An extract from an American paper to show that our neighbours are no better off than ourselves :—

DIVERS.—The Port Royal correspondent of the *Baltimore American* gives an account of the operations of the divers employed to clean the bottoms of the Monitors. He says that the principal diver—appropriately named Waters—is so used to this work, that he has become almost amphibious, remaining for five or six hours at a time under water. The work is very arduous. The diver sits upon a spar lashed athwart the bottom of the vessel, so arranged as to be moved as the work progresses, and with a scraper fixed to a long handle works on both sides of himself as far as he can reach. The mass of oysters that become attached to the iron hulls of one of the Monitors, even during one summer here, is immense. By actual measurement it was estimated that 250 bushels of oysters, shells, and sea-grass were taken from the bottom of the “Montauk” alone.

In the construction of composite ships with iron frames, I believe, a great economy would be found by sheathing on this plan; the destruction of the bolts, by the approximation of the copper, be avoided; and iron-fastened vessels coppered more effectually by the interposition of a waterproof medium. The application of copper, by adhesion, on the bottom of a wooden vessel, from the light line to the keel, would remove all possible risk of leakage, and injury to cargo from damp, the close adhesion would prevent oxidation internally, and the external waste be reduced, from the sheathing being dressed on a smoother surface.

In conclusion, I would ask what alternative has been proposed that promises to meet the difficulty excepting an application of copper sheathing. There is risk; but what is done without it. The powder in the magazine is merely isolated by a sheet of glass from the light-room, but that risk is preferable to fumbling in the dark; and, to quote the words of Sir John Hay, when referring to this subject in the House, “I believe if the talent and ingenuity of the country were appealed to, there is no doubt the practical difficulty could be overcome.”

ANTI-CORROSIVE AND ANTI-FOULING COMPOSITIONS FOR IRON SHIPS.

By F. N. GISBORNE, Esq., C.E.

GENTLEMEN,

Before submitting the following brief observations relative to anti-corrosive and anti-fouling compositions for use upon iron ships, allow me to acknowledge the valuable assistance rendered me in the preparation of this paper by my friend Mr. W. H. Walenn, a gentleman who has rendered great service to the public by condensing (to order of the Patent Law Commissioners) all the various patented inventions appertaining to electric science. Mr. Walenn is himself the patentee of a very ingenious method for coating iron with copper, and from his know-

ledge and experience was well qualified to aid me in rendering this paper instructive as well as interesting and reliable.

The introduction of iron in lieu of wood as a material for ship-building has raised several practical questions for the consideration of the shipwright, engineer, and man of science.

The stability of the structure, exposed as it is to strains of peculiar character, the adjustment of the magnetic compass and other difficulties which have arisen have all been more or less successfully dealt with, and now we have one more desideratum pressing seriously upon the attention of all interested in naval architecture. I allude to the subject of the present paper, "Anti-corrosive and anti-fouling compositions for the bottoms of iron ships."

A similar question formerly arose in regard to wooden ships, but the experience of years has been so well directed to the preservation of all ligneous structures when immersed in sea-water, that but little anxiety is now felt respecting their durability. That this was a matter which deserved and received much attention from our ancestors is abundantly manifested by the early date of patents having such an object in view, for we find that although letters patent were first granted by James I., 1617, and then most sparingly granted, the thirty-second patent was secured to William Beale, in August, 1625, for "Preserving ships from hurt by the sea-worms or barnacle by means of certain cement or dressing."

The introduction of *iron* as a material for ship-building is of comparatively recent date. It appears, however, that a canal boat of iron was built 1787, and that iron canal boats were in general use 50 years ago. The Horsley Iron Company, of Tipton, Staffordshire, built the first iron sea-going steamer, the "Aaron Manby," in 1821. Mr. Grantham navigated an iron steamer on the Shannon, in 1824, and from about 1838 to 1840, iron vessels began to come into general use. The apprehension excited in the minds of shipwrights and shipowners respecting the want of durability of iron in sea-going vessels, together with the heavy item of current expenditure for keeping iron vessels in serviceable repair, are so great that even now, many assert that wood-built ships maintain their superiority. Only last week, when I had the honour of reading a paper at Glasgow before the "Scottish Shipbuilders' Association," upon *Electric Signals*, there were many advocates for composite ship-building, *i.e.*, iron frames, planked and coppered, the great objection raised to all iron being the great cost of cleaning in foreign ports, and the great falling off in speed from the rapid growth of animal and vegetable matter, even upon the best anti-fouling compositions known.

The corrosion of the iron wherever the sea air and sea water can act conjointly upon it is quite a secondary consideration, as compared with the annoyance and loss occasioned by the rapid fouling of iron ships, more especially when at anchor in tropical climates; and it is this chief difficulty which has engaged the attention of so many aspirants to fame and fortune.

As a matter of history, it may be mentioned that the ingredients of the paints used for the preservation of wooden ships in all the earlier

patents were principally pitch, tar, resin, and sulphur, while the idea of *poisoning* the "sea-wormes" appears to have entered the minds of inventors about the year 1737. Metallic sheathing, however, either with or without a layer of felt between it and the wood, was at last the plan generally adopted.

The inventions that relate to the protection of iron ships from corrosion and fouling are extremely varied in the means employed to effect such purpose. In the early part of this century, Sir Humphrey Davy proposed, as a preventative against oxidation, the attachment of sheets of zinc to all iron exposed to sea water relying upon the galvanic action of the zinc and iron. The result, however, of this arrangement proved that the iron was only in part prevented from rust, while its surface became even more attractive for the growth of seaweed and crustaceæ.

Some inventors rely entirely upon pitch and tar, and their mixtures with oleaginous and other organic substances.

Paints, properly so called, are employed by others either with or without a previous preparatory coating.

Many experienced shipwrights are of opinion that nothing surpassed ordinary red lead, or white zinc, mixed with boiled linseed oil; but these paints do not entirely prevent rust, while they permit the growth of weed and barnacles, and require very frequent renewal, and consequent dock expenses. To stop short, therefore, in the enquiry for an anti-corrosive and anti-fouling paint at this early stage of our experience, would be to announce our belief in the impossibility of a perfect solution of the question, and would be utterly unworthy of the nation which is destined to be the greatest iron ship-builder in the world.

Other inventors again apply cements, vitreous compositions, and even vitrified surfaces to the vessel; Jeffrey's marine glue, or other glue in one instance being the means of attachment of vitrified iron plates. The application of Sir Humphrey Davy's metallic zinc plates is again revived, either as a total or partial covering, or with varieties in detail, and to this basis a large class of inventors have turned their attention; others again interpose a layer of wood between the iron and the zinc plates with their fastenings, while others use felt in lieu of wood for the same purpose. Amalgamated zinc plates are another variety of the same general principle, while several inventors propose to encase each iron plate within a thick coating of other metals.

Mr. W. H. Walenn has been particularly successful in encasing iron with copper or brass by galvanic action, the latter metals being precipitated upon the iron to any thickness required.

No less than 57 patents, exclusively for paints for iron ships, are now in print, since the first protection was obtained in the year 1831, for an anti-corrosive and anti-fouling pigment for the bottoms of iron ships.

In some of these the composition consists of a mixture of salts of the metals with sulphur, or other readily-melted substance, and is applied hot. Gutta-percha, india-rubber, and other gum compositions have their enthusiastic supporters. Pitch and its combinations with organic bodies appears from its cheapness and ready application to

satisfy a large number of inventors. The *favourite* idea, however, appears to be a revival of the old shipwright's notion of poisoning the "sea-wormes," accordingly, arsenic, antimony, sugar-of-lead, verdigris, croton oil, cyanide of potassium, mercurial ointment, asafetida, and strychnine figure in the list of material weapons brought to bear against the unconscious barnacles, and their tendency to growth (under difficulties) in contact with submerged iron. Essential oils, powdered glass, powdered metals, plumbago, and other forms of carbon, metallic oxides, and gums, enter into the composition of the paints put forth by a great proportion of aspirants to fame in this department of practical science. One patentee advocates the use of guano; two inventions relate to the use of oil, constantly expressed from pores in the sides of the vessel, so as to ooze out over the submerged iron plates. In one of these the oil is combined with arsenic. Clay, lime, and other mineral earths are announced by some inventors to form, in combination with other ingredients, a specific for the evils complained of.

Among all these numerous patents there are, however, some few in general use which are of sufficient importance to merit particular notice.

Mr. William John Hay, Admiralty Chemist at the Dockyard, Portsmouth, has obtained two patents. The first, under date February 1st, 1858, consists of a mixture of Trinidad pitch or asphaltum, vegetable tar, and naphtha, to which caoutchouc, creosote, and turpentine may be added. The second patent, under date November, 1861, is based upon the use of protoxide of copper, ground and boiled in linseed oil, until reduced to suboxide, to which silver or its oxide may be added, with naphtha or turpentine as a drier.

It is wisely recommended that a *protective* coating be applied to the iron before this anti-fouling composition is used.

Green's and Peacock and Buchan's paints are also among the few best known to commerce. I am not aware of the basis of these paints, but am informed that arsenic and carbonate of copper are respectively combined with them.

Jeffery's marine glue has been used alone, and in connection with other inventions. The patent has expired some years; the composition is based upon caoutchouc and shellac.

McInnes has also two patents, the first under date June, 1854. This composition consists of pale yellow soap and sulphate of copper.

That of the 2nd of October, 1856, relates to a composition containing powdered emery and shellac, dissolved in spirits of wine and mixed with resin, castor oil, and ammonia, to which ground glass, sand, and cement may be added.

Dr. White patented, in 1863, a pigment composed of tallow, oil, and powdered quicklime.

The object of the foregoing and most generally known inventions, is evidently based upon two principles, viz., either to *poison* crustaceæ and marine vegetation, or to offer a continually changing surface of so unstable a nature, that neither shell fish nor weed can take permanent hold of their first resting place.

This latter intention I believe to be the *first* step towards a solution of the question. All of the foregoing inventions are now before the public, and have met with more or less success in various climates, and under varied circumstances, for it is a curious fact that the results obtained from avowedly the same composition, will prove either a "success" or a "failure," under apparently precisely similar application, and when exposed to the same run of ocean.

It is therefore with the utmost deference to the ingenuity and experience of other inventors, that I now state the component parts of my own composition, and endeavour to offer a reasonable explanation of the grounds upon which I rely for success.

My patent is dated October, 1863, and was secured only after a twelvemonth's private trial of its capabilities. It consists of a combination of quicksilver, vermilion, oxides of lead, powdered flint, glass, litharge, and boiled linseed oil, in such proportions and so triturated and ground together, that the large proportion of quicksilver used, namely, one-fourth, and in some instances one-third of the entire weight of materials, disappears, and still more curiously remains in suspension throughout the entire mass months after mixing.

The theory, and I may now add the proved results of the foregoing combination is as follows:—

First. That the paint is of such consistency and "body," that it interposes a sufficient thickness of material between the sea water and iron surface, as will stand ordinary wear and tear, and at the same time is in some degree a waterproofing composition.

Secondly. That the attachment of the paint, owing to its nature, is perfect when applied to a clean and dry surface of iron.

Thirdly. That the chemical action of the paint is not necessarily *poisonous*.

Fourthly. That the character of the pigment enables it to evolve an element which is obnoxious to animal and detrimental to vegetable existence, and that in so remarkable a manner that not only is the iron partially free from barnacles and other crustaceæ, but that *not one* attaches itself to iron thus protected.

Fifthly. That the paint itself slowly wears away, thus continually preventing an unstable surface for anything inclined to fasten upon it, and also at the same time exposing fresh chemical agencies to produce the effect hereinafter explained.

Lastly. That in case of any slight scratch or abrasion in the coating, the exposed iron is, to a considerable extent, protected by the adjacent composition.

In all ages, and for various purposes, quicksilver forms illustrations of a remarkable character. Some philosophers believe that the Egyptian magicians employed it when Moses defied them before Pharaoh to cast down their rods, and to cause them to become serpents. Dædalus is reported to have moved a wooden statue of Venus by means of a stream of mercury, while at the present day mercury is employed to show the heat and weight of the atmosphere, and to cure diseases. The advance of physical, electrical, and chemical science is greatly due to its adaptability to various purposes. The

mercurial trough for the collection of gases that are soluble in water, the use of mercury as a reflecting medium in optics, its conductability of heat and electricity, its fluidity at ordinary temperatures, its high specific gravity, its power to dissolve metals, and its easy volatility, present a combination of properties that is rarely met with in an isolated elementary body. One other property of quicksilver which enables it to be employed as a metallic paint is its singular affinity for oleaginous substances, and it may be stated here that it has strong sympathetic and anti-pathetic tendencies, which are not only manifested by chemical affinities, but by affinities not less strong (although their display is more rare), of which physical science takes especial cognizance. The power of mercury to unite or amalgamate with metals in general, and the repellant action of mercury on iron and platinum are illustrations respectively of these sympathetic and anti-pathetic tendencies.

The forces by which the particles of bodies are held together, are—

Firstly. "Cohesion;" by means of which particles of an identical character form a mass.

Secondly. "Adhesion;" by means of which particles of different kinds form a mass, each constituent particle retaining its individual properties.

Thirdly. "Chemical affinity;" in which particles of different kinds unite to form a mass, the properties of the resulting compound being of a totally distinct character from those of its constituent particles.

It is to the second development of force, "adhesion," that the attraction or affinity of mercury for oleaginous substances belongs. This adhesive force is much increased by the increase of surface of the bodies brought within its influence. There is every reason, in fact, to believe, that adhesion increases in direct proportion to the increase of surface. By pulverizing a substance, the surface is increased to its maximum in proportion to the weight of the substance. Dr. Miller calculates that if a cube of one inch in the side is subdivided into a number of cubes, each of which is $\frac{1}{1000}$ th of an inch in the side, the adhesive force is increased 1,000 times. The size of the globules of the paint now under consideration is so minute that they are undistinguishable by the naked eye, the quantity of light which they collectively reflect being so small as not to interfere perceptibly with the colour imparted to the paint by its other constituents, although, as before stated, there is 80 per cent. of metallic mercury in it. The average diameter of the globules is ascertained to be $\frac{1}{10000}$ th of an inch, and the adhesive force is increased by communion in comparison with that of a sphere or globule one inch diameter, 10,000 times. The natural adhesive power of mercury for oil, and the minute degree of fineness to which it is reduced in this paint, accounts for the singular fact that whilst the powdered flint glass employed to divide the globules in the first instance, when manufacturing the paint, is partially deposited at the bottom of the containing vessel if the paint be at rest for some time, yet the mercury is retained in suspension with little or no tendency to separate itself from the other ingredients of the composition, thus neutralizing the powerful effect of the attraction

of "gravitation" upon mercury by the still more powerful effect of the attraction of "adhesion" of the mercury for the boiled linseed oil in the paint.

Other means besides attrition with oil are known of comminuting mercury and bringing out its adhesive force for certain other substances. Some substances cause the development of the force to a greater degree than others. When pure mercury is shaken with water, ether, or oil of turpentine, or rubbed with sulphur, sugar, chalk, lard, conserve of roses, &c., &c., it is very highly comminuted. If metallic mercury is precipitated by adding an aqueous solution of proto-chloride of tin to an aqueous solution of bi-chloride of mercury (corrosive sublimate), the precipitate takes several hours to subside; and if running mercury is agitated in dilute sulphuric acid in contact with a few crystals of sulphate of copper, electrolytic actions cause hydrogen gas to be given off at the surface of the mercury, while the mercury assumes the form of froth.

The uses of comminuted mercury have, until lately, been almost entirely confined to its therapeutic action upon the human system. The mercurial ointment, bluepill, and "*pulvis hydrarg cum cretâ*" of the pharmacopœias are instances of its application as a curative agent. In contradistinction to this, it may be noticed that Brande in his "*Chemistry*" states that it is probable that mercury, administered to the human system in mass, is medicinally inactive. An inventor finds another use for the compound of mercury with grease, by employing it to insulate those parts of the zinc plates of galvanic batteries that are not directly opposed to the negative plates.

As the mercury exists in my paint, there can be no effect produced upon the marine vegetable and animal deposits, such as barnacles, by the agency of any *poisonous* substance, but other experimenters and patentees have sought to obtain the desired results *by poisoning* marine animals and plants, *such being an impossibility*. Professor Wilson tried many careful experiments in proof of such assertion. He mixed the most subtle poisons known with ordinary ship's paint, and after barnacles of large size had grown upon the wood and iron thus protected, he boiled the fish, and with such food poisoned many animals within a brief period, thus proving that mollusks could imbibe the poisonous matter into their systems without detriment to their own existence. The Chairman of the Scottish Shipbuilders' Association also stated the other evening that an iron plate had been coated in squares with four of the best known anti-fouling compositions, and after some months' submergence was raised for examination. The plate was covered with barnacles, and, ludicrous to relate, the biggest fellow among them had fastened in the very centre of the plate covering the junctions of the four paints, as if to taste and defy the villainous bait laid for himself and compeers.

With such testimony before us, I think we may very fairly conclude that henceforth we must look to other agency than *poisoning* as the basis for anti-fouling compositions. In my paint I have endeavoured to obtain the desired result by the combination of two theories, one being the gradual wearing away of the paint from its surface by the action and attrition of moving sea-water, and the other from electric action

upon the delicate organisation of incipient life in either animal or vegetable matter, always bearing well in mind that such chemicals are made use of, as shall in no possible manner give rise to galvanic action at the expense and to the consequent detriment of the very material we seek to protect. It is upon the latter reasoning that objection arises to all paints containing copper, which is in itself an element of destruction to the iron plates of a vessel afloat; this arises from the tendency of the salt, or precipitate of copper, which gives body to the paint, to become decomposed and to yield up its copper in the metallic state, and in contact with the iron. These observations apply to any paints in which metallic substances electro-negative to iron in sea-water are made use of.

It is only after numerous experiments, in which I have been materially aided by my coadjutor, Mr. John Hughes, in many of our part works, and during which we have had to deviate from the specification of my patent, that successful results have been obtained; and it is a curious fact that even with the same weight of mercury employed, slight additions or subtractions from our present formula most materially affect the lasting value and effects of the composition.

Twenty years ago, when in the Gulf of Mexico, the Captain of the vessel I was in tried experiments with mercurial ointment taken from his medicine chest, with little or no effect upon crustacea. The idea then was to *poison* or salivate the shell fish, and, lately, Captain R. Johnson has taken out, but since abandoned, a patent in which he tried the effect of one-eighth part of mercurial ointment and one-eighth part powdered arsenic in his composition.

Before an inventor in this country can obtain aid to introduce a new material he finds it necessary, in the first instance, to obtain a "patent" or "protection" (the latter frequently proving an expensive misnomer). This, as you are aware, I have done, and I have laid before you the main features of the composition therefrom; but the secret of manufacture, &c., which is only of personal interest, I feel sure you will readily excuse my entering upon.

From trials, which have extended over twelve months each, it appears that plates and vessels coated with this paint are as free from animal or vegetable growths when taken out of the sea-water as when placed therein, while the material has worn away but maintained its virtues to the last film. All testimonies tend to show that not only is freedom from barnacles secured (even though the coated surfaces are stationary in sea-water at places most favourable to their growth), but that the grass overhanging the upper edges of the sections on ships allotted for experiment is dwarfed in growth and of lighter colour than that which is contiguous to my composition.

There is clearly, therefore, some other active agent at work, which I thus explain: Electric or galvanic action can be excited between two fluids of different nature, and one metal as between two different metals and one fluid.

The quicksilver is the metal which I employ, the salt water one fluid, and the acids peculiar to crustacea and marine vegetation the other fluid.

You thus create, under the fish or vegetable germ, as many galvanic

batteries acting upon their extremely delicate organization, as there are minute points or globules of mercury in contact with them. There is also a certain amount of resilience or elasticity in my paint which I attribute to the film of oil between the mercury and iron remaining moist, and thus in itself protecting the iron to a certain extent; this is also a valuable adjunct in assisting the mercury to flow over and protect the iron in case of any slight scratch or abrasion, and forms one of the peculiar properties of the paint. The attachment of the mercury to the naturally repellant iron by aid of the oil is thus a good example of the adhesive force already explained.

Such, Gentlemen, is the theory of my composition, and, in conclusion, I will call your attention to one or two certificates which you can substantiate to your own satisfaction, bearing in mind that from the varied alterations in the course of our manufacture we have made errors, since discovered and corrected, which would have been more or less discouraging had we not proved that the basis of the invention was unquestionably correct.

The officers of the steamer "Caroline," running in the Mediterranean, pronounced my sections after twelve months trial, during which time the rest of the vessel was three times painted with other paints; as clean as when first coated with the composition. This steamer is now owned by Mr. Henley (the well-known electrician) who will confirm their statement. I believe she is at anchor in the Thames at the present time.

Captain Jackson, Lloyd's agent at Milford Haven, thus writes of the plate now before you. "This plate was submerged in Milford Haven waters for over six months, and at the termination of that period was found to be worthless on the red lead side; but perfectly free from corrosion, weed, and barnacles on your composition side," a similar result was reported of a plate ten months submerged, and he adds, "You may depend upon the practical value of this composition, and you may refer shipowners to my experience in almost every patent composition extant. I have seen none that will compare to the one now referred to." Similar evidence has arrived from Malta, while lately our experimental vessels have been arriving from all parts of the world, and the owners are purchasing the composition largely.

Among other successful experiments I may mention the "Eastern Province," of the Diamond Steamship Company, although the paint used upon that vessel and one other belonging to the company was among our experimental errors, by which the addition of peroxide of iron reduced its *lasting* though not its *effective* qualities fully one-half. The "McGregor Laird," of the African Steamship Company, also painted with the peroxide of iron mixture, came in clean, and the "Aleppo," belonging to the Cunard Mediterranean fleet, was last week docked and found clean.

I have now the pleasure to add that, after some successful experiments in the Medway, we have executed an order from the Lords of the Admiralty to paint Her Majesty's ship "Valiant." This vessel we have coated upon one side only, Mr. Hay (Admiralty Chemist) and another patentee having the other side for competitive trial.

We are still experimenting, with a view to making our paint last over a longer period than twelve months without detriment to the qualities which it now possesses.

In conclusion I may add, that although necessarily costly from the expensive nature of its component parts, *i.e.*, costly per cwt., yet it spreads over so large a surface that it is not beyond the pale of commercial sale, while, should continued trial prove it to be all that we believe it to be, the extra speed, and immense saving of time, and dockage expenses will make it a boon to all iron-ship owners, and a valuable adjunct to our naval superiority.

Mr. J. W. HAY, H.M. Dockyard, Portsmouth: I am a stranger who has been invited here, and I may, perhaps, be allowed to clear up a point which has been mooted by my friend, Captain Warren. In the *Transactions of the Institution of Naval Architects* an error of the reporter has occurred, which I never saw until the *Transactions* were in my hand. For any scientific purpose, or for the gentlemen who are in this room, I do not consider it necessary to explain that error; but I wish to clear away any imputation that might be put upon my professional character. When the meeting was on the point of breaking up, and the room was consequently in a state of disturbance, the question was asked, "Mr. Hay, what effect would three feet, five feet, or one foot of wood have in stopping galvanic action between Muntz's metal and armour plating?" Knowing, as I did, that Muntz's metal had been placed on ships, and that the only man who ought to have been consulted had not been consulted, and this was a professional officer that asked the question, I stated that before they sheathed an iron-ship or an armour-cased ship, they should have consulted the man who had been devoting his energies from twenty to twenty-five years to the service, in a chemical point of view. That was my remark; but in the confusion occasioned just as the meeting was breaking up, it was misunderstood, and I pardon the reporter. I did not consider it necessary to explain the error; indeed, I never thought any gentleman would chaff me with the ridiculous imputation that we must wait twenty or twenty-five years before sheathing an iron ship, when we do not know from hour to hour that we may not require the ships in action. I beg simply to explain this, because I do not wish gentlemen to go away with the notion that I could have made such an assertion. I am sorry that Captain Warren should have alluded to the newspaper reports respecting one or two ships. The "Resist-ancec,"—unfortunately, we only get part of the information,—happened to be coated simply with a protective varnish. She went out to Malta, and at Malta she was "hogged" without disturbing the composition in any way that had been put on eight months before. But being in dock, it was considered necessary, owing to where the chain cable had rubbed and other places, to coat this ship's bottom. But as there was nothing at Malta suitable for the purpose but the protective varnish, the protective varnish was alone put on. The protective varnish consists simply of asphalt, pitch, and naphtha, which we never for one moment consider will prevent anything like fouling. This ship was docked again in six months. She never had Hay's composition put on her. And as to the report about the "Recruit," it is beneath me to notice it. I regret that it should have been necessary to make these remarks; and thank you for the patience with which you have listened to me.

Captain CRAIGIE HALKETT: As I am one of many individuals who have taken an interest in the discovery of a coating for the prevention of fouling in iron ships, I should like to say a few words in connection with the subject under discussion. I do not propose to take up the question of sheathing brought forward by Captain Warren; nor shall I attempt to remark at all on many of the coatings which at various times have been suggested; but I shall limit myself to the consideration of certain points in reference to the invention of Mr. Gisborne, comparing his invention with one presenting many analogies to it, in which I have taken no small amount of interest. During the period in which Mr. Gisborne was carrying on his experiments

for the purpose of proving his invention, there were experiments going on in the neighbourhood of Edinburgh, which I had a good deal to do with. Those experiments were quite independent of his, and were carried on in perfect ignorance of his proceedings. They were conducted in a systematic manner, and showed, after the trials of a number of substances, that certain compounds of mercury were best able to answer the purpose of preventing both fouling and oxidation. My reason for wishing to say a few words here to-night, is because the patent that I am about to allude to, is very nearly connected with Mr. Gisborne's, and is, to a certain extent, an opponent of his. With reference to the oxidation of iron, we all know that mercurial ointment has been used many years for the prevention of corrosion. Every Ensign who goes out on foreign service, finds a jar of mercurial ointment in his gun case, put there by his gun-maker, to be rubbed with a rag over his gun or rifle on any occasion when the weapon is to be exposed to damp, especially to sea air or salt water. The results of the experiments before alluded to, formed the basis of a patent taken out by Mr. Francis Cruickshank, of Edinburgh. I will name the three compounds of mercury which he employs; but before doing so, I would briefly state certain principles which were deduced from the experiments, as they have a most important bearing upon the question at issue. Firstly, I would state that a coating, in order to protect a vessel effectually from fouling, must contain some substance or substances which shall excite deleterious action on animal and vegetable organisms. Secondly, that the chosen substance shall be insoluble, or so slightly soluble that, while acting energetically on the living organism, the action of sea water in contact with it shall be very slow. Thirdly, that the deleterious substance or substances shall be fixed to the vessel by means of a medium of sufficient hardness and toughness to resist the friction which a vessel necessarily encounters in passing through the water. In support of these principles, I may state that the experiments I have been watching near Edinburgh, have clearly shown that the animal and vegetable organisms giving rise to fouling, are remarkably affected by contact with surfaces coated with various metallic poisons. In the case of the large majority of these, the absence of insolubility renders them altogether useless. The substances which are in the composition of Mr. Cruickshank's coating, in a wonderful degree possess the qualities upon which I have insisted. They are energetic poisons, not apt to vary in their composition, and when applied by means of a suitable coating or paint to iron plates, they have been found to protect them from fouling in the most effectual manner, whether the said fouling be caused by animal or vegetable life. I will now mention the three compounds of mercury in Mr. Cruickshank's patent:—First, white precipitate of mercury; second, oxichloride of mercury—a term which includes various definite chemical compounds of corrosive sublimate and protoxide of mercury; third, the red oxide of mercury. I may add, that the powers which these ingredients possess to prevent fouling, will, I feel confident, prove valuable to the Admiralty and to the mercantile marine. Now, allow me to say a word upon the principles upon which Mr. Gisborne's invention is said to rest. I am far from saying that I think Mr. Gisborne's coating is not a successful one. I believe it is a successful one. It has been alleged that the action of Mr. Gisborne's invention is purely mechanical, by means of electric action; and that this action is noxious to animal and vegetable life. Whatever action Mr. Gisborne's coating does possess, I am satisfied that it is explained by the principle I advocate. I am firmly convinced that the reason why it is so far successful, is because the mixing of his pure mercury with a greasy matter brings about a certain amount of oxidation in his metallic mercury, and it is *that oxidation* of his metallic mercury that is deleterious to animal and vegetable life. Mr. Gisborne states that the electric action is affected by two fluids and one metal. He states that the acids of the juices of the animal and vegetable life are necessary to produce this electric action. We may naturally presume their adhesion and presence are necessary; but Mr. Gisborne keeps these organisms entirely off by his coating. The simultaneous presence and absence are not easy to comprehend. Metallic mercury possesses no poisonous action. When combined with other elements, however, it gives rise to compounds possessing the most poisonous properties. When mixed up ultimately with greasy matters, for instance, a very small quantity of mercury is oxidised; and by this oxidation, the

physiological action of the metal becomes altered, because a substance has been procured which is poisonous, and almost, if not entirely, insoluble in water:—a substance, therefore, possessing properties which fit it for the protection of vessels from fouling. I am aware that it will be objected that such powerful poisons as arsenic and tobacco, exert no action upon the animals which are, to a great extent, the cause of fouling. I meet this by saying, that because some poisons do not act injuriously upon marine animals, it is most illogical to argue that none can affect them. Innumerable instances occur of individual animals and plants becoming affected by some poisons and not by others; and it is an incontestable fact, that the substances which I have named, not only protect iron from fouling, but actually are poisonous to marine animals. You will, therefore, admit that a coating which contains a definite amount of such insoluble and poisonous substances must be preferable to one whose action depends on the tardy and incomplete oxidation of metallic mercury—an oxidation which will vary with the mode of the preparation of the mixture, and with the temperature, &c. These were the reasons which induced me to join Mr. Cruickshank. I have already received the greatest justice from the Admiralty, who have been so kind as to give me permission to coat a portion of one of their ships.

Mr. BEALE: Does Captain Warren take any measure for riveting the surface, or does he put the glue on the surface of the metal? I understood from Mr. Gisborne that his composition will last for twelve months. I do not know how long Captain Warren says his patent will stand, how long the copper will remain firmly attached to the iron, and in how many years it will be affected. Captain Warren spoke of the length of the commissions, but he did not state any definite period.

Rear-Admiral Sir EDWARD BELCHER, C.B.: For a great number of years my attention has been directed to the fouling of copper on vessels by crustaceæ. I found, particularly at Bermuda, where we were stationed for two years, that the *animalculæ* preferred the oxide of copper, which is poisonous, to any other substance on which they would fasten. I grew corals on my own account. I began with Lady Lumley's scent bottle, and I grew a coral tree on it for her. I tried jars, bottles, iron, the back of a knife, the sole of a shoe, a slate, and every possible substance that I could get hold of, and I had a beautiful museum of these things. The controller wrote to me the other day, asking my opinion whether coralline would attach themselves to glass in preference to any other substance, and whether the coralline so attached would be more difficult to remove. I remarked distinctly, the corallines were more difficult to be removed from vitreous surfaces, and could not be removed by an ordinary scraper; but wherever they came into contact with copper, which is slightly oxidised, they sealed off immediately, because they came off with the oxidised portion. In 1824 Sir Humphrey Davy commenced his experiments, by adding zinc plates on either side of the stem, to endeavour, by galvanic action, to overcome oxidation. I do not know if chemists understand exactly why the animalculæ decline to attach themselves to copper which is so protected; but if they will place a zinc plate under the tongue, and a silver plate over the tongue, and bring the two in contact, they would find that the insect would experience a tingling, sharp sensation, which would warn him off the copper. As long as the protection was in proper proportion, and the galvanic action kept up on the surface of the copper, to the destruction of the more oxidizable metal, zinc, so long we had no insects settling on the outside of the copper. The zinc was covered with weeds and coralline, but the copper, so far as I witnessed the experiment, was perfectly free from anything of the sort. In 1824 we were treated in a different manner. We had under each fore-chain an iron plate, nine feet long, and above four inches wide; and a similar one under the mizen-chain on each side. The ship was four years and a-half in commission. Her copper was constantly bright and clean; but when we came home to England, weeds and *animalculæ* were found attached to those four spots. When the "Blossom" was docked she was perfectly clear, except where the iron was; but the iron was gone, for as we were going into dock the iron tumbled off in a lump, in a state of oxide. In 1830 Captain Sweeney took out a patent with some Frenchman for protecting ships' bottoms sheathed with polished iron. He had a brig, and she was protected by this method, by zinc bars. Tanks were also fitted up at Portsmouth, and water was kept in the polished tanks

for four or five years without any alteration taking place in these tanks. The brig which went out to Halifax was found very foul; the plan did not answer at all; but it did answer internally in the tank.

The CHAIRMAN: Were those tanks made of iron or zinc?

Sir EDWARD BELCHER: Iron, with zinc bars. At the time I fitted out, in 1831, the Government provided me with zinc bars for the purpose of following up these experiments. I found, where the connection took place between the iron and copper, at the stem of the boat, that the zinc interposed there did protect the iron from corrosion. To show how rapidly barnacles will form, I will mention an instance that came under my own experience. In 1830, when my ship was in dock, I had an idea that if I whitewashed it I should keep off a great part of the galvanic action between the heads of the nails and the copper; and I thought that when the ship got to sea she would wash off all the river scum and be clean. We sailed in December, and we returned in the August of next year, only seven months away. At the Navy Office, in the collection made by Sir William Symonds, you will find barnacles four and a-half inches long taken off the vessel, and which were named after me. They were found in plates along the whole line of the keel, where the lead came in conjunction with the copper. That circumstance shows how rapidly barnacles will form on copper. I am afraid this composition of Captain Warren will not stand the wear and tear, unless it is very heavy copper. Is that 32-ounce copper?

Captain WARREN: The 38.

Sir EDWARD BELCHER: When it comes in contact with a rock, or with any other rubbing substance, I question whether the difficulty will not be greater than if the end were not simply pointed. I believe a patent will be taken out at the end of this week for the protection of the walls of the Houses of Parliament. The inventor of the secret has a peculiar varnish, which has been applied to iron that has been for four years under water; it may be seen at the Kensington Museum. The varnish which was under water the whole time was less affected than the varnish which was exposed above water. It was applied under Sir Baldwin Walker's directions, and was forgotten for a time.

The CHAIRMAN: Do you know the price of that varnish?

Sir EDWARD BELCHER: It will be very cheap indeed; but until it is patented no one will know anything about it. But I can tell you what the groundwork of it is. Nero was buried in his vessel, which was covered with this same pigment. It has no moisture in it at all; and it will not yield moisture under distillation at red heat. The varnish in question has puzzled Professor Faraday. He states that, so far as he knows, it will do everything that the patentee states it will do. When Nero's vessel was got out, a portion of it was placed in the Museum at Rome; and Cardinal Mezzofanti allowed this man to buy some portion, and with that he bought his secret, for he examined the paint and discovered what it was made of. I have seen two letters, one from Glasgow and another from Liverpool, asking for further supplies of the paint, stating also "it is the best covering for bottoms they have had as yet."

Mr. LEETCH: I have heard with a great deal of pleasure the arguments this evening. I think the subject is one of sufficient importance to call for a few observations. The first thing is to preserve iron from corrosion; the next thing is to prevent the adhesion of the animalculæ to it. All the attempts to use copper on iron vessels have hitherto been failures, because the galvanic action which will result from damage to a portion of the copper, will cause the galvanic current to go right through. It at first sight seems a ridiculous idea to think of glass, because, being so brittle, it is believed that it will break. So long as it is afloat, it will not break; but, if it goes on a rock, of course it will. But there is the fact that nothing will permanently adhere to it. Many people imagine that things will adhere to it. So they will; but they will never be able to eat into the smooth surface, and, therefore, never be able to cling to it permanently; they would be wiped off as easily as the incrustation off a bottle in a cellar, or as dust off a window.

The CHAIRMAN: Perhaps you can tell us the result of your experiment on the "Buffalo."

Mr. LEETCH: The result has been completely successful. I exhibit a piece of the glass sheathing that was twelve months on; there is nothing more on it now than there was at first. I should not think of putting glass on so thick as that, nor would I think of doing it in the way it was done, for it was done in a hurry. The great object is to preserve the iron. Iron, at present, is not being treated in the way it ought to be treated for sea-going vessels. My own impression is, that if the iron was left with its own natural skin, it would be much better than with any of the applications that have been put upon it up to the present time.

Mr. MORSEY: I have listened with great pleasure to Captain Warren's paper. With regard to one remark that he made upon the friction of water on iron my experience is very different. I left Plymouth Sound in 1853 on a cruise. We went to Lisbon and Madeira, and different places; but before we left, being an engineer on board the ship, I put a piece of tallow on the driving side of the screw. We came back from Lisbon, after steaming some thousands of miles. We then steamed up the Baltic. By-and-bye we lifted our screw for examination, and, to my astonishment, this piece of tallow was still on the driving side of the screw. There was a remark made by Captain Warren which, as Mr. Peacock is not present, I wish to correct. He said that Peacock's composition contained copper.

Captain WARREN: I beg your pardon.

Mr. MORSEY: That is not the case, for it contains no copper, and is perfectly harmless. Mr. Gisborne spoke about the cost of his composition. If the "Valiant" has on one side 8½ cwt., how is it that the "Kingston" of 700 tons takes 10 cwt.? and to that has to be added the cost of docking and preparing the vessel. As to the "Kingston," I do not know whether Mr. Gisborne intends his composition to dry; if so, why was she kept in dock so long after it was put on? And this morning, at seven o'clock, the composition was just as wet as when it was put on.

The CHAIRMAN: Where is she docked?

Mr. MORSEY: At Fletcher's dry dock. I should also like to hear what was the Admiralty Report of Mr. Gisborne's composition on the trials that have been made.

Dr. COLLIS BROWN: May I make one remark with reference to the preparation of Mr. Gisborne? It is stated that it consists of mercury, and other combinations, with lead and oily substances; that the destruction of the *animalcula* and marine *algæ*, takes place from galvanic action. I rather attribute that to other changes. He has forgotten that where oil comes in contact with the galvanic current, the galvanic action ceases. There is nothing so destructive of galvanic action as oil. One proof I will give you is the steam-boiler, where an electric current is given off a steam-boiler it is corrected by a few drops of oil. The anti-fouling poisons that result from the use of mercury, I should rather attribute to the calomel that is formed. The fatty substance that is produced destroys galvanic action.

Captain SELWYN, R.N.: I wish to draw Captain Warren's attention first to a point which I do not think he brought out with sufficient importance—that of the rivets passing through the felt, in some instances, and touching the iron underneath. That would be sure to produce an accumulation of electric action, due to the two metals coming in contact at those points. There would be a strong local action set up. Secondly, to the fact, that wherever you put copper and iron together in a vessel, exposed not alone to the water of the sea, but even to the moisture of the atmosphere, there you will inevitably have a strong galvanic action. There is no known means of stopping that. Probably, if you could keep a band of grease at the junction, that would be more efficient than wood or anything else. There is no part at which there is not a deposit of salt water upon it, and that salt water is the conductor to continue galvanic action through. I think it would be cheaper to build our ships of copper than to go into plans for making copper bottoms to iron ships. If we are in that way to accomplish the object in view, it clearly must be by abandoning iron bottoms of ships altogether, and having the whole outside of the ship of wood. If you can do that, and having done that, if you can keep the ship from straining, opening her bow ends, and letting in the water to the inside iron, then you might succeed; but short of that, I am sure the galvanic action will go on. With regard to the black fluid of which Captain Warren spoke, as oozing from behind the plates of the "Royal Oak," it is nothing but the gallic acid acting upon the iron, and producing

tanno-gallate of iron as a result of an electric current between the copper and the iron, the iron forming the more destructible metal in the couple. We have there, in the iron, the oak, the gallic acid, an action going on which has this result, that the iron becomes the positive metal; the copper is protected from that oxidation which is the only means of preventing the deposit of all substances on the bottom of a ship. So sure as you prevent exfoliation, whether that exfoliation is produced by the destruction of the copper, or the destruction of any other substance that you choose to put there, so sure are you to have a deposition of barnacles, grass, sea-weed, and other materials. Here is a bottle which the Secretary has been kind enough to bring for your inspection. I was aware that in the Museum and elsewhere there were a great number of bottles that had been recovered from the sea at various times, and which have been covered with barnacles. Sir Edward Belcher has seen not only submerged bottles, but bottles which floated about the ocean perfectly covered with barnacles and sea-weeds. I may mention a curious fact to show the way in which Nature obviates this deposition of *animalcula* when one of her operations is stopped. In the North Pacific we came across a large old whale, which had become diseased, and which was so covered with barnacles and shell-fish from head to tail, that we really took it for a half-tide rock, and we lowered our boats to examine it. The only way we could account for it was, that the fish was diseased, and that it had ceased to secrete the *mucus* which all fish secrete in health, and which protects them from the deposition of barnacles.

Sir EDWARD BELCHER: All whales have barnacles.

Captain SELWYN: There is the barnacle proper to the whale, just as there is the louse proper to the salmon, but that is not the kind of barnacle that we saw. The practice of coppering vessels is now going out. As regards the wooden and copper vessels of which Sir Edward Belcher spoke, there is no possible doubt that if you sacrifice any one metal in a couple, you may protect the other. I had a wooden vessel on the coast of Africa, whose iron rudder was in a state like red cheese, from galvanic action; and as for stopping that by the application of felt, where you have copper nails passing through it and the points touching the iron, you could not do it. Mr. Gisborne has brought before us a composition in which mercury plays a part. I am sure he is too good an electrician not to see that there are no two metals in contact in salt water, in which a galvanic action does not go on. I attribute the success of his composition more to the fact that his paint is so made that it gradually wears off, than to the fact of its having any mercury at all in the composition. I think the probability is that with copper you get a more energetic action, but with mercury, you will get some, in any of its forms. The object of all compositions, hitherto, has been to protect ships' bottoms, not alone from oxidation, not alone from fouling, but to do both at the same time; and I do not think, unless we get some application of the mineral oils that have been spoken of in this theatre, that we shall be successful. The plan of allowing the oil to flow out of the ship's bottom has this to recommend it—that wherever grease or oil from a ship's bottom is allowed to come out from the bilge pumps, there you find, in the immediate vicinity, and in a line upwards to the surface of the water, an entire freedom of attachment of any description. Some will say it is due to the frictional action of the water. I confess I think it is more due to the oil that is oozing out, being carried against the ship's bottom, and greasing the surface in its passage upwards. I see no possible reason why, if the oil be emitted at the bottom of the ship, you should not produce that action over the whole surface, that you have produced over a small portion of the surface. I take the greatest interest in the subject, and I have my best thanks to give to Captain Warren and Mr. Gisborne for bringing forward the subject, for as I said in a former paper, the whole secret of success in naval warfare must depend upon *speed* and the power of *keeping up that speed for the greatest amount of time*.

Mr. LEETCH: Speaking of oils, you all know that fatty matter will evaporate after a certain time and will become dry. With regard to glass, if a bottle is sunk to a number of fathoms in the sea, and is allowed to remain there, things will accumulate upon it; but where a vessel is kept moving about in the sea, there is very little chance of anything adhering to it. But barnacles will not adhere permanently to glass placed on ships' bottoms. The only instance I know of is that in the case of a

bottle obtained from the wreck of the "Royal George;" there, one incrustation had actually eaten into the glass, it having been sunk nearly a hundred years.

Captain WARREN: I am very sorry that Mr. Hay should have been so distressed. I really thought, in what he said on the occasion in question, that it was a little piece of sarcasm on his part, and you see it by the context:—"I think the subject should be taken up by chemists who should work at it for twenty or five and twenty years."

Mr. HAY: "Who have worked at it for twenty or five and twenty years?"

Captain WARREN: I quote from the volume of the *Transactions of Naval Architects* referred to by me. Mr. Hay is made to say, "I think the subject should be taken up by chemists who should work at it for twenty or five and twenty years," and as the context shows, Mr. Hay could get no reply to his scientific questions I do not think he gave himself a very long period to settle the question. Mr. Hay, as the Admiralty chemist, tells us that wood is a very perfect conductor between two metals, Mr. Reed, the Chief Constructor, says that it is the only effectual interposition, so thinks differently, but I do not see how that can affect Mr. Hay in any way as a scientific chemist, which Mr. Reed certainly is not. As far as the "Recruit" is concerned, I quoted the "Recruit" as I quoted other vessels; I quoted the case of the "Megara," which was a much worse case than that of the "Recruit," and in which Mr. McInnes and Mr. Hay's compositions were used on different sides, and she was described as a putrid mussel-bed. There was one portion which I had noted, but which appeared to me so strongly worded, that I did not intend to read it. I will read it now, it is from the naval intelligence of the "Times":—

"The 'Warrior,' 40, iron frigate, Captain Arthur A. Cochrane, C.B., in the dock at Portsmouth, has, according to established custom, had her hull, below the water-line, and the compositions and experimental sheathings with which it is coated, examined and reported upon to the Admiralty by the officials of the dockyard. It is four and a half months since the 'Warrior' was in dock. She was then coated below the water-line with the preservative and anti-fouling compositions prepared by the Admiralty's Chemical Assistant, and at the same time had three patches of 'Brown's vitreous sheathing' attached to her port side. The ship's bottom, as she now lies in dock, has the appearance of a well-made thrummed-mat, being covered with a fine crop of tuft weed, which must have grown at the rate of about three-quarters of an inch per month since the ship has been afloat, to reach its present condition. The vitreous sheathing had less of this weed upon it than the compositions, and they have adhered to the ship's bottom with two exceptions."

Mr. HAY: May I be allowed to make one observation upon that? With respect to that last quotation which Captain Warren has been so polite as to introduce, that has been publicly denied in the newspaper; and I assure you that Captain Warren, who is in the habit of seeing ships, might have brought forward some that had come under his notice personally, rather than have taken up loose newspaper reports. There is one vessel that has been seventeen months coated since last docked—she has been coated for seventeen years on my plan and the iron and rivets are as good as when put together. Captain Warren knows this, as at the time of the examination of the mortar-boat, sheathed on his plan, she was in the same dock.

The CHAIRMAN: The simple fact is, Captain Warren has read an extract from a newspaper, and you state that it is not correct.

Mr. HAY: Certainly so. I wished to make a few observations upon the subject, to confute the arguments that have been brought forward, followed by these beautiful illustrations.

Sir EDWARD BELCHER: If the accounts that we read in the newspapers were to be taken as facts, the Admiralty would be very much to blame for employing Mr. Hay any longer. But, if the Admiralty are satisfied, I think we ought to be.

Mr. GIBSONNE: In reply to the remarks upon my paper I will not detain you more than one or two minutes. 1st. In reply to Mr. Halkett, we tried corrosive sublimate and other preparations of mercury, and found them to be exceedingly deleterious to the efficacy of the paint. 2ndly. Dr. Brown remarked that there could be no electric action upon mollusks that attached themselves to the paint on

account of the oil in it. But, when paint is completely filled with minute particles of quicksilver, so soon as a mollusk fastens upon it the fish feeds upon the skin of oil until, by uncovering a globule of mercury, galvanic action acts upon it. Captain Selwyn mentioned that no metals come in contact with salt water without galvanic action arising; the mercury I use would not however adhere to iron but for the oil which insulates it from the iron, as already explained in my remarks upon adhesion. One of the patentees I have named, employs mercury with grease to prevent galvanic action upon one side of the zincs in a battery. You have heard that red lead is a very good anti-corrosive; yet, when brought into competition with my paint, as on the plate now before you, you will notice that two coatings of the best red lead have not prevented destructive corrosion, while my side is perfectly clean and free from all corrosion, and what is remarkable, as you will perceive upon closer inspection, is that even the hammer marks made in flattening the plate and which sealed the iron show through the paint without any corrosion upon their abraded edges. This plate has been submerged six months and is authenticated by Lloyd's agent at Milford Haven. In reply to Mr. Moysey I beg to state that we did not paint the "Resistance," the "Valiant" being the only one of Her Majesty's ships under experiment. She went into dock on the 12th, and had three coatings, each coating drying within twenty-four hours, and in reference to the merchantman, "Kingston," I ascertained upon my return to town, after a fortnight's absence, that good *boiled* linseed oil had not been used with my paint, and the paint will not dry quickly unless such oil is used. If you paint two plates of iron with my paint and allow it to set an hour or two and then submerge one plate, the plate so submerged will dry more quickly than the one left in the air. The best proof, however, of all paints is to test them by actual experiment at sea.

Captain WARREN: Captain Selwyn made a remark as to the rivets. The felt which was tried before was a very thin felt. The felt now is so thick that if the rivets were driven in in the form of nails, they would not penetrate through it to the iron. Mr. Beale asked a question as to the length of a ship's commission. A commission is usually for three years, so we believe this copper will last six years. I now think that I have answered all the questions put to me. I knew very well before I came here that composition-makers and African travellers are the most belligerent of people.

The CHAIRMAN: I will not detain you long by making any observations myself. I think the conclusions to which we must all come are:—first, that it is a subject of the very greatest importance; secondly, that it is not at all an easy problem to solve how to coat the bottoms of iron ships. I think the fact of the very large number of patents, and the innumerable substances which have been tried on various occasions, are sufficient proofs that the subject is not easily handled. I believe I may say that we have not, as yet, hit upon the right method of preserving iron ships' bottoms. I think it is a matter of regret that Captain Warren has not been able to tell us that his sheathing has been tried at sea. It is quite possible that his plan may be so far good as to preserve an iron mortar-boat while in harbour; but so far as I understand him, it has not been tried at sea.

Captain WARREN: It has not.

The CHAIRMAN: Therefore, I quite agree with what Mr. Gisborne said just now, that the only way to prove these compositions is to try them at sea. I have a recollection of having occasionally been taken to a ship in dock, and I have been told to look at one side and then at the other; and I could really see very little difference. On one side was Mr. Hay's composition, and on the other was what we called the Woolwich composition, which is simply coal-tar and a little spirits; and I could see no difference. With respect to the new patent which Sir Edward Belcher mentioned for preserving the stone-work of the Houses of Parliament, so far as I have heard, it is a vitreous composition.

Sir EDWARD BELCHER: No. I cannot inform you of the secret.

The CHAIRMAN: My impression was, that being a vitreous composition, all the objections which Sir Edward Belcher applied to Mr. Leetch's plating of glass would apply to this vitreous composition. However, I shall not detain the meeting by going into a variety of points, especially with reference to the coppering of iron-cased

ships. The matter has been very much considered, and I do not know how the question stands at present. I think the "Royal Sovereign" was covered with peculiar corrugated plates.

A MEMBER: They have been removed.

The CHAIRMAN: I do not know the present state of the "Caledonia." A belt of wood was originally placed between the Muntz's metal on her bottom and her iron plates; it was well-known that damp wood is a partial conductor, still it was supposed that this would be a better plan than bringing the Muntz's metal right under, and in contact with, the armour-plates. If that had been done, there is no doubt that the armour-plates would have been ruined. I have now only to thank Captain Warren and Mr. Gisborne for preparing these papers and bringing them before us.