Ventilation, Heating and Berthing.

By Mr. A. E. BATTLE (Member of Council),

READ AT

The Engineering and Machinery Exhibition, Olympia,

On Saturday, September 28th, 1907, *at* 8 *p.m.*

Chairman: Sir Alex. B. W. Kennedy, LL.D., F.R.S.

Chairman: I have been asked to take the chair for this second lecture, and without losing any time will now call upon Mr. Battle to give us his lecture on "Ventilation, Heating and Berthing."

Pure air is as essential for health at sea as on shore, and the various branches of sanitation require equally as much, in fact more study and attention on shipboard than on land, owing to the confined spaces and peculiar and varying conditions.

The idea that sea air solves all hygienic difficulties, the apparent belief in its magical purifying properties, I am sorry to say, must be refuted as ridiculous and absurd, born only of human inclination to be contented with any and every conscience-quelling possibility, in the endeavours to obtain economy, yes, economy, so called, apparently at any costs.

The blind following by precedent, together with the fact that men still follow the sea calling, and perhaps the fact that public attention is not continually riveted upon individual vessels is possibly accountable for the lack of even an attempt, in most cases, at efficient sanitary arrangements (by sanitary arrangements I mean the term in its broadest sense). In other cases money has been spent in purchasing and equipping desirable apparatus, but a want of care and knowledge on the part of the builders often results in frustrating the ends desired.

This lack of the combined knowledge of sanitary science, together with that of the internal economy of all types of modern steamships, induces me to confine myself this evening

to the subject of ventilation and heating, together with berthing arrangements on board ship.

It is surprising that more attention has not been paid to this subject, when it is considered what an exhaustive amount of literature has been written on ventilation ashore. This want of special knowledge is therefore my excuse for referring to the elementary principles of ventilation and practices ashore, as, maybe, suggesting to the ever-fertile brain of the naval architect and marine engineer, possibilities of their application for marine purposes ; or, at least, that as ventilation is so necessary ashore it is possible that those magical purifying properties of the ocean air may not have such beneficial effects, as apparently has been too frequently fondly imagined, upon the foul and polluted air the other side of even a very thin mild steel bulkhead.

I must ask your indulgence if I repeat somewhat certain sections of my previous lecture : " Sanitation as practised in the Mercantile Marine," delivered in this hall last year.

Everybody will agree that, at least ashore, pure air is essential for health, together with equality of temperature, also that in certain occupations the matter of ventilation requires special attention and consideration. I would also venture to suggest that, for the safety of the public and their property, the berthing of officers and men on board ship should be such as will allow their taking healthy rest, and also that in such places where men are employed on watch, ! such as in the engine-room, etc., ventilation should receive careful consideration. To keep a watch of four hours in a close and heated atmosphere, where ventilation can best be described as nil, after sleeping in a badly ventilated and badly situated berth, requires considerable effort on the part of the officer in charge to keep from napping on his watch, for he is only human. And I venture to say that if such a case were investigated by an unbiassed mind, the verdict would be in favour of the unfortunate culprit, and a condemnation of the ventilation system.

We inhale in the course of twenty-four hours 480 cubic feet of air per minute when at rest, and more than double this amount when at ordinary work. The process of the purification of the blood is outside the sphere of our present investigation, and if any of my hearers are not already acquainted with the same, it commends itself to your investigation. The form and type of air impurities, however, certainly demand attention.

The impurities of the air vary greatly with the local conditions. It is worthy of passing note that CO_2 when present in the atmosphere in excess of ·04 per cent. is considered an impurity, and that when present in the atmosphere in ·06 per cent. it indicates the permissible limit of air pollution in accordance with the best hygienic practice ; ·06 per cent. of CO_2 is therefore termed the standard permissible impurity. Carbon dioxide is of itself harmless in quantities likely to be encountered in the atmosphere, but the fact that all increase of dangerous impurities is accompanied by a corresponding increase of CO_2 decided this selection.

On shipboard such a standard as the above might hold good in saloons and in some cabins ; but I doubt whether, in the bunkers of a ship, or in the stokehold or engine-room, the increase of the dangerous impurities could be so indicated by the presence and quantity of CO_2.

The conditions of ventilation of a bunker are not, as a rule, the best. It would be of advantage if the bunker doors were open to allow an air current to pass up through the coal. I have here an apparatus consisting of a U tube filled with fine coal dust ; it will be observed that when the air pressure is most slightly disturbed in the one tube by means of this indiarubber ball the indicator at the other side shows clearly that the air current freely passes through the coal.

I cannot impress upon those in authority too forcibly the necessity of providing through wind current in bunkers, even if at a little discomfort to the berths in close proximity to the bunker hatch. For down there in the dull black bunker the conditions of working are, if anything, worse than a coal mine itself.

But confining myself for the present to such conditions as prevail in saloons and sleeping berths, the land rules may apply. It is estimated that to keep the standard of impurity of the atmosphere to within ·06 per cent. will require for each person 3,000 cubic feet of air per hour. Upon this is based the deduction of the cubic space required per individual. Now, the space required is a matter dependent upon the facilities for changing the air, and providing the changes can be satisfactorily effected, the Board of Trade allowance of 72 cubic feet per man might be termed a luxury. In fact a mere box would suffice as a sleeping compartment. But unfortunately the rate of air change is very limited, temperature playing

no small part in this direction. Air travelling at 1½ feet per second is not perceptible, and even at two to three feet it cannot be said to cause a draught. This would perhaps suggest that all air should be heated in a system of marine ventilation, on account of the limited space and the consequently many changes required to maintain anything like a satisfactory standard of purity.

A change of air three times an hour is all that can be borne under ordinary conditions, and with such conditions the space required per individual would be 1,000 cubic feet. The authorities have thought fit to allow Tommy Atkins when in barracks 600 cubic feet, and the common lodging-house, where a considerable number of our firemen collect when ashore, 300 cubic feet per man, and viewing the above facts, the basis of 72 cubic feet, as allowed by the Merchant Shipping Act, is surprising. It would be certainly interesting to know the field of research whereby it was discovered that men at sea could under certain conditions apparently be, shall we say, content, with such a limited space.

The usual method of deducting the air space required is of itself instructive and interesting, namely—

$$\frac{\text{The amount of } CO_2 \text{ given off by one person per hour.}}{\text{Possible maximum quantity of } CO_2 - CO_2 \text{ in 1,000 cubic feet of air}} = \text{Air required per individual.}$$

The rules for computing the air space on board ship is laid down in the Board of Trade instructions to surveyors, and can be broadly stated as the most that can be made of the floor space in square feet independent of its utility, divided by 12, providing always that the cubic capacity does not fall short of 72 cubic feet per seaman after deduction has been made for certain encumbrances, such as hatches and ventilating trunks. For some reason, however, spaces occupied by bunks are not deducted.

It is a noteworthy fact that builders fit the maximum number of berths allowed by the Board, independent of whether that number of crew are to be carried or not, and so greatly reduce the all too small air space accordingly. Perhaps it is to induce the owner to carry a larger crew, for we know that quite a number of owners realize that the Merchant Shipping Act complement of men is small, and for this great blessing—for it is a blessing—we who go down to the sea in ships are duly thankful. But why any berth should be a

fixture, built in in such an immovable fashion, apparently on the same principle as the laws of the Medes and Persians, is a question perhaps the shipbuilder can best answer. Why cannot the great improvements effected ashore in this direction be adapted to ship requirements, and upon that basis I would suggest the following rules, in connection with ships' bunks, as a possible guide to health and cleanliness generally.

1st. All bunks should be constructed clear of the ships' side or bulkhead, to allow a free circulation of air.

2nd. They should be placed for preference against the inner bulkhead; that is, not against the ship side.

3rd. They should all be removable, the framework of iron and wire springs substituted for the usual wood lathing. The sides or bunk boards not more than 8 in. deep. The foot and head boards to be carried to within 6 in. from the deck above. The minimum dimensions being 6 ft. 6 in. long by 2 ft. 3 in. broad. The bunk to be as much above the deck as possible.

The cubic system of crew accommodation, however, is preferable, possessing more of the civilized element, and the class of men following the sea, who live forward, would undoubtedly improve if the conditions of living were more pleasant.

Stringent regulations should be enforced regarding fitting lockers under bunkers or obstructing the free circulation of air by stowing boxes and the like under bunks in both cabin and forecastle.

The farce of morning inspection of a ship by a commander ignorant of the elementary rules of sanitation, or a medical man who, with few exceptions, is ignorant of the internal economy of a modern vessel, generally results in discomfort only, and is productive of very little good.

The ordinary attempts at ventilation on board ship must, to use the mildest language, be termed ill-directed, possibly from a combination of want of thought and want of special knowledge. Conformity to the letter of the Merchant Shipping Act with regard to ventilation, irrespective of the elementary principles governing the position of ventilators etc., in many cases is all that one finds, and ventilators are more often so arranged as not only to be useless, but a source of annoyance when anything but the mildest weather is encountered. In some cases ventilators discharge directly over

a bunk. The natural consequence being it is kept plugged up from below to prevent intolerable draughts. This arrangement is more often than not due to the absurd notion of sacrificing all for appearance on deck, a condition which must give way to utility and practical science as it did under compulsion, when the black smoking funnel found a place on the before spotless deck to lay smuts belched forth with clouds of black smoke, and covering with soot, masts, riggings and sails alike.

Sir John Clarke, one of the leading authorities on hygiene, says : " Air, as it increases in temperature, or becomes loaded with watery vapours, has its weight diminished and ascends. Now the air in an inhabited apartment, being both heated and generally combined with a portion of watery vapours from respiration, etc., becomes specifically lighter, at the same time that it is vitiated, and rises to the roof. If it is given the means of escape it would be gradually forced out by an equal quantity of pure and more dense air entering from below, which in its turn becoming heated and deteriorated, would in like manner ascend and make its escape, thus would a continual current of the air circulate without any trouble on our part. Unless provision be made for the escape of the ascending current of impure air, no admission of external air will secure proper ventilation."

This in compartments where the changes could be made without causing a draught would be highly desirable. But where it is considered that under natural conditions air cannot be changed more than three times per hour without creating a draught, together with the following table (taken from a reliable source) of the rate of increase of impurities, it will be noticed, and I think forced home to any of my hearers who may have control of such things, that air in a small space becomes impure quicker than in a large.

RATIO OF IMPURITIES FOUND IN AIR PER HOUR.

	1,000 cubic feet.	500 cubic feet.
1 hour	·12 per cent.	·18 per cent.
4 „	·30 „	·54 „
6 „	·42 „	·78 „

One is apt to speculate after perusing the above. What would be the figure for 72 cubic feet, under sea conditions where ventilation can generally be classified as non-existent ?

It is obvious, therefore, that for vessels trading in cold

climates, some system of heating the incoming air is necessary to enable sufficient air changes to be effected without undue draught, and adequate heating at that.

Ventilation can be classed under two broad heads, Natural and Mechanical. Of the natural system for marine purposes, the Boyle patent air pump system certainly ranks high. The essential features of this system are the air pump ventilator (uptake), consisting of an arrangement of metal plates, at certain curves and angles, enclosed in a central chamber, from which the air is exhausted through a series of openings or slots, by the deflecting of the current of external air across the opening, and so creating an induced current in the ventilator and up the shaft, and a down current ventilator of such a form, that the heads require no trimming, and a series of air shafts complete the system.

The makers claim for this system the following advantages :—

1. Boyle's Patent " Air-Pump " Ventilator creates a continuous and powerful up-current when the vessel is lying in harbour or sailing. The latest patent has double the extracting power of the earlier forms, so that smaller ventilators may now be used, effecting not only a considerable reduction in the cost, but also a saving in space.

2. It is entirely free from down-draught.

3. It is perfectly water-tight, and may be kept in action during the stormiest weather.

4. It is a fixture, and never requires trimming, acting with equal efficiency with the wind blowing upon it from any point. Having no mechanical movement, it requires no attention and can never get out of order.

5. Boyle's Patent Downcast Ventilators send an abundant supply of fresh air below, and have in an equal degree advantages 3 and 4.

6. The exhaust and supply pipes may be concealed behind cornices, underneath seats, bunks, etc., and do not interfere with the structural arrangements or decorations of the saloons or state-rooms.

7. Hot water or steam pipes may be placed within the supply shafts for the purpose of warming the air in cold weather. Ice-boxes can be also fixed in the main shafts for cooling the air supply in hot weather.

8. The air is admitted into the saloons and state-rooms through small vertical tubes, so that no draught is experi-

enced, and the supply can be regulated as desired by means of a valve fixed in each tube.

9. The warm vitiated air is exhausted at the upper parts to where it naturally ascends, and the fresh air admitted in a vertical direction at the lower parts.

10. The ventilators can be readily adapted to existing arrangements and fittings on board ship.

11. Being waterproof they are most suitable for the ventilation of ships' tunnels.

The mechanical systems can be again sub-divided into suction and propulsion. It has been said of the propulsion system that it causes stagnant places and consequently results in dirt and filth heaping up in out-of-the-way corners. A combined system of extraction and propulsion would possibly better meet the requirements. Steam jets have been used for creating a draught in ventilators, but the great noise and loss of water all worked against its success.

In connexion with the ventilation of the engine-room and stokehold a problem presents itself. Care should be taken, when natural draughts-methods are in use, to so arrange ventilators to prevent the air merely passing down the one and up the other. I would advocate a more efficient and satisfactory system of ventilating the bilges by extending both ventilators and uptakes down through the stokehold plates, the latter carrying some convenient exhaust pipe to assist in producing an up-draught. By this means a cool current of air would continuously pass under the plates, resulting in a cooling effect in the engine-room, besides greatly preventing the discharge of bilge fumes, directly into the engine-room, as is at present the case.

How often do we find ventilators in the stokehold and engine-room so placed and constructed as to be useless. The fact that a right-angle bend in an air trunk reduces the delivery of air by one-half seems to be unknown, or, where merely a matter of fresh air is concerned, ignored. Many cases are to be found where the back of the engine-room is supplied with ventilators, all too small under the best conditions, but rendered absolutely useless by two right-angled elbow bends.

The position of important ventilators on deck often sacrifices efficiency for appearance, and I am sorry to say the prevailing conditions are often intensified by the thoughtless persistence in erecting screens for a little personal comfort, smart appear-

ance and the protection of a small portion of the snow-white deck, so dear to the heart of the chief officer. Figs. 1 and 2

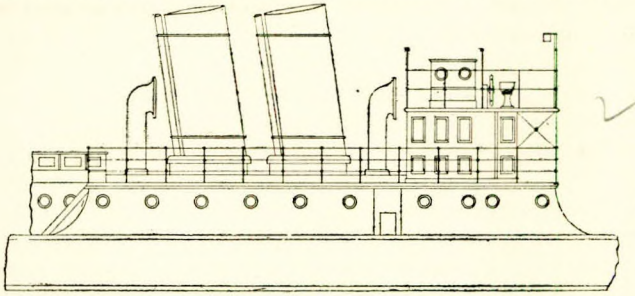

FIG. 1.

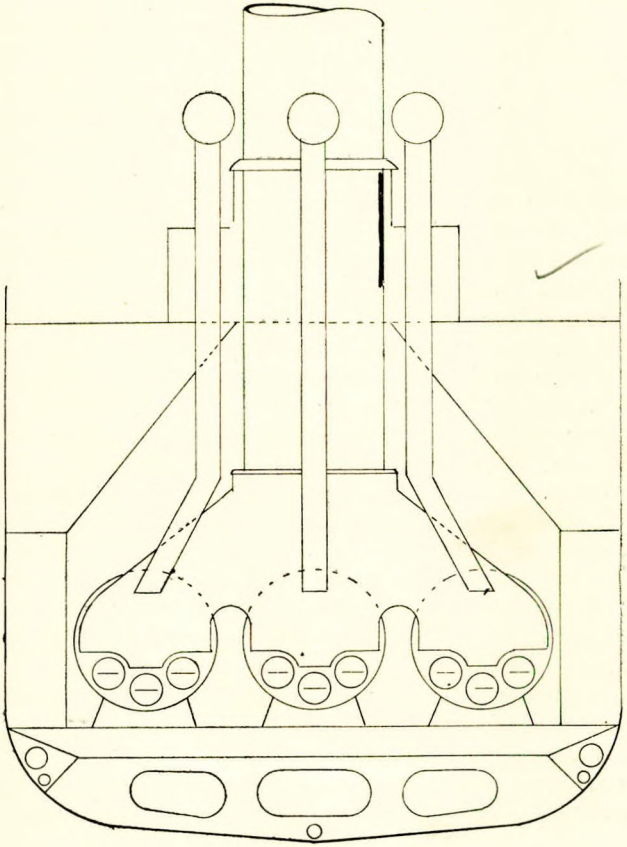

FIG. 2.

illustrate the common practice of placing ventilators on deck and in the stokehold. Perhaps the most glaring case of want of thought on the part of builders is illustrated in Fig. 3, which speaks for itself.

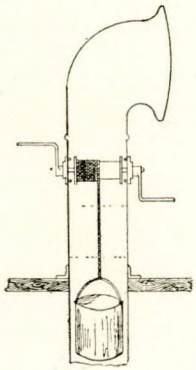

FIG. 3.

In connexion with the ventilation of an engine-room and stokehold, therefore, I would suggest the following rules :—

1. Use circular ventilating shafts instead of square, a circular section only offering seven-eighths of the resistance of a square of the same area.
2. Have shafts as short, smooth and air-tight as possible.
3. So place the up-takes and down-comers as to avoid air merely passing down the one and up the other.
4. Avoid angles and bends.
5. Fit cowls to both up-takes and down-comers.
6. Arrange ventilation and exhaust steam pipes so that the otherwise waste heat of radiation will assist ventilation.
7. Do not sacrifice appearance on deck for efficiency of ventilation.

CABINS AND BERTHING.

The general arrangements of cabins for the passengers, and especially those of the ship's company who have to make the vessel their home, now demands attention ; by cabins I include the berths of the ship's company as well as those of the commanding officers.

Perhaps the most satisfactory position for berthing accommodation is in the alleyway, but, like everything else, it is

not sufficient that a berth should be so placed ; a little thought is also required to ensure the best arrangement of berths.

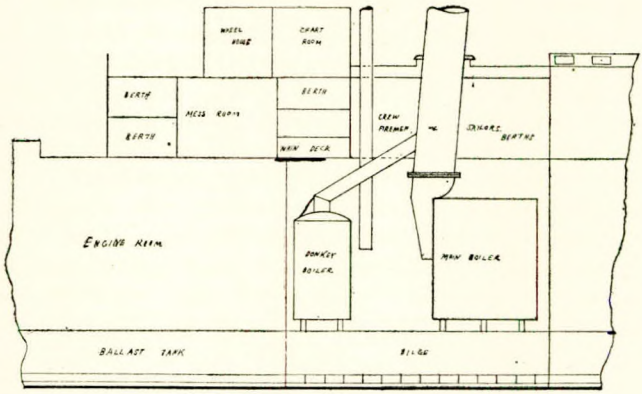

FIG. 4.

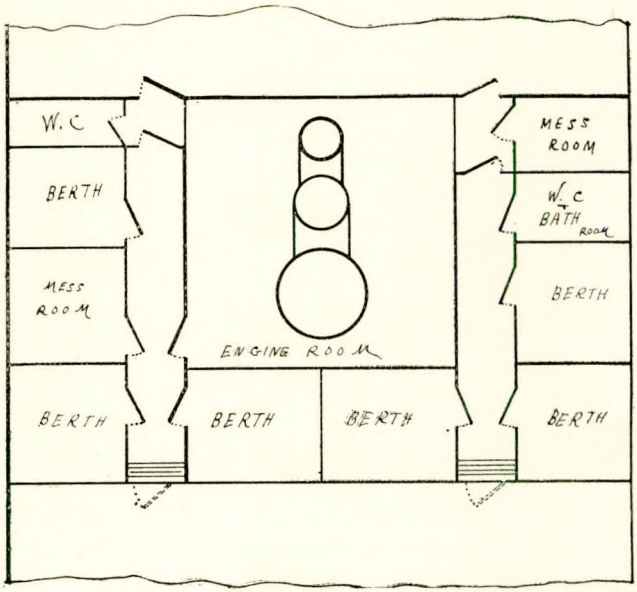

FIG. 5.

Such conditions as you have illustrated in Figs. 4 and 5, I am sorry to say, are not uncommon in the mercantile marine.

And I say that the placing of berths adjoining engine-room, galleys or stokehold, the berthing of firemen in the fiddleys and engineers in the engine-room, is a practice which should be abandoned as both insanitary, dangerous and intolerable.

Berths in modern ships, generally consigned to those whose duties are both responsible and trying, are still constructed where the temperature and impurity of the air from moisture, engine fumes and bad ventilation are so great as to make even the necessary repose a matter of impossibility. Sleeping berths placed next to the galley, with bunks separated from the cooking stove by a thin steel bulkhead covered with thin match boarding, or what might be termed a special incubating apparatus for bugs and beetles, are also conditions which, in this twentieth century, do still exist and which have to be

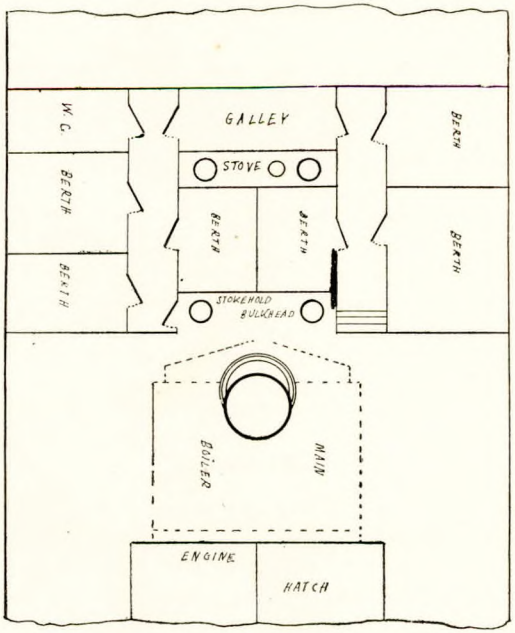

FIG. 6.

tolerated by those who enjoy "A life on the ocean wave." See Fig. 6.

In connexion with berthing in alleyways, care should

be taken to ensure a through current of air at all times, and that cabin doors are as far as possible away from those of w.c., baths, engine-room and galley; parts can be then arranged opening into the alleyway with very beneficial results.

In this direction I would strongly advocate the introduction of a form of Tobin's tube as used ashore, fitted with a cotton air filter to remove any particles of dust from the entering air.

The practice of fitting sounding pipes to bilges and tanks in places used as berthing accommodation should decidedly be discontinued. Not only is there risk of contamination of the water due to animal and other impurities passing down the pipe, but badly fitting plugs, as they usually are, allow foul gases to discharge directly into small berths. Badly constructed and badly ventilated lavatories discharging impure air into blind alleyways could be remedied. I am sure that those who are personally acquainted with the facts will agree that these conveniences at sea, especially those marked "For crew's use," are not of the best.

Paint locker and bo'sun's stoves next to forecastles and the use of the fore peak as a general store-room, with only an opening through the forecastle, covered over with a few planks, all indicate a want of thought on sanitary subjects on the part of those responsible for ships' construction; while the common practice of fitting shelves and food lockers in forecastles, where one watch or the other are always sleeping, and in the case of what might be termed "weekly boats," such provisions meat, fish, etc., stored in the forecastle, should be at least changed in practice.

Heating.

The earliest method of heating was by stoves, and to-day in many instances this type is still in existence. My own opinion is that in many cases it is the best means of heating remote parts of the ship, but not the type as usually seen. A proper ventilating stove would solve many problems, but to allow the use of an ordinary cast-iron stove with a funnel passing through the ventilator, stopping ventilation and pouring poisonous carbon monoxide into the air, to say nothing of organic particles in the air giving rise to a sickly odour, is a condition which cannot be too strongly condemned.

Steam heating is handy and, if combined with ventilation, is satisfactory. Dr. Reed, M.D., says the following about steam heating :—

" No system of warming by hot pipes is advisable unless both inlet and outlets are provided for ventilation," and from this it is obvious the practice of introducing a series of steam coils or pipes only is harmful and objectionable, only less so than unhealthy oil stoves, heated bricks, or drums of hot water frequently changed.

The coils are usually placed in out-of-the-way corners, they collect dirt and filth, which is duly baked and dispersed in fine powder to be breathed by the inmate, or where a pipe is led along the floor of a cabin, collecting around it all the débris. Leakage of joints makes the berths damp, and the noise caused by water hammer action, the minor trouble, is certainly undesirable and frequently extremely objectionable.

In connexion with heating and ventilation system the patent Ventilating Thermo Tank is good, and is shown in Figures 7 and 8.

The system consists of a cylindrical tank fitted with tubes from end to end, the whole being enclosed in an outer casing, connected with which is the discharge fan.

The heating medium (steam) circulates in the cylinder (round the tubes), while the air to be heated passes through the tubes, as shown in the illustration.

The system can be admirably adapted for cooling the entering air (for vessels trading in the tropics) by connecting the Thermo Tank to the refrigerating brine circuit, or connecting the tank to the refrigerator, upon the expansion system.

The makers kindly furnish the following description of the apparatus :—

In order to show the working of the Thermo Tank for supplying, circulating, or exhausting air, different valves have been arranged and lettered A, B, C, D, E, F, respectively, on the sketch, and the mode of operation is as follows :—

1. Heating and cooling fresh air supply. Valves A, C and C are closed. The air then enters by the valve B and is driven by the fan through the tubes in the Thermo Tank (which is either heated or cooled as the case may be) into the trunks through the valve D. It is then distributed to the compartments by the louvres in the usual way.

2. Exhausting foul air. Valves B, C and D are closed.

The air is then drawn by the fan from the trunks through the valves E and F, and there discharges to the atmosphere through the valve A.

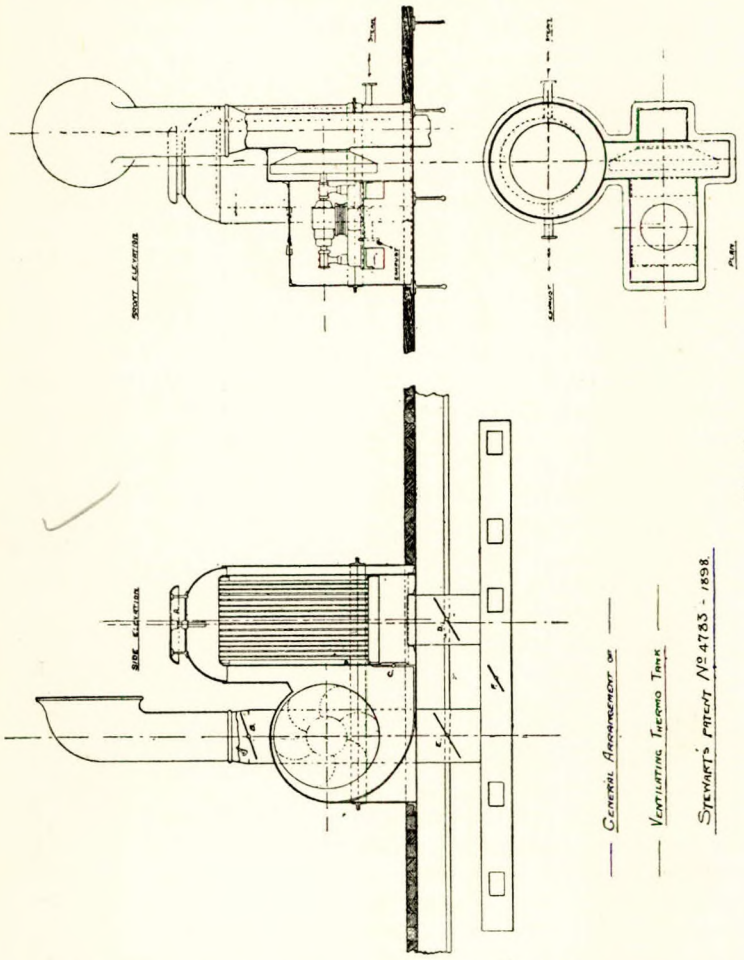

Fig. 7.

3. Fresh supply of air at atmospheric temperature. Valves A and E are closed, the air is then driven by the fan through the valves B, C and D into the trunks, and also to the compartments.

4. Circulating air through the compartments. Valves A1,

B, C and F are closed. The air is then drawn through the valve E from one section of the trunks, and is then driven through the tubes to the other section of the trunks through the valve D, thus maintaining a continuous circulation and heating the compartment very rapidly.

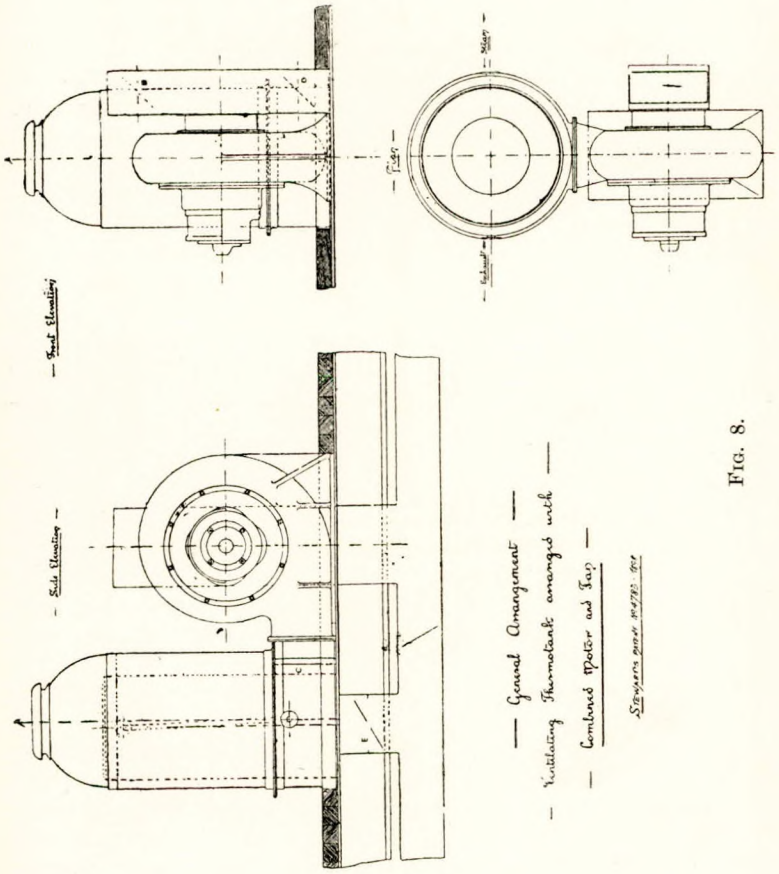

FIG. 8.

It is not sufficient that apparatus are made and placed on the market claiming sanitary advantages to justify their use. An investigation of the many discarded apparatus ashore since sanitation and sanitary experts have come prominently into existence will justify this remark. In fact, a close study

of the various methods would be a material help in solving the complications that a modern steamship offers.

The problem presents difficulties which can be only solved by combining a knowledge of practical sanitary science with an intimate acquaintance with marine conditions in all their phases.

That improvements can be effected in even existing vessels is apparent, and that in many cases where owners have fitted special appliances at considerable expense, these appliances more often than not prove not only useless, but an encumbrance, is too truly a fact. The introduction of forced draught, liquid fuel and turbine arrangement, while offering advantages and being a step in advance, make it more than ever necessary to study ventilation for humanitarian reasons. It is not sufficient to indiscriminately sluice around fluid from a drum labelled "Disinfectant," and to imagine that that and the sea air will do the all in all required.

Upon the subject of disinfectants I repeat an extract from my previous lecture as possibly being acceptable information.

The term disinfectant should be only applied to those substances which are absolutely destructive to disease germs; many so-called disinfectants are merely antiseptics, that is, they prevent disease germs from developing, but in the strength used on board ship, even the best can be ranked as merely deodorants and of practically little or no use.

Dr. Reid says, "The essential condition of a true disinfectant is that it shall be capable of killing germs and their spores, it shall be applied to every part, in sufficient strength for a sufficient time."

Taking two of the best, namely, bichlorate of mercury and carbolic acid, we find that to be effective a solution of 1 in 1,000 in the first, and 5 in 100 in the latter is required. Below this it degenerates into an antiseptic, and as practised in the engine-room on board ship it is merely so. It would require a veritable cargo of carbolic acid to effectually disinfect the engine-room bilges on an ordinary short voyage. It is obvious that sanitation does not wholly lie in disinfecting fluids.

It has always been a matter of surprise to me that such poor attempts have been made, when designing a ship, at ventilation and ship's sanitation in general. Confining myself to the section laid down, namely, ventilation, heating, berth-

ing of ships, I would suggest that owners, builders, superintendents and the ship's crew in general could do much to improve the conditions, for it can be laid down as a maxim "A healthy ship is a wealthy ship."

To the owner I would say, do not grudge such space and conditions for your ship's company as will make their forced home afloat livable in all climates.

To the builder. Consider the sanitary side of marine engineering and naval architecture. You have hot pipes which could be aptly used for desirable ventilating system in conjunction with trunks, such as tunnels, casing, masts, derricks. Remember human beings have to spend many valuable years of their lives in the confines you fashion.

And for all those who go down to the sea in ships.

Remember each other and for a little personal comfort or possible inconvenience do not inflict such a condition on others as makes life burdensome and unhealthy; adequate light, heat and air are reasonable conditions and go a long way to help an efficient service from all hands.

CHAIRMAN: Before we separate, I hope you will give Mr. Battle a very cordial vote of thanks for the lecture we have just heard. All of us who have travelled on board ship have experienced the many inconveniences which must of necessity arise there,—some of these are preventible, and the remainder are enough already, without adding those which are unnecessary. Put in one sentence, I think the point of Mr. Battle's remarks is, that in this important matter people should not be content to do as their grandfathers did, but should freely exercise their own commonsense and experience. The subject is an important one, and the importance of it will be still more recognized in the future.

Hearty votes of thanks were accorded to Mr. Battle for his lecture and to Sir Alexander Kennedy for presiding.

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On Monday, October 7th 1907.

PRESIDENT'S ADDRESS.

CONTINUED DISCUSSION ON "SALINOMETRY,"

AND

REPORT OF THE ANNUAL DINNER

HELD IN

THE KING'S HALL, HOLBORN RESTAURANT,

On Wednesday, October 30th, 1907.

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