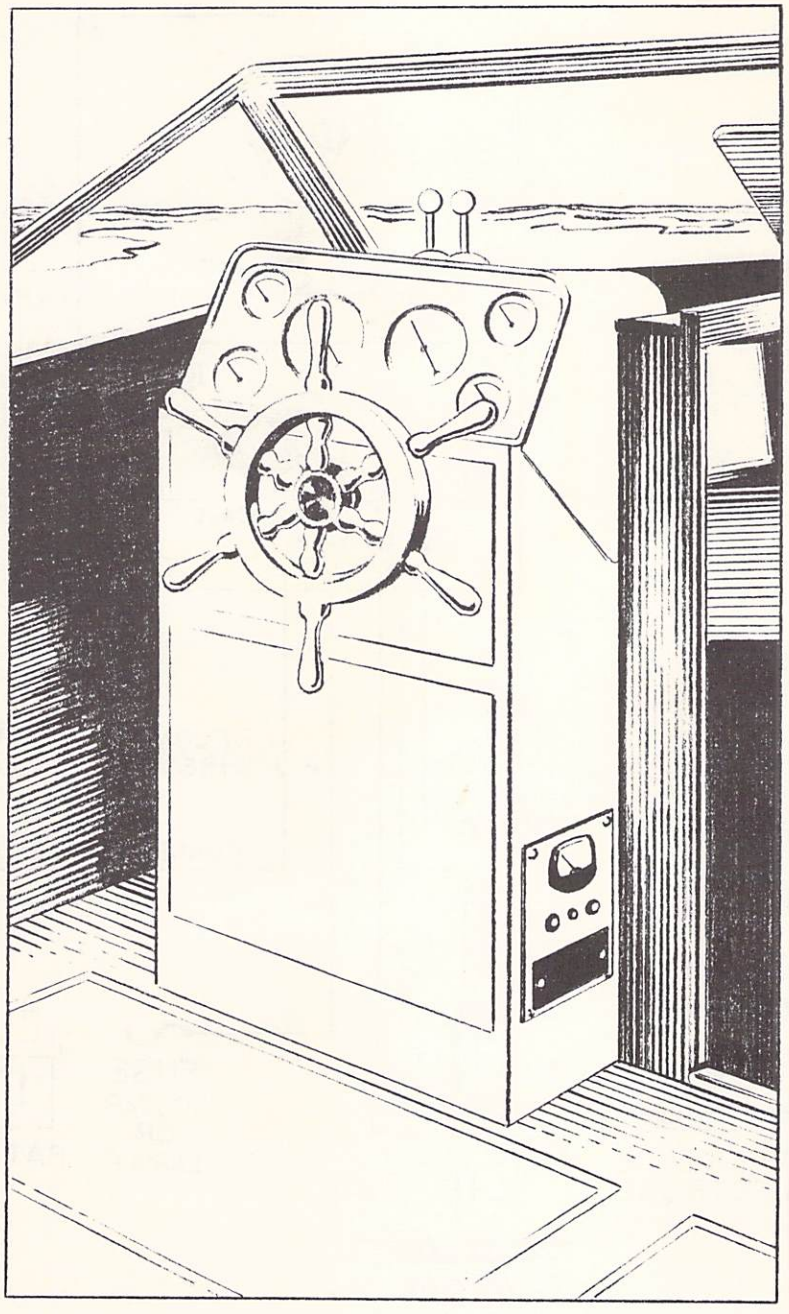


FIG. 3 - CONTROLLER AT HELM

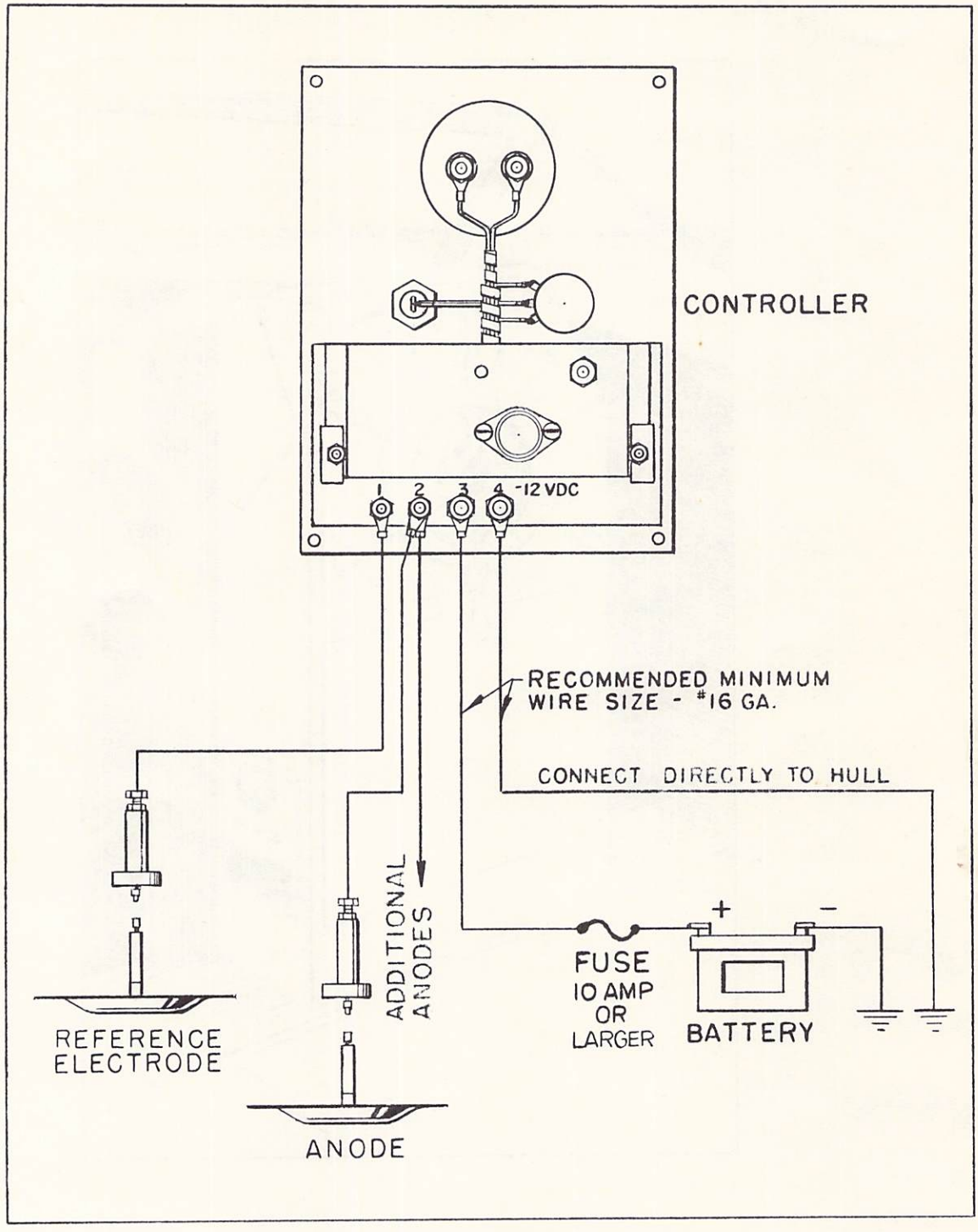


FIG. 4

TYPICAL WIRING DIAGRAM
AUTOMATIC TRANSISTORIZED CONTROLLER

OPERATING INSTRUCTIONS

Model 10A12D System

To achieve optimum results with Capac, the equipment must operate continuously while the boat is in the water. Therefore, to prevent accidental de-energizing of the system, no on-off switch is provided. The system begins to operate immediately upon launching the boat. This will be evident by virtue of pointer deflection on the meter. The degree of pointer deflection determines whether or not the hull is adequately protected. For optimum results pointer deflection should be as specified in Figure no. 2. To obtain these meter indications proceed as follows;

a) A meter indication as per Figure no. 2 signifies the hull is receiving sufficient protection and no control adjustments are necessary.

b) Remove cover over automatic adjustment set-point.

c) If the meter indication is below the specified range, rotate the control shaft clockwise until the pointer of the meter rests within the specified range.

d) If the meter indication is above the range, rotate the control shaft counter clockwise to bring the pointer down to the correct value.

e) Replace cover over automatic adjustment set-point.

Although the hull receives protection immediately upon launching the boat, complete polarization may require as much as six weeks in fresh water. During the polarization period, efforts to adjust the meter indication within the specified range may be difficult, but this should not be alarming. As the polarization film builds up, the meter indication will show a daily increase. The pointer may even overshoot the optimum range which will then require counter clockwise adjustments of the control. Once the polarization film has been built up, the system will require no adjustments.

In general the anode current required for best hull protection changes with water salinity, speed and aging of the paint system. The reference electrode permits the automatic controller to continuously measure the amount of protection on the hull. The controller rapidly increases or decreases the current as conditions demand to maintain the hull at the level of protection set by the automatic adjustment set-point.

IMPORTANT INSTALLATION NOTES

1. On wooden hulls it is necessary that all underwater appendages be bonded to form a common cathode which is in turn connected to the negative terminal of the battery which powers the Capac unit. This bonding should be done with No. 14 gauge wire or larger. It is preferable that the fittings, including the rudder post be soldered to the wire rather than only screwed or bolted to the fitting. Ground plates need not be included in this common bond for the current drain on the battery would be excessive. Grounding for any electronic equipment is accomplished by connecting a capacitor (0.5 microfarads at 200 volts) between the common ground and the ground plate.
2. If the craft is equipped with an isolation coupling on the propeller shaft, it is recommended that it be removed. Unless the isolation feature is removed, the propeller and shaft will not receive protection. Engines equipped with hydraulic drives should be checked while in motion with an ohmmeter. If not grounded, a grounding slip ring should be installed.
3. Although the motor boat code has standardized negative electrical grounding as of 1958, some boats still have positive grounds or no grounding. These boats, must be modified to provide a negative ground system before operating the Capac unit. This modification is generally simple to perform, but should conditions prevent changes in the existing electrical system, a separate power source must be provided. The negative terminal of this alternate power source should be connected to the hull and the positive terminal to the Capac controller as described previously. **Under no condition should Capac be operated on other than negatively grounded hulls.**

MODEL 10A12D SYSTEM

Section II
Anode

Description

There are numerous anode geometries and constructions manufactured by the Instruments & Section Division for particular applications. All of them are platinum surfaced to insure their permanency. Small boat pleasure craft are best served by the anode construction illustrated on drawing 34534C. (Figure 5).

The anode disc is 2½" in diameter and is supported and electrically insulated from the hull by the black plastic structure. The threaded stem serves to mount the anode as a through hull fitting. Water tightness is insured by the special gaskets and the electrical connection is protected by the special nut provided.

Location

Single Anode Installations

For single anode installations on steel hulls it is recommended that the anode be mounted as close as possible to the keel line approximately 1/4 the length of the hull as measured from the stern. On wooden hulls where a ground plate is mounted on the keel, the anode should be placed away from the keel by approximately 1/4 the width of the boat at that section.

Double Anode Installations

In two anode installations, one anode is located as described under "single anode installations" while the other is mounted on the opposite side of the keel line, one third the length of the hull as measured from the bow.

Its distance from the keel should be as described under "Single Anode Installations" for steel and wooden hulls. Although the recommended positions; ensure uniform hull protection, the exact

anode location is not critical in either installation and should take into consideration the following factors:

(1) The anode must not interfere with existing installations. A location which may be clear in the bilge is not necessarily clear on the outside hull surface and vice versa.

(2) The anode should be reasonably accessible so that inspection of the electrical connection can be made conveniently.

(3) The hull area where the anode is to be mounted should be virtually flat.

(4) Avoid locations which would interfere with lifting slings. Additional anodes may be installed as shown on drawing SK220B (Figure 6).

Installation Instructions – Dwg. 34534C

NOTE: The anode assembly is identified by its black plastic holder. It must be handled carefully so as not to abrade or scuff the platinum surface nor damage the threaded stem. Installation is accomplished as follows:

Hull Thickness: 1/8" to 1-1/8"

(1) Drill a 9/16" diameter hole through the hull from inside the bilge.

(2) Thoroughly mix the neoprene putty, item 14, with the contents of the bottle of N-300 accelerator.

(3) Apply a coat of the neoprene putty so prepared to:

a. The backside of the anode assembly, item 1.

b. Both side of the special mat, item 2.

c. The hull area which will be covered by the anode.

d. Both sides of the neoprene washer, item 4, plainwasher, item 5, and the lockwasher, item 6.

e. The hexagon face of the special nut, item 3.

(4) Loosen the compression nut of the sealing grip on the cable assembly, item 10, and slide the sealing grip away from the terminal lug a distance of approximately two feet.

(5) Insert the terminal end of the cable assembly through

a. Special nut (from the round end) Item 3

b. Tubing Item 15

c. Lockwasher Item 6

d. Plainwasher Item 5

e. Neoprene Washer Item 4

(6) Assemble the special mat, item 2, to the anode assembly, item 1.

(7) From inside the bilge, pass the terminal end of the cable assembly through the drilled hole. Thread the special screw on the end of the cable assembly into the fitting on the end of the anode. Care must be exercised to make a tight connection but not cause damage to the assemblies.

(8) Insert the anode stem into the drilled hole and assemble in sequence the following items onto the stem:

a. Neoprene Washer Item 4

b. Plainwasher Item 5

c. Lockwasher Item 6

(9) Slip the transflex tubing, item 15, over the cable connection.

(10) Thread the special nut onto the stem of the anode assembly. Tighten the nut with moderate pressure to avoid cracking the plastic structure of the anode assembly. Cold flow of the special mat and the neoprene washer may necessitate tightening of the special nut in successive steps.

(11) Fill the hole in the special nut with melted paraffin, item 17, to within approximately 5/16" of the top.

(12) Thread the sealing grip of the cable assembly into the special nut using the neoprene putty as a thread seal. Tighten the compression nut of the sealing grip.

(13) Wipe away any excessive neoprene putty which may have been squeezed from the assembly. Gasoline or similar solvents may be used.

Hull Thickness: 1-1/8" to 2"

(1) Drill a 13/16" diameter hole through the hull from within the bilge.

(2) Follow steps 2, 3, and 4 outlined for the installation on a 1/8" to 1-1/8" thick hull.

(3) Insert the terminal end of the cable assembly through

a. Special nut (from the Hexagon head side)	Item 3
b. Tubing	Item 15
c. Lockwasher	Item 6
d. Spacer	Item 16
e. Plainwasher	Item 5
f. Neoprene washer	Item 4

(4) Assemble the special mat, item 2, to the anode assembly, item 1.

(5) From inside the bilge, pass the terminal end of the cable assembly through the drilled hole. Thread the special screw on the end of the cable assembly into the fitting on the end of the anode. Care must be exercised to make a tight connection but not cause damage to the assemblies.

(6) Insert the anode stem into the drilled hole and assemble in sequence the following items onto the stem:

a. Neoprene Washer	Item 4
b. Plainwasher	Item 5
c. Spacer	Item 16
d. Lockwasher	Item 6

(7) Complete the installation as outlined for the installation on a 1/8" to 1-1/8" thick hull.

Hull Thickness: 2-1/8" to 3-1/4"

Installations on hulls of this thickness are similar to those on a 1-1/8" to 2" hull except that the spacer, item 16, is eliminated.

NO.	REVISION	BY	DATE	CHK.
1	REVISED PICT. TO AGREE WITH DETAILS ECN 2390	CS N	4/6/60	
2	ADDED ITEMS 11, 12 & 13. REVISED PICTURE TO AGREE. ECN 2978	CS N	9/16/62	JGG
3	ITEM 15 WAS TRANSFLEX TUBING. ECN 2983	CS N	6/1/64	MF

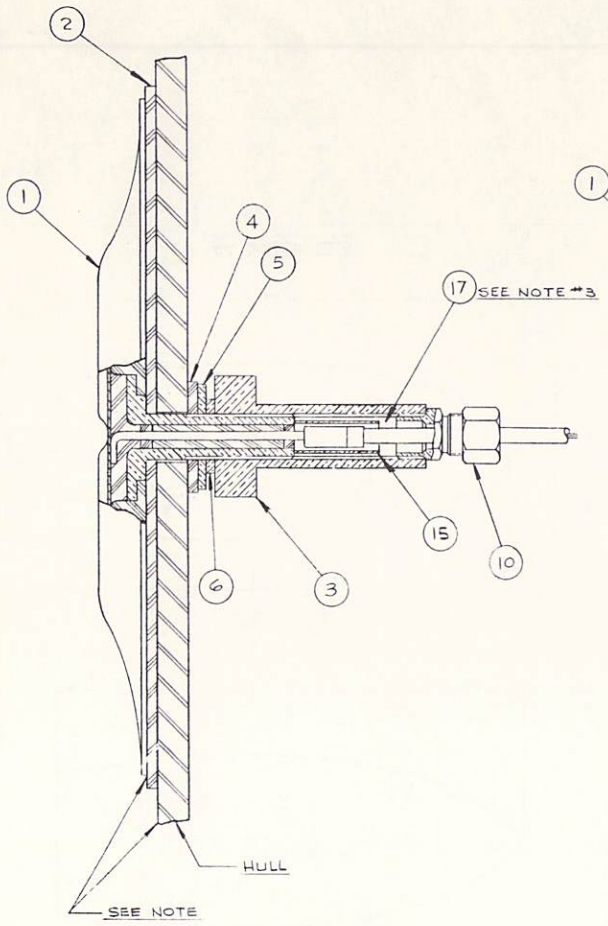


FIGURE 1.
STEEL HULL APPLICATION
1/8" THK. TO 1 1/8" THK.

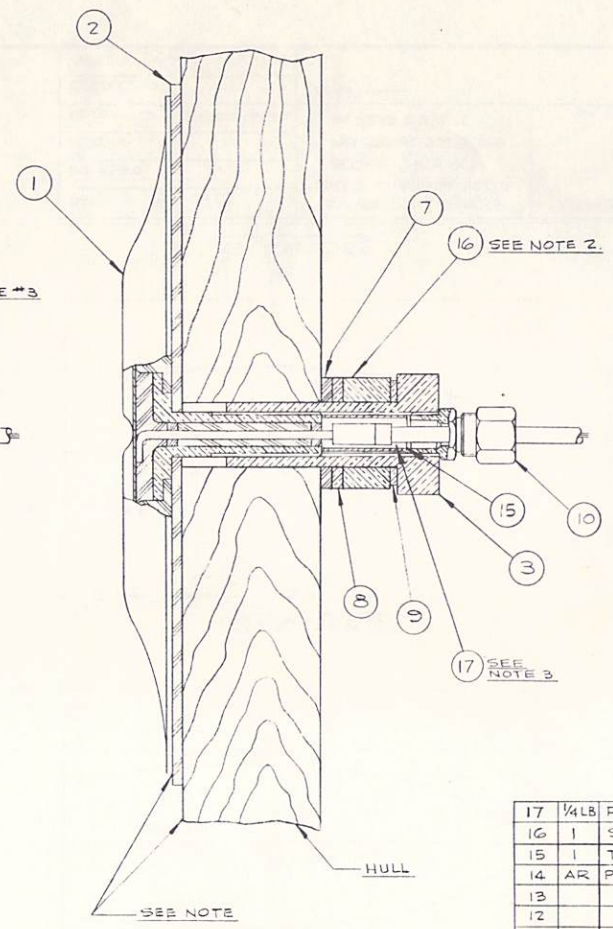


FIGURE 2
WOOD HULL APPLICATION
(WITH SPECIAL NUT (ITEM 3) USED AS EXTENSION & NUT.)
1 1/4" THK. TO 3 1/4" THK

NOTE:-

1. ALL MATING SURFACES TO BE COATED WITH NEOPRENE PUTTY (ITEM 14).
2. SPACER (ITEM 16) TO BE USED ON HULL THICKNESSES OF 1 1/4" TO 2" ONLY.
3. POT WITH PARAFFIN PRIOR TO ASSEMBLY OF FITTING CABLE ASSEMBLY.

ITEM	REQ	DESCRIPTION	DWG. NO.
17	1/4 LB	PARAFFIN	
16	1	SPACER (SEE NOTE 2)	34573A
15	1	TUBING - TYGON	34554A
14	AR	PUTTY - NEOPRENE - GACO #N-250-1 WITH N-300-5 ACCELERATOR - 1/2 LB	
13			
12			
11			
10	1	CABLE ASSEMBLY	34533-1A
9	1	WASHER - LOCK, 3/4" INT. TOOTH, BRONZE - SHAKEPROOF #1232-00	
8	1	WASHER - PLAIN, 3/4" BOLT, AN960-B1216	
7	1	WASHER - NEOPRENE, 3/4" BOLT	34529A
6	1	WASHER - LOCK, 1/2" INT. TOOTH, BRONZE - SHAKEPROOF #1224-00	
5	1	WASHER - PLAIN, 1/2 BOLT - BRASS	
4	1	WASHER - NEOPRENE, 1/2" BOLT	34530A
3	1	NUT - SPECIAL	34531A
2	1	MAT - SPECIAL	33844B
1	1	ANODE ASSEMBLY	34411B

DATE: 1-5-60	STANDARD TOLERANCES UNLESS OTHERWISE NOTED. DECIMAL DIM. ± .005 FRACTIONAL DIM. ± .016 ANGULAR DIM. ± .15'	MATERIAL: —	CHARLES ENGELHARD, INC. EAST NEWARK, NEW JERSEY
NO. REQ'D.: -			ANODE ASSEMBLY COMPLETE
NEXT NO.: -			
DRAWN: G. NIELSON			
CHECKED:		FINISH: —	SCALE: FULL SIZE / DRWG. NO. 34534C / REV. 3
APPRVD.:			

DEFIANCE SALES CORP. 28178

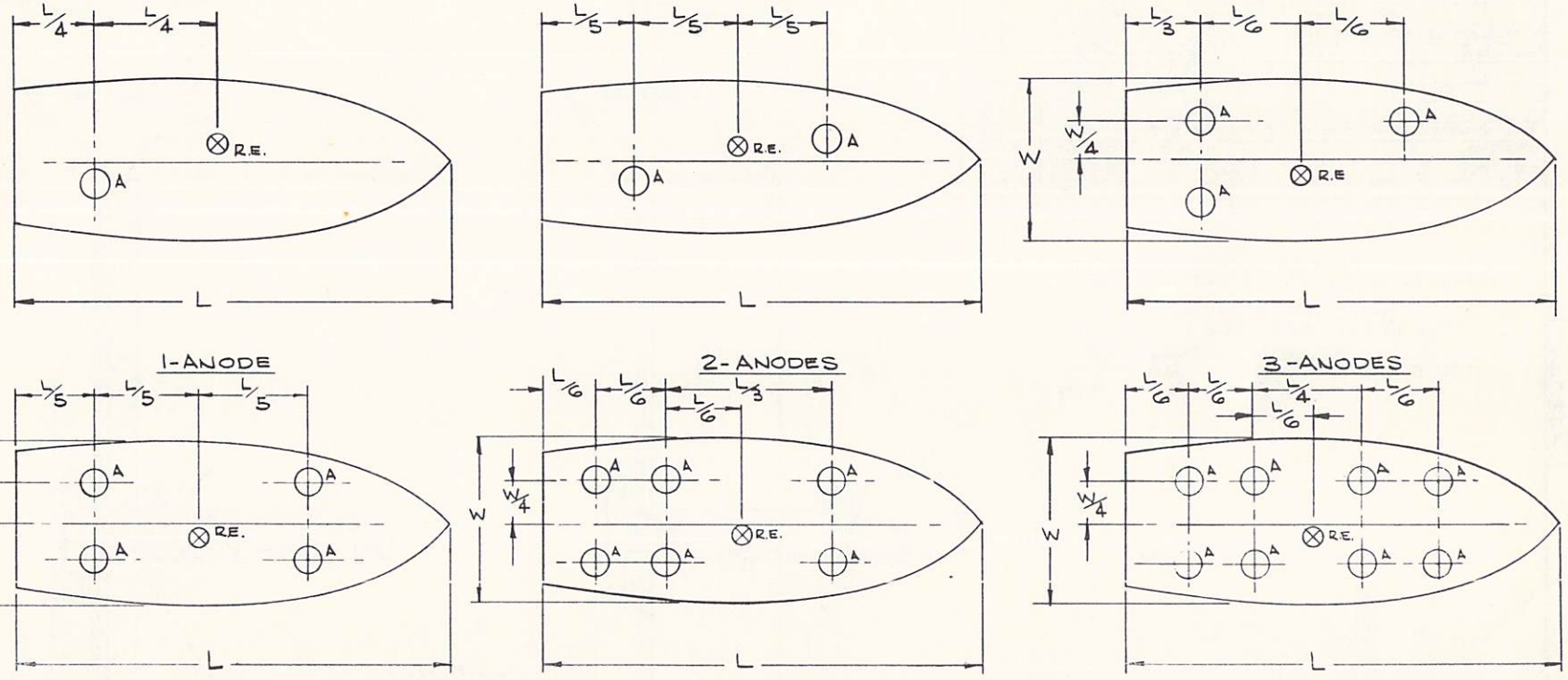
REL. 261

DRWG. NO. 34534C

Figure 5

DRWG. NO. SK-220B

NO.	REVISION	BY	DATE	CHK.



1-ANODE

2-ANODES

3-ANODES

4-ANODES

6-ANODES

8-ANODES

DATE: 7-8-60	STANDARD TOLERANCES UNLESS OTHERWISE NOTED. DECIMAL DIM. ± .005 FRACTIONAL DIM. ± .016 ANGULAR DIM. ± 15'	MATERIAL: —	CHARLES ENGELHARD, INC. EAST NEWARK, NEW JERSEY
NO. REQ'D.: —			RECOMMENDED ANODE & REFERENCE ELECTRODE LOCATION
NEXT NO.: —			
DRAWN: S. RIZZOLO			
CHECKED: pbb	FINISH: —	SCALE: —	DRWG. NO. SK-220B REV.
APPRVD.: 7/8/60			

DEFIANCE 88128

Fig 6

MODEL 10A12D SYSTEM

Section III
Reference Electrode

Description

The reference electrode configuration is similar to that of the anode. It is constructed of a metal which provides a voltage the magnitude of which is indicative of the protection being provided. This function of the electrode requires that it be exposed to the water. Therefore, the exposed surface must not be painted and its gradual oxidation is normal.

Location

On a steel hull, the reference electrode is located adjacent to the keel approximately six feet forward of the stern anode. On a wooden hull, the reference electrode should be located as close as practical to a bonded metallic appendage. The considerations mentioned for locating the anode should also be observed for the electrode.

Installation Instructions Dwg. 34555C

The installation of the reference electrode, identified by its gray plastic holder, is similar to that of the anode. Refer to the anode drawing 34534C.

SECTION IV

Service:

Capac, the trademark of an impressed current cathodic protection system, is an electrical device designed to eliminate the corrosion or rusting of metal surfaces immersed in a conducting liquid. The system is commonly applied to the protection of the exterior hull, however, it is equally effective in eliminating corrosion from tanks, docks, pilings and similar structures.

The system is composed of four major units: One reference cell, a controller, one or more anodes, and the hull of the ship, as shown in Figure 4. These units perform the following functions:

(a) The reference cell produces a voltage which is proportional to the amount of protection received by the hull.

(b) The controller compares the voltage produced by the reference cell with an internal voltage manually set by the operator. The output of the controller is automatically adjusted to keep the reference voltage equal to the manually set voltage.

(c) The anode is an electrically insulated unit located outside the boat's hull through which current flows from the controller into the sea water and back into the hull.

The amount of anode current delivered by the controller is dependent upon factors such as: the physical dimensions of the hull, the number, placement and type of anodes, the condition of the paint on the hull, conductivity of the sea water, and the speed of the boat. For this reason, the operating current of the controller is difficult to predict.

In order to understand the operation of the Capac System, the following facts must be remembered:

1. When the anode current is increased, the protection given to the hull gradually increases and corrosion is reduced. This process is called polarization.
2. When the anode current is increased, the voltage between the reference cell and hull increases gradually.

3. Tests have shown that there is an optimum reference cell voltage (hull potential). Increasing anode current to give a higher reference cell voltage gives no further reduction in corrosion and wastes current. Excessive current may even cause paint damage. When the reference cell voltage is below the optimum voltage set by the operator, output of the controller increases until the reference voltage equals the set voltage. A reference voltage greater than the set voltage causes a decrease in controller output.

These facts can be used to check on the operation of the Capac System.

4. With the hull afloat:

   The reference electrode develops a voltage between its lead and the hull and fittings, which may be measured with a high impedance (20,000 ohms/volt) DC voltmeter. This voltage will usually lie between 0.1 and 1.0 volt depending on the type of hull material and the degree of protection provided to the hull. The hull will be negative (–) and the reference electrode positive (+). On some unprotected wooden hulls the voltage may be zero or negative. The presence of this voltage shows that the reference electrode is not shorted and that the wire is not broken. An anode developes a voltage between 0.3 and 2.0 volts when disconnected from the controller. A properly installed anode will always develop a higher voltage than a reference electrode on the same hull.

5. With the hull out of water and dry:

   An ohmmeter will indicate a high resistance (greater than 10,000 ohms) when connected between an anode or reference electrode lead wire and the hull or fittings. Lower readings will be observed if the anode, electrode, or cables are wet.

   The cables connecting the anode and reference electrode to the controller can be checked for continuity by shorting the controller ends of the cable to the hull (terminal 4 on the controller) and checking for continuity between the face of the anode or electrode and the bare hull. Proper installations will show a reading of 1 ohm or less. A higher reading indicates poor connections or in the case of wooden hulls poor bonding of fittings to the negative terminals (#4 and battery minus).

6. The meter on the Capac controller reads 1.0 volt full scale (reading of 10) between terminals 1 (+) and 4 (–). The Capac meter can be checked by using a 1½ volt battery, dividing resistor and another DC voltmeter connected to terminals 1 and 4.
7. The anode current flows from the controller terminal 2 to the anode (s). An ammeter inserted in the anode lead wire will measure this current.

The following procedure will help to localize difficulties in a Capac System:

(a) Check battery voltage at terminals 3 (+) and 4.

(b) Check reference electrode (Par. 4 or 5).

(c) Check anodes.

(d) Check Capac controller meter.

(e) Insert ammeter in anode wires to see if control setting adjustment changes anode current.

Detailed Service and Theory of Operation

Anode:

The anode is constructed of a 2½ inch diameter platinized titanium disc.

The current delivered by the anode depends upon the anode voltage and the resistance of the seawater. With 12 volts applied directly to the anode, the anode will deliver up to 5 amperes in warm seawater, 3 amperes in normal seawater, and as little as .01 ampere in fresh water. It is recommended that the anode voltage does not exceed 14v DC.

Reference Electrode:

The reference electrode is prepared from a selected bronze disc. In order to assure accurate results, it must never be painted. If it should accidentally be painted, the paint should be removed with a chemical solvent and then bronze disc be cleaned with steel wool.

CAUTION: **NEVER** use steel wool or any abrasive cleaner on an anode. If a reference electrode is connected as an anode, it will be destroyed within a few days. If it is connected for several minutes, it will subsequently develop an inaccurate voltage. These points should be remembered when checking a Capac System.

Controller:

Specifications:

Operating Voltage	12v DC
Automatic Control Range	0.15v to 0.75v
Current Range	From 0.01 ampere to 10.0 ampere
Control Sensitivity	±0.025v from control point
Type of Control	On – Off
Circuit Components	7 Transistor
	1 – 2N1557
	1 – 2N1038–1
	1 – 2N1305
	4 – 2N1302
Fuse	10 ampere

The controller operates in an on-off fashion, delivering current to the anodes in pulses. The ratio of "on" to "off" time determines the average current output which can be read on a normal DC ammeter.

The transistor control circuit consists of three separate stages, as shown on the schematic figure 7. Q1 and Q2 are low level DC amplifier stages which drive an on-off Schmidt trigger, Q3 and Q4 which in turn drive three high current stages, Q5, Q7 and Q6. The final transistor, Q6, turns the anode current on and off.

Transistor Q1 compares the reference cell voltage appearing between terminals 1 and 4 with a voltage set on the automatic control setting, in this case R14. The difference is amplified by Q2. The following two stages, Q3 and Q4, form a Schmidt trigger circuit. The second transistor of the Schmidt trigger circuit Q4 drives the Driver transistor Q5 which in turn operates the power transistor Q7 which drives the high current transistor Q6 which is in series with the 12-volt supply and the anodes.

To explain the operation briefly, the difference between the desired hull potential voltage set on R14 and the reference cell voltage appearing at terminal 1 is amplified by Q1 and Q2. This voltage appears across R6 and is connected to the base of Q3. If this voltage exceeds approximately 5 volts, Q3 will conduct and because of the coupling to Q4 will cause Q4 to turn off (non-conducting). When the voltage at the base of Q3 falls below 4 volts, Q4 starts to conduct. This increases the voltage on R12 and causes Q3 to cut off. While Q4 is conducting, current can pass from the base of Q5. This causes the voltage across R13 to be nearly equal to the battery voltage appearing at terminal 3. Therefore, no current can pass from the base of Q6 and Q7, and no anode current is available. When the voltage at the reference cell falls, Q1 draws less current, Q2 draws more current, and the voltage across R6 and at the base of Q3 increases. This turns Q3 on and Q4 and Q5 off. Now current can pass from the base of Q7 through resistor R13 and, therefore, anode current is available through Q6.

When the voltage at the reference cell rises, Q1 can conduct more current, Q2 conducts less and the voltage across R6 and at the base of Q3 decreases. This turns Q3 off and Q4 and Q5 on. No current can pass from the base of Q7 because the voltage drop across Q5 is only 0.2v while the drop across DR3 is 0.5v which means the base of Q6 is at a larger positive voltage than the emitter.

The Rectifier DR1 is used to generate a regulated voltage of 0.7v DC across the potentiometer R14. Rectifier DR2 and capacitor C2 are used to filter the supply voltage delivered between terminals 3 and 4. Rectifier DR3 is used to provide a voltage drop of 0.5 to 1.0 volt at the emitter of transistor Q6 which affords temperature stability at transistors Q6 and Q7 for the off or non-conducting state.

Trouble Shooting:

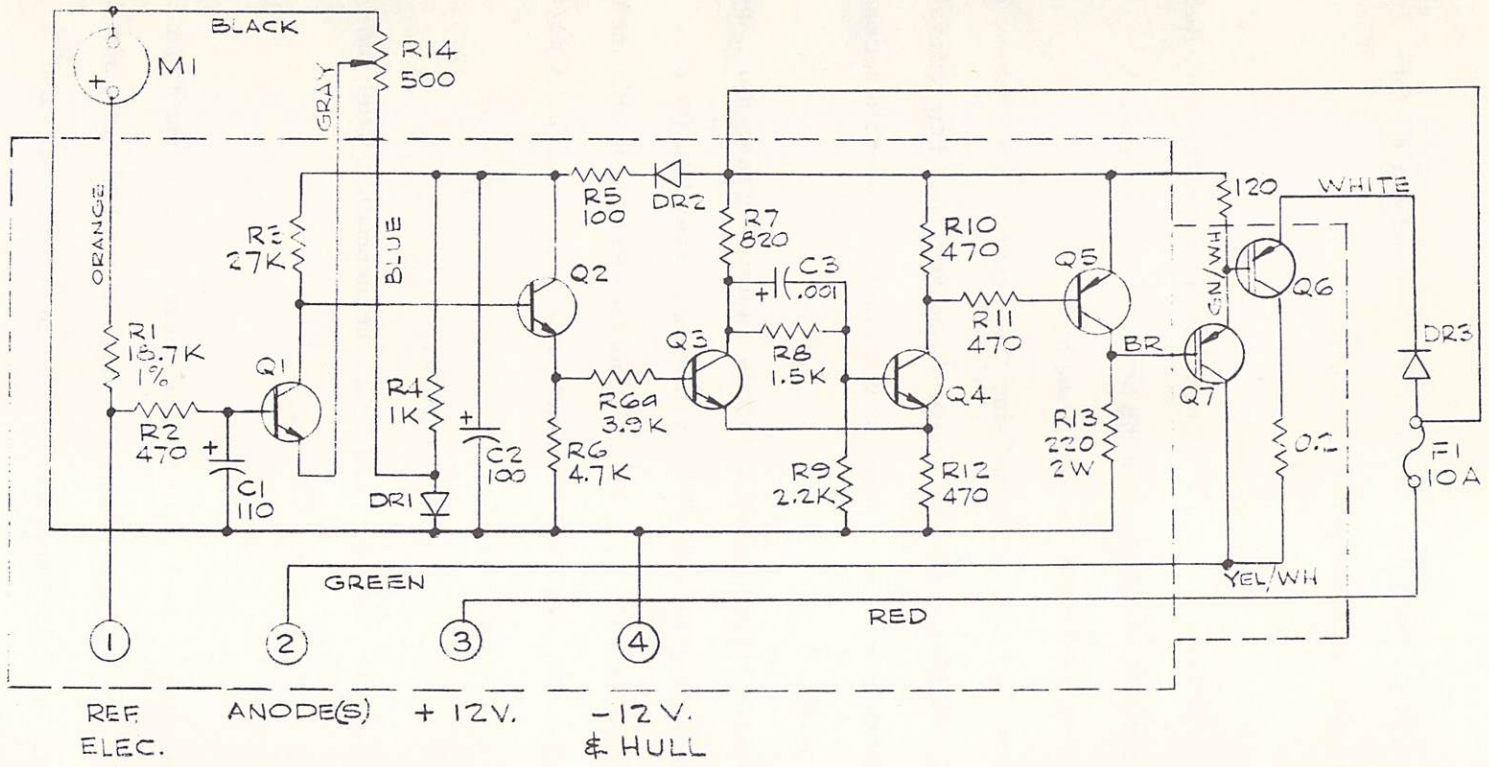
Some probable causes of failure and their symptoms are:

DRWG. NO. 35190A

NOTES:-

1. ALL RESISTORS ARE 1/2 WATT UNLESS OTHERWISE SPECIFIED.
2. VALUES OF CAPACITORS ARE IN MICROFARADS.
3. Q1, Q2, Q3 & Q4 ARE 2N1302; Q5 IS 2N1305; Q6 IS 2N1557; Q7 IS 2N1038-1.
4. DR1 & DR2 ARE IN1692; DR3 IS F1128.
5. M1 IS 0-50 ua - READS 0-1VDC.

NO.	REVISION	BY	DATE	CHK.
1	REDRAWN & REVISED.	SSN	10-23-62	



DATE: 10-23-62	STANDARD TOLERANCES UNLESS OTHERWISE NOTED. DECIMAL DIM. ± .005 FRACTIONAL DIM. ± .016 ANGULAR DIM. ± 15'	MATERIAL: —	ENGELHARD INDUSTRIES, INC. INDUSTRIAL EQUIPMENT DIVISION INSTRUMENTS & SYSTEMS SECTION
NO. REQ'D.: —			SCHEMATIC DIAGRAM MODEL 10A12D
NEXT NO.: —			
DRAWN: G. NEILSON			
CHECKED: GB	FINISH: —		SCALE: — DRWG. NO. 35190A REV. 1
APPRVD.: bb			

DEFIANCE NO. 1000H 36543

MODIFIED TO 34835 REV.4 REL. 350

Figure 7

Steel and Aluminum Hulls:

1. Sympton:

Meter reads higher than the correct value – above 7 for steel and above 7.5 for aluminum with the control setting fully counterclockwise (over protection).

Check:

(a) Anode and reference electrode cables may be reversed or shorted together. Recheck wiring as shown on Figure 4 and test as explained in the Service paragraph 4 and 5.

(b) Wire tc terminal 4 is not securely connected to the hull.

(c) The craft may be receiving protection from "zincs" or another Capac System. If the zincs are attached to the hull, nothing can be done except to remove them. Their removal i s not absolutely necessary, but in general, a reading above 7.5 indicates over protection and this condition is not recommended.

In some circumstances, a higher reading at dock is obtained because of over-protection of a nearby craft, and the reading should fall when the boat is away from the dock.

(d) If the controller is faulty and the high reading is not caused by a, b, or c, then the meter should gradually fall to 2 or 3 on steel hulls and 3 to 4 on aluminum hulls when the fuse is removed.

2. Symptom:

The controller continually reads between 2 and 5 with the automatic control setting fully clockwise (under protection).

Check:

(a) Blown 10 ampere fuse caused by a shorted anode or excessive current demand.

(b) Dead or discharged battery. Check for battery voltage on terminals 3 (+) and 4 (–).

(c) Open anode lead wire to anode. Check as described in Service, par. 4 and 5.

(d) If the controller is defective, connecting a wire from terminal 2 to 3 will place the battery voltage on the anodes and will give an increase in hull potential. The controller must then be repaired.

3. Sympton:

The meter reads zero.

Check:

(a) Reference electrode for open or short, as described in Service, par. 4 and 5.

(b) Capac meter, as described in Service, par, 6.

IMPORTANT NOTE: If at any time the meter continuously reads zero on aluminum hulls, the fuse should be removed from the controller until the difficulty is located.

Wooden Hull:

The servicing procedure for wooden hulls is the same as for steel hulls except that the Capac meter may read zero when the hull is unprotected. This means that the checks given under Symptom 2 for steel and aluminum apply when the Capac meter on a wooden boat reads zero.

PARTS LIST

Model 10A12D Controller

Quantity	Part Number	Description
1	34835D	Controller
4		Oval Head wood screws – No. 8 x ¾" long, chromium plated steel
4		No. 8 Cupwashers - chromium plated brass

Replacement Parts

34672A Fuse 10 amp

34537A Meter - Capac

35085A Transistor 2N1557

35966D Component Board Assembly

34743A Shaft Cover – Automatic Adjustment Set-point

PARTS LIST

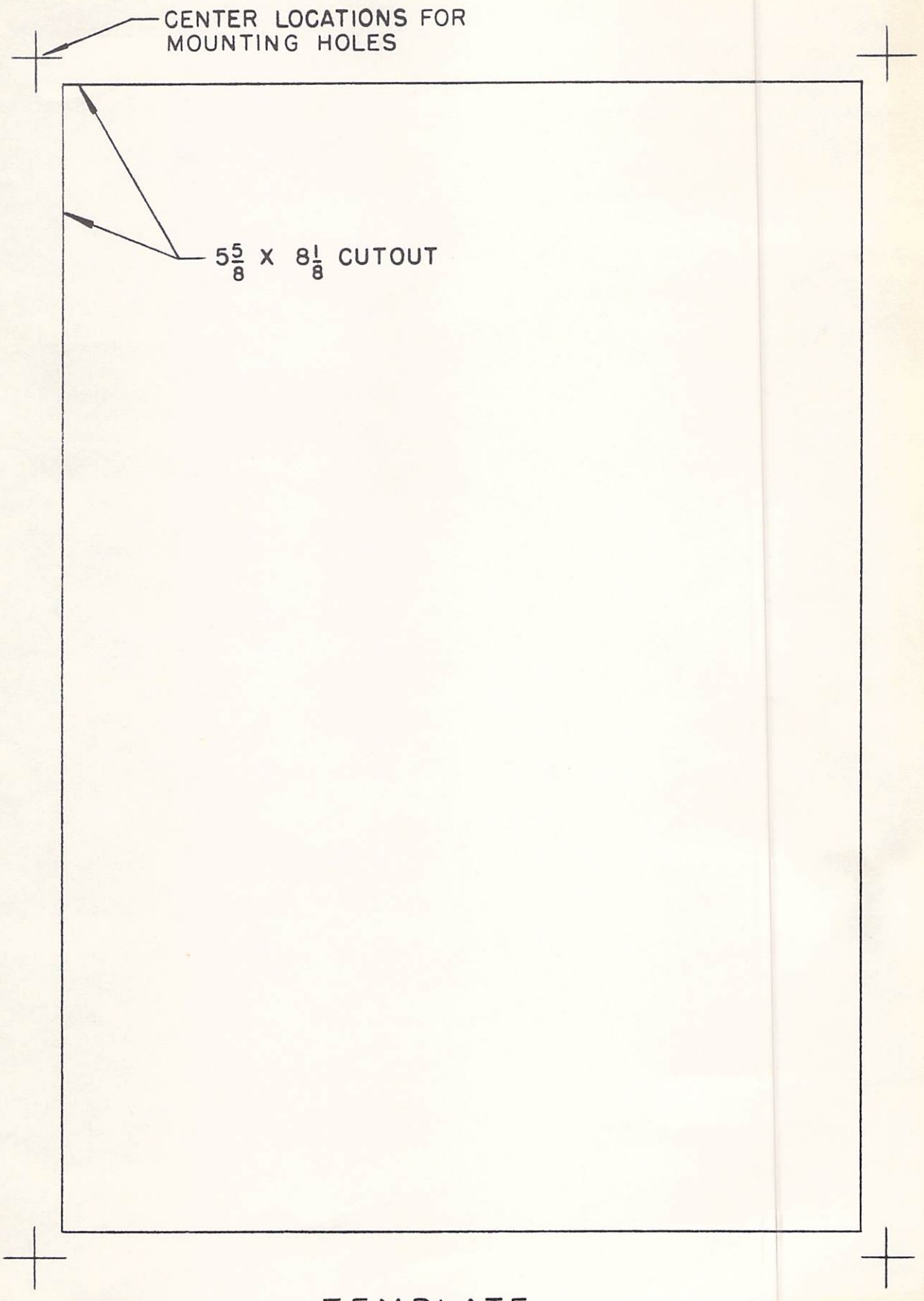
Anode Assembly – 34534C

Quantity	Part Number	Description
1	33844B	Special Mat
1	34411B	Anode Assembly
1	34529A	Neoprene Washer – ¾" bolt
1	34530A	Neoprene Washer – ½" bolt
1	34531A	Special Nut
1	34533A	Cable Assembly
1	33554A	Transflex Tubing
1	34573A	Spacer
1		Round Head Screw – No. 4–40 x ¼" lg. Brass
1		Lockwasher – No. 4 split, Bronze
1		Lockwasher – ½" internal tooth, Bronze
1		Lockwasher – ¾" internal tooth, Bronze
1		Plainwasher – ½" bolt, Brass
1		Plainwasher – ¾" bolt, Brass
1		Hexagon Nut – No. 4–40, Brass
½ lb.		Neoprene Putty
¼ lb.		Paraffin

PARTS LIST

Reference Electrode –34555C

Quantity	Part Number	Description
1	33844B	Special Mat
1	34529A	Neoprene Washer – ¾" Bolt
1	34530A	Neoprene Washer – ½" Bolt
1	34531A	Special Nut
1	34533A	Cable Assembly
1	34554A	Transflex Tubing
1	34556B	Reference Electrode Assembly
1	34573A	Spacer
1		Round Head Screw – No. 4–40 x ¼" lg. Brass
1		Lockwasher – No. 4 split, Bronze
1		Lockwasher – ½" internal tooth, Bronze
1		Lockwasher – ¾" internal tooth, Bronze
1		Plainwasher – ½" bolt, Brass
1		Plainwasher – ¾" bolt, Brass
1		Hexagon Nut – No. 4–40, Brass
½ lb.		Neoprene Putty
¼ lb.		Paraffin



TEMPLATE

MODEL 10A12D