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The Fittings of her Majesty's Ship "Victor. Emanuel," as an Hospital Ship during the Late Ashantee Campaign

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LECTURE.

Friday, May 29th, 1874.

SIR ALEXANDER ARMSTRONG, K.C.B., LL.D., F.R.S., &c.,
Director-General Medical Department of the Navy, in the Chair.

THE FITTINGS OF HER MAJESTY'S SHIP "VICTOR EMANUEL," AS AN HOSPITAL SHIP DURING THE LATE ASHANTEE CAMPAIGN.

By Vice-Admiral A. P. RYDER.

It was hoped that Captain Parkin, who commands H.M.S. "Victor Emanuel," would have read a paper on this subject; he could have answered much better of course than I can any questions about her, but she is, it is believed, under orders for China, and he has not been able to find time to do so. Having suggested that a paper be read on this subject, I had therefore to undertake to prepare one and visited the ship for the purpose. I hold myself responsible for the contents of this paper and for the statements in it.

The object I have had in view is threefold.

(1.) To place on record the successful fittings of Her Majesty's ship "Victor Emanuel," for the use of my brother Officers abroad, who may be called upon suddenly to devise and superintend the fittings of a hospital ship, far removed, perhaps, from access to the Construction Department of the Admiralty.

(2.) To point out, as far as I have been able to ascertain them during a short visit, what fittings were unsuccessful and require alteration.

(3.) To afford an opportunity for discussion on Dr. Macdonald's paper, read here on the 12th of February last, which may, perhaps, aid us in arriving at the best system of ventilating all classes of ships, hospital ships, low freeboard ironclads, &c., &c.

The following account of the fittings has been in part extracted from the columns of the *Lancet*, November 22, December 6, 1873, and April 18, 1874, by permission of the Editor; corrected in some minor particulars by the explanations of Dr. Marston, on the Staff of the Director-General, at Whitehall, and in others by the writer after a recent visit shortly after her return from the Coast.

When Her Majesty's ship "Victor Emanuel" was chosen, the Medical Department of the War Office were requested to signify their wishes as to her equipment, and from the commencement of the work no expense, no mental, manual, nor clerical labour, were spared to send to the West Coast of Africa a very complete hospital ship for the benefit of our fighting men.

The following description was mainly prepared by a gentleman who, though not belonging to either service, has had very large experience in the sanitary arrangements of troop, emigrant, and war ships of all classes, both at home and abroad, and who was specially sent by the Editor of the *Lancet* as a Sanitary Commissioner to inspect the "Victor Emanuel," by permission of the Admiral Superintendent of Portsmouth Dockyard.

Her Majesty's ship "Victor Emanuel" is a wooden screw steamship of the old class, of 5,157 (3,087) tons, 2,414 (600) h.-p., and carried originally 79 guns. She had a complement, as an hospital ship, of 240 Officers and men. She was launched at Pembroke Dockyard in September, 1855, under the name of the "Repulse;" but having been, shortly after the close of the Crimean war, visited and admired by the King Victor Emanuel, she was ordered thenceforth to bear the name of that monarch.

It is not necessary to record her special services afloat. The work of converting her into an hospital ship commenced on the 15th of September last.* The ship was in the first instance caulked throughout, and her bottom and sternpost were thoroughly repaired. She is now a flush-decked ship, with a poop added; and has below, for what may be called service work, a main, gun (or lower), and orlop deck. Proceeding from above downwards, we commence aft, and find under the poop the stern cabins on the port side assigned to the Captain of the ship, and the starboard cabins to the military Officer in command. The Surgeon-Major, who will have a staff of some six or seven medical Officers, as well as a still larger staff of subordinates, occupies two small side cabins.

The general arrangements of the Officers' quarters are very good; and baths, as well as closets with special ventilating and disinfecting arrangements, are provided on both sides of the poop. On the latter, on each side amidships, are four large water-tanks, raised so as to be quite clear of the upper deck. Each of these tanks will hold two tons of water. Three of these large reservoirs will contain salt water for flushing the closets; three, fresh water for washing and bathing purposes; and the contents of the remaining two will be sent into Crease's patent filters for drinking and cooking purposes only. Elaborate sets of pipes extend from these tanks in all directions over the ship—to hospital-decks, bath-rooms, galleys, saloon, and surgery; thus salt, fresh, or filtered water can, by means of these arrangements, be obtained at any moment in any part of the vessel. Immediately abaft the mainmast a hatchway has been cut in the deck for the special purpose of lowering the sick or wounded to the quarters below, the arrangements in connection with which appear to be very complete. The amount of enlargement necessary

* She sailed on the 30th of November, 1873, anchored off Cape Coast on the 1st of January, 1874, started on her return to England on the 26th of February, 1874, and arrived at Spithead on the 10th of April, 1874. During her stay on the coast, the thermometer did not rise in the shade above 87° Fahr., but the air was so charged with moisture, that boots blacked in the morning were covered with green mould in the evening.

for an entry-port to the hospital deck may possibly have been open to objection on the part of the Admiralty. The accommodation ladders and all the hatchways are very spacious and contrived to give a minimum of difficulty to all engaged in the work of transferring the sick from boat to ship.

Proceeding forward along the upper deck, we find on both sides of the ship an admirable arrangement of latrines, just abreast of the smoke-stack, well protected, opening "for'ard" (the bow port), and very well ventilated. Further on, on the port side, are the various departments of the laundry, enclosed, but well supplied with skylights, ports, and screened ventilators. The foul linen is hoisted in a closed bucket from the hospital deck below, and sent at once into the washing-chamber, which is fitted with Bradford's apparatus. The drying-rooms adjoin the washing-room, and it suffices to say that this part of the floating establishment will, we believe, if properly conducted, prove a very great success.

The starboard side on the forward part of this deck is occupied by a very convenient "butchery," and a large hospital lavatory, the arrangements of which might be examined with pleasure and profit by all connected with the organization of similar institutions ashore or afloat, and do infinite credit to all concerned.

There is a slop-room, provided with a large tank and trapped pipe, for cleansing soiled hospital utensils, which will be carried up from the hospital deck in a galvanized iron box through a scuttle to this part; and another room, communicating with the hospital deck by a trap, admits of the removal and storing of the hospital mess utensils.

This description includes pretty well all that is worthy of notice on the upper deck. We may here observe that all other parts of the ship are, by means of "trunked" hatchways, entirely cut off from the hospital proper, and that in no single instance does any general discharge-pipe lead into a soil-pipe.

Before going below we remark that two planks have been removed from either side of the upper deck, fore and aft, to the extent of about 79 feet. The open spaces or slits thus formed are protected by combings covered by long wooden hoods, which, by means of nuts and screws, can be raised or depressed to any extent up to 8 inches in order to ventilate the main (hospital) deck by acting as a large and very efficient *up-cast*. This resembles the ridge ventilation so commonly adopted in hospital huts, and, as the cover is subdivided into four parts, each portion can be raised separately, so as to admit of the degree of ventilation being regulated to different sections of the hospital deck, when this part is divided, as it is intended to be, by movable screens scalloped at the top.

We may now go down the aft companion ladder to the main deck, which is of course the most important division of the floating hospital. The height from deck to beam is 6 feet 2 inches, and from deck to deck nearly 7 feet. The extreme length is 230 feet, and the width 52 feet. For purposes of ventilation as well as of light there are 66 ports, $3\frac{1}{2}$ feet in height by 3 feet wide, and five scuttles, each 8 inches

in diameter. The ports are fitted with sashes and jalousies, either or both of which can be raised or opened, shipped or unshipped, at pleasure. General ventilation will be assisted by the hatchways, and by two large stern ports. Direct down-cast ventilation will be effected by means of seven cowed tubes, each 18 inches in diameter, projecting some feet higher than the bulwarks, and trimmed, of course, "head to wind," the lower openings being brought down to within about 8 inches of the floor of the hospital deck, so as to diffuse the air without causing a draught. The up-cast ventilation will be promoted by the long open spaces above described, and by numerous tube orifices along the top sides of the deck above, which will discharge the foul and heated air through goose-neck pipes.*

The engine-room hatchway is completely "trunked" off by glazed bulkheads, so that no heat from this source can find its way on to the hospital-deck.

There is a set of cabins on each side at the stern,† which will be used by sick Officers, but the rest of the deck, except of course amidships, presents a clean sweep fore and aft. The interval between the sick Officers' cabins is to be provided with large stern windows, capable of being kept wholly or partially open; and this part admits of being screened off from the remainder of the hospital-deck.

The baths are placed amidships in three or four sets, and are provided with pipes to convey salt or fresh water from the deck tanks above described, with steam jets to heat the water, all the taps being conspicuously lettered.

The lavatory arrangements consist of two long rows of wash-basins forward, fixed on either side of the bowsprit, each supplied with salt or fresh water, and there are, as well, basin-rings screwed to the sides of the deck for emergent purposes. The closets are arranged in three sets on each side of the vessel, and there are no fewer than four for the Officers and 28 for the men, making a total of 32 on this deck. Two sets are fixed aft, two at the bows, and two about opposite the engine hatchway. They are furnished with patent pans and disinfectors; each is ventilated by means of a goose-neck up-cast; the lower outlets have a good angle of inclination, and are of large diameter, and there are ample means provided for flushing.

The deck will accommodate 140 patients, occupying cots arranged in three rows fore and aft, on each side of the deck, with about 2½ feet of gangway space between each row. The cots will be hung to short iron stanchions screwed into the deck below, and the cots will all both "rock"‡ and "lock."

* When the "Victor Emanuel" reached the Coast, the two foremost water-closets on each side were removed to give freer ingress to the breeze when the ship was head to wind, the two hawse-plugs were removed, and two openings of considerable size were fitted to lead to the hospital deck sidewalks, which were always kept open.

† Experience on the Coast showed that it would be better not to have cabins on the deck, as they blocked up the ports.

‡ It was found that, when the mattress was on the bed, and a patient also, the centre of gravity of the bed was so high that the stability was entirely lost; the bed had to be always locked or re-slung with rope grummets. There were 50 beds for the poop, to stand on legs.

Every iron cot has been fitted not only to rock and lock, but to be removable at will; there is no reason why the spare ones should not be taken down and stowed away; and under these circumstances it was deemed best to provide fittings for a maximum number.

A certain proportion of the cots are constructed especially for certain classes of surgical and medical cases.

The sick cots for surgical cases were used in the Abyssinian war. They have *movable* and not *fixed* sides, and are furnished with a trap-door. These cots have been distributed on the hospital-deck in such a way that no two of them are contiguous, and they are placed in the position best adapted for ventilation.

Mosquito curtains will be provided of a light material, rendered unflammable by tungstate of soda, but most of these will be made up from patterns during the outward passage. Light canvas screens will be also provided, so that by hooking up one of these any single patient, or set of patients, can be isolated from the rest.

The hanging screen, which will be rigged up "athwartships" for the purpose of separating the Officers from the men, will be lowered only under exceptional circumstances and for the short period of time that the sick Officers might desire to secure privacy. This was one of the requirements made by Medical Officers who had served on board other hospital ships. For though privacy is a privilege much appreciated, especially on board ship, the value of stern ports cannot be exaggerated, and any obstacle to their use, whether as inlets or outlets, will vastly influence the purity of air between decks, whether the wind is ahead or fair, and whether the ship is sailing, steaming, or at anchor.

A clean sweep of deck fore and aft is most essential, and such will be the case when the canvas screens are rolled up, as they are ordinarily intended to be; and they have purposely been deeply scalloped at the top and left free of the deck at the bottom, so as, when down, to intercept the current of air as little as possible. But the chief explanation of the presence of these screens and of the American stoves is this:—At the end of the campaign the ship will have to convey the sick to this country. Patients recovering from tropical fevers and dysentery are, as is well known, very susceptible of the effects of cold, and they may have to encounter the danger and discomfort of a voyage home at the most inclement season of the year. With the number and variety of natural and artificial sources of ventilation in this ship, it was felt that there should be some means for protecting the sick against the effects of a colder latitude. With thermometers to indicate the temperature, and doctors to direct at what degree it should be maintained, the sick attendants cannot go very far wrong.

The dispensary is built up forward amidships, is 17 feet 9 inches in length and 10 feet in width, well lighted from above, and is being fitted up with all medicines and necessary appliances by Messrs. Savory and Moore. The sides and flats of this deck are coated with white zinc paint, so that they can be kept clean by ordinary scrubbing.

The reasons for having the whole of the hospital-deck painted white*

* The writer of the article in the *Lancet* objected to the coating of white paint on

were—that there is nothing like a white surface for showing dirt; that paint renders the wood non-absorbent; that any part of the deck can be washed with soap and hot water; that white paint is common, cheap, and readily renewed; and that for a hot climate it is the coolest colour that can be selected. With the jalousies specially provided to exclude the sun's rays, without impeding the ingress of air, it is to be hoped that no one will be inconvenienced by the "glare."

A special feature in the arrangements of this hospital-deck is the erection on each side, at about the centre of the vessel, of a large outside platform, on which several of the sick can be placed, either in beds or chairs. These platforms are protected by a sort of fine wire fencing, and might fairly be the "birdcage-walk."

Our description of the main-deck is, we believe, complete when we mention that several of Crease's patent filters (which were described in the *Lancet* some months ago) are placed here, as in many other parts of the ship, as well as a very complete set of fire-pumps.

We may now descend to the lower or gun deck. Commencing aft, we find that the port side of the old gun-room is fitted with seats, lockers, and berths for the use of the hospital sergeants; that accommodation is provided for sixty convalescents between the sergeants' quarters and the chain-lockers, and that the convalescents will all sleep in ordinary swing cots, hung as usual from beam-hooks, and will have mess-tables fixed athwartships, as in an ordinary transport.

A special system of ventilation is adopted on this and on the orlop deck which is worthy of particular attention. Two strakes of the main deck flooring have been taken out on each side, fore and aft, for 180 feet. In this space a hollow iron trunk has been inserted, which communicates by means of numerous and large circular apertures with the deck below, *i.e.*, the deck to be ventilated.* Each trunk again communicates with transverse shafts, which latter conduct the foul air into the hollow iron masts and the funnel casing, and so up into the external air.† The plan adopted is, in fact, a modification of Dr. Edmond's system, steam-jets not being used.

The berths for the crew are on the gun deck from the mainmast forward, and bulk-heads, with lock-up doors, will separate them entirely from the convalescents and from all hospital arrangements. The down-cast ventilating arrangements are precisely similar to those on the main deck, there being five tubes, each of from 12 inches to 16 inches in

account of the glare in the tropics, suggesting that it should be toned down. His opinion was confirmed by experience.

* So successful was this that the air from the holds passing up through the skin was drawn into the Officers' cabins through the holes over the shelf-piece, and being charged with gas from the bilge-water, was both disagreeable and unwholesome. It became necessary to allow the holes to be stopped up.

† When sail was set, the ordinary upward draught of air through the masts and on which the whole ventilation of the holds, lower and orlop decks, hospital, &c., depended was reversed; this must be remedied by providing the mast with dampers, and some fittings which will allow of the free egress of the vitiated air when sail is set, and also fittings to enable artificial ventilation to be brought into play to supplement the ordinary natural ventilation under the above circumstances.—A. P. R.

diameter, as well as sixteen square ports and ten scuttles, each of 8 inches in diameter.

Lower still to the orlop deck, below the water line, and in the region of perpetual gloom, albeit where nearly all our naval Officers used to have, and many still have, their quarters at sea. The orlop deck of this ship will be occupied by the hospital issue room, the medical comforts, the wine stores both for hospital and saloon, the hospital medical store, the utensil store, the wholesale drug store, and the troop and hospital bedding store. Some of the Non-commissioned Officers and crew are berthed here, and the system of ventilation adopted is similar to that on the gun deck, a collecting trunk being inserted for up-cast duty, and four large tubes for the down-cast work.

We penetrated deeper still, and found the starboard shell-room converted into an ice store, the after magazine into an extra wine store, and the "landing-room" of the magazine into a linen store. And now about the bilge. We descended to the "end of all things"—i.e., the keelson, along and at the sides of which Portland cement has been applied. The whole was then lime-washed, and afterwards washed with a solution of carbolic acid. At the time of our visit a sponge might have been drawn along the keelson without taking up any appreciable amount of water.

Returning to daylight and to the upper deck, we have yet to notice the arrangements of the galleys (or cook-houses). They are placed between the fore- and main-masts, just abaft the funnel and over the old engine-hatch. The hospital galley is very spacious and complete; there is a washhouse and a bread-room adjoining the galley, and the poultry will be carried above, in the place usually occupied in merchant ships by the "long" boat. Salt and fresh water are laid on here, as everywhere; and Crease's filters pervade this deck as well as those below. The galley is also provided with special scuppers, so that no bucket work or slopping of any kind about the deck will be necessary.

It is almost a work of supererogation to record that the ship is amply provided with Massey's, Downton's, and other pumps in great number and variety, for pumping bilge, washing decks, flushing closets, and extinguishing fire. The ship will be provided with double awnings, fore and aft, two feet apart; but side flaps will not be used. These awnings will cover the vessel from stem to stern, subdivided, however, to admit of the ventilating tubes communicating with the external air. The aft part of the poop, beneath the awning, is to be used, in case of need for infectious diseases, and provided with a screen, ropes, and sentry. It is intended to utilise the upper deck for hospital purposes if required.

On a second visit, three days before the "Victor Emanuel" sailed, we descended to the main or hospital deck by the hatchway just abaft the mainmast, constructed for sending below the sick and wounded, and found the cots all slung fore and aft in three rows on each side, and a specially convenient hand-rope over each cot. Here and there were cots for particular cases, with rests and fixed sides. All have small head table boards, which can be shipped and unshipped at pleasure. Many of the canvas screens were fixed to the rods above, but rolled up, and have scalloped tops, so as, when lowered, to impede

ventilation as little as possible. This deck is also furnished with six of Messrs. Deane and Co.'s 16-inch American stoves, which may be useful when the vessel is passing through cold latitudes. The deck will be lighted by twenty-six Palmer's candle lamps, hung clear of the gangways. All are so placed that their glare will not fall upon the eyes of the patients immediately below, and they will be unshipped during the day. The closets have been ventilated with 14-inch pipes, which will act as up-casts, and have goose-necks above the upper decks. The floors immediately below the closets have been coated with cement, so that all accumulation of damp deposit external to the apparatus may be prevented. And, finally, slides have been provided for the perforated spaces near the floor, to be used if required.

The night-stools on the convalescent deck are only intended to be used under exceptional circumstances, as for instance, for convalescents from dysentery, and as water-closets would have been most objectionable on this deck, night-stools had to be furnished; but they are intended as *night*-, and not day-stools. The "night-stool" is a portable water-closet, with a well for a disinfecting liquid, a pump, and a means (fish-tail) for discharging this liquid on the excreta as the pan is depressed. The receptacle is of metal, and fitted so as to be sealed when covered. With the efficient medical staff on board and an abundance of well-trained subordinates, it is believed that the objections to these hospital utensils may be overcome, or, at any rate, reduced to a minimum.

As the ventilation of the Officers' sick quarters on this deck aft appeared to be defective, perforated zinc spaces have been cut, opening into the screw well, which will serve as very efficient up-casts, if the slides with which they are also furnished are seldom or, as we hope, never used.* This part of the deck is abundantly provided with seats, shelves, and various other conveniences.

We omitted in the former description to explain that the "birdcage-walk" on either side of the vessel is got at very easily, inasmuch as one of the ports has been cut to form an exit nearly six feet high, which might be used, as we believe, more conveniently for the entry of helpless cases than the hatchway specially constructed for that purpose. The utmost care appears to have been expended on the little but very important items of hospital arrangements. The cots are numbered on the beams above. There is an arrangement for lifts between the hospital and upper decks, by which the foul linen will be sent up in closed galvanised iron boxes, and, if necessary, plunged at once into boiling water. These lifts will also be used for removing the hospital utensils, &c., and so greatly economise labour and prevent dirt about the decks.† The water tanks here and everywhere are conspicuously lettered, so that "what we shall drink" need be no mystery to any one on board, and the way to obtain it is equally patent and simple. The down-cast ventilators are all furnished with deep saucers, to provide against sudden squalls. The fire hose and buckets are all snugly but very conspicuously hung. The dispensary, which opens on

* These had to be closed, the smell was so offensive, and other means were adopted.

† These lifts were never used; it was found preferable to carry up aloft.

to both sides of the deck, is in good sea-going trim. And, finally, the deck has been lined throughout, above and below, from stem to stern, with a coat of white paint.

Having finished with the hospital deck, we took a last turn below. Here, on the gun deck, the ventilation had been considerably improved by the introduction of a special down-cast and up-cast into a sort of cul-de-sac near the chain lockers immediately abaft the engine-hatch, and as the mainmast is close at hand, this up-cast runs into it about two feet above the deck. We omitted to mention, in connection with the ventilating arrangements of this deck, that there are two ports at the stern, and two at the bows.

One of Messrs. Siebe and West's ice-making machines* has been fitted on board. (It is an ether machine.) This machine, which has an engine of its own, was, at the time of our visit, in full working order, and will manufacture nearly half-a-ton a day, in 48-inch slabs, which will be stored in the ice-room close at hand.

The laundry staff were in full swing with Messrs. Bradford's washing apparatus; and the blue-jackets and marines had, apparently with very favourable results, tested the culinary properties of the galley.

Proceeding forward on the upper deck, there is little but praise to bestow. Tanks, galleys, washing apparatus, slop and washing rooms, are all excellently arranged, as are also the urinals and latrines, although there appear to be too few of the former, for it should be a cardinal point in all vessels not to allow any person whatever to use the closets below if able to come on deck. The lifts between this deck and the hospital proper will be very valuable for the purposes above described.

And now for the hospital deck, the ventilating arrangements of which are, of course, superlatively important. We enumerated in our last report the number and variety of natural and artificial sources of ventilation adopted as to this deck, all of which, according to our opinion, can be constantly available except in very heavy weather indeed, when it might be necessary to close the ports, and to lower the up-cast ridge coverings. And, as we take it, the designers of this hospital have taken advantage of every available means for inducing constant air movement between decks, although it is almost as difficult a matter to compass when the outer atmosphere is nearly stagnant, and the thermometer at 90°, as to supply the crew of the "Devastation"

* It was found that 480 lbs. of ice were made per day, at a cost of 2d. per lb., a very small price to pay for such an essential in cases of fever, &c. The annual consumption of fuel, for condensing and all other purposes at anchor, was 3½ tons per day. The result of experience proved that it would have been better to have had the ice-machine on deck in place of the lavatory. The hot water from the condenser of the ice-machine would then, instead of running below, and being, as was the case, the fruitful cause of bad smells, have been discharged overboard instead: by its action on the wood, a "very bad" smell was created in the bilge, although several of the crew were continually employed cleaning it. The unavoidable hurry at the last, prevented this being remedied before the ship left England. It may be well to state, as a matter of comparison, that in England ice has lately been purchased wholesale in London at the rate of three shillings per cwt.; but the retail price is of course higher.—A. P. R.

with fresh air when their hatches are down, and their ship set in order of battle. It is perhaps hypercritical to add that one or two fans with corresponding shafts, similar to those fitted to the monitors, might have been put into this ship for emergent purposes. But with all the admirable arrangements already provided, it is necessary to look below, as well as above, so as to keep the "nethermost" parts of the ship as free from bilge and foul air as they were when the vessel sailed. This is, perhaps, less thought of now than formerly, since iron has superseded wood afloat.

Generally speaking, the extent to which the ventilation has been placed under control has been advisedly adopted, in consequence of the confidence with which it was felt that this might be left to the discretion of the medical officers on board.

The number of closets is large;* for, as will be recollected, there are no less than four for the Officers and eighteen for the men. The difficulty of keeping clean closets, "heads," and latrines on board ship can hardly be estimated by any who have not served in a vessel carrying invalids, troops, or emigrants; and, as is known by experiences gleaned in the "Dreadnought" and other smaller institutions of the same class, stationary floating hospitals are no exception to this remark. Under ordinary circumstances, several of these closets can be closed up (*e.g.*, one of each set), for it is probable that those of the sick who are well enough to use them, and not well enough to go on deck, will be very small, bed-pans in many cases being absolutely necessary.

The dispensary is very well lighted, and will serve also as an operating room in case of need.

We believe that the authorities have exercised a wise discretion in omitting in their arrangements a mortuary and *post-mortem* room. Death in the tropics, and especially aboard ship, is followed so speedily by burial, that all necessary arrangements can be readily made by utilising the canvas screen above mentioned, and so securing a requisite degree of isolation.†

Dr. Marston, the Officer on the Staff of the Director-General at Whitehall, was the Officer to whom was specially entrusted the responsibility of supervising the medical and hygienic arrangements of the ship, and proved himself fully equal to the occasion.

It is very important not only that the plans and specifications of the fittings be preserved, but a working model made. This country has never, and probably no other country has ever, sent out a floating hospital so carefully planned. It is of the greatest consequence that an exact record should be preserved for future guidance, as it seems probable such vessels will be largely employed in all future wars.

Our Government has been accused of parsimony, but in this instance no charge of that kind can be brought against it. Nothing more could have been done for our troops, and all concerned in the fitting out of the ship deserve the greatest credit for their exertions.

The above description, chiefly from the pages of the *Lancet*, of the fittings of the "Victor Emanuel," is, I believe, accurate and exhaustive.

On the 13th of February of this year, Dr. Macdonald read a paper

* One in each batch was found sufficient.

† A mortuary and *post-mortem* room was fitted on the upper deck.

here, at my suggestion, on the "ventilation of ships, especially low-freeboard and hospital ships." I had in my mind when I suggested that a paper on that subject be read, that the return of the "Victor Emanuel" would afford an opportunity for recording her fittings, and for a discussion on Dr. Macdonald's paper; that opportunity will be afforded this afternoon. The number of the *Journal** in which that paper appears has only been issued within the last few days, and has probably not been read by more than a few of the members; it is well deserving of the attention of the authorities of any country possessing a navy, and of every English Naval Officer. There is in it a great deal of information, but what struck me most forcibly was that there is evidently as yet no final agreement in opinion on the part of those who have made the ventilation of ships their study, as to what is the best way of effecting it (see p. 137), where Dr. Macdonald informs us that "good authorities are still divided in opinion on the subject," and at page 141, where he informs us that "the magazines in most ships are ventilated on a system which obviously demands a radical change;" again at page 143, where he speaks of "currents of impure air constantly rolling into cabins of Officers and the sleeping places of the men, to mingle with air already contaminated with the products of respiration, combustion, &c., and for the escape of which no rational provision is provided;" again at page 146, after describing the system adopted in war ships, "Devastation," "Glatton," &c., as the "plenum" system, he says that "there is no special provision made in them for the removal of vitiated air in either of the ships referred to, after its more or less complete diffusion, it must find its escape as best it may;" again, at page 147, referring to low freeboard vessels, he says,—"The whole subject is indeed so new, and involving as it does considerations upon which good authorities are yet at issue, that I would approach with caution any criticism as to the detail of the system carried out in the ventilation of our *low freeboard* ships.

Dr. Macdonald concludes by stating his conviction that the "system of extraction would be found to be much more satisfactory than the plenum system, as applied to the ventilation of our *low freeboard* ships."

The Chairman, Admiral Sir R. S. Robinson, the late Controller, than whom we could find no one who has enjoyed better opportunities of forming an opinion, wound up his concluding observations with these words:—

"For my own part, I believe the true principle of ventilating ships as well as buildings is the principle of *extraction*, and you will really do very little good unless you thoroughly and completely adopt the system of getting rid of the foul air, by artificial means, if you please, and leaving the supply of pure and fresh air to natural means, which will be easily accomplished."

Now as all our *low freeboard* ironclads are ventilated, not on the "exhaust" principle so strongly recommended by Sir R. S. Robinson and Dr. Macdonald, but on the "plenum" principle, I think I may safely say that this very important question has reached a stage when some

* Vol. xviii, No. 76.

solution should be found, and for this purpose some further experiments tried, with the view of enabling us to see our way. The fitting of the "Victor Emanuel" as an hospital ship is such an experiment as regards hospital ships, and it may help us towards improving our present method of ventilating our low freeboard ironclads.

It is not an easy problem; it is now in ships of the latest construction—low freeboard ships—much more difficult than it used to be, and especially in low freeboard ironclads, as "Devastation," "Hotspur," &c., without side ports or scuttles. I will, in speaking of ventilation of ships, adopt the names used by Dr. Macdonald, and speak of "*natural*" methods of ventilation and "*artificial*" methods of ventilation, and divide these again into "*plenum*" and "*exhaust*" methods.

By "*natural*" methods I mean those in which, after expense has been incurred in fittings, the ventilation is left to nature, to currents of air created by the laws of nature, without any assistance that costs money—such as fans driven by machinery, either to force in air or abstract it, or suction created by the action of furnaces heating and rarefying the air.

Arrangements for *natural* ventilation in a room consist, as a general rule, in affording means for the exit of the vitiated air at the top of the room, and for the ingress of fresh air lower down, thus setting up a circulation of air. This system is exemplified on board ship by the old-fashioned wind sail, and as no special means existed for facilitating the escape of the vitiated air, this system may be called the "*natural plenum*" system. There is also the "*natural exhaust*" system, in which the fittings for facilitating the escape of the vitiated air are the only or the prominent features. This is exemplified in the "Victor Emanuel," where, although there are air tubes and cowls, the three masts and funnel for the "*exhaust*" are the prominent features of the system. As regards the funnel, the current of air passing through it is no doubt accelerated by the heat from the furnaces, and to this extent the system adopted in her is the "*artificial exhaust*."

The *artificial* means of ventilation may also be divided into those that force in the fresh air, the "*plenum*" system, as described by Dr. Macdonald, and the "*exhaust*" system, which abstracts the vitiated air through pipes, there being tubes and cowls for the ingress of fresh air. This was the system advocated by Dr. Edmonds, who used jets of steam to aid the exhaust. For a detailed account of Dr. Edmonds' system, as adopted in our Indian troop ships, see end of paper.

When I visited the "Hotspur" some time since, I found that the *artificial* "*plenum*" system had been adopted. It is to be found, I believe, in all our low freeboard ironclads; and may perhaps be the only possible system in such vessels—as there can be no opening to the outer air except amidships—and the furnaces have therefore to be relied upon to create an exhaust.

The "*artificial exhaust*" system has been largely adopted in France, in the ventilation of prisons, and notably at the new opera house, also in cattle ships, and, it is said, with success. I will refer later on, to this method as adopted in France.

A thoroughly efficient "*natural*" means of ventilation would be a

great boon, because after the first cost it would be inexpensive and automatic; but as yet it has not been found that we can rely with certainty on the action of natural causes alone to ensure that the currents of air shall always flow in the required direction at the required speed, and this speed easily controllable. The current sometimes reverses its direction. This took place in the "Victor Emanuel" when sail was set, and the air descended through the iron masts instead of ascending, as was intended, and had always previously been the case.

The "Victor Emanuel" is ventilated, I have stated, on the "natural exhaust" system, the exhaust being for the main deck through a long slit in the upper deck, 80 feet by 12 inches; from the lower deck and orlop deck through horizontal pipes into the lower masts; from the bilges and holds partly through the holes in the skin, over the shelf pieces into the Officers' cabins and orlop deck.

This latter was an oversight; it caused great annoyance, and was corrected by these holes being allowed to be hermetically closed. It was no doubt owing to the thorough ventilation of the lower and main decks up the masts that the draught from the bilge through the skin into the Officers' cabins was caused.

An outlet for the vitiated air from the bilge, after ascending through the skin, was made in the "Victor Emanuel's" upper works, outside, where various jalousied openings may be seen; but the vitiated air in the bilge frequently preferred, as I have already stated, to escape through the openings over the shelf-piece into the Officers' cabins, yielding to the solicitation of the reduced pressure of the air on the orlop deck and on the lower deck, owing to the vent up the centres of the masts.

I ascertained by letter from the French Minister of Marine that "artificial" ventilation on the "exhaust" principle is being tried in a horse trooper, the result not known yet. I have since learned that some of our cattle steamers are successfully ventilated on the "artificial exhaust" system. All the four methods, two "natural" and two "artificial," have therefore been tried on board ship, with various success.

Plans of Ventilation.

I. Natural.	{	1. Plenum.. Example: The old-fashioned wind sail.
		2. Exhaust.. "Victor Emanuel" primarily; but she combines also 1 and 4.
II. Artificial	{	3. Plenum.. Our low freeboard ironclads. The House of Commons.
		4. Exhaust.. Some cattle steamers, a French cavalry trooper, and numerous large public buildings in France.
- III. Combinations of the above.

There are two varieties of the "artificial exhaust," viz.:—

(a.) Exhaust, upwards. Example, the old House of Commons. The air is now introduced through the carpet; refrigerates the legs of the Members, and carries the dust from their boots to their mouths and nostrils. These must be very doubtful improvements.

(b.) Exhaust, downwards. Example, French public buildings. The natural process is reversed, and vitiated air is sucked downwards; fresh air admitted above. This plan is most generally approved of, and would apparently be well suited for steamers' cabins and for hospitals, as the vitiated air, instead of rising from the beds to the respiratory organs of the medical attendants, the nurses, and the other patients, would be instantly drawn downwards to the floor, and find vents through the openings provided for the purpose in the skirting board.

Wooden ships and iron ships require of course different treatment. In the former we have a hollow space between the two skins of the ship, purposely left open to secure ventilation and preserve the wood from dry rot. In the latter, except when there is backing to armour, we have nothing but the thin iron side of $\frac{5}{8}$ or $\frac{7}{8}$ of an inch between us and the water. In the former the necessity of ventilating this space between the two skins obliges us, while seeing to the ventilation of the decks, not to overlook the ventilating of the space; in the latter the question is simplified.

Having read to you the statement in detail of the fittings of the "Victor Emanuel," it is only right to state that the medical Officers on board considered that her sanitary condition was irreproachable during her short stay on the coast—there were no cases of hospital fever, or anything to show that she was otherwise than in a satisfactory condition. The percentage of sick among her crew was not greater than in ships on the home station; diarrhoea attacked one-third of the crew at one time, but yielded to change of diet. No leave was given, which accounted in great measure for the good health of her crew, but made it difficult to understand how it came to pass that remittent fever and dysentery attacked a few of the ship's company (four), cause not ascertained. Great care was taken not to expose the men to the sun; rest was enforced for $2\frac{1}{2}$ hours in the middle of the day; the latrines and bilges were cleansed with carbolic acid solution. On the other hand, it must be remembered that she was only there for a few weeks in the most favourable season; that the thermometer never stood in the shade on board at more than 87° F.; and that she was rarely full of sick.*

The useful question to ask is, have we drawn from the experience of the "Victor Emanuel" any useful lesson? Should we, if we were fitting out another hospital ship, or refitting the "Victor Emanuel" for another term of hospital service, make any, and, if any, what change, or was she in every way perfect?

The old wooden line of battle ships are admirably suited for hospital ships, and for many years to come we shall probably have a few left available for the purpose. When they are all broken up, and we have

* The "Victor Emanuel" has accommodated, since her departure, a total of 565 invalids, of whom three only died on board before she sailed for England. Of this number, 104 were discharged fit for duty, 125 were transferred to other ships, or to join their respective corps, 165 were invalided home, 167, of whom four were Officers, remained in the ship when she sailed for England. Of these only 31 were admitted into hospital when she arrived in England. Three Officers and seven men died during the voyage.

to build of *iron*, high, roomy hospital ships, it will be time enough to speculate upon how best to ventilate *them*.

The pest-house of a neglected ship is the hold; into that receptacle, all filth, if there is any, subsides, unless great care is taken to prevent it; and all water from decayed parts of the ship runs and stagnates, unless means are constantly taken to remove it; and upon the state of the hold and bilges, no doubt depends, to a great extent, the health of the crew.

It is after clearing the hold of a ship in the tropics that even the well-seasoned negro not unfrequently succumbs to the attack of yellow fever. It is the hold of the hospital ship, as of every other ship, that has to be watched. How may this best be done? I believe that a plan I adopted in every ship I have commanded is the best way of ventilating a hold; viz., to separate the contents of each hold and provision room in such a way that there is a well-defined continuous passage through the centre of the hold fore and aft (see Fig. 6). This was effected in the spirit-room, in the provision-room, and in the store-room, by two rows of stanchions with battens, as in a magazine; the tanks were also separated amidships, so that I could walk at any time along the keelson, except of course where the machine and boilers and magazine were. The keelson throughout the whole length of the ship, with this exception, was exposed to view. This passage was about 3 feet broad, just the breadth of a cask, so as only to lessen the stowage very slightly.

On first starting from harbour, full of provisions, this passage was filled up with casks, and would of course be the first cleared,—probably in a fortnight or three weeks,—after which we reached the keelson. It was one of the duties of the Surgeon to walk along the keelson of the ship, before divisions every morning, and report the ship to me as perfectly sweet and clean. In screw ships, this access to the keelson is effectually secured *abaft the engine* by the screw alley, but the above plan may be adopted with benefit *before the engine*. I copied this plan of fitting and stowing the holds from Her Majesty's ship "*Vesuvius*," Commander Herbert Austen, in 1848, and have often brought it under the notice of the authorities, hoping that it might be universally adopted.*

In a ship with iron masts, the masts, if connected with horizontal tubes in the orlop deck, as in the main and lower decks of the "*Victor Emanuel*," would carry off upwards any air that might accumulate in the bilges or in these central passages in the holds under the orlop deck. I have no doubt that all connection between the bilges and the skin should be closed, by order from the authorities (see the stop in Fig. 4); we should then never hear again of these complaints which culminated in the "*Victor Emanuel*" in orders from the captain to close the ventilating holes over the *shelf pieces*.

We may now consider the ventilation of the orlop deck and its

* I showed this plan of fitting and stowing holds to Admiral Sir W. Mends, Director-General of Transports, yesterday. It was quite new to him, and I was gratified to find that he highly approved of it. I have no doubt he will introduce it whenever it may be in his power to do so.

skin, the lower deck and its skin, the main deck and its skin, and of course in a three-decker the middle deck and its skin.

Description of Drawings.

I am much indebted to the courtesy of Admiral Stewart, the Controller, for deck and section drawings of the "Victor Emanuel," showing her fittings. I have had them enlarged (see drawings 1 and 2). No. 3 is an enlargement of the drawing given in Dr. Macdonald's paper. No. 4 has the additional fittings which I have suggested. I am under the impression that in any vessel having *iron* masts capable of being fitted for ventilating purposes, Dr. Macdonald would prefer that the vitiated air pass directly to the masts and not up the ship's skin, as in his drawings; his method would be very applicable to ships with wooden masts, but there must be two sets of cowls and tubes, one for the up and the other for the down take.

If we effectually cut off all connection through the skin of the ship with the holds and the bilge water, we might venture, perhaps, to ventilate through the skin *downwards*, reversing, therefore, the arrows in Dr. Macdonald's drawing, and taking the fresh air in, through slits, such as those on the bulwarks outside of the "Victor Emanuel," and inhaling it downwards through the skin, through the holes, over the shelf-pieces, and into the decks and cabins; but we should be exposed to this possibility, viz., that if the upward draught on, say the orlop deck, and into the mast, were stopped, then the current at *c* might be reversed (see dotted line), and the vitiated air from the orlop deck might be drawn, first through *c* and, then at *b*, into the lower deck.

It has been thought better, therefore, to admit the fresh air to each deck and hold by separate air tubes (with cowls and cups) from the upper deck, as is done in the "Victor Emanuel," for main and lower deck; each deck will then have what Dr. Macdonald desiderates independent ventilation, provided that the masts can be built or altered as I now propose. The masts should have an interior diaphragm of light galvanised iron, in this form, thus creating in each mast three ventilating chimneys, independent of one another (see drawing No. 5). The three masts would afford nine chimneys, none too many, especially if the vessel is divided into compartments.

In the sketch, the arrows *d*, *e*, *f* show the exit of air from the holds up the masts, and *m*, *n*, *o*, and *p* show the tubes for bringing air down from the upper deck. There should be balanced valves in the masts, or some other means should be taken to prevent down draught when under sail.

The existing horizontal exhaust tubes for the lower and orlop deck, the down-takes on the main and lower, the openings into the masts and funnel, would all remain the same as at present.

If it were thought necessary to increase the natural ventilation by artificial means, and provide beforehand for supplementing the natural ventilation, which appears to me to be of great importance in an hospital ship for use in the tropics, it might be effected by connecting each uptake with a chamber having fans or screws, to be driven by a doukey-engine, or by adopting Dr. Edmonds' plan, with steam jets.

Either of these plans would, when in gear, abstract the air from the hold or decks with increased rapidity.

I may perhaps be allowed to state in a few words how the French have lately ventilated the new Opera House, also a large prison for 1,000 persons. I was a juror on Heat, Light, and Ventilation at the Great Exhibition in France in 1866, and I studied the various systems then in vogue, for the French had, and probably still have, numerous ventilating professors. Ventilation is a profession in France. M. Hamlin-court was the professor, most approved of by us. His system was "artificial exhaustion" of the vitiated air, the system approved of by Sir R. S. Robinson and Dr. Macdonald; he abstracted the vitiated air near the floor of each cell—there were 500 cells in the prison I visited—he let in the fresh air through a hole about 8 feet above the floor; the exit was through the hole in a privy. Each cell had its separate privy, down which the air of the cell was drawn. M. Hamlin-court was bound by his contract to empty the cell of its air a fixed number of times an hour; a steam engine in the cellar was constantly at work, and there was a very tall chimney to carry off the vitiated air. With such a system continuously at work, it is evident that the sanitary rules which insists on there being 600 to 1,200 cubic feet of air-space to each prisoner and to each boy in the dormitory of a school would be quite unnecessary. In a diving-bell the man has probably not more than 60 cubic feet of air around him, but the constant change of air answers the same purpose. I would much rather pass a night in a room which was 6 feet cube, and containing therefore only 216 cubic feet of air if the air were constantly but gradually changed, than in a room containing 2,000 cubic feet of air in which very slow or no change took place.

Before the "Victor Emanuel" is again employed as a hospital ship, her fittings will no doubt be carefully considered, and be altered if necessary. She has been a costly* but a most invaluable and, in the main, a thoroughly successful experimental ship. The points requiring attention are, in my opinion—

1. Vitiated bilge air to be prevented from having access through the skin to the Officers' cabins, the orlop, lower and main deck.
2. Orlop deck and holds to be supplied with fresh air by cowed tubes from the upper deck, in addition to the supply already given to the main and lower decks.
3. Holds to be fitted with stanchions and battens for establishing a clear passage to the keelson throughout the ship when possible.
4. The upper part of the holds to be ventilated as the lower and orlop deck are already ventilated, by horizontal tubes leading into the masts.
5. Arrangements to be made for supplementing the "natural" system of ventilation by "artificial" means.
6. Arrangements for preventing a down draught through the masts, when sail is set.
7. Arrangements to be made by means of dampers in the masts for stopping the ventilation instantly in case of fire and to be under

* Expense incurred would probably be—Labour, about £7,000; materials, £7,000; and time occupied, 21 weeks.

- command from the upper deck, as also the supply of water to the pumps. At present the ventilation can only be stopped by sending a man to the lower-mast head to stuff a hammock or something equally suitable into the masts.
8. The space in the masts to be subdivided into three or four, thus each deck and hold would have its separate vertical chimney.
 9. That as it is the tendency of most screw vessels to settle down by the stern, as coal and provisions are consumed; and all water in the ship therefore finds its way aft, the suction of the bilge pump should be lengthened sufficiently before the vessel leaves the dockyard in anticipation of this change of trim. The "Victor Emanuel" ventilation suffered for some time until the suction pipe of this pump was considerably lengthened.
 10. The ventilation of screw alley should be improved by providing an escape into the mizenmast, and by cutting air holes in the roof of screw alley; also by having two air tubes (with cowls) carried from its after end to the upper deck, one for *down*, the other for *up-draught*; the holes open in the screw aperture which now distribute the foul air on the main deck and in the poop cabins, might then be closed.
 11. All bulkheads of cabins and store-rooms fore and aft should have ventilating openings at top and bottom.
 12. The condensing rooms require additional ventilation; this will be best obtained by direct tube connection with upper decks.

I have now presented my crude ideas on this subject to you, and I hope the discussion to follow may be useful. If it does nothing else, it will awaken attention among the Officers afloat, and when in some future war, ships on distant stations, have to be promptly prepared as hospitals, and are perfectly fitted and successfully ventilated, the Officer who superintends and directs the arrangements, will perhaps, although he may have forgotten the fact, have learnt his first lesson in ship-ventilation from the valuable paper by Dr. Macdonald, from the report of the *Lancet's* Commissioner, from the discussion this afternoon, and from the record in our *Journal* of the "Victor Emanuel's" fittings. The points for discussion, I submit, are, first, the general principles of ventilation in their application to ships; and, secondly, what, if any, are the features in the system adopted in the "Victor Emanuel" which are susceptible of improvement. I have suggested twelve.

APPENDIX.

By the courtesy of Admiral Sir W. Mends, Director-General of the Transport Department, I have been allowed to append the following official account of the ventilation of Her Majesty's Indian troop ships:—

"The plans for the ventilation of Her Majesty's Indian troop ships having been prepared chiefly in accordance with the principles known as Dr. Edmonds' system of ventilation, some explanation is considered necessary as to its general features and management, in order that those entrusted with the charge of the sanitary arrangements may understand its action and make it available—in conjunction with the

other means provided—for thoroughly ventilating all parts of the ship, especially those which will be occupied by troops or their families.

“Ordinary tube and cowl ventilators are placed wherever their action is thought desirable and space will permit. Where they are in connexion with this system of ventilation, their action is distributed through all its ramifications in the close parts of the ship. These main ventilators are five in number.

“The first and second pass up from the lower deck through the fore-castle near the side of the ship. The ventilating shafts with which they are in communication are placed on each side in the angle formed by the lower deck and the ship’s side: one branch passes forward as far as the prisons; the other extends aft along the fore troop deck, ventilating these parts by the air-shoots which join them and terminate in the perforated zinc openings close under the beams.

“These two ventilators are also connected with the deck air-channels over the women’s compartment, the heated air from which will pass into them and up the ventilators through the circular apertures opening into it overhead.

“The third and fourth main ventilators are also lateral, and pass up near the commencement of the poop. They pass down into the after cockpit to assist in its ventilation, and of the cabins which are on each side.

“The fifth is central, placed a short distance before the mizen-mast, and passes through one of the ventilating hatches. Its action is distributed to the lower cabins, and it is also connected with the after deck-air-channels, which ventilate the central cabins of the lower saloon, through the circular apertures in the ceiling overhead. These deck-air-channels are a substitution of a longitudinal air space for the width of about a foot of the deck planks, covered in above with thick plate iron, and below with thin sheet iron, in which are the apertures. These act directly on the foul air which tends to collect between the beams and which is heated by the lights, respiration, &c.

“All these main ventilators are designed to act by the wind alone, when this is sufficient. By turning the cowls to windward fresh air will be diffused equally through their branch air-shoots, and even in calms, when the ship is going fast through the water, much air will be forced below by their action; but in hot close weather, when a more powerful ventilation is necessary, provision is made for it by means of steam jets. The circular perforated ring which may be seen in each of these ventilators is in communication with the auxiliary and main boiler of the engines. When the steam is turned on, it escapes with great force through the minute apertures of the jet-ring, and emerging from the cowl—which must be turned to leeward—carries up with it a strong current of air, which is drawn from all the ramifications of the longitudinal air-shafts and deck-channels with which the main ventilators are connected. This effect may be observed by holding the flame of a candle to any of the air openings.

“This ventilating action will be found most useful at night, when it will carry off much of the heated air arising from so many persons sleeping crowded together in a confined space, and also at meal times.

“As, owing to the length of the steam pipes connecting the ventila-

tors with the boiler, some steam must be condensed before it escapes upwards, the steam should be first turned into the pipes alone for a few minutes, and the condensed water blown through the extreme end before turning the cock which admits it into each ventilator.

"The supplemental means of ventilation on Dr. Edmonds' plans are, 1st, double-acting ventilating shafts; and, 2nd, the gunwale ventilators.

"The double-acting ventilating shafts are divided vertically into four or six divisions leading down to the lower deck. These divisions open outwardly above the deck; and one or more of them will face the wind from whatever quarter it blows, and will introduce fresh air, while the remainder will be to leeward, and by the exhaustive action of the wind, added to the upward tendency of the foul air below, its escape will be aided through these latter. Thus they have a double ventilating action, and will exert a powerful effect in renewing and purifying the atmosphere of the lower deck. The outlets below are so arranged that the influx and efflux currents will not interfere with each other. Covering doors are provided, to close the windward openings in wet or stormy weather. A half-round canvas screen may be substituted should these be carried away.

"The revolving gunwale ventilators, placed at short intervals along each side of the ship for the whole length of the gunwale, are designed to ventilate the frame of the ship and the parts into which they communicate by grated openings along the side of the main deck and cabins. Each water-closet has one of these over it, which must be used to draw up foul air, the open part of the tube above the gunwale turned *from* the wind. The others may be used either to introduce fresh air or to draw up foul air, as may be preferred. They act more strongly with the open part turned *to* the wind for forcing air downward.

"When these gunwale ventilators are in the way of ropes in working the ship, or at any other time, they should be temporarily lowered; they then offer no obstructive surface, and can incur no damage.

"As a general rule, the cowls of all ventilators should be turned *from* the wind in wet, cold, or stormy weather, using them as uptakes. In hot weather, on the contrary, every means for introducing fresh air should be made available, and their cowls should be turned *to* the wind; the heated air below will then be forced up the hatchways. In calms or very light winds, when the steam jet is used, all the cowls of the other ventilators should be turned to windward, and all ports or scuttles for the admission of external air should be left open.

"HENRY EDMONDS, M.D.,

"Staff-Surgeon, R.N.

"6th June, 1867."

Orders have been issued by Sir W. Mends to the Indian troop ships, that steam jets should be turned on for ten minutes at a time, not less than twice in the first watch, three times in the middle watch, once in the morning watch between Egypt and India.

The CHAIRMAN: Gentlemen, I am sure you must have listened with as much pleasure as I have done to the very admirable and exhaustive paper just read by Admiral Ryder. The subject is, I believe, one of the most important that can be brought before this Institution. I hold that it is most right and proper that some system of ventilation should go forth to the world bearing the stamp of the authority of this Institution for the instruction of Officers in command on foreign stations, as showing the best method of utilising the means at their disposal either to meet the emergencies of war or sudden epidemics, if obliged to extemporise hospital ships. It is not necessary that I should here enlarge on the importance and the value of ventilation after the full and comprehensive manner in which it has been treated. I may state, however, that having regard to the efficiency of our fleets, I look upon the maintenance of dryness between decks as only second in importance to ventilation, for with dry decks and good ventilation you will diminish your sick-lists and raise the standard of health in our ships to a wonderful degree; and in proportion as these two agents have been at work in our ships as revealed in the statistics of the health of the Navy, so in direct ratio have you had crews healthy, and ships efficient. It will be in the recollection of the distinguished Officer on my left, Sir Henry Codrington, that upwards of ten years ago, in one of our line-of-battle ships in the Mediterranean, owing to the overcrowding of the decks and the bad ventilation, very nearly one-half the ship's company were rendered utterly inefficient, and several other line-of-battle ships were in a condition but little better, and ultimately entailed their return to England; a state of things which, in time of war, might prove very disastrous. This is one of the many incidents daily occurring. I am sure you will gladly endorse all that has been said with regard to the good effects attending a sound system of ventilation, more particularly when combined with dry decks. I shall be very happy if any gentleman will favour us with a few observations on this subject, and from the number of distinguished Naval Officers whom I see in this room, the result of their experience and observation on a subject of such vast importance to the Navy cannot fail to prove valuable, and will, I am sure, go far in support of the views brought forward so ably and lucidly by the gallant Admiral, and with which I entirely concur, and I endorse the opinions expressed on a former occasion by Sir Spencer Robinson and Dr. Macdonald.

Admiral Sir HENRY CODRINGTON, K.C.B.: Was the "Victor Emanuel" painted with zinc paint or ordinary paint, because I hold it makes a great difference in a sanitary point of view, as well as in the increase of comfort?

Admiral PAYNTER: May I ask whether these openings in the deck are intended to let the foul air up, because if so, it appears to me you are letting in the foul air from all the decks below.

Captain JASPER SELWYN, R.N.: I have had some little experience on the Coast of Africa as to the benefits of ventilation, and I must say I admire very much indeed the results which have been obtained already in the "Victor Emanuel," with her well-considered fittings. I think, as Admiral Ryder has said, these may not only be improved upon for the purposes of a hospital ship, but they may also furnish us with most useful groundwork to insure thorough ventilation in all our ships. It is quite true since we got rid in a large measure of wood in the construction of our vessels, the difficulty has been considerably diminished, because those acids and those gaseous emanations constantly produced on board a ship in the course of her service are not absorbed by the wood, and do not become so difficult to treat. I commanded two steamers at different times on the Coast of Africa, and I found in one, the "Prometheus," that it was impossible to prevent the bilges becoming saturated with grease and what I take to have been sulphuretted hydrogen, in large quantities, arising from the decomposition which always goes on between vegetable substances and the water as it comes from the condensed steam. Wherever we get absolutely pure fresh water, we get one of the most subtle solvents that is known to chemists; it will attack even iron in a mode which must be seen to be believed. In the cases to which I referred on the Coast of Africa, I was unfortunate enough in both instances to have yellow fever on board; and although in one instance I landed the whole ship's company on a well chosen island, and gave them all the appliances of ventilation which could be secured, yet so long as I had to combat the malaria of the Coast it was utterly futile to expect good results. I may mention one thing

which is known to some of the Officers who were then with me, though it is perhaps rather beside the present question—I found that at certain stages of the yellow fever, particularly those where complete exhaustion threatened to bring a fatal termination, although the fever itself had been apparently overcome, the administration of the strongest vegetable food I could get, in the form of Scotch ale, invariably induced sleep and restoration of strength, while any attempt at giving strong animal foods, in the shape of jellies or broths, invariably had evil results. Of course I leave it to the medical profession to see how far they are able to explain that. The opinion we arrived at, on consideration, was, that in certain cases and forms of disease, organisms may be propagated in animal substances, while in vegetable nutriment the same organism at least cannot be further propagated. This is a useful hint for those who will have by-and-bye to treat the constantly recurring symptoms of yellow fever on the Gold Coast. With regard to the ventilation of the ship, the only method we found successful was that of taking the men on deck, putting up a double awning, and sprinkling the outside awning constantly with water. By this means a very strong current was set up, and I got very fair results. On the Brazilian Coast I again had yellow fever on board, and as I there had a very crucial experiment showing how far the fever depends on the vicinity of the coast, I will narrate it. I commanded a large brig, and was left as Senior Officer in Rio Harbour. Having yellow fever on board, I found that the bringing of the men up from the lower deck of the brig to the awning, as before described, diminished the percentage of deaths by nearly one-half. On my being relieved by an Officer commanding a large and roomy steamer, I expressed my intention of going at once off the coast to a distance of 300 miles at least, for at that distance the land breezes lose their effect, and told him that my experience had proved to me that no less distance would suffice to materially arrest the fever. He seems, however, not to have attached much importance to what I told him. I left him, and before I reached Trinidad my fever cases were doing well, and had almost disappeared; there were no fresh cases, and those who had it before I left were doing very well. By the time we got into the river at Buenos Ayres we had no further cases. My successor, on the contrary, when he was relieved in his turn, came down along the coast. The yellow fever had appeared on board his ship about ten days after I left Rio; he proceeded down the coast, and the fever never left him till he came into Buenos Ayres. Unfortunately he died, as also two-thirds of the Officers and a large proportion of the crew. My ship was by much the worst ventilated of the two, but yet I succeeded by adopting this plan; his was the best ventilated of the two, and he failed I think by adopting the reverse plan. With regard to the difficulties which may exist as to the ventilation of ships, I conceive Admiral Ryder has very correctly stated that so much difference of opinion exists among authorities as to the employment of a plenum or a vacuum that we need not expect to see our ships more thoroughly ventilated than the House of Commons. I thoroughly agree with him in thinking the process of exhaustion by the ordinary means to be found on iron ships is by far the best. That may be supplemented by exciting a more active action of exhaust rather than by attempting to force down air, which, as a highly elastic body, has very little effect at great distances. In coal mines we find a fan forcing air has not one-twentieth of the efficiency of a fan drawing air. Our masts should have been made long ago, there is no doubt, the main means of ventilating our ships, and to divide them by diaphragms, as Admiral Ryder proposes, would materially strengthen these iron masts and enable them to be made lighter. A tube is not strong unless it has some such diaphragms, which would do a great deal of good in protecting it against certain forms of collapse. In some of our ships, where we have only one mast, such as the "Devastation," such a system of diaphragms would be most useful; but as in a great many of our ships we have as many as four masts, I think Admiral Ryder will acknowledge that we could easily manage to ventilate each deck by its own mast, and so give it the full and free ventilation which belongs to the full area of the mast. With regard to the cows and tubes connected with them, I conceive that they are to be looked at as mere iron wind-sails, which can be got up in a ship more readily sometimes than the wind-sails themselves, and more easily placed in action without unnecessary interference with the sails. With regard to the reverse current induced by the sails, that was to be expected as long as you made

your ventilating opening on the head of the mast, so exposed to a down draught, so like the top of a chimney without a cowl, and it would not be difficult to devise means by which it could be kept either out of the influence of the sails, or that it should be covered as an ordinary chimney is covered to prevent down draughts. I agree with Admiral Ryder as to the utter fallacy of expecting ventilation through the openings over the shelf-pieces in the upper part of cabins. In my experience there has been almost invariably a quarrel in wooden ships between the carpenter, who desired to keep the skin of the ship thoroughly aired, and those who did not desire foul air in their cabins. We did not like them, and we were compelled to have them. At the same time, as naval Officers, we should not forget that to attempt to leave a free communication between the upper part of the vessel for air—the bulwarks and the bilges—is not only dangerous in case of fire, unless proper means of cutting it off can be provided, but it is also dangerous in those cases where a ship heels over, and the ventilating openings become openings for the admission of water to the bottom of the ship. I hope that the subject will be still further studied, and will receive the attention which it certainly deserves from the Admiralty and the profession.

Captain the Hon. E. R. FREMANTLE, C.B., C.M.G., R.N.: It was not my intention to have taken any part in this discussion, because I did not suppose I was likely to be able to shed any very great light on this question, which is much more a medical than a naval one, viz., the ventilation of ships. But as I was obliged to be on the Gold Coast during the whole time of the last war, it may perhaps be expected that I should say a few words on this subject. As regards the "Victor Emanuel," I went on board her two or three times, but not being at Cape Coast very long after she arrived, I was not able to study the subject as fully as I should have wished, and I am very much obliged to Admiral Ryder for having brought it before the Institution. At the same time, she certainly struck me as being exceedingly well fitted in every respect, as far as I could judge from cursory observation. One thing which I heard complained of, it may be as well to draw attention to, although it may be a good deal accounted for from the peculiar nature of the service out there. It will be recollected that when Sir Garnet Wolseley first went out he took out a very large staff of Officers. The result was, there was a superabundance of Officers to white men at that particular time. The Officers accordingly, having been on the coast longer than the men, were the first to knock up, and the result was a certain amount of complaint that the "Victor Emanuel" had not been sufficiently fitted out for Officers, and had been more fitted for the men. If similar circumstances arise, and the Officers have to go out before the men do, it may be worth while to see whether this can be remedied. I will just say a few words as to the health of our ships out there. They were generally very healthy so long as they were able to move about the coast, and the men were not employed on shore. The "Druid," and "Argus," and other ships on the coast were all very healthy, so long as the men did not land. The sick list of each ship in the squadron used to average something under ten, which was very healthy for an unhealthy climate. There were very few diseases incidental to the climate at that time. When the "Rattlesnake" came up from the Cape, she was still more healthy; but then, of course, she had come from a healthy climate, and it was natural she should be healthy. Still, I think as she always had been the healthiest ship on the coast, it may be attributed very much to the extremely good system of ventilation on board that ship. After the men had been on shore some time, we always found them go down with fever. The "Druid" was the first ship that left the coast; her sick-list got up to 50. Her marines and seamen had been on shore, and she left for Ascension, and came back with her ship's company partially restored. The "Barracouta" was also very healthy a great part of the time, but when we were afterwards engaged very much at Essaman, Abracrampa, &c., the men marching up the country, especially very hard marches in the heat of the day, two of which we had, our ship's company began to go down, and I was horrified to find we had to discharge 25 men to the "Simoom" in one day. The men went down very rapidly; I fondly hoped it would have been arrested, but it was not so; we had shortly afterwards to leave the coast with something over 40 on the sick list. I had the fever myself; and although it was not of a very dangerous character, still there it was; it was increas-

ing day by day. We left the coast, went round to St. Helena and Ascension, and came back in six weeks, with only about eight on the sick list. We succeeded afterwards in keeping our sick list down tolerably, although, when we had hard work in the sun, the sickness again increased. I should also mention, that when our sickness increased in that considerable amount, not only had our men been on shore some period of time, but those who remained on board the ships had been employed by day and by night in coaling, clearing transports, and all that sort of work, which is very trying. Every medical man will no doubt agree with me that in that climate we always find any excessive exertion likely to produce fever, dysentery, or some other climatic effect. Of course we are all very careful to attend to the cleanliness of the bilges; that is a thing that by this time we all understand on board Her Majesty's ships. I am happy to say that on board my ship I adopted the plan Admiral Ryder has mentioned; it certainly was not my own idea, but it was suggested to me, and was immediately adopted. I think it would be a very good thing if it were adopted in all Her Majesty's ships. In our case, we put up capstan-bars on each side, and so were able to make a centre compartment, and to keep that cleared, and the work of clearing the hold was not the great undertaking it very often is. I always made it a point on Sundays to go round with the doctor, and to have a tumblerful of water out of the bilge. We generally found it was very sweet; and although the ship which I commanded (the "Barracouta") had had the credit of having very bad bilges on former commissions, yet we succeeded on the coast in escaping altogether any yellow fever, the fevers we had being unmistakably due to excessive exposure, and not to anything else. While on the subject of ventilation, I may state that I always had extra wind-sails; I found the ship with three wind-sails, and increased them to six. We found it very hot on the lower deck when we were condensing, and as we were obliged to condense frequently, all the water we drunk on that coast being condensed water, it was absolutely necessary to improve the ventilation of the after part of the lower deck. The old-fashioned plan of windsails was the one adopted by us, the cowl being used as up-takes. That we found the best plan we could adopt. I have spoken more particularly about my own ship the "Barracouta," but I would speak also of the other ships. They all paid equal attention to the cleanliness of the bilges and the ventilation, and I think the result, as regards Her Majesty's ships on that coast, was extremely satisfactory, considering what used to be the case in former times, when sanitary arrangements and ventilation were less understood and attended to.

Captain ROSEASON, R.N.: I would ask Admiral Ryder what part of the ventilation of the deck he proposes to stop up; does it refer to the lining of the ship?

Admiral RYDER: A block cuts it off from the bilge.

Captain ROSEASON: I remember once lending my cabin to a lady passenger, and sleeping in a side cabin of the "Inflexible," when in the middle of the night I was obliged to rush out of the cabin and call for assistance. I could not make out the cause, though I really felt as if I was dying. Taking a light, it was found that the whole of the cabin was as black as my hat. The next morning it was reported to me that every bit of my plate was nearly black, and a part of the sugar basin was absolutely unsoldered. I ordered the hands up to clear the spirit room, and when that was done we found to our astonishment hardly any bilge water at all. There was a kind of hole in the keelson which did not seem to hold more water than this hat would hold. The impression of all was that it could not be from so small a quantity of water that the gas had escaped. When, however, one of the men stirred it, we all had to rush from the hatchway immediately; it was so putrid. It only shows how dangerous it is to keep the opening that you allude to under the roof of the cabins.

Captain CURME, R.N.: I commanded one of the Indian troop-ships for three years, and have frequently carried 1,600 men, women and children. You are aware we were fitted with Dr. Edmond's system of ventilation, the "artificial exhaust" system. I habitually went round at night while the men were below, and examined the sails. The effect of turning on the steam jets was very marked. There were tubes with perforated zinc plates over them in each cabin, and at frequent intervals along the deck, and if a candle was put to them it would be blown out immediately. I was frequently accompanied by a medical officer—the thermometer showed most

remarkable results. From what I have seen, my own opinion is very decidedly in favour of the "exhaust system." If you can afford it, let it be artificial. We had a very large number of cowl; these we took care to trim so that the foremost or weather ones were "down-takes," and the after or leeward ones up-takes, but very often if it had not been for the steam jets, they would have been of little or no use. On the so-called "plenum system," if you blow a large quantity of fresh air down, after a time air must be driven from below, and the chances are even of pure air coming up with the foul. A carefully arranged exhaust must find out the impure air, and take it away. My opinion is decidedly in favour of the exhaust. In the "Repulse," we had no artificial heat, and nothing peculiar except an unusually large number of ventilating tubes with cowls—our masts were also ventilators. The men on the lower deck knew in a moment when the current was reversed, as it often was under sail. A part of our bilge was exceedingly troublesome, and nothing but the being able to get at it easily all along by an arrangement similar to that suggested by Admiral Ryder, and the excellent system of ventilation fitted by the dock-yard authorities, prevented its being a dangerous nuisance.

Commander BRENT, R.N.: I should like to ask Admiral Ryder whether he has any means for taking off the foul air from the top of the men as they sleep in their hammocks. It has always seemed to me that we leave the air to accumulate over the faces of the men when sleeping, and that the effect must be injurious. As the hammocks are all placed regularly, I do not see why we should not have some pipe, whether perforated or partially open, running just over the part above their faces to exhaust the foul air that must remain up against the beams. With our ironclads cut up into compartments as they are, it would seem to me very difficult to ventilate them on the plenum system, but much more easy on the exhaust. It is, I consider, very important that we should have a means of cutting off the ventilation, for if I remember rightly, one of the great causes of the "Bombay's" loss was that the air came down what had been an up-take, and made a regular blast. That was one of the reasons why she burnt out so quickly.

Admiral RYDER: In reply to Sir Henry Codrington, I may state the paint used was zinc-paint. Admiral Paynter asked whether the cowls and tubes were shown there.

Admiral PAYNTER: I do not mean your cowls. I mean these great openings between the decks.

Admiral RYDER: Figs. 1 and 2 represent what has already been done on the upper, main and lower decks of the "Victor Emanuel." The vitiated air is carried off the main and lower decks through long horizontal iron-tubes, which have replaced two planks: on each deck there are tubes full of large holes, these of course are over the heads of the men in their hammocks, which answers Commander Brent's inquiry. The vitiated air passes up into the masts, and is carried off. The cowls and tubes bring down fresh air from the upper decks in its stead. Captain Selwyn spoke of ventilating complete decks, and doubted the necessity for having the diaphragm dividing each mast into separate chimneys. Of course the difficulty of ventilating an ironclad divided into 12 or 13 compartments is very great, and I should think it preferable to make the stack of chimneys, as I called them, as shown in Fig. 5; you would want all of them, thoroughly to ventilate the compartments. With a simple extended deck, such as we have in our open ships, I dare say the ventilation could be effected as Captain Selwyn suggests, with the simple undivided masts.

The CHAIRMAN: However much we may differ in opinion on the system of ventilation, there is one thing in which I am sure we shall all be fully agreed, and that is that the gallant Admiral is fully entitled to our most cordial thanks for his valuable and interesting paper.