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Mechanical Ventilation and Heating as Applied to Ships.

BY THOMAS WRIGHT (Member)

READ

Tuesday, March 2, at 6.30 p.m.

CHAIRMAN: MR. F. M. TIMPSON.

The CHAIRMAN: The subject of Mr. Wright's paper is of great interest, particularly at the present moment, in connection with oil-engined vessels, on which Mr. Wright has some remarks to make.

ALTHOUGH the subject of ventilation and heating does not come so prominently before the minds of marine engineers as the engrossing problems in the utilization of the natural sources of power for propulsion, it must of necessity in its bearing on the health and comfort of the individual, both passenger and crew, and in its bearing on the many conditions in the satisfactory working of a ship, be one of commanding interest. Not only does the competition in the passenger carrying trade —probably as keen to-day as at any previous period, and the rapidly increasing numbers of ships fitted with internal combustion engines, call for adequate and carefully considered systems of ventilation, but there is, as is noticeable in the trend of legislation for workshops and factories on shore, a decided tendency to provide for the passenger irrespective of his class and for the members of the crew irrespective of his rating conditions more compatible with his well-being.

It is now many years since the subject began to receive the consideration it deserves, and so far as the author can find out, the American Line were the first owners of relatively large ships to utilise fans for the discharge of fresh and, when necessary, heated air through trunking to the various sections of their passenger accommodation. Their efforts were in the main successful; and, though since that time more efficient fans have been produced and experience has shown improvements in the proportions and runs of ducts, etc., the outcome was undoubtedly a long step in the improvement on existing conditions. At the outset it is advisable to consider what can be laid down as satisfactory conditions as far as the individual is concerned, and later to touch on the requirements of the inanimate, and to this end some general remarks of the hygiene of ventilation may not be out of place. The human being is so constructed that the breathing again of air, a large proportion of which has already been breathed, though not always apparent through uncomfortable sensation, produces ill-health and incapacity to resist certain diseases. It is clearly demonstrated that this is not due to the excess of carbonic acid gas, or the absence of oxygen within reasonable limits, nor can it be traced that these deleterious effects are produced by any organic inhalation which on rebreathing is poisonous when absorbed in the blood. From various eminent authorities it would seem that uncomfortable sensation is brought about by undue retardation or increase of the heat loss consistent with physical welfare, the retardation principally by the stagnation of the air, and the increase by abnormal temperature. The degree of humidity has also a considerable bearing in this respect. When the air is too dry, moisture is absorbed from the breathing organs and from the skin, and when too damp, again causes abnormality in the heat loss. Minute particles in the form of dust, and brought from a variety of sources, should not be omitted from consideration, as they in many cases are of an irritant or infectious nature. Incidentally it might be pointed out that a ray of bright sunlight will show to what extent the atmosphere is laden with these particles. The physiologist and the careful medical experiments which have been made of recent years have produced much valuable information, for which the ventilating engineer is indebted, but generally, and in connection with ships it is rather to the result of experience and to what has been proved as most acceptable to passenger requirements that the present position can be attributed. Broadly the standards laid down in the production of practical and satisfactory ventilation might be stated as follows:—

(a) That a certain number of cubic feet of pure outside air shall be delivered to each compartment in a given time in such a manner as to obviate its moving at a velocity higher than that pre-arranged.

(b) That the system be such as will insure such removal of vitiated and dust-laden air as will permit the previous clause to operate effectively, and also to obtain freedom from odours from quarters inseparable from the working of a ship.

(c) That the temperature be maintained in the various sections of accommodation to the requisite degree.

(d) That results should be obtained with due regard to economy in space, and in power involved.

The Board of Trade lay down in their instructions to surveyors that proper ventilation in every space appropriated to officers and crew is one of the most important points the surveyor has to consider, and decide upon in crew space inspection, and though no hard and fast rules are prescribed in the case of the use of a mechanical system, approval is only consequent on the details ensuring efficiency under—irrespective of the last—the gist of the above clauses. The intent is similar so far as other accommodation is concerned. The greater part of the passenger carrying steamers make use of the combined fan and heating unit designed either for the direct discharge of air, or alternatively as a unit capable of also extracting the air from its connected compartments, and these are turned out as a speciality by several well known heating and ventilating firms and embody in various measures the saving of weight, compactness, ease of control, and efficiency. These units in the average are fitted with 20in. fans, which in a well designed type are driven by electric motor at about 850 revolutions, will supply 10,500 cubic ft. of air per minute, and approximately give six changes of air per hour to each of the thirty-six average cabins. The size of the ventilating and heating unit is, however, governed by the duct areas which can reasonably be accommodated, and the advantage of being able to regulate the temperature of accommodation situated inboard as compared with that adjacent to shipside follows on the allotment of the separate units to distinctive blocks. Interconnection of the duct systems in many cases is of advantage to meet the varying conditions and requirements. Within the past few years several large steamers have been fitted with electro vapour heaters of capacities to meet the temperature requirements, but whether with advantage from the point of view of economy, consideration of initial cost, and upkeep, considerable uncertainty exists. Heating under these conditions permits the passenger to regulate the temperature of his own cabin to meet his peculiar conception of what is desirable. This is by no means unimportant with people, berthed under the same conditions of heating, who have been used to different climates. It is probably due to the relatively greater humidity of the English climate that an internal temperature of about 60° is sufficient, whereas in America and on the Continent where the air is normally drier, temperatures of 68 to 70° are invariably demanded. Of more or less recent date the adoption of a louvre, of which several types are on the market, and which is designed to give a flow of air in any required direction and at the same time to regulate, or entirely shut off the supply of air, has by its being accessible to and under the control of the passenger, gone a long way to meet this demand for varying temperatures and conditions.

With a system which discharges air to the various compartments there must be of necessity the provision for outlet to a corresponding degree, and generally in the arrangement of accommodation it has been found satisfactory to fit suction fans in lavatory blocks opening on to the main passages and thus in extracting the air issuing from cabins to passages ventilate efficiently both the passages and the blocks referred to. Similarly odours from galleys can be prevented from percolating in an undesirable manner. The reference in the foregoing has been mostly to the superior class of accommodation, and it is possible, though somewhat irrevelant to the subject in hand, that greater necessity may exist for the utmost attainment in ventilation and heating for its users as compared with those for whom an inferior class of accommodation is provided. However, where the statutory conditions are complied with, and merely to that extent, there is ample scope for improvement in the conditions of the inferior accommodation.

To the heating and ventilating engineer two of his principal considerations are the design and efficiency of the fan proper and a clear conception of the discrepancies, or rather apparent discrepancies, which occur therein and in the delivery of air through the necessary irregular leads of ducting. Two classes of fans cover practically the whole field, the one calling for little comment, as its action is merely that of the inclined plane or screw propeller, and its uses are, for the major part, confined to the production of movement of air in spaces, against little or no resistance. Hung from the deck, and of adequate proportions, there can be arranged without difficulty just sufficient movement of air in the larger compartments to give the agreeable sensation produced by movement without the effect of draught. It has never struck the author that the movement or even the appearance of large size propeller fans in motion in public compartments on board ship is consistent with passenger comfort, but with the louvre previously described and its directional and regulating capacity, it is possible to produce by a studied system of direction of air currents this beneficial effect of movement without objectionable features. The other class of fan demands more attention, and, in present day use, is the embodiment of improvement on the multi-bladed centrifugal, or what was termed the "Squirrel-cage" runner type. A word on its development may be of interest.

In 1863, Bennet Hotchkiss, of New Haven, Connecticut, U.S.A., designed and patented a multivane fan-wheel or runner which was considerably more efficient than previous designs. It had long narrow scooped blades forming a cylindrical drum with an open centre, a large eye, and the inner and outer longitudinal edges of the blades were parallel to one another and to the axis of the wheel. Several stages in improvement in the subsequent development of the machine can be attributed to such well-known types as the "Sirocco" and the "Sturtevant." At a later date, say since 1906, designs to which various terms might be applied, with their stronger and lighter construction, were adopted with consequent further improvement. Experiments on the part of the late Mr. James Keith and others, to meet the increasing demands from all sources for greater efficiency, had decidedly successful results, and between 1908 and 1910, the introduction of a distinctly different type from the same source produced a multi-blade fan, which the term "Conoidal" distinguishes, and which is used for the major part in pressure-volume work to-day. Briefly, it might be said that in using fewer but deeper blades of calculated configuration, the passage of the air through the impeller has brought about streamlines more free from sudden change in direction and of reasonably continuous course.

In shape a truncated cone, and with double inlet, the same in double form, and tapering inwards, the impeller or runner has built on its shaft deep and curved blades, their outer and inner edges inclined to the axis of the runner and their inner

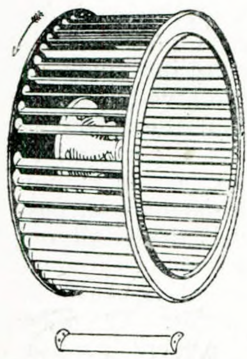


Fig. 1.—"Hotchkiss,"

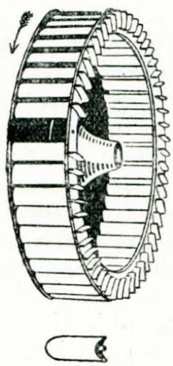


Fig. 2,—"Barlow."

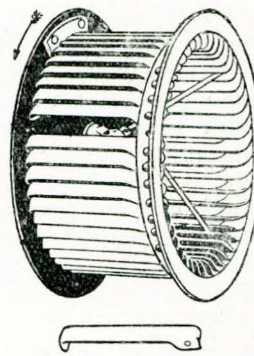
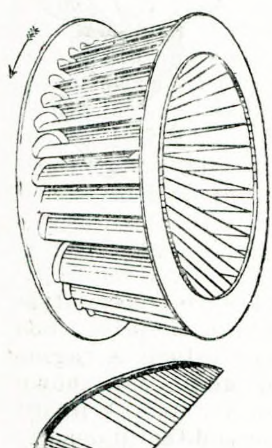
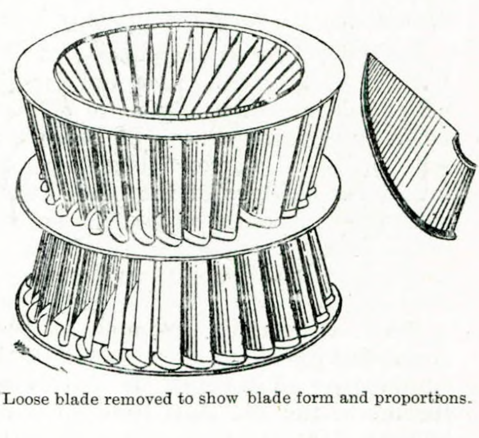


Fig. 3.—"Sirocco."

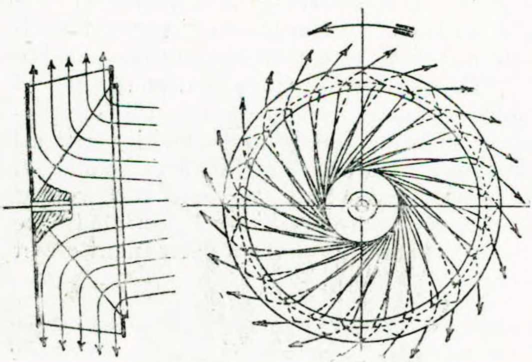


Loose blade removed to show blade form and proportions.

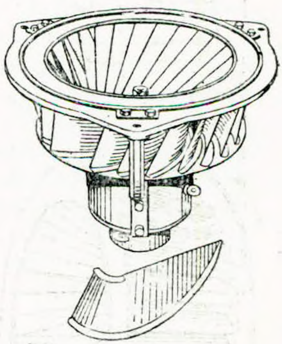


Loose blade removed to show blade form and proportions.

edges askew to the same axis. The design relieves the incoming air to a great extent from distortion or eddying, and gives to it more uniformity in passage through the runner without excessive thrust, or, as was experienced in the earlier designs, a tendency to recirculation. In working, the type has shown itself particularly noiseless, and in itself it is rigid in construction, thus obviating the necessity for internal staying. The demand for volume-pressure air in deep engine-rooms, for forced draught, and in the closed stokeholds of warships and torpedo boat destroyers, and its production with the minimum of space, also brought about what can be termed the "open" type of this "Conoidal" fan, a type in which the blades follow closely on the lines of those in the fan above described and in the truncated cone are deepest where the diameter is the least. The direction of rotation is to the opposite hand as compared with the closed fan, and the configuration of the blades tends to give an increased induction in the intake and a more uniform delivery along their outer inclined edges.



Open " Conoidal " Runner.



" Open " Tpye

*A very excellent example of the use of these "open" type fans was given in a paper read at this Institute in 1915, when descriptive sketches of their installation in the turbine engine rooms of the SS. *Aquitania* were included, and it was shown that the results were of a very satisfactory nature. Without retracing the ground then covered it may be said that it demonstrated the effect of the utilization of the absolute velocity of the air at the point of leaving the fan in diffusing the air in a most favourable manner, and thus sweeping out the more or less pocketed areas in the engine room wings. Not only this, but it also demonstrated the reduction in power involved as

* By the late Jas. Keith on Nov. 2nd, 1915.—J.A.

compared with a system delivering air in identical volumes from fans situated at the skylight level. That this class of fan should find favour in motor vessels is as would be expected, but as contrasted with the above application, an obstacle in the way of obtaining the same results is met with by the casings in the enclosed type of main engine barring the way, when twin-screws are used, to the outboard passage of the air. The wings therefore of this class of engine-room require their separate ventilation, and the need is in especial degree in the vicinity of the engine's generating power for auxiliary purposes. That conditions compatible with the health of the engine-room staff and at the same time consistent with the maintenance of efficiency of the internal combustion engine, can, and must be brought about, is undoubted. In the first place, and bearing on the matter of health, the following excerpt from a recent letter by the Liverpool Port Sanitary Authority to the "Lancet" throws light on the seriousness of the present position. In writing on the injurious effect of vapours inseparable from motors, he says: "These are so obvious that at the end of a voyage, anyone could separate with accuracy the engine-room staff of a motor vessel from that of a steamship—not all are equally affected, but an occupation which causes headache, drowsiness, vomiting, loss of appetite, an evident pale yellow tinting of the skin, and a great susceptibility to an obstinate type of furunculosis (boils) is likely to have a permanent effect on the strongest constitution in time."

Confirmation is not wanting from other sources. The question has been raised, and is being given the serious attention of the owner and the shipbuilder, and the author is inclined to think that a closer co-operation with the ventilating engineer would be of benefit, and would bring to bear the experience of the latter in dealing with the many phases in industrial practice where poisonous or semi-poisonous gases are dealt with. In the second place, and bearing on the matter of the efficiency of the internal combustion engine, it is evident on the presumption, and it must be so, that greater volume of air will be required to overcome the difficulty, that there would be, in many cases, the necessity for the application of heat to the source of supply, when the air used for the engines is taken direct from the engine-room. It would not seem impossible to obtain this heat from the waste gases of the engine, or to obtain sufficient heat from the same source to meet the requirements of the engine alone.

Should this paper, in bringing the question of ventilation in motor vessels before the Institute, be of no other service, it will, in the opinion of the author, have served a good purpose.

Mechanical ventilation has its uses in connection with certain classes of cargo, and in the drying out of holds, in preparation for incoming, after the discharge of refrigerated cargo. With certain classes of fruit, which in transit is kept at a temperature of from 38° F. to 40° F., a continuous circulation of air is maintained and renewal provided for once in every five or six hours, the air passing over brine grids before entering the chambers.

In a recent "Special Report" from the Food Investigation Board of the Department of Scientific and Industrial Research, dealing with the leakage of carbon dioxide gas from "unventilated" holds of ships, it is stated that the necessary leakage for successful apple carriage is of the order of 25 cubic feet of air per ton per day to keep the carbon dioxide content within the safe limit of 10%. Apples, it seems, produce, even at the temperature of cold storage, carbon dioxide, and in an air-tight chamber the gas accumulates until a concentration is reached which will injure the fruit. That the average chambers are far from being as air-tight as it was presumed is shown, and the report suggested that the use of a small motor-driven fan for extracting through thermometer tubes this air in sufficient quantities is expedient and necessary. Important investigations are also being carried out by this Board in respect of "Air Conditioning" or means of obtaining the requisite degree of humidity of air in the storage of fruit and produce.

In conclusion there would arise the question of test, and as much as in any other phase of engineering does it happen that complete results depend, not only on individual values, but on the values of varying conditions in combination. The fan in itself has become so specialised that for standard sizes, graphs, corrected from practice, of its variations in speed, volume, pressure and horsepower involved, also for temperature, can be relied on to very close limits, and the accumulation of experience in the resistance of trunking, the design of junctures, bends and leads, places both suction and discharge quantities beyond inaccuracy, but to the interested engineer even no complaints have arisen from passengers or crews, it being a very fair criterion if these sections can be dealt with without being conscious of the mechanical means employed—there is still much data from the varying conditions in marine practice which would be of interest and value.

The CHAIRMAN: Mr. Wright has given us much to think about, especially in the matter of ventilation of motorships. It is no doubt a subject deserving very earnest consideration, and one which can only be touched upon to a minor degree in a paper such as this. No doubt there are many of our members who have experienced the discomforts of bad ventilation of machinery spaces on board ship, and it is well that the new problems affecting ventilation of marine motor engine rooms should become known in order that they may be dealt with. The question of the carriage of fruit has received considerable attention, and some experts at Cambridge University were detailed to investigate the subject some time ago. It is also necessary to keep electric motors cool in ships where electric auxiliaries are used. I heard only a little while ago of motors burning out due to becoming overheated, when improved ventilation helped matters subsequently.

Mr. Wright will be pleased to answer questions relating to the paper.

Mr. W. HAMILTON MARTIN: With reference to the matter of health referred to by the author, the following may be of interest. Only a few weeks ago I was told by a well known Marine Engineer in Liverpool of this trouble they had among engineers, and as a specific instance he mentioned a case of a sturdy young engineer who had sailed some time in a motorship, and had turned yellow in the way described in the article in the "Lancet," by Dr. A. G. G. Thompson, Assistant Medical Officer of Health of Liverpool. He had to give up sailing and luckily was successful in obtaining a good shore position, which is the exception in these days. In some cases I understand there have been difficulties to get men to stay on motorships which make extended voyages to warm climates and which allow them little time to recuperate when at home.

Dr. Thompson suggests the obvious remedy, better ventilation. As we have been told to-night by the author, there are several very efficient methods available to-day to give us improved ventilation. All these methods, however, require fans and the necessary driving means, while extra space has to be allotted to them, and apart from the capital outlay, it means more upkeep, attention and fuel expenditure, and a certain amount of extra weight carried.

The author suggested making use of the exhaust gases to heat up the supply of air when required. There is, however, another way of making very good use of these gases to materially assist in overcoming the above-mentioned trouble. We can make use of the energy contained in them to induce a large amount of vitiated engine room air to be drawn up the vessel's funnel, and in such a way create a very powerful and efficient engine room ventilator, requiring no special driving means for this part of the vessel. Otherwise wasted energy is thus usefully employed, increasing overall efficiency. This has been done in some vessels with great success: all trouble from fumes, etc., has been completely overcome thereby. It might be possible to extend its use to holds, etc. The illustration shows you the arrangement; the gases enter from below into a chamber through a special type of valve which damps the impulse action of the gases and thus a substantially constant flow is obtained, which incidentally results in silencing their "kick." The gases are then made to pass through a series of baffles in a lagged chamber, after which they leave this through a vertical nozzle and enter the contracted part of an ejector shaped set of pipes. As the gas velocity has now become practically a constant one, it can then be made to induce a great amount of comparatively cold air along with it, which air is the vitiated engine room air drawn up through the skirting surrounding the base of the funnel. The hot gases and the colder air then gradually expand and mix in the upper part of the combining tube to atmospheric pressure, when they silently escape by the louvres at the top of the funnel. The cooling and retarding effect in this expanding tube at the same time acts as a very efficient spark arresting and extinguishing medium.

To prevent rain or spray finding its way down the silencer nozzle, a set of louvres are fitted with a bilge connection down the centre of the funnel.

Three useful purposes are thus served at once, as apart from it being a powerful and economical means of engine room ventilation, it is also a very effective exhaust silencer and spark arrester, reasons which should lead to its wider application in tropical climates especially.

It would no doubt be possible to heat part of the air entering the engine room if required for the engines, by bringing the downward supply around the exhaust piping, or outside the baffle chamber of this silencer, taking the place of its lagging.

The author has brought an important subject before us which is of interest to many of us at present, and for which I would add my thanks to him.

Mr. A. Jobling: I would have preferred that the author had dealt more fully with the method adopted in keeping fruit cargoes in sound condition and particularly apples free from CO_2.

This seems to be one of the most difficult cargoes to keep right and it speaks volumes for the care taken by engineers in charge of fruit boats that so few cargoes turn out bad.

As the Chairman points out, a Research Committee have been studying this type of cargo, but in my opinion the best information will come from the chief engineers.

With apple cargoes, there is evidently much importance to the size of the dunnage used, also to the arrangement of the tiers, the ducts between them, as well as the amount of space separating the wing tiers from the grids.

Much useful information could be elicited from the right quarters in answer to the queries raised by Mr. Wright's paper.

The Author: The question of dealing with fruit cargoes is one which presents difficulties due to the difference in type of fruit, different requirements for different varieties of the same species, and the condition both in which the fruit is put on board and that required on discharge, but so far as this paper goes, it may be sufficient to say that when carried under ventilated conditions and with the air being changed every five to six hours and kept to the requisite temperature, satisfactory results for the greater part obtain. The research which was carried out at Cambridge dealt with what might be termed non-ventilated holds, and it has been shown that—and to an unexpected extent—there exists a considerable leakage and stirring up of the air with consequent reduction in the carbon dioxide content. The quantity of CO_2 was found where apples were concerned and in storage for some four weeks, to be twice as much half way down the hold as at the top. It was considered that the spilling of air through crevices in hatches caused a distribution of CO_2, inconsistent with what would be expected due to the gravity of the gas. The committee suggest that the thermometer tubes should be led down at various depths in the hold so that the carbon dioxide content could be lessened by extracting with small fans part of the mixture in the hold and allowing corresponding quantities of air to replace it—thus keeping to a safe limit.

Mr. A. F. C. Timpson: One point has been raised in connection with fumes in Diesel engine rooms, and a suggestion has already been described for drawing away the vitiated air. That still leaves the question of the oil fumes inside the engine framing itself to be considered. I believe there is an apparatus on the market for extracting that vapour and recovering the oil from it, thereby reducing the amount of oil vapour present in the atmosphere of the engine room.

The Author: On this point fans have been fitted in the latest Diesel-engined vessels to extract from the casings a certain quantity of vapour arising from the lubricating oil, thus preventing its percolation into the engine room, but the apparatus referred to by Mr. Timpson has not, so far as details and results are concerned, been before me. It is supposed that a certain amount of the detrimental effect to engineers is due to the inhalation of not only the burnt gases, which might partly be caused by the opening of the small cocks at the bottom of the cylinders to see if they are firing, but by the inhalation of lubricating oil, which has found its way from engine casings. How far this latter is involved—that is the escape of lubricating oil—can be surmised by the effect oil has on the nasal organs.

I think, again, that an amount of the detriment arises from tank tops, from the waste oils lying about in the average motorship engine room, and the mixing up on tank tops of various foreign matter during repairs, when more or less poisonous fumes may be given off. I have enquired from the engineers responsible for the running of motorships, and they confirm my assumption. Some of the motorship engine rooms are not particularly clean, and would present a considerable difficulty, especially in the region of the auxiliaries to being kept in constant cleanliness.

A Visitor: Having read this paper and being away for some time from sea life, I have come to the conclusion that much more attention has been devoted to the ventilation of fruit cargoes than engine rooms. The various problems raised have been met with also on shore, and if a big building is put up, ventilating engineers are employed to provide fans, ducts, extractors, etc., and in 1926 there is no difficulty in putting in ventilating plant which will fulfil all requirements. On the assumption that if ventilating engineers were given a reasonable say before a ship was built, there would be no difficulty in providing suitable plant to make the engine rooms hygienic and comfortable. I would like to have heard the author say a little about the distribution of air in public rooms, the position of inlets, and the differences of temperature permissible in the air. I think it is about 10°, as compared with the outside temperature, which is considered comfortable. On a hot day in the summer 15° less would be quite cold and uncomfortable. I would also have been glad if the author had stated what is a permissible air speed at the inlets. I suppose in an engine room, or in a public room for that matter, it is necessary to have mechanical extractors, and if sufficient speed is allowed, there is a limit. I imagine there are inlets, and the air must obviously be forced in by mechanical means, yet surely there is an air speed above which conditions become uncomfortable.

With regard to air washers, I have never heard of these being fitted at sea, but on shore the provision of such apparatus is quite common. They consist of a number of sprayers which atomise water through a screen. Here in London we can sometimes get eleven, twelve and even slightly more degrees difference in temperature. The author mentions that the Americans were the first to provide ventilation on a large liner. I think it is due to their climate. They are compelled to give far more attention to ventilation problems, also their buildings are much larger. I consider that ventilation of engine rooms calls for much more consideration than it receives at present.

Mr. J. S. Kistruck: My experience of ship work is very limited, and so far I have only seen one vessel in which an apple cargo was being carried, but I understand that the method of storing suggested by the author is the arrangement generally adopted. The whole side of the ship was a series of ducts, one side being the outlet and the other the inlet.

The Chairman: The author spoke about the atomisation of oil which the staff of the engine room would be breathing. I have heard it stated that quite a considerable number of gallons of lubricating oil became evaporated during the day, and the effect of this must be considerable. In the early days we were accustomed to engine rooms being battened down and being very uncomfortable, but in later years I believe much more consideration has been given to the subject. As I mentioned before, there is another question as regards ventilation of motors in connection with electrical machinery. In tropical climates, if the motors have not a large margin of ventilation they will frequently run hot. The question of ventilation of coal mines is studied very exhaustively, and I think that the information so acquired might with advantage be applied in connection with marine work.

Mr. J. B. Harvey: It appears to me that the ventilation of engine rooms is quite a simple matter as compared with the general ventilation of large passenger ships. I do not know whether the suppliers of fans for passenger accommodation consult the engineers on the subject, or whether they leave it to the builders, but I know that it is a very difficult matter to fit the ducts properly, with the result that one has ducts with inside bends in them, and thus one finds the supply of air is inadequate, and less than what was anticipated by the designers. The air has become side-tracked in ducts. I have known instances where it has been necessary to alter ducts by making easier bends so as to pass more air through. I should like to know, therefore, whether engineers leave the arrangement of these bends to the builders or whether they deal with the question themselves. If they do not, I think they should take the matter up with the builders with a view to seeing that proper ducts are provided.

Mr. W. H. Martin: I might add to what I said before that we have fitted the same method of ventilation which I have described, to land power stations.

Mr. J. B. Harvey: I should like to ask Mr. Martin whether that system is not likely to short-circuit the air. It appears to me that it is liable to draw the air in at the base of the funnel.

Mr. Martin: No, the gases shoot out at the top of the funnel at very high speed.

Mr. Harvey: Does it not draw the air from the skylight?

Mr. Martin: In the case I referred to, it is a ship with the funnel skirting on the deck. In a ship with a higher skylight, you would naturally fix the cone higher. That could be any length.

Mr. Harvey: My point was that the funnel, being near the skylight, might draw the fresh air in when taking the gases.

Mr. Martin: You might put a skirt in with wings to draw the air in from the engine-room.

The Author: As far as I can ascertain, the concensus of opinion amongst engineers is that improved ventilation of engine rooms is urgently necessary, and I have found that in some cases advice has been given to engineers to satisfy themselves as to the ventilation before proceeding to apply for appointment. Having dealt with the repair of a number of motorships during a period of three to four years, I have noticed when talking to engineers that their first complaint was of drowsiness, and inability to eat, and another of their complaints was that where their quarters were in the neighbourhood of the engine room, they were never free from the smell coming from the engine room. It is an open matter, and I am inclined to hold the view that the present Diesel engine room does not have sufficient consideration so far as ventilation is concerned.

I think, as regards Mr. Martin's sketch, for which we thank him, that a great amount of consideration should be given to ventilating the under floor spaces, because gases may accumulate which are not beneficial and may be detrimental to health. In the case of the engine room, I take it the flanges would be spread, because the engine closes off the passage of air from the wings. It would be necessary to have ducts to collect the air. It seems that there is a possibility of dispersing a considerable quantity of obnoxious gases by means of this device, but whether motorships will have funnels in future is questionable.

Mr. Harvey referred to the matter of ducting, and said that alterations had had to be made in certain ships recently, possibly I assume, to provide an increased ventilation. As a rule the shipbuilder has a considerable amount to do with that, and it is not always that a shipbuilder has the co-operation of a ventilating engineer—it is rather rare, especially in large firms which have staffs to deal with this matter. As a rule I have found that the shipbuilder is pretty well conversant with bends and junctures as regards their effect in designing a lay-out which will keep friction down to a practicable minimum. It is very well known that where there are bends and junctures (that is a duct leading into another duct or trunk) if such pieces are not shaped so as to be consistent with what has been found in practice to bring about what might be called a minimum of friction, some quite sharp right-angled bends will cause as much friction as 75-100 ft. length of similar sized ducting. I think with Mr. Harvey that in many of these cases even after the design has been got out with its provisions for the efficient distribution of the air, the decorator comes along and says, "Oh, that large radius is not at all necessary." That is common experience, but there is no doubt that the shipbuilder tries to keep to what is laid down as essential, and nowadays it is fairly clear what is good practice.

The question of screens was also raised. As far as ship work is concerned, as distinct from work on shore, these screens are unnecessary, if intended for the prevention of dust, etc., entering with the incoming air, and the question of humidity for which apparatus is used on shore to obtain a correct degree, does not present itself to any marked extent. The air is usually drawn from places whence it is desirable to remove such gases as are obnoxious to passengers, and discharged where there is the least possibility of its finding its way into fan suctions. It is a very remote possibility of the ventilator cowls being placed in such positions on the ship as would admit of them accepting air from other systems. In the case of a Diesel-engined ship, where there is a following wind there is no necessity for screens, as the exhaust from the funnel, where one is fitted, is comparatively small.

The question of the noise of fans has to be considered, and it is found that many of the types of fans at present on the market, in fact all the fans of well-known makers to-day, will maintain a certain pressure at a certain volume at certain revolutions without emitting the noise which was common in the fans constructed 15 to 20 years ago. As regards the passage of air through the main ducts, it might be laid down that, say, 2,000 to 2,500 feet per minute would be the velocity at which the modern fan would work, quietly and without carrying any indication of its running to passenger accommodation.

I think one member wishes to know the velocity at outlet of the large fans. That depends to a great extent on the method of arranging the ducts. It has been found of value to reduce for a short space the area of the ducts leading from the main trunks to large accommodation spaces, and to gain the advantage of a reduction in velocity and consequent freedom from draught at the point of discharge to the spaces concerned. It might be said that with the more or less modern system of ventilation there has arisen the application of what is termed a directional louvre, which at the same time has possibility of controlling the quantity of air that is supplied where it is fitted. It is made with openings to suit various conditions, and at first sight would tend to give the idea of promoting draughty ventilation. As a means of directing air, especially for ships going through the tropics, it has its advantages, but by arranging these louvres it is possible to control the currents of air so that in their striking and interlacing they will give just that amount of movement which in turn gives the fluctuation which causes in itself really good ventilation. Under these conditions, it is naturally necessary to keep up a higher pressure in the ducts.

The CHAIRMAN: We are much indebted to Mr. Wright for his paper, which should assist in directing attention to this important subject. I ask you to accord the author a hearty vote of thanks.

[Contribution from Mr. W. R. WALLACE, Member.]

NOTES ON MODERN MARINE PROPELLING MACHINERY WITH PARTICULAR REFERENCE TO INTERNAL COMBUSTION ENGINE TYPES.

The following notes are intended to represent an unbiassed and general comparison of the multitudinous methods adopted for modern propulsion in the mercantile marine, together with an attempt at indicating the trend of future evolution in this branch of engineering.

The present day shipowner has the choice of an almost bewildering variety of means for transforming the energy he buys in fuel into mechanical energy at the propeller, but his main division of choice will lie between the steam and the internal combustion engine; while these again, will be further divided, the former into three main alternatives, namely, the reciprocating engine, the turbine (geared or direct coupled) and the turbo-electric drive; while the internal combustion engine will be either in the form of the simple oil motor or the so-called Diesel-electric drive.

It may be mentioned here that no attempt is being made to deal with the smaller classes of marine engines, in which field the semi-Diesel engine enters to a large extent, but only deep sea going vessels of 3,000 tons gross or over are in mind.

Before discussing the main types or their sub-divisions, it would, perhaps, at this point, be as well to consider just what is required from a marine propelling plant. The answer to this, it is suggested, is a plant capable of maintaining the horsepower specified by the owner, and possibly some slight reserve of power, with a minimum fuel and upkeep cost over a period of from 20 to 30 years.

The period mentioned might, perhaps, be emphasised in view of the rather extravagant claims made in certain journals devoted to the internal combustion engine, which are inclined to overlook the important fact that an admittedly quite considerable saving in fuel per annum during a vessel's first five or six years of life, might be very easily counter-balanced and exceeded by the repair and renewal bill when taking into consideration its total period of commission; and in passing, one must remember that one of the oldest, if not the oldest deep-sea motor ship afloat, the *Selandia*, is only 24 years old—quite a normal, if not young, life for a steamer.

While referring to the extravagant claims of builders and the press devoted to the internal combustion engine, it would be as well to protest also in the true interests of the oil engine itself, against the ostrich like attitude so often encountered with regard to mishaps—the "hush, hush" tactics adopted with respect to oil engine break-downs and, be it also said, regarding turbine gearing troubles, are very much to be regretted, as it is only by frank discussion, and the publishing of all details relating to such break-downs, that the troubles experienced can be eventually overcome and the true advancement of the best type of prime mover can be obtained.

Where it is decided to instal a steam engine as the means of propulsion, whether in either of the three main forms referred to, the factor which materially affects such a decision is the fuel to be used for steam generation, if oil, then many of the frequently claimed advantages of the oil engine, such as increased cargo carrying capacity due to reduced bunker space, cleanliness and speed in bunkering, maintenance of constant speed owing to the elimination of fire cleaning losses, etc., are negatived, while at the same time, the economy in fuel consumption of the oil engine, compared with the steam engine with oil firing boilers, is very much emphasised—in fact, to many, the idea of burning oil in boilers, except in case of very high speed passenger vessels, is looked upon as inexcusable waste, but before going to that length in condemning such procedure, it must be remembered that the types of oils which can be, and are, used under boilers, are usually, by reason of high sulphur, asphaltum, ash content, or high specific gravity or viscosity, quite unsuitable for satisfactory combustion in the engine cylinders of the present day types of internal combustion engines.

There can be no doubt that the reciprocating steam engine's claim to continued adoption in marine vessels is largely due to the low upkeep and repair costs over a large number of years, reliability (even when in an indifferent state of efficiency) ease of manœuvring, simplicity, and limited requirements in the way of auxiliary machinery, but when these advantages have been fully attained by the turbine and internal combustion engines, there seems little doubt that the steam reciprocating engine will have to give way to one or other of these prime movers, as it is only the above mentioned features which at present can counteract its very low thermal efficiency, and consequent expense in fuel consumption.

The steam turbine, while in advance of the reciprocating engine as regards thermal efficiency, has a considerable way to go before reaching that attained by the internal combustion engine, and, but for the unfortunate gearing troubles that have been encountered, would no doubt have compensated, to a large extent, for its efficiency loss by its comparative simplicity, low upkeep and repair costs over a long period, and adaptability for the use of high superheat steam.

There are many who are apt to consider the marine mechanical gearing problem as incapable of a satisfactory solution, inasmuch as the rigidity of the turbine, gearing and shaft foundations in a ship (which all said and done is only a beam subject to varying methods of support, loading and deflections) can never approach that required for the continuous and correct alignment met with in land practice.

Gearing trouble will be overcome, however, and probably by greater attention being paid to flexibility of coupling, rather than super accuracy in teeth cutting. An indication that would seem to support this statement would appear in the comparative immunity from serious break-down that has been experienced by the single reduction type of gearing when compared with the more rigid arrangements of double reduction gears. Again, in the overcoming of gearing troubles, the hydro-mechanical transmission system would appear to have a promising future, although unfortunately its application in this country has not, so far, received much attention.

*By the hydraulic transmission referred to is meant the Vulcan-Föttinger hydro-mechanical gear, consisting of a simple hydraulic clutch for ahead running, and a hydraulic transformer for astern running, of a toothed pinion meshing with the propeller shaft gear wheel, as distinct from the original Föttinger hydraulic coupling and transformer as fitted in the *Koniger Luise* and the *Von Tirpitz* (now the *Empress of*

* See p. 506. Vol. XXXVII. Dec. 1925 Issue—J.A.

Australia), in which a hydraulic coupling only of large reduction ratio was utilised for power transmission—it has been claimed that the hydro-mechanical system (by having an approximate one to one reduction ratio between the clutch and pinion) has overcome the reported low efficiency of the original Föttinger gear, and transmission efficiencies as high as 95% to 96% have been recorded.

Another important feature of this gear, which will be referred to later when discussing internal combustion machinery, lies in its permitting the use of non-reversible prime movers.

This, in the case of the turbine, eliminates the necessity for astern turbines and complicated manœuvring gear.

Yet another alternative, which lends itself to the adoption of the non-reversible turbine is the turbo-electric drive, and while, to the average marine engineer, this appears to be introducing additional complications in the form of comparatively delicate electrical main machinery and controls, there is no doubt that the system has much to commend it, and, more so than any other form of transmission, would permit the introduction into marine practice of that highly compact and efficient prime mover the Ljungstrom turbine.

It is when turning to the internal combustion engine, however, that the shipowner is confronted with the greatest diversity of types, and it is when the battle between the oil engine and the steam turbine becomes more acute that this diversity of types must eventually resolve itself into the survival of the fittest, and there can be little doubt that the crux of the whole problem lies in the evolution of the type which combines with the thermal efficiency of the internal combustion engine, the simplicity, reliability and long life of the reciprocating steam engine, and which also converts into useful work a maximum proportion of the approximately 30% of total heat energy in the fuel, which in the ordinary type of oil engine is lost in exhaust.

Reliability and long life are probably more closely connected with simplicity of design than is usually credited, and, although the average type of internal combustion engine (with auxiliaries) presents anything but the idea of simplicity to one accustomed to steam engines, it must be admitted that the later types have shown considerable advance in the desired direction.

Simplicity more especially is desired in the cylinder covers and in the valve gear, and in this respect it would appear that the four stroke engine and the two stroke valve scavenging engine will ultimately have to give way to the two stroke single or double acting engine with port scavenging.

Before proceeding to review the features peculiar to the various types, a word or two on the very much debated question of "blast" versus "solid" injection of fuel, might not be out of place.

While it is fairly obvious that the more complete combustion of the fuel must be obtained when the very intimate association with air provided by the "blast" system is utilised, still the elimination of "continuously" working air compressors, storage of high pressure air, and the reduction in compression pressure made possible by the "solid" injection system, would seem to outweigh the advantages of the formed method. It must be noted that "continuously" working air compressors were referred to, in that it is quite appreciated, that for the present at any rate, and with the exception of one type of engine, compressed air is necessary for starting purposes—this, however, need only entail the use of an independent compressor suitable for the occasional supply of air at a pressure of about 300 lbs. per square inch against the 900 to 1,000 lbs. per square inch required continuously for fuel injection purposes.

It may be found, however, that the "blast" injection system will have to be retained for long enough when the problem of satisfactorily burning the cruder or boiler qualities of fuel oil in engine cylinders is seriously tackled—mechanical separators alone can scarcely be expected to solve this problem.

The following short and necessarily superficial review of the commoner types of marine oil engines is intended to bring into perspective features specially with reference to simplicity of design, which it is considered tend to the evolution of the ideal form of internal combustion engine.

Taking the Burmeister & Wain, Beardmore-Tosi, Werkespoor, Vickers, and M.A.N. as being among the commonest of the four stroke single acting marine engines, there would appear little to choose between them, either on the score of mechanical or thermal efficiency and simplicity in design. There seems to be no doubt that the popularity of the four stroke, single acting engine, as exemplified by these types and particularly the Burmeister & Wain engine, is greatly due to the fact that up to the present it has been in a good relative position compared with the two stroke single acting and the double acting engine.

All five types have what might be termed "four-valve" and consequently complicated cylinder covers—even the institution of the "exhaust-inlet" valves in the Beardmore-Tosi engine, while dispensing with the necessity for having separate water cooled exhaust valves, does not appear to have simplified the cylinder cover design.

The Vickers type is the only one of the five employing solid injection of the fuel, thus dispensing with continuously running air compressors, and this engine, like the Werkespoor engine, by using sea water for cylinder and piston cooling allows a certain reduction of auxiliary gear in the form of separate piston cooling pumps and coolers.

Probably the simplest reversing gear of the five types is that employed on the Beardmore-Tosi engine, while the Werkespoor engine is a good second in this respect.

Turning to the two stroke single acting engine, the Sulzer, Mirrlees-Nobel, Polar, Doxford and Fullagar might be taken as good representatives of this class, while the last two, being of the opposed piston type can claim certain advantages peculiarly their own—this will be discussed separately.

The first three types have all comparatively simple designs of cylinder heads, in the case of the Polar and Sulzer engines there being single central openings only—in the Sulzer engine for the accommodation of both fuel and starting valves and in the Polar engine for the fuel valves only, one of the important features of this latter engine being the abolition of starting air valves in the cylinder heads.

It is the utilising of the lower end of the cylinder as a scavenging pump and starting engine in the Polar engine that affords one of its most desirable features, both in the simplification of the general design and the reduction in cylinder head valves and operating gear, slight counter balancing of pressure on the combustion side of the piston, and ease in starting afforded by the elimination of the expansion and consequent cooling effect of the starting air in the combustion cylinder.

Blast air injection of fuel is utilised in all three engines, also sea water cooling of pistons and cylinders, while mention should be made of the novel decompression valves incorporated in the starting air valves of the Sulzer and Mirrlees-Nobel types.

The Doxford and the Fullagar have the great advantages over the other three two stroke single acting types of "end to end" scavenging, resulting in that operation being very much more complete, and also eliminating to some extent cylinder liner distortion, discarding of cylinder covers, better balance, and compactness, while the Fullagar engine, by reason of its "crossed rods" becomes in effect a double acting engine per crank, affording still greater compactness for the same power.

The Doxford engine alone out of the five types, employs solid injection of fuel, and is thus enabled to claim the additional features of low compression pressure (300 lbs. per square inch) and the elimination of continuously running air compressors with consequent gain in mechanical efficiency.

Both opposed piston types employ fresh water cooling throughout, the Fullagar by means of telescopic pipes and the Doxford by telescopic pipes and swinging arms—probably there is little doubt, however, that the marine engineer much prefers the former system.

A desirable feature in the Doxford engine, distinct from the other types mentioned, is that all manœuvring and starting operations are carried out entirely by hand.

Turning to the double acting four stroke engine we have the two prominent types of the Burmeister and Wain and the Werkespoor, and while these, like the four stroke single acting engines in general, are very much in the position of being known and are really only the natural evolution of their well tried, single acting prototypes respectively, it seems rather difficult to imagine that there is any great future for them in the marine propulsion field—simplicity is not their strong feature.

The double acting two stroke engine, on the other hand, is in a very different position and three outstanding examples of this type are the Scott-Still, MacLagan, and Richardsons Westgarth engines (the two former, by now well beyond the experimental stage), which besides being admittedly ingenious, can claim to have that rarely combined quality—simplicity.

Probably, out of the three types, the Scott-Still engine approaches nearest to the ideal, and quite apart from the gain in thermal efficiency afforded by the cooling of cylinders and pistons by steam generated from the exhaust gases and the utilising of that medium on the undersides of the pistons, should appeal to both shipowner and marine engineer by reason of its simplicity, flexibility and ease in manœuvring.

The internal combustion side of the engine could hardly be simpler with its elimination of piston cooling gear and all valves and valve operating gear other than an automatically operated fuel valve.

Excessive temperature stresses in piston and cylinder metal, experienced in other types of water cooled internal combustion engines, have, in this type, been reduced to a minimum by the employment of steam as a cooling agent, and it may be mentioned here that the desirability of maintaining the cooling medium at the highest possible temperature in an oil engine cannot be over emphasised.

The engine also has the advantage of low compression pressure (300 lbs. per square inch) by reason of the "solid" system of fuel injection, and also by reason of steam being used for starting, can dispense with both "continuously" and "occasionally" running air compressors.

It is rather strange that both the Scott-Still and MacLagan engines have been described as "boxes of tricks" and, entirely by reason of certain novel features, have created a great amount of suspicion and prejudice, whereas in reality, and especially as far as the purely internal combustion sides of these engines are considered, they are remarkable in representing bold and progressive steps towards that simplicity which means reliability, long life, and, in the long run, economy.

Like the oil pressure controlled steam valves in the Scott-Still engine, the sliding cylinder in the MacLagan engine is merely a mechanical novelty, and has nothing very complicated or entailing problems of a far reaching nature connected with it.

By eliminating the piston rod, the MacLagan design has overcome the real difficulties experienced with the double acting engine with regard to the shape of the lower end combustion space, disposition of valves, and piston rod gland, while in addition, it has secured the advantage of the opposed piston engine in having an "end to end" scavenge. The cylinder covers could scarcely be of simpler form, being jointless and with one central opening only for both fuel and starting valves; and while it is understood that with the engines of this type at present in operation the original design of fuel valve operating gear has been replaced by one involving the usual form of cam shaft and levers, it is to be hoped that the original idea of operating these valves, partly by the motion of the cylinder, and partly by the compression pressure will eventually be perfected and adopted, thereby simplifying the operating gear to a further extent.

In the MacLagan engine, fresh water is used throughout for cooling and "blast" air is used for fuel injection.

In the latest British development, the Richardsons Westgarth engine, simplicity again appears to have been an attendant accomplishment and despite the piston rod gland difficulty both the top and bottom cylinder covers of this engine are of a simple design and interchangeable, and as in the MacLagan engine, jointless, gas tightness being effected by spring rings.

Starting air is only admitted to the top of the cylinder and thus by maintaining a warm lower combustion space easy starting is effected, and the starting valves as well as the fuel valves being automatically operated by the pressure of their respective fluids, permit the removal of cam shafts, levers and all top gear from the engine, the fuel pump and starting air valve cams being compactly situated at the control station, where, as in the Doxford and Scott-Still engines, all manœuvring operations are carried out by hand gear without the assistance of any Servo motor.

Fresh water cooling is employed throughout, and by the use of the "solid" system of fuel injection a fairly low compression pressure of 350 lbs. per square inch is possible.

Before passing, mention should also be made of the Worthington two stroke engine. Here again, the double acting principle has been evolved, hand in hand with comparative simplicity.

While the Diesel-electric and Diesel-hydraulic drive has not received much attention in this country, there would appear to be solid grounds for its further adoption, if only, as with the turbine, on the score of its permitting the use of efficient, light, high speed, and non-reversible engines.

Either system, and in particular the Diesel-electric method, would permit the compact grouping of a number of engines with a large combined output, but at the same time allowing economic flexibility in power and a very much greater immunity from complete vessel disablement than in the case of direct coupled engines.

It seems highly probable that the internal combustion engine of the future for high powers will be developed along the lines of these two systems, while for the lower powers, required by cargo and intermediate passenger vessels, the direct coupled, two stroke double acting engine, as exemplified by the Scott-Still, MacLagan or Richardsons Westgarth engine, or the opposed piston engines of the Doxford or Fullagar types, will be the ultimate survivors.

A very serious competitor to the oil engine of the future, however, will be the high pressure and high superheat steam turbine, taking steam from the pulverised coal fired boilers. Here again, especially with regard to the use of pulverised coal at sea, instead of being the complicated system which in some quarters it is imagined to be, the reverse is really the case. There is at least one system of pulverised fuel in land practice to-day where the whole operation of pulverising the coal from the raw state and feeding it into the furnace chambers of a boiler of 30,000 lbs. evaporative capacity can be carried out in the usual space available for stocking marine boilers of similar power, and the combustion of the fuel can be carried out in two barrel shaped chambers of elliptical section not more than 8 ft. by 9 ft. in extreme axes, and of a height of about 10 ft., thus negativing the assertion that the huge combustion chambers admittedly used with certain systems of pulverised fuel would prohibit the use of the system at sea.

When it is remembered that in land practice pressures up tc and above 1,200 lbs. per square inch have been in use for at least a year or two, it will be appreciated that the adoption of high pressures and superheat (even with the 575 lbs. per square inch pressure Yarrow boiler for use in connection with a Parsons turbine installation nearing completion on the Clyde), is only commencing, and the day may yet come when the Benson boiler working at 3,200 lbs. per square inch pressure and fired with pulverised fuel will become a practical proposition in marine work in conjunction with a turbo-electric or turbo-hydro-mechanical drive.

Although possibly not seemingly connected with the foregoing notes, a few final remarks with regard to the "human element" will not be out of place.

A great deal, and far more than is credited in the evolution of new or novel types of machinery, depends on the "human element"—the man who operates—and it is to be sincerely hoped that as far as the internal combustion engine is concerned, the present remarkable progress towards simplicity and the ideal engine, will not be unaccompanied by a real endeavour on the part of all concerned to give every consideration to the health of the operating engineer, and, by greater attention to ventilation of engine spaces, provision of light and airy quarters and the best of food, so counteract, as far as possible, the effects of the slow but insidious gas poisoning which, with the older types of engines especially, has been rather a disquieting feature affecting the health of the "man below," humorously referred to by himself as "dieselitis," but very rarely, if ever, mentioned in the press.

For engineers in the tropics or sub-tropics to come off two arduous watches per day of four hours, each with smarting eyes, "tight" chest, and more often than not a "head," indicates a state of atmosphere which in time, must very seriously effect the strongest constitution, and yet the symptoms referred to are in no ways an exaggeration.

It is very often overlooked that the marine engineer in oil engined ships is in a very different and more responsible position than his confrère, the "shift" or operating engineer in control of internal combustion engines ashore. Whereas the latter is concerned with units developing usually from 300 to 600 B.H.P., and in rare cases up to 1,000 B.H.P. the marine engineer is dealing with such powers developed in each cylinder of a sixteen or more, cylindered main propelling set, besides having in addition all auxiliary machinery comprising oil engine driven generating and compressor sets of anything up to 400 B.H.P., possibly some steam plant, refrigerating machines, and a more or less delicate steering engine or gear, all of which plant, let it be emphasised, is usually cramped into the smallest possible space with very little head room (or side room) for dismantling, compared with the generous spaciousness and lofty head room usually obtaining in land generating stations. A complete shut down for any length of time at a generating station is a fairly rare occurrence, owing to the alternative temporary arrangements which can invariably be made for maintaining or partially maintaining the supply of light and power, but the complete stoppage of main engines at sea, especially in narrow or dangerous waters could very easily result in the loss of a valuable vessel, cargo and lives.

In the event of breakdowns at sea or in remote ports where only indifferent labour or appliances are available, be it also noted, the "makers" could *not* "be called in"—the vessel's engineering staff just have to set to and make good the damage as best they can, and the fact that they invariably do so, quite as a matter of course, and very often with the display of no little ingenuity only serves to emphasise the plea that conditions, especially with regard to ventilation of engine rooms, and concerning the health of the staff, should receive the very greatest attention and sympathetic consideration from shipowners, so that that contentment and enthusiasm found in the engineering department and so essential to the development and smooth and economic operation of a vessel's machinery shall not be damped by ill-health or parsimonious treatment with respect to what may appear to be trivial details to designers.

CONTRIBUTION FROM AN ASSOCIATE.

Referring to the paper on Ventilation, the following is my experience on a voyage in a small motor coaster delivered to South America.

The engines were semi-Diesel, 2-stroke type, 225 revs. per minute. The engine-room was limited as far as possible, the cargo space having a prior claim.

On account of the leakage, the bilge water throughout the run was covered with about ½ in. of oil, due to—

(1) A leak in the reverse fuel pump, which could not be remedied as there was no spare gear on board for this part.

(2) The main bearings had to be lubricated excessively to keep them from running hot, and this led to an over-run into the bilge.

(3) The drain-locks fitted at each crank case overflowed into the bilge.

We did not experience any ill effects during the cool weather, but after running down south, when the temperature exceeded 80°, and a lack of fresh air in the engine-room, we felt run-down.

Two ventilators were provided, one on each side of the ship, the one on the starboard side leading underneath, the other about 9 feet above the floor plates.

But unfortunately for the engineers these ventilators are fitted abaft the wheel-house and even some inches lower than the latter. When the wind was standing on our starboard quarter this ventilator carried the air underneath the floor plates, blowing the oil fumes into the engine-room. The ventilator on the port side was covered by the wheel-house, thus bringing no air whatsoever down below. This direction of the wind was of course the worst, but even in every other position to the wind, the ventilators did not give a satisfactory service and during the trip, which lasted just over three months, the health of the engineers was not of the best, and we suffered considerably through the fumes. It must be said that this ship was not built for a trip across the Atlantic and through the tropics, and the new owner will have to make alterations to get rid of these troubles and make life more sweet.

The first thing I would do in such a case is to take steps to prevent oil of any kind getting into the bilges. One method would be to gather the oil in a well and with the aid of a semi-rotary pump, pump it anywhere required. On larger ships, oil purifiers which have reached a high standard would be suitable.

After getting rid of the oil in the bilges there should be no great difficulty in building a good ventilation in any engine-room of a motorship.

Notes.

CONTRIBUTED BY E. W. L. NICOL (MEMBER).

COKE AND THE COAL CRISIS.—That important gas, electrical and transport services are being maintained at practically their full normal efficiency in this the ninth week of the coal stoppage is an achievement for which those responsible are deserving of the highest praise. In the matter of tramway services London, compared with many provincial cities, is specially fortunate, the County Council service being maintained at its full normal efficiency, while in other towns the tramway services have been reduced by half, as a result of the closing of the mines.

The London County Council has been enabled to maintain normal working largely by the use of coke to supplement the coal consumed for generating electricity. As is well known, the ordinary power station is designed upon a coal-fuel basis, and is not equipped for, or capable of, substituting coke, however plentiful the latter fuel may be, and is therefore at a great disadvantage when suddenly required to accept an alternative fuel. This is the unfortunate position of many power stations in the present fuel crisis; but the London County Council, among other important electric tramway and electric power-supply authorities, finding themselves within easy reach of the big gasworks of the Gas Light and Coke Company and the South Metropolitan Gas Company recognised the practical and commercial advantage of an alternative fuel and equipped their power stations some years ago, so that they could in an emergency take full advantage of the immense stocks of coal and coke, necessarily maintained by these gas companies in order to ensure continuity of gas supply.

That the wisdom of this course has been entirely justified is evidenced by the fact that London tramway services, as well as certain electric railway and lighting services which are also supplied with current generated at coke-fired power stations, have, so far, been maintained at practically their full normal efficiency, and a considerably larger proportion of coke has been used during the present crisis than in any previous year since coke was first introduced as fuel for this purpose.

The method employed in order to adapt the coal-burning mechanical stokers used at power stations, to use coke is that known as the patent Sandwich system, so-called not from the inventor's name, but by reason of the fact that, by means of a simple apparatus, the coke is "sandwiched" automatically between the travelling grate and an upper layer of coal-dust, which serves to ignite it as it enters the furnace under the steam boilers.

The patent Sandwich system was first introduced during the acute coal shortage of 1918 by the London Coke Committee (who still freely advise steam users on its use) and was then instrumental in maintaining vital public services and in saving coal. The London County Council first adopted this system during that never-to-be-forgotten fuel crisis; and at the invitation of the Coal Controller then in office, the invention was inspected and adopted by many provincial electric engineers, any question of patent rights being waived by the patentee in the national interest. During the coal strike of 1921 and the present closing of the mines, coke and the Sandwich system have played an increasingly important role in maintaining services essential to the life and well-being of the Nation; but considered as an engineering achievement, tending materially to conserve the Nation's coal resources by utilising low-grade coal and coke breeze, perhaps the most gratifying feature of this simple invention is the fact that since its adoption in an emergency as a means to alleviate the effects of a national fuel crisis, it has in most cases been retained in use on its merits as an economical innovation; and, indeed, it has been incorporated in the design and is now used in several of the most economical power stations in this country, including the new super-station at Barton, Manchester.

Boiler Explosion Acts. Report No. 2708.—The wooden steam drifter *Harry and Leonard*, of 92 tons gross, was engaged in fishing off Plymouth early in December last, and had encountered very bad weather, with severe rolling and pitching. After a heavy roll the engine-driver heard an escape of steam from the boiler top. He made an effort to locate the cause, but the circumstances, owing to the darkness, the weather and the steam escaping, were against him, and observing that the boiler was loose on its seating and moving to the roll of the vessel, he reported the conditions and she was got into port, where an investigation was conducted by Mr. W. R. Watson, Board of Trade Surveyor, and reported upon.

The engines are triple expansion and the boiler of the ordinary cylindrical type, supported upon two sets of stools of cast iron, resting upon oak packing chocks about 4 ins. thick, secured to the timbers of the vessel. Stays were also fitted from the upper portion of the boiler to the hull. An inspection was made in January, 1924, when it was noted that the hardwood chocks were softening, probably due to the heat. No steps were taken then, but in the following month of May new wooden chocks were fitted under the forward boiler bearers and the stays from the hull to the boiler were overhauled. In November the engine-driver noted a slight movement of the boiler in heavy weather and an examination was made, and two wooden chocks were fitted between the wings of the after boiler-stools and the sides of the bunkers. The cause of the steam escape was due to the breaking of the steam whistle connecting piece of gunmetal $1\frac{5}{8}$ in. diam. and $\frac{3}{4}$ in. bore. It was screwed into the dome of the boiler with a lock-nut inside and a flange outside to which the whistle valve was bolted. The motion of the boiler during the heavy weather had evidently led to the breakage. The boiler was lifted and the chocks and bearers thoroughly overhauled and made good, and the connecting piece renewed. The boiler bearers were also renewed and stiffened to the hull to ensure stability.

The following letter appeared in "The Times" of July 13th:—

THE MINES DISPUTE.—COAL AND OTHER INDUSTRIES.

Sir,—It is very difficult under the present conditions to understand how, or why, any trade union leader, or any lover of his country or any one interested in the welfare of the miners, can find any serious objections to the Government measure which they have passed to enable the eight-hour day to be worked in coalmines.

It is an Act passed for freedom and not compulsion; it is necessary to enable the suggestion of the Report of the Coal Commission to be carried out that miners might have the option of working longer hours rather than accept lower wages. Apart from all this, experience has proved absolutely that the British mining industry cannot prosper without a reduction in wages or longer work hours, if not both. And reason and common sense, teach that miners cannot have nine hours' pay for seven hours' work.

Apart again from all this, it is as certain as anything can be that the miners' strike cannot succeed, and any, in Parliament or out of it, who encourage men like A. J. Cook, and the miners, to continue their impossible strike, are not friends either of the miners or the country. It is only prolonging and deepening the present great distress.

Mr. Cook and the miners' leaders are not only ruining the mining industry, but what is much more important still, they are ruining our iron and steel and shipbuilding and engineering industries, and preventing the recovery of our export trades without which we cannot live. It is a stern fact that without cheaper coal, and more of it, our country cannot prosper. That fact is being ignored, but in the long run it cannot be ignored.

Yours faithfully,

G. B. HUNTER.

Wallsend Shipyard, Wallsend-on-Tyne,
July 10.

The following report is from "The Times" of July 15th, and judging from this we are still without a clear understanding of the situation. It would be a desirable act to appoint a Representative Engineer as a Sea Lord at the Admiralty. The purple stripe is not the vital point. What is wanted above all is peace and harmony between the Deck and Engine Departments, *pro patria*:—

HOUSE OF LORDS. WEDNESDAY, JULY 14.

NAVAL ENGINEER OFFICERS.

The Duke of Northumberland called attention to the alteration in the status of the Royal Naval Engineer Officers effected by Admiralty Fleet Order 3241/25, and moved for papers. He said the order abolished the last vestige of the improved status of the Engineer officer under the 1902 scheme for the amalgamation of the engineering branch with the deck officers. Engineers generally admitted that that scheme went too far, but, assuming the necessity of scrapping it, was it necesary to abolish what was only of sentimental or moral value to the engineering branch? The order not only relegated the Engineer Officer to the non-executive branch of the Navy; it emphasised the distinction between the deck officer and the Engineer Officer by reimposing the wearing of the purple stripe.

The Duke of Montrose said that the order had been issued by the Admiralty after careful consideration and as a result of the experience gained in the Great War. To go on harping on this purple stripe was to cast a grave reflection on the gentlemanly instincts which pervaded the Navy. After all, purple had been worn by Kings and Emperors. Why was it not to be good enough to be worn by a naval engineer? In view of the great importance of engineering to-day, he thought it would be a graceful gesture to appoint a naval engineer as a Sea Lord at the Admiralty. He also thought that naval engineers should be given executive command in certain naval establishments ashore. If the appointment of naval engineers could be favourably considered from that point of view, this Admiralty Fleet Order ought to stand. There was no more room for two executive authorities in a ship of war or any ship than there was for two Kings of Jericho in the days of old.

Viscount Chelmsford said this question arose during his time as First Lord. It was not ripe for decision while he was at the Admiralty, and so he left a purely private note for his successor, Mr. Bridgeman, in which he said: "I should say, let sleeping dogs lie. There has been no acute demand for any change at the present moment, and I do not propose to stir up trouble by introducing any change in the present admittedly illogical system, a system which, at all events, is working." He felt it was most necessary not to arouse any new feeling of grievance; it was so important that there should be harmony in the Navy and that that great branch of it, the engineering branch, should not be under any sense of grievance in regard to their status. He supported the Duke of Northumberland in the observations he had made.

The Earl of Selborne said that the scheme of 1902, which he described as the Selborne-Kerr-Fisher scheme, absolutely stopped agitation at a time when there was danger of a serious cleavage between the officers of the Navy. He did not think the Engineer Officers liked the important alteration of 1922, but they did not greatly resent it. But by the unfortunate order of last year, the whole of the old sore had been reopened. Rear-Admiral Sheen, in a letter to " The Times " on June 1st, recapitulated the point of view of the Engineer Officer, and he had not seen any answer to that. Discussing the effect of the Order on the future supply of Naval Engineer Officers, the noble lord asked if the Lords Commissioners of the Admiralty really believed that they would in the future get enough officers from the public schools and by the common entry system to supply their needs? The order might do great harm, and could do no possible good.

Earl Stanhope, Civil Lord of the Admiralty, said that, after having gone into this question thoroughly, he concurred absolutely in the decision of the whole Board of Admiralty that the change which was brought about by the Fleet Order issued last November was necessary and desirable. The order had been the cause of a great deal of misunderstanding, both in the Press and elsewhere, and had been exaggerated into giving the impression that a great change of policy was involved. Nothing of the kind was the case. The order did not affect the rank, title, or powers of Engineer Officers. It did little more than regularise the situation already existing. It had been realised that engineering was a profession which was a whole life's work, and that it was utterly impossible for any ordinary individual to be able to learn enough of engineering to be a capable Naval Engineer Officer and, at the same time, to be capable of taking on deck duty. The general public appeared to think that unless an officer belonged to the military branch he was a non-combatant. That was absurd. Every officer on board was a combatant, except doctors and chaplains, and the Navy objected to the term " non-combatant," because every officer on board underwent the same dangers and faced the same risks.

The recent order swept away an anomalous position and divided all officers into categories according to their duties. It did not in the smallest degree affect either the status or the powers of the officers. The powers of Engineer Officers would remain exactly as they were before the Order was introduced. If the engineering profession was going to be recognised in the Navy as a branch which was vital to the service and safety of the country, it was right that the members of it should bear some distinguishing mark to show that they had the honour to belong to that service. To talk about the purple stripe as a degradation was obviously absurd and ridiculous. The Fleet Order would not make the smallest difference in the case of the electrical engineer officer, and it had not so far affected adversely either the quality or the number of boys entering the engineering branch of the Navy. There was no intention to put the smallest slight on the engineer branch of the profession.

The motion was then withdrawn.

Engineering, Shipping and Machinery Exhibition.—The Advisory Committee and Committee of Experts met on July 15th, presided over by Sir Chas. Parsons, who was supported by Engineer Vice-Admiral Sir Robt. B. Dixon, Sir W. J. Berry, Engineer Vice-Admiral Sir Geo. G. Goodwin, Sir J. F. Flannery, Sir Joseph Petavel, Sir David Wilson Barker, Dr. Hele-Shaw and others interested in the exhibitions of former years.

It was arranged to hold the next exhibition at Olympia on September 8th to 24th, 1927, and on the proposal of Sir Chas. Parsons it was agreed that the Duke of Northumberland should be invited to become President of the coming exhibition.

Books Added to the Library.

Industrial Tests of Internal Combustion Engines. By W. A. Tookey, M.Cons. E., M.I.Mech.E., M.I.A.E.

Rubber and Its Uses, being a short account of the preparation and properties of rubber, with particular reference to its uses in building and allied trades. By H. P. Stevens, M.A., Ph.D., F.I.C., and B. D. Porritt, M.Sc., F.I.C., F.R.S.E. Presented by the publishers, The Propaganda Dept. of The Rubber Growers' Association Inc., 2, 3 and 4, Idol Lane, Eastcheap, London E.C.3.

By the courtesy of the Council, The Proceedings of The Institution of Mechanical Engineers. 1925, Vol. II, May—Dec.

NICKEL STEEL. DATA AND APPLICATIONS. By the courtesy of The International Nickel Co., 67, Wall Street, New York.

NICKEL AND NICKEL CHROMIUM IN CAST IRON. By T. H. Wickenden, New York, and J. S. Vanick, Bayonne, N.J. Published by The American Foundrymen's Association.

SPECIFICATIONS FOR LUBRICATING OILS FOR USE IN HEAVY OIL ENGINES (Diesel and other High Compression Types). Published by The Diesel Engine Users' Association, 19, Cadogan Gardens, London, S.W.3.

PAPER T—145. SPECIFICATION FOR FITTING SHIPS for the Conveyance of Horses or Mules for voyages up to five days. Sea Transport Dept., Board of Trade. Published by H.M. Stationery Office, Adastral House, Kingsway, W.C.2.

We are indebted to Mr. B. P. Fielden, V.P., for Vols. 1873/4 to 1901/2 of The Transactions of the Institution of Engineers and Shipbuilders, Glasgow.

Mr. C. J. Hampshire, A.M., has kindly presented to the Institute another of his artistic works, a water colour drawing of the cable steamer *Viking*, operating in the Amazon, when he was one of the engineers.

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Election of Members.

List of those elected at Council Meeting held on July 5th, 1926:—

Members.

Clarence John Earnell Bonner, 325, Lordship Lane, East Dulwich, S.E.22.
George Deans, Junr., 51, Kilnside Road, Paisley.
Arthur Frederick Evans, 2, Castleton Mansions, Barnes, S.W.13.
Alfred Littler-Powell, 3, Rue Sophocles, Athens.
Alexander Bain McIntyre, 176, Bellingham Road, Catford, S.E.6.
Francis Henry Peck, Atlantis (Brazil), Ltd., Caixa 1973, Sao Paulo, Brazil.

Robert William Scott, Mining and Metallurgical Club, 3, London Wall Buildings, E.C.2.

Alexander John Sutherland, Customs House, Townsville, North Queensland.

James Mackay Swanson, 427, Clarkston Road, Muirend, Glasgow.

Leonard Thomas Tomlinson, "High Elms," Hockley, Essex.

Associate.

George Bolam, 10, Drummond Street, Wallsend-on-Tyne.

Graduates.

Reginald Thomas Gardiner, 7, Sidney Ville, Bellevue Park, Cork.

Transferred from Associate-Member to Member.

David Jones, 48, Bank Road, Bootle, Liverpool.

Frank Mitchell, Commd.-Engr., R.N., H.M.S. *Stuart*, *c/o* G.P.O.

Transferred from Graduate to Associate.

Ian H. Cowie, 6, Georgette Place, S.E.10.

W. E. Hoes, 29, Farnaby Road, Bromley, Kent.

F. R. A. Hutton, 11, Abbeville Gardens, Clapham, S.W.4.

T. Durant Shilston, East View, Stockton Road, West Hartlepool.

George A. Wilkins, 1399, 19th Avenue, E. Vancouver.

Transferred from Graduate to Student-Graduate.

John K. Barrow, 29, St. James's Avenue, Sutton, Surrey.