Zinc salts act as a preservative in boilers, and the painting of the whole of the interior of a boiler with zinc oxide, and the addition of some zinc salts (the chlorides excepted) to the boiler water, has been proved to be beneficial.

Mercury salts are known to be an efficient protector against rust, and the only reason against their use I can find is excessive cost.

Alkalis.—In some ships slacked lime, caustic potash, soda, or their carbonates, is sometimes added to neutralize any free acid in the water. If added in excess it may do harm, the lime forming as a sediment on the heating surfaces, and the soda eroding the spigots, etc., of the brass valves, and if copper pipes are used in the boiler, galvanic action may be set up. When an alkaline or basic compound is brought into contact with an acid compound the H of the acid and the metal of the base exchange positions and form a salt as:—

Sulphuric acid (H_2SO_4) + Caustic soda ($2NaOH$)
= Sulphate of soda ($NaSO_4$) + Water ($2H_2O$)

An alkali also has the power of absorbing and neutralizing Carbon dioxide (CO_2).

Anti-Incrustators.—Of these Sodic carbonate, in one form or another, generally plays the principal part; its action is to convert the calcic sulphate and magnesic chloride into carbonates.

Calcic Sulphate		Sodic Carbonate		Calcic Carbonate		Sodic Sulphate
$CaSO_4$	+	Na_2CO_3	=	$CaCO_3$	+	Na_2SO_4

The hardening effect of the calcic sulphate being done away with and the calcic carbonate precipitated in a soft condition, when it can be blown out. Ammonic chloride is also sometimes used, and when boiled in presence of calcic carbonate decomposes it, forming soluble calcic chloride whilst the ammonic carbonate volatilizes.

Whenever there is any doubt as to the harmlessness of fluids or salts intended to be put into a boiler, it is better to test them as follows:—Boil them and then put a clean knife blade into the liquid: should rust be formed, should the water be discolored or should copper deposit itself on the blade, then the substance should not be used. If certain free acids are present, the above test will give no warning, but a few drops of prussiate of potash should be added, when, if steel is being dissolved a light bluish precipitate is at once formed which slowly turns dark blue, or if tannic acid be added, a substance like ink will be formed. Salt in the water can be found by putting a few drops of nitrate of silver in a glass of boiler water, when the contents will become cloudy.

The Behavior of Hydro-Carbon Oils in Boilers.—Filters should be used for feed water to arrest solids and oils, principally oils, for once the oil gets into the boiler the globules, if in sufficient quantity, coalesce, forming an oily scum on the surface of the water, but if present in smaller quantities remain as separate drops; these drops show no tendency to sink as their specific gravity is about .889, but they gradually come in contact with the minute particles of calcic sulphate and other solids separating them from the water and in time covering them with oil, which enables them to stick to any surface they come in contact with. The S.G. of the particles will increase as they become more and more loaded with the solids, till a point is reached, at which they have the same specific gravity as the water, and they now rise and fall with the convection currents of the water, attaching themselves to the surfaces they come in contact with, the position on the surfaces depending on whether they come in contact whilst descending or ascending. This deposit is a non-conductor of heat, and also from its oily nature it tends to prevent intimate contact between itself and the water. On heating surfaces this leads to overheating of the plates, and the deposit begins to decompose by the heat, the lower layer in contact with the plate giving off gases which blow the greasy layer, ordinarily about 1-64 in. thick, up to a spongy leathery mass often ⅛ in. thick, which, owing to its porosity, is now even a better non-conductor than before; the plate becomes heated to redness and being unable to withstand the pressure of steam collapses.

During the last stages of this overheating, however, the temperature has risen to such a point that the organic matter, oil, etc., present in the deposit, burns away, or more properly speaking is distilled off, leaving behind as an apparently harmless deposit the solid particles round which the oil had originally formed.

Impurities in the Metal.—The composition of boiler plates often has a great deal to do with corrosion in boilers. In a ship built in the north of England, her boilers lasted only months, when, notwithstanding that all preventives and preservatives were tried the boilers were condemned by the B.O.T., and new ones had to be put in. I should think that is a case where there were some injurious impurities in the steel. The steel used for boiler plates is generally that produced by the acid Siemen Martin's regenerative furnace process, as its composition can be regulated better than by any other method for the same cost. The heat in this furnace is produced by a gas, mixed with air, generally coal or water gas, and it is assumed that the metal occludes some of the components of the gas, such as carbonic gas, hydrogen, etc., and that in cooling it gives most of them off again, but should any injurious substance remain it is often the cause of rapid corrosion, and this may have been the cause of the trouble in the above-mentioned boilers. Pickling the plates has been tried with partial success, though it is said to reduce the elongation about 15 per cent., and the ductility about 40 per cent.; this can be rectified by annealing, but it is a question whether the plates will not return to their former state after being in the annealing furnace. It was found on analysing steel that had been galvanized, that it had occluded from .002 per cent. to .005 per cent. of hydrogen, and taking into consideration the low atomic weight of hydrogen, these percentages should be multiplied by 32 and 31 respectively to make them comparable with the volumes of sulphur or phosphorus. This goes to prove that under certain conditions the occlusion of gases by metals does take place.

Galvanic Action.—I think that there is room for a great deal more knowledge of this; even at the present time it is often the practice to blame it for certain peculiarities of corrosion, when nothing else will explain it. The theory of galvanic action is most lucidly explained as follows:—"When two metals of dissimilar nature are immersed in a liquid capable of chemically acting on both of them, and are connected, or are in metallic contact, then that which is the more easily corroded becomes the positive element or anode, while the other metal becomes the negative element or cathode." The impurities in steel with an electrolyte in contact will cause galvanic action. The electrolyte in the case of a boiler is acidulated or alkaline boiler water. Another form of electro-galvanic action is that between different materials, as in the steel shells and iron tubes (steel tubes are used in the British Navy, but iron are still mostly used in the Merchant Service). Zinc is put into boilers to prevent corrosion, and does it, but zinc put into boilers to absorb galvanic action is a fallacy and the polishing of the contacts as is often insisted on, is a waste of time. Supposing that the boiler is just newly closed up, and the zinc