

containing pieces of asbestos heated to redness by a row of Bunsen burners) showed that the amount of carbon monoxide given off into the air over the fireplace was inappreciable when the burners were properly lighted. When the burners "struck back" traces of carbon monoxide were given off. In one experiment 0.013 per cent. of carbon monoxide was found to be present in the air over the fire. When an ordinary Bunsen burner "strikes back" I find that the air escaping from the top of the burner may contain as much as 0.2 per cent. of carbon monoxide, and Haldane has shown that an atmosphere containing this amount of the gas is incapable of supporting life. The gas-stove associated with the unfortunate occurrence contained nine burners, the flames of which impinged on three perforated iron plates, and it is possible that these plates when red-hot contributed to the production of carbon monoxide. There was an asbestos tile behind the burners, but there were no asbestos "bricks" in the stove. I have an impression that when the products of combustion have to pass through incandescent pieces of asbestos more complete oxidation of them occurs. It is interesting to note that the man was found dead near the door, as if he had made an effort to escape and that this effort had accelerated his death, whilst the woman, although lying close to the stove, was still alive. Exercise is known to accentuate the poisonous symptoms even when non-lethal doses of carbon monoxide are inhaled.

CASE 2.—This was the case of a man, about 50 years of age, who was found dead in a bedroom on Jan. 7th, 1910.¹ Death was due to gas poisoning and the blood was saturated with carbon monoxide to the extent of 76 per cent. It appeared from the evidence that the deceased man was in the habit of going to his bedroom for a nap in the afternoon, and that on the occasion in question he had been poisoned by the escape of gas from a $\frac{3}{8}$ -inch gas-pipe which had fused owing to being in contact with a leaky electric wire. A $\frac{1}{2}$ -inch gas-pipe and an electric wire had been properly laid parallel to each other and about a foot apart underneath the floor of the bedroom. From the side of the $\frac{1}{2}$ -inch gas-pipe a $\frac{3}{8}$ -inch pipe came off at right angles, and in its path crossed the electric wire. At the point of contact fusion of the gas-pipe had occurred. A leakage of electricity had evidently generated sufficient heat to melt the gas-pipe and ignite the gas, which had burned long enough to scorch the surrounding boards, but as the space was very confined there was insufficient air to support combustion, so that the gas flame had become extinguished, and then the gas escaped into the apartment above.

The deceased had not been exposed for longer than two and a half hours to the effects of the gas. There was a fireplace in the room and the window was partly open at the time. Knowing the area of the room and the rate of escape of the gas, &c., I made a calculation to determine whether a poisonous atmosphere would have resulted if ordinary coal-gas had been in the pipe, and came to the conclusion that in that case death would probably not have occurred.

Haldane has shown that with coal-gas it is almost impossible to produce a poisonous atmosphere in a room by simply leaving the gas turned on during the night, whereas with water-gas a poisonous atmosphere is easily produced even in very large rooms. In conjunction with Mr. Harold Totton, B.Sc., I made an analysis of the Belfast gas-supply at this time and found that it contained on an average 20 per cent. of carbon monoxide. Ordinary coal-gas contains from 6 to 8 per cent. of carbon monoxide and carburetted water-gas from 30 to 32 per cent., so that the Belfast supply contained a mixture of about equal parts of these gases.

Haldane has also shown that deaths from carbon monoxide are enormously more frequent in cities using coal-gas mixed with carburetted water-gas than in cities in which coal-gas only is consumed. From statistical data he concluded that the number of accidents referable to the use of mixed gas would appear to increase approximately as the cube of the gain in percentage of carbonic oxide. Thus, if the percentage of carbonic oxide were increased from 6 to 12 the chance of being poisoned was not twice or even four times, but eight times as great as before the increase, and if the carbon monoxide became three times as abundant as heretofore the chances of being poisoned became increased no less than

27-fold. Carburetted water-gas began to be introduced into the Belfast supply in 1892. A return obtained from the coroner's office at Belfast showed the number of deaths from gas poisoning during the years 1889 to 1891 and 1907 to 1909 was as follows: 1889 *nil*, 1890 *nil*, 1891 one, 1907 two, 1908 five, and 1909 seven. Of course, there has been a great increase in population and in the use of gas since 1889, still a very large proportion of the deaths must undoubtedly be attributed to the increased amount of carbon monoxide in the gas-supply. Only one of the above deaths was due to suicide; all the others were occasioned by misadventure or accident.

McWeeney has shown that from the year 1880 to 1900 no death in Dublin was tabulated by the Registrar-General as having resulted from coal-gas poisoning, that the supply of carburetted water-gas mixed with coal-gas commenced at the beginning of 1900, and that during the four succeeding years there had been in Dublin 10 cases of gas poisoning resulting in 7 deaths. None of these deaths were suicides.

In America, where carburetted water-gas has been in use since 1880, the number of deaths from gas poisoning is enormous. The records of New York are instructive. From 1867 to 1880 there were 16 cases of gas poisoning; from 1880 to 1892 the number was 202. During recent years the number has increased still further, many of them being cases of suicide; for instance, in 1906 there were 419 deaths in New York due to gas poisoning, and of these 250 were the result of accident and 169 of suicide.

The facts which I have mentioned show how urgently such measures as the following are needed to prevent this wastage of life: 1. A limit should be put by Act of Parliament on the amount of carbon monoxide allowable in a gas-supply. The Departmental Committee recommended that the amount of carbon monoxide in the night supply should not exceed 12 per cent. 2. The inspection of gas-fittings and the prohibition of the use of gas-stoves unless provided with a flue. 3. Where the gas-supply of a town contains a large proportion of carburetted water-gas the householder should cut off completely the supply of gas to his bedrooms. The resulting inconvenience would be trifling compared with the risk which is otherwise incurred.

Bibliography.—J. S. Haldane: Appendix to the Report of the Departmental Committee appointed to Inquire into the Manufacture and Use of Water-gas, &c., 1899; also Journal of Physiology, vols. xviii, xx., xxii. E. J. McWeeney: Scientific Proceedings of the Royal Dublin Society, 1904. Belfast.

THE VENTILATION OF SHIPS, PARTICULARLY MERCHANT SHIPS.¹

BY FLEET-SURGEON W. E. HOME, R.N.

WHEN men begin to live together in society, I suppose their first reasoned step in hygiene concerns itself with the disposal of their excreta. Their earliest sanitary concern is to get safely rid of their solid and liquid dejecta. With these we have at sea no difficulty, but the gaseous excreta it is that are always giving us trouble in their removal.

Your houses ashore are severely limited in size, for reasons of economy, but ours even more. In the cost of ours must be reckoned, not only the capital expenditure, but the continuing expense of carrying them about on voyages. Each member of the crew adds for his accommodation two tons to the bulk of the ship; it will soon be three, and there are people asking for more. Thus it will be seen how difficult it is for owners to give more room to the men, and for us to get them satisfactory, that is, draughtless, ventilation into the very small spaces in which they live. While you, under protest, accept 300 cubic feet as the limit in a common lodging house, and require 600 in barracks, we at sea are jubilant because the Merchant Shipping Act of 1906 has enlarged the minimum cubic space for a merchant seaman, in ships laid down after 1906, to 120 cubic feet or 3 tons (albeit with deductions), a great advance on the 72 cubic feet formerly prescribed. Liverpool is trying to get 400 cubic feet per adult in houses let in lodgings. The emigrant who leaves Liverpool need only have 15 square feet of area on a deck 7 feet high, or 105 cubic feet, or perhaps, I think, 170 cubic feet on a lower deck less well lighted and

¹ THE LANCET, Jan. 15th (p. 209) and 22nd, 1910 (p. 272).

¹ A paper read at the Congress of the Royal Sanitary Institute at Brighton on July 9th, 1910.

ventilated than usual. In men-of-war bluejackets seem to get 200 cubic feet pretty generally.²

The more nearly we can approach natural conditions the better, but natural conditions are far beyond us and impossible.

In England the general motion of the atmosphere is eight miles an hour (Whitelegge), so that through a cross-section the size of a man (Galton) 6 feet by 1½ feet, these will flow some 400,000 cubic feet of air every hour. The advantage to health of this open-air ventilation was noted by Parkes to be strikingly shown in the improvement wrought on the health of cavalry horses, whose food, water, exercise, and treatment in other respects were tolerably uniform. Previous to 1836 the annual mortality of French cavalry horses was 18 per cent. They then got larger stables and an increased ration of air. By 1846 the death-rate was 6·8 and in 1862-66 it was 2·75, while in the Italian war of 1859 he tells us that 10,000 horses stabled in open sheds had hardly any sickness even. Each horse sick is a loss to his owner; each horse dead has a capital value, more readily brought to account than in the case of a man, consequently the need for ventilation here was strongly felt. I was told by a merchant captain, holding a prominent position, that he had as a younger man been very successful in command of horse ships, that the captain got a bonus on each horse landed, and that horse ships were the best ventilated of all—not improbable when the benefit of sanitation blessed both ship-master and ship-owner. It is difficult to convince people of improvements that do not write themselves down so in their bank books.

When we are in the open air we much enjoy our 400,000 cubic feet per hour, but we cannot live in this great flow, in fact, we build houses to keep it off us, so we must now inquire how much air we ought to have. A man's hourly output of carbonic acid is variously stated from 0·6 cubic foot (Whitelegge) to 0·8 cubic foot (Prausnitz, whose Austrian text-book is widely read in Germany). Professor J. S. Haldane states it at 0·6 cubic foot for a man at rest, 0·9 cubic foot generally, and 1·1 cubic feet during work; so I suppose we shall not be very far wrong if we take it at 0·8 cubic foot.

This quantity we must dilute with fresh air, but with how much fresh air? In England and America de Chaumont's old standard is still accepted. He found that if the carbonic acid in the air of barracks increased above 0·06 per cent., the air was "stuffy," had an unpleasant smell. Accordingly, he, and we follow him, considered 0·06 per cent. carbonic acid as the limit of respiratory impurity. The outer air already contains 0·04 per cent., so it can only take up 0·02 per cent. more—that is, 1000 cubic feet will take up 0·2 and 4000 cubic feet will be required to keep sufficiently diluted the 0·8 cubic foot of carbonic acid produced hourly by the average man. This same amount, 4000 cubic feet per hour, was also reached by Galton when calculating how much air a man required every hour to prevent the air about him becoming too damp, and by Dr. Shaw when deciding how much is required to keep down the temperature due to many people sitting and breathing together. So it has much sanction this 4000 feet of hourly ventilation supply to one man.

In Germany another standard is taken, 0·1 per cent. carbonic acid, Pettenkofer's original figure, the proportion submitted by Haldane and Osborn as sufficient for factories and workshops. If this be accepted, we see that each 1000 cubic feet of air can take up (0·1—0·04=) 0·06 per cent. of carbonic acid. That is to say, we shall now only want 1330 cubic feet of hourly supply. And from my experience I would say we shall do very well on a ship if we manage to get as much.

I have only spoken of carbonic acid percentages, for we measure the respiratory contamination by the easily estimated carbonic acid. The pure gas added, in the proportions of 0·06 (making 0·1 per cent.) to air, does no harm; at 2·5 per cent. it puts out a candle, but it must reach a proportion of 3 per cent. before, of itself, it causes unpleasantness, respiratory inconvenience to man. If the carbonic acid, however, be respiratory carbonic acid inconvenience and discomfort arise with far smaller percentages, particularly if they arise from the respiration of other persons. And it is not quite clear to what accompanying product the

inconveniences are specially due. In any case it seems to increase uniformly with the carbonic acid. Flügge and his school urge that the chief physical inconvenience of overcrowding is interference with the agencies which naturally cool the body—the dryness, coolness, and movement of the air; that the air of overcrowded rooms is unduly stagnated, warmed, and humidified, so it has less cooling effect; that consequently there is a congestion or accumulation of heat in the organism, and that this it is causes the headache, giddiness, &c., of crowded rooms. Others believe these inconveniences due to the smells which people give off from the respiratory system, alimentary canal, skin, and clothing; in this case, the cleaner the people the less the need for so large an hourly supply, and Pettenkofer long ago pointed out how wasteful and unfair it was to expect ventilation to do the work of conservancy and ordinary cleanliness.

As bearing on these alternative theories, I must mention an interesting case of ventilation with unusually pure air, reported by Dr. W. H. B. Stoddart,³ of Bethlem Hospital. We were all thinking a good deal about liquid air in 1902, and Dr. T. B. Hyslop suggested to Dr. Stoddart to use it instead of ether in his microtome. It gave great satisfaction and was the more valued as the laboratory was now found to be unusually well ventilated. Dr. Stoddart reports: "It is no exaggeration to say that after a morning's work in the laboratory I have felt as if I had been for a blow in the country." Unfortunately, a great rise in the price of liquid air has prevented further researches, amongst others some I had planned. Now what was it made the difference? Apparently only 66 gallons, 10 cubic feet of air, were used in a morning. No one can surely urge that it was the cooling effect of this 0·8 grain of air. I submit it is more likely that we shall find the explanation in what Dr. Stoddart says about the purification of the air as it is liquefied. At one stage impurities, being condensed, settle out, impurities "with a stench like a London fog," as he says. I submit it was the freedom of some of his laboratory air (but how little) from the "smells" or "the organic matter" the books mention in the air that accounts for the difference.

And now to go back to ventilation with ordinary air. We have agreed that in ships 1300 feet per head per hour are as much as there is any use asking for. How are we to get that? The first rule of ventilation must be emphasised: "Do good by stealth." As the Greek sage said, *λαθε βιωσας*, escape notice throughout your life, otherwise you will find yourself considered a nuisance. A ventilation current that attracts attention to itself ruins its own usefulness by its too great zeal, gets itself disliked, and is probably at once put out of existence. The exceptions occur in the tropics, where a current slightly cooler and with some drying power is greedily welcomed. There is obviously at every temperature a velocity and a cooler temperature of ventilating current that would be just tolerable, slower as the temperature was lower, and conversely. I suppose the limiting condition to be the amount of loss of heat they produce in the time. Dr. Nocht of Hamburg, in his very valuable book for doctors of ships, "Vorlesungen für Schiffsärzte," says that no velocity above six feet a second is endurable; it must be low. People often say that sailors do not like air, that it is no use giving them ventilators as they will only close them up. To talk like this argues a narrowness of view. It is not air men object to, but cold air, especially damp cold air with its higher specific heat, and consequently greater chilling effect; cold air they will certainly exclude if they can. To meet this difficulty, in the first place give them more inlets, break the current up into smaller sections of less velocity, and if you really want to do them well warm the incoming air. The misery of cold is infinitely more painful, more acute than that of gradual suffocation, which is rather a soporific.

The most ready means of ventilation at sea is perfilation, popularly known as a blow through. Here we take advantage of the existing wind or of the draught produced by the onward course of the ship. The air is collected by cowls, which direct it through shafts. Also, it may be sent below through temporarily fitted canvas shoots called wind-sails, or in calm weather by wind-scoops, in the ports. This is a very satisfactory method when available, as it supplies most cheaply enormous volumes of air to flush out and dry up the

² Gatewood's Naval Hygiene for the United States Navy, Nocht for the German Navy.

³ THE LANCET, May 17th, 1902, p. 1385.

decks below. Often it is unavailable, because there is no wind, often because with the air rain- or sea-water would be carried down.

The official ventilation of emigrant ships is by perflation. Each statute adult is allowed $2\frac{1}{2}$ square inches of inlet and $2\frac{1}{2}$ square inches of outlet ventilator. His 1300 cubic feet must pass through these with a velocity of 20·8 feet per second, cruelly too fast. The German emigrant regulations only requires 1 square inch in each per person. Nocht points out that in calm weather, with the ship going at the low speed of 10 knots only, that means a current of $16\frac{1}{2}$ feet per second, too fast for comfort and only giving 400 cubic feet per hour. There is more wind against the west-bound ships, so they have better air-supply when they are carrying most passengers, i.e., across the Atlantic.

The wind then fails us, and we have to bring our air in for ourselves, and the methods we employ are classed as natural or artificial, as Dr. Shaw has well observed, in proportion as they cost nothing specially or as they require money or energy definitely expended upon them.

Air becomes lighter when heated, also when it takes up water. Hence it is that on a damp day we say we feel the air heavy, not because the air is heavier but because, being lighter, it buoys us up less and it takes us a trifle more exertion to stand up and support our own weight. We it is are heavier.

The weight of a cubic foot of dry and saturated air at 30 inches barometric pressure, and at various temperatures, is given in the following table from Galton:—

Weight of 1 cubic foot of Air. Bar. 30 inches.			
Temp. Fahr.	Dry air.		Air saturated with moisture
32°	566·85 grs.	.....	565·58 grs.
40°	557·77 „	.....	556·03 „
50°	546·82 „	.....	544·36 „
60°	536·28 „	.....	532·84 „
80°	516·39 „	.....	509·97 „

Persons living in a room heat its air by convection off their persons, and, by respiration, reduce its density further by heating it more and adding moisture, and increase its density by replacing its oxygen by carbonic acid.

A.—A cubic foot of air (bar. 30 inches), temperature 60° F. (wet bulb 55°=humidity 71 per cent.), before inspiration, weighs 533 grs.

B.—A cubic foot of air (bar. 30 inches), temperature 98° F. (wet bulb 88°=humidity 61 per cent.), before inspiration, weighs 492·8 grs.

C.—A cubic foot of air (bar. 30 inches), temperature 98° F. (wet bulb 98°=humidity 100 per cent.), expired, weighs 496·15 grs.

So if a man breathed in an atmosphere like the sample A his expired air, C, would rise away from him, being now 7 per cent. lighter, but if he breathed in an atmosphere like the sample B the expired air would tend to fall, as being now 0·8 per cent. heavier. Dr. Shaw has given careful attention to this question, and finds that the temperature at which the reversal takes place is in the neighbourhood of 81° F. In a paper read to the Epidemiological Section of the Royal Society of Medicine on "A Disease of Overcrowding in Ships,"⁴ I tried to explain by this principle, stagnation about 81° F., the enormous prevalence of respiratory disease which occurred in a ship at that temperature.

Persons, like the other surfaces in a room, radiators, walls, windows, &c., alter the temperature of air in contact with them, setting up convection currents. These convection currents are most important, and Dr. Shaw has done great service by showing how often ventilation schemes have miscarried through neglect of this great law—every person or surface warmer than the air of the room causes an upward current, every surface colder than the air in contact with it causes a downward current.

In ships the run of the ventilation currents is very complicated, and so little understood that an acute friend of mine, a lawyer in very successful practice at the Bar, told me that as a result of a large experience in cases where compensation was claimed for damages to cargoes through insufficient ventilation, he had come to the conclusion that air travelled in a ship always in the direction contrary to that you would expect. The same idea appears in Romeril's book, "Sanitation in the Mercantile Marine," where he says

it is well known among seamen that the smell of bilge water and offensive cargoes works to windward, and Dr. Nocht also mentions the old advice to ventilate a sailing ship by turning the cowls on the weather side to act as exhausts. He also recalls an experience of his own showing that the air-currents in the saloon of a steamship, most unreasonably, travelled from aft forward, though there was a good breeze from ahead. These all only mean that the factors influencing ventilation have been incompletely observed and appreciated. The results are surprising, but we do not believe that the natural laws act erratically, only that we do not take enough pains to trace out and allow for all the factors in the problem.

I was once told by a chief constructor that in designing the steering engine compartment of a second-class cruiser years ago he had arranged a large trunk at the forward end to supply fresh air, taking it in the course of the natural drift from forward aft, expecting that the uptake would be through a shaft further aft to a cowl on the poop he provided. But in fact the ventilation went the other way. The trunk forward was the uptake, and whenever the door into it from the space under the poop was opened, the officers' quarters were flooded with oily smell. Why? Well, he explained it that the trunk was at the fore end of the compartment, close to the warmer bulkhead next the engine-room, and that just under the trunk was the blazing hot steam-pipe to the steering engine, so the air thereabouts was greatly heated and insisted on rising at once through the trunk, compelling air to replace it to come down the after shaft. The principles of ventilation were being obeyed by the unconscious air, just as much on board ship as ashore, but in the planning of the complicated structure of a ship, too little consideration had been given to them.

Another example of apparently perverse ventilation may be quoted from my last ship at sea. To ventilate her mess deck in a head sea, with all hatches and sidelights forward shut, it proved best to take the air in aft and let it out forward. The head wind as it blew aft got caught against the after screen, and, and banked up there, much of it escaped down the hatches and streamed forward along the main deck. One such day, when the sea was lessening, the captain shipped a cowl, with its back to wind and sea, on the fore bitts right forward; this acted as an exhaust, relief of pressure occurred, and splendid ventilation of the mess deck and main deck was established, not as one would expect from forward aft, but from aft forward.

In all navies nowadays⁵ ships are so divided up by bulkheads that natural ventilation and windsails are becoming things of the past. The ordinary fore-castle of merchant ships, the place where the crew live, is by no means an easy place to ventilate. Fore-castles are generally two in number, for the sailors to starboard, for the stokers to port. They are roughly wedge-shaped, each like a right-angled triangle, the side-lights in the hypotenuse, the door either in the base or in a little recess excavated at the base end of their perpendicular sides, between the two fore-castles; this is preferable. They have been greatly improved in recent years; this improvement is to be traced through Dr. W. Collingridge's paper in THE LANCET of May 5th, 1894, p. 1111; Romeril's book on "Sanitation in the Mercantile Marine," 1898; and Dr. Wright's paper in the Journal of the Institute for 1904, p. 442. The evil-smelling forepeak is no longer entered through the crew's quarters; the paint store is cut off by an air-tight bulkhead, and its door is on the upper deck. The hawse pipes or cable pipes are often air-tight, more often than formerly; still the need for good ventilation remains clamant. Many a fore-castle one has visited in which the atmosphere was more oppressive than one would expect to find in a bad back-to-back house. The men need only have 72 cubic feet each, and in this in harbour they are all eating, smoking, and sleeping. By-and-by, when these ships wear out, everyone will have 120 cubic feet. As to ventilators, they are small, perhaps only one, sometimes there are two, but always opening overhead, never carried down to the deck. There is also in cold weather the chimney of the stove, and there is the door, usually so close to the stove that the air-supply of this latter comes from the door and does not draw foul air out of the fore-castle. Then

⁴ THE LANCET, May 1st, 1909, p. 1238.

⁵ For the American Navy see Gatewood's Naval Hygiene, for the German Navy see their Health Report for 1906-07.

there are the sidelights, generally of necessity closed at sea, and not opened in harbour because so small, the air coming in through them would do little good. It is difficult to find places for ventilators, space on the top-gallant fore-castle overhead is very small. In one small ship I saw there was an 8-inch cowl for the seamen's mess-deck, right forward; there was none for the stokers, for where that would have come up, beside the steam capstan, a man had to stand to work the capstan engine. As the mate said when I suggested another ventilator: "There isn't much room up here when we have wires all over the place and are working in the dark." I would suggest a goose-neck ventilator right forward, 6 inches in diameter, continued down to within a foot of the deck for supply of air, and an uptake, also 6 inches, as far aft as possible, just to open through the roof for an uptake. With the stove lighted and the door and sidelights shut both would act as inlets. This latter ventilator might be replaced in some ships by an opening in or over the door. Ventilators are not much good if they have to be closed at sea; but there are water-excluding ventilators like Utley's, so widely used for cabins and holds; they are very reliable. I was told when taking passage in the *Campania* that they never give any trouble or got out of order; I have never chanced to see one in a fore-castle.⁶ They are expensive and they do increase weight but are helpful; and ventilation saves money. Dr. S. Barwise, in the *Journal of the Royal Sanitary Institute* for January, 1889, notes that a large mill at Blackburn had increased its output $2\frac{1}{4}$ per cent. since they had put in adequate ventilation, and the opinion of the owner was that the expenditure had been a wonderful investment. Also Carnelley found that £20 spent annually in mechanical ventilation for 1000 scholars gained £125 improvement in government grants; and you know what Parkes told us about horses, and what I heard about horse ships.

An Utley ventilating side-light is supposed to be equivalent to 15 square inches of ventilator in the deck; they must be good or there would not be 600 in the *Mauvetania* and *Lusitania*, where it is so expedient to cut down weights. Besides, there are other water-excluding ventilators, as Sugg's.

If fore-castles were kept clean they would need ventilation less, but the first step towards getting them cleaner would be, in my opinion, to give them more light by fitting larger side ports (that means probably heavier frames and stronger scantlings). Then take the bunks away from the side of the ship, where they obstruct the light and involve greater risk to the crew in some cases of collision. To put them against the inboard side would probably, however, mean enlarging the fore-castle. In a German ship I have seen the bunks arranged like the teeth of a comb. After we have got larger side-lights and the bunks away from the ship's side, if we could get the exposed surfaces of iron covered with varnish and cork it would be well, or they might be cased in wood. Then if that wood were smoothly finished and painted white the men could see the dirt clearly, and in a year or two great improvements would be noted. The stone, brown, and grey paint I see do not force people to wash them, and give them little satisfaction when they do; whitewash I think positively degrading.

Crew accommodation is, I am glad to see, being put aft. The most commodious crew space I have seen was in a huge cargo boat in London, under the poop. The best crew space I remember was in quite a small Swedish timber-carrying steamer. It was aft, and under the upper deck. It was wood-lined all round and overhead, painted white enamel. The berths were, it is true, round the ship's side. They had larger cubic space, electric light, and, most marvellous of all, I must mention it though outside my present subject, a fixed washing basin with a four-gallon supply tank over it. It gave me an idea of comfort, that crew space, I have never felt before. This Swedish ship had also the best water-closet for the men I have seen, just as it might have been for passengers, and kept clean. Owing to position there could be no ventilators through the deck, and they would have been useless even if fitted, because under the deck cargo of wood the ventilators were in the panels. If the ship is to be wired for electric light the ventilation is quite simple: estimate for an extra lamp and replace it by

a propeller fan, and put it at an opening in the bulk-head to extract the foul air as in a laundry. The usual employment of a table fan, to make an eddying of the air round the compartment, does little good to ventilation. The ventilation requirements of fore-castles would be further reduced if wash places were separately installed, as contemplated by the Merchant Shipping Act of 1906; there would be less drying to be done by the air, and then if they only had good water-closets, merchant seamen would be no worse off, unnecessarily, than their brothers who are housed under the conditions generally prevailing ashore; their discomforts would then be only those essential to their employment.

The stokeholds of ships can be generally well ventilated everywhere if baffles are fitted to distribute the cool air through the whole space, for each 30 pounds of coal burnt in an hour brings down enough air for a man, but the bunkers where the coal-trimmers work are a problem. The engine-room is also a difficulty, for it has no through draught, and very hot "pockets" occur. I remember what seemed a tragic irony, an engineer in the merchant service getting heat stroke when attending to the refrigerating engine, which was in one of these backwaters. The principle is to exhaust from the hottest places by fans and shafts.

Various alterations of air occur in holds, best detailed by Nocht. We are all thinking of ferro-silicon, but that is a very special case I cannot touch. The risk to crews from offensive cargoes is nowadays much decreased, as bulkheads are iron and watertight. Nocht notices that there may be danger in entering newly-opened (and ill-filled I would add) holds, for certain cargoes of moist cellulose—e.g., rags, cotton, and paper—absorb the oxygen, and replace it with carbonic acid and perhaps marsh gas. This forms an explosive mixture with air when there is about 10 per cent. of it present. Maize and oats are apt to "heat," and coal sometimes spontaneously ignites, this latter event being usually heralded by a smell of ammonia. Ventilation is required to keep these processes in check and to keep the temperature down. This is managed sometimes by fans, and sometimes by shafts with cowls. I wonder why it is not sometimes done on the lines of the old experiment with a burning candle in a bottle with a long neck. If a diaphragm was slipped into the neck of the bottle ventilation was established, the up and down current no longer interfering with one another; if the diaphragm was removed the candle went out. If a temporary bulkhead or screen were fitted through the hold amidships, leaving a couple of feet clear below, air to get from one side to the other must pass all the way under that screen. A ship is hardly ever the same temperature both sides (action of sun and wind); if the two halves of the hold were separated the air on the sunny side rising would have to be replaced by cold air from the other, which must pass all through the cargo and the hold. At present I expect the change only occurs in that part of the hold upon the water line. It would be most useful in ships carrying grain in bulk or in bags. The hoped result would follow; I think so from Dr. Shaw's pregnant remark,⁷ "Nature provides without difficulty a convection current wherever air is locally warmed." As the temperatures have little difference the currents would be slow, consequently the resistance would be small, and we might be able to make them come, to our advantage, from farther away.

Ventilation would also save money if applied to holds while they are being stowed. It follows from H. Wolpert's observations (reported by Prausnitz) that a man who sweats as he works is doing less good work than if he were supplied with air, so much and so dry as to prevent the sweat from appearing. If air, then, in volume to prevent this sweating, were supplied to the holds they would be stowed more quickly, and the ships get away the sooner. An electrically-driven fan at the top of the hatch with a long and large discharge pipe is what is wanted, for with a pipe double the diameter the same power will send down four times the volume of air.

In the artificial ventilation, both of ships and houses, some people prefer the plenum, some the vacuum system, and the systems are sometimes (as happens with the sexes) pitted against one another as rivals. In fact, they show to much greater advantage when working together. If there is only one system, the pressure required to carry the air through

⁶ Fleet-Surgeon (now Deputy Inspector-General) W. Tait mentions (*Journal of Royal Institute of Public Health*, 1905) that they were fitted in the new Royal yacht and there acted "most efficiently."

⁷ Shaw: *Air Currents and the Laws of Ventilation*, 1907, p. 41.

the whole area must be raised twice as high above the normal as is necessary when the air has only to be forced halfway and to be sucked the other half; consequently the installation of power for the combined system is cheaper and the opening of doors and windows produces a merely local effect, whereas with a "single" system it may ruin the ventilation altogether if a window is opened in a tactless place. The Glover-Lyon appears to be an excellent example of the combined system; it emphasises the need for many apertures in order to prevent draught and the advantage of making large apertures. The trunks should be so arranged that they can be cleaned; the efficiency of ventilation may easily fall 20 per cent. through deposit of fluff on the sides. Besides, we all heard how streptococci fell out of the ventilators in that convalescent home at Broadstairs.⁸ The trunks should also be as large as possible, for to double the supply costs nothing after the area of the shafts is doubled, the power will remain the same, but to get a double supply with the same shafts as before we must multiply the power by eight.

Extended accounts of the ventilation of the very largest passenger steamers have been given at intervals in the last three years by the Special Sanitary Commissioner of THE LANCET. The Cunard Company warm the *Mauvetania* by hot air from thermotanks standing on the uppermost deck of all; these supply air to all parts of the ship, while the offices generally are exhausted by trunks leading to the funnel casings. The White Star warm all parts of the *Adriatic* by steam radiators, supply no fresh air, but extract the air from saloons, cabins, water-closets, and lavatories by fans. The ships of each company are plentifully supplied with Utley porthole ventilators.

The ventilating mechanisms are specially three: the thermotank, the sirocco fan, and the Utley ventilating sidelight.

The thermotanks, of which there are 65 in the *Mauvetania* (situated, as I said, on the topmost deck), collect the purest air, warm it, and pass it through a fan at a temperature regulated nowadays automatically within 2°, and so it passes to the area of distribution. This machine can also be used as an exhaust, and prides itself that disinfecting gases can be distributed by its agency.

The sirocco is a fan, in principle quite distinct from any that preceded it, quite distinct from any of the flat or propeller fans we know so well. It is a multivane fan, has somewhat the shape of a tall hat, the 64 narrow vanes, each with a parallel twist, are arranged up the side of the hat, while the middle is empty. The ordinary fan takes air in and accelerates its motion in the same direction. The sirocco fan takes it in at the centre of the hat and throws it out at right angles round the periphery. For the same ventilating effect this is much smaller and lighter than the old fans, and uses up much less energy, hence its existing great popularity.

The Utley porthole ventilator (or, as they call it in Germany, the Utley "swimmer" or float) is essentially a passage over the top of the sidelight or scuttle, defended against the waves by cork floats, which are pressed by the waves against a seating so that no water can get through. As the water falls away, down come the corks, and the gangway for air is again left clear. I described this mechanism in THE LANCET of June 7th, 1902, p. 1597, where there is a figure.

The statistics of the ventilation in these large ships are interesting. There are in the *Mauvetania* 65 thermotanks, each capable of supplying 33·3 cubic feet per second; this is in all a little over 9 tons of air supplied to the ship a minute. It looks very large, but does only work out at 800 cubic feet of air supplied every hour, artificially, to every person on board, and there is, besides, the natural supply through the Utley sidelights. The ventilation inlet in the cabins is 20 × 8 inches; 800 cubic feet will pass through this in an hour at a velocity of $\frac{1}{3}$ th foot per second. This will cause no one discomfort from chill. This good ventilation, as Dr. Nocht remarks, draws passengers, and so is profitable to the owners. To this I need only add the wise conclusion of Dr. Collingridge: "The more comfortable and cleanly forecastles can be kept, the more contented and happy men are, the longer they will remain in the ship, and the more work can be got out of them."

⁸ Brit. Med. Jour., March 23th, 1910, p. 770.

Clinical Notes : MEDICAL, SURGICAL, OBSTETRICAL, AND THERAPEUTICAL.

HYOSCINE POISONING: PILOCARPINE AN EFFICIENT ANTIDOTE. A MAXIMUM DOSE.

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THE patient, a five-year-old boy, in response to an urgent summons, was seen by me in an unconscious condition, coupled with wild erratic convulsions of the limbs and face, the eyes, however, being fixed. Both pupils were widely dilated and the fundi seemed normal. There was no response to tactile or painful stimuli nor to bright light. The temperature was 100° F., the pulse bounding at 124 per minute, while the skin was hot, dry, and flushed. I catheterised him and obtained a small quantity of urine. I could obtain no history except that of a sudden onset after having had his evening meal of simple food some two hours previously. I ordered him at once a hot bath and mustard stupes to the back of his neck and soles while I returned for a stomach siphon and to test the urine. The latter was free from albumin and sugar. On my return the similarity of his condition to poisoning by the atropine group of alkaloids struck me, and as the belladonna plant grows in the locality I injected at once a quarter of a grain of pilocarpine hydrochloride. Within 10 minutes the condition improved, and by the next morning apparently a complete recovery was determined. All inquiries failed to discover the source of poisoning, and I was disposed to regard it as an auto-toxæmia when three days subsequently the father brought me a tube which had contained tablets of 1-100th grain of hyoscine bromide and which the boy had found near his school. He had shared such as it contained as comfits, the larger portion (four or five) being taken by himself previous to the attack.

Regarding the maximum dose I may report the following incident. When engaged in the exploration of the Loangwa Valley in North-East Rhodesia during 1896 a witch doctor and his chief were captured by our Angoni and Atonga askari for having burnt live infants in the practices of their craft. They were tightly bound and conveyed to the base camp on the Loangwa foreshore. Their imprecations and ravings made night hideous, so much so that the indunas wished to kill them there and then. I promised to quiet them, and injected into each (both being big Sengas) the fortieth part of a grain of hyoscine hydrobromide. Within 15 minutes both were soundly anæsthetised, only slight twitchings of the extremities distinguishing their condition from that of sound sleep. So much so that their guards loosened their bonds, and in the early morning both bolted into the wilderness. Whether they escaped or were knobberied by the infuriated Angoni (who are not torturers) I failed to discover.

Great Marlow.

NOTE ON A CASE OF HÆMORRHAGIC DIARRHŒA ACCOMPANIED BY GREAT EMACIATION.

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ON May 13th, 1909, I saw a man, aged 23 years, who had been sent home from an adjoining town as unfit for duty. I attended him after this date up to the present time. Previously to his arrival home he had had medical attendance and was told he was suffering from dysentery, and a milk diet had been enjoined upon him. He gave me the impression of a person suffering from oligæmia. His temperature was over 100° F. During the daytime there was a hectic flush on his face. Pain in the abdomen was complained of, as also were hæmorrhoids. Stools were frequent; indeed, diarrhœa and bloody offensive motions were his great complaint. The motions, I found, were very offensive, and the hæmorrhage was profuse. On examination he had perceptible pain in the region of the left groin, and warm bran and salt bags, alternated often with a linseed poultice, were applied