MARRACK PRIZE ESSAY NUMBER


APRIL

THE NAVAL ENGINEERING REVIEW

The Organ of the Royal Naval Artificer Engineers & Engine Room Artificers


1914

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NOTICE TO CONTRIBUTORS AND CORRESPONDENTS.

Articles and letters intended for this Review may be sent either through the Branch Secretaries of the Benevolent Fund, or direct to the Editor, 76 Manners Road, Southsea.

It is particularly notified that if MS. or drawings be submitted their return can only be ensured when properly directed and stamped envelopes are enclosed with matter sent.

Articles or letters submitted for publication must be written on one side of the paper only. If it is desired that the name of a contributor should not be published a notice to this effect must accompany the contribution.

Matter submitted by members of the Benevolent Fund, found suitable for publication, will be paid for.

NOTES AND COMMENTS.

Mates (E.) and their Selection

At last the conditions and regulations which are to hedge round the Mates (E.) are published, and the first selections of those who will compete made for the coveted promotions. The appointed committees of squadrons and commands have chosen from amongst the many candidates presenting themselves those that are considered eligible, in all respects, for ward-room rank. At one port not more than 5 per cent. of the candidates were chosen at the preliminary proceedings, and from all that we can gather a fairly rigorous method was adopted to secure the fittest aspirants for commissioned rank. The highest hurdle has yet to be jumped by the selected ones viz., the professional examination. This, undoubtedly, will be of such a nature as to gravel some of those selected, and as only ten are to be promoted this year, there should be no difficulty about getting the required number.

Following the qualifying examination, a further selection will be made by the Admiralty; but, to put the matter clearly and definitely, we quote the Admiralty W.O. L. 837:—"A final selection will be made at the Admiralty from candidates who are successful at the examination. Those chosen will be given the rank of Acting Mate (E.), and will proceed to the R.N. College, Greenwich, for a six months' course of instruction, followed by a course of the same duration in Engineering at the R.N. Engineering College, Devonport. . . . Examinations will be held at the end of the Greenwich and Devonport Courses, and classes of certificates awarded. Acting Mates (E.) who pass successfully will be confirmed in their rank and appointed to seagoing ships. While so serving they are to be reported upon periodically. . . . Should a candidate selected below the rank of Artificer Engineer again fail in either examination, he will be eligible for promotion to that rank irrespective of qualifying service."

The qualifying examination is to be held on May 1st, and from a glance at the syllabus which appears in another part of this REVIEW it will be seen that the selected candidates have formidable obstacles in front of them to overcome.

If all the chosen candidates succeed at the three examinations, and should there be more than ten (this point is doubtful), it is presumed that, other considerations being favourable, those below the first ten candidates will, automatically, go on to the roster for next year's promotions; but should any fail to qualify at either the second or third examinations—their previous rating having been that of a Chief Petty Officer—these will become Artificer Engineers by virtue of having been selected and having passed the qualifying examination.

This procedure, clearly, points to the raising of the standard for the Artificer Engineers' examination, though not immediately, and therefore it behoves all aspirants for this rank to keep their lamps trimmed and their educational equipment well burnished if they are to succeed in their ambition. As will be seen, all those who qualify for the six months' Greenwich course, and eventually for the Keyham course, will be singularly lucky individuals, for there is every reason for believing that these two courses, short though they be, represent the very highest standard engineering curriculum that exists in this country.

We respectfully submit that all Artificer Engineers should be privileged to undergo this training, for whatever knowledge is essential for qualifying for the more advanced Keyham course should prove of incalculable value to the junior officers, who will, as heretofore, have charge of the machinery of destroyers and similar vessels of high horse-power.

It should not be forgotten that the outside entrant Engine-room Artificer labours under many disadvantages compared with other branches of the Imperial Services so far as educational facilities being placed at his disposal are concerned.

Take the Army for instance, and the opportunity which it offers for non-commissioned officers to secure a first-class school certificate. This certificate, it is generally known, has to be obtained before a "non-com." can be promoted to warrant rank. For the soldier, every facility is placed in his way for obtaining educational accomplishments.

Schools, with excellent schoolmasters, are provided; the men have ample leisure at their command for study, and the resultant is a body of non-commissioned and warrant officers highly equipped educationally, and ready for the call when it is sounded for them to join the officers' ranks. In another and somewhat similar manner the warrant officers of the Seaman class (R.N.) are fitted for their highly specialised duties. The full gunnery course given at Whale Island is perhaps, of its nature, the best in the world. Nothing of a similar nature exists for the Engine-room Artificer class of the Royal Navy.

Whatever study is necessary to pass for the rank of Artificer Engineer has to be obtained in the student's own time, at his own expense, and at his own home, or at that of a private "coach," for study of any kind is almost an impossibility in the mess places provided for these men on board ship. Furthermore, it must be remembered that, owing to the existing conditions of naval usage, these men get but very short spells at home, which means that they get but few opportunities at all for the purely academic side of the engineering profession. This is why we advocate that all passed candidates for the Artificer Engineer rank should be given every facility for a special course of training at Greenwich. It goes without saying that in the near future the Engine-room Artificer class will be drawn upon for the bulk of the watch-keeping engineer officers of the Navy; therefore, whilst these potential officers are still young and mentally elastic is the period when additional training should begin. This is felt to be necessary for Mates (E.), and so something of a similar nature should be established for Artificer Engineers.

A Word to Candidates for Mates (E.)

It is by no means our duty here to question the methods adopted by the selection committees when testing a candidate's fitness and aptitude for commissioned rank, for, from all that we can learn, the questions, many of them of an intimate nature, were all scrupulously fair and not at all of an inquisitive nature. What, however, we do desire to draw attention to, and that in the interests of future candidates for the position of Mates (E.) is that the selecting officers set great store by the answers given to questions set to test the candidates' faculties for observation. This faculty under any condition of life is an important one, but in a naval officer's career it is paramount; for all naval professional success is the outcome of the utilisation of the powers of observation.

The highly intelligent man is he who sees and pigeon-holes in his memory the little things which come under his ken. Any purblind fool can see the bigger things, for they are obvious, and therefore are only relatively important. It is the smaller things of life—just the unconsidered trifles to the herd—which count, and if these be properly observed and synthetically treated, go to build up the knowledge and power of the truly intelligent person.

Darwin, for instance, was the great exemplar of what we have attempted to state. Wellington, in another way, was just as observant and had as keen an eye for detail. There is a story told of him about the period when the Chartists were threatening a raid on London. Wellington was given command of the military preparations to defend the City. Obviously, a good deal of the work had to be delegated to subordinates. On Wellington going the rounds of inspection to see that the hastily improvised defences were in order, one of the first questions he asked of the various commanding officers was: "Where are the men's latrines: their number and their accessibility?" Only a detail, but a most important detail to the old campaigner and to the men affected. And so with many other humdrum and apparently unessential things of life.

In a word, look round you, connote, and synthetise the result of your observations in such a way that you will not be gravelled when some simple explanation is called for or an answer required to an apparently very simple question.

Finally, as a last piece of advice, and this specially to the younger readers of these pages who are ambitious to climb the rungs of the promotion ladder. See to it that the necessary steps are taken to get the confirmation and stokehold certificates, and next, the engine-room or taking-charge-of-engines certificate—these as early as possible.

Be sure you sit for the Chief Engine-room Artificers examination the moment you are eligible, for "To-morrow" won't avail you. Never heed the waiting time that may elapse before you can get promotion. And, lastly, never forget that, in addition to the aforesaid assessments being in your possession, there can be awarded on the passing certificate for Chief Engine-room Artificer, by the examining officers, that of Special Mention if the candidate deserves it.

In a nutshell: Take your examinations with the minimum of qualifying service required, and be sure you aim high.

* * * * *

Naval Estimates and Mates (E.)

The Naval Estimates for 1914 to 1915 are now public property, and the principal vote, that for wages (naval ratings) has passed the House of Commons. The estimates are notable only for an increase in the number of men (5,000) and for a most remarkable speech delivered by Mr. Philip Snowden in criticising them. Never in the history of a Naval Estimate debate has such a speech been delivered. Mr. Snowden, in his terrible philippic against the large armament manufacturers, held a full and interested House almost spellbound; and this as much by the nature of the indictment which he drew up as by the magic of his eloquence. No serious attempt has, as yet, been made to refute the astounding statements which the member for Blackburn placed before the House. Readers interested to see a full report of this speech would do well to get a copy of the official report, Vol. 59, No. 27, price threepence. On the same night and in the same debate Mr. Hugh Edwards moved the following motion:—"That, in the opinion of this House, the selection of officers for the Navy should be on a wider and more democratic basis, and that provision should also be made for a more rapid promotion from the lower ratings to the executive rank." This motion Mr. Barnes seconded.

Many pithy and refreshing statements were made by both gentlemen in the course of the debate. We regret that we cannot find space to give the text of the speeches in full, and so must content ourselves with a few quotations.

> Mr. Edwards: "We are all ready to give assent to the broad principle that personal merit should, in every sphere, come up to the top We are all ready, also, at all times, to endorse Napoleon's famous dictum, that every private soldier should be made to feel that he carries a Marshal's baton in his knapsack. As a mere theory these sentiments carry ready assent, but it is in their application that failure comes. . . . Had Mr. John Burns joined the Navy as a youngster the highest position he could have attained would have been that of a warrant officer. . . . One other point to which I draw attention is that candidates for commissioned rank must not be more than thirty-two years of age."

DR. MACNAMARA: "That is Mates (E.)."

MR. EDWARDS: "Exactly. I for one protest against a stipulation of that kind, for thirty-two is much too low a limit of age. . . Supposing that restriction of age were applied to the Treasury Bench, how many men of Cabinet rank are there below the age of thirty-two? You require as much nerve, brain, and sagacity in the Navy as you do in work of this kind. The age of thirty-two should be raised, and I appeal to the First Lord and to the Financial Secretary to see what can be done on that point. Promotions in the Navy are extremely meagre. The men do not get promotion. They ask for bread and are given a stone; they ask for promotion and are given these green pamphlets . . . I appeal to the department to broaden the basis of selection in the choice of officers and to make merit rather than money the main avenue into the service. . . . . Let not the Right Hon. Gentleman and his colleagues forget that in the stress of battle, when the Naval resources of this country are put to the test, an abundance of good red blood will be as essential as any amount of blue blood."

MR. G. N. BARNES: I come now to Mates (E.), and here I am going to state that the Admiralty are carrying out a sort of petty classification. Where are Mates (E.) drawn from? Practically speaking they will be drawn from the class known as the boy artificers. . . . I think it is with the obvious intention of shunting the engineering operative from the Navy, and getting rid of his trade unionism and all that pertains to civil life. . . . First of all, I suggest to the Right Hon. Gentleman that the entry for Mates (E.) should be extended to the age of thirty-five. Assuming that an artificer joins at twenty-three, that would be twelve years for him—four years of a margin over the eight year's service which is the present qualification."

DR. MACNAMARA: "My hon. friend, Mr. Barnes, said that we had made it thirty-two (limit age for Mates (E.)) and that we ought to make it thirty-five. I cannot give my hon. friend an undertaking about that, but it should be represented to the Admiralty Board."

We must refrain from giving further extracts from the speeches made on the Estimates, but these printed go to show that the whole tone of the debate was of a healthy and vigorous nature, and as such should have a leavening effect upon the officials at Whitehall. The suggestion made by Mr. Barnes as to the age limit for Mates (E.) being raised to thirty-five is a moderate one. It is interesting to note that the Financial Secretary stated that he would lay it before the Board.

* * * * *

Increase of Personnel as shown in Estimates.

From the table given below it can be seen at a glance what increases are intended in the engine-room *personnel* during the current financial year. With the exception of Engineer Lieutenants, in which rank a decrease is shown, there is a substantial increase in all other grades. The additional 38 Chief Artificer Engineers show a considerable increase in promotions and should give joy to the Artificer Engineers. Actually, this means that 108 promotions to Artificer Engineer should take place before the end of March, 1915. Engine-room Artificers will note that 56 additional chiefs are provided for this year and 181 Engine-room Artificers. It will be noted, too, that there is an added number of stoker warrants by 16, and to their stepping stones 114 additional are to be made.

We can only express regret that no other means of promoting deserving stokers has been found other than by converting them into half-trained men who are to usurp a title (not by any means of their own choosing) that rightly belongs to the artificer class. Service nomenclature stands badly in want of an overhaul and drastic amendment. In the late sixties, when the Engine-room Artificers' branch was established, the engineer officers of that time had to decide upon a name for their new *confrères* which would unmistakably differentiate them from themselves, and so the word "artificer" was adopted. It is a good name, in a way, none better: but now that the term "mechanician"—one versed in mechanics and mechanical laws—has been applied to promoted stokers, the fully trained mechanic begins to have some doubt about his exact status in the Royal Navy. The term "mechanician" is in universal use in other navies, but in those it means a man in a similar capacity to the Engine-room Artificer in the British Navy. Truly, the Pucks at the Admiralty devote a lot of attention to studying how not to keep the peace in the Navy.

Showing Numbers in Ranker Personnel in Engine-room Staff for Years 1913-14 and 1914-15

	Engr Lieuts.	Mates(E.)	Chief A.E.'s	A.E.'s	C.E.R.A.'s	E.R.A.'s	Stoker Warr nt Mechs	Stoker Mechs.	Boys under training for artificers.
1913-14	18	Nil	150	506	1,104	3,365	20	642	620
1914-15	15	10	188	576	1,160	3,546	36	766	720
Increase	Nil	10	38	*70	56	181	16	114	100

* * * * *

First Lord's Speech and its Presage of an All Oil Navy.

In another note we have stated that the only notable feature about the current Estimates is the increase in the number of men; but it must not be understood that there were not many interesting points raised in the First Lord's speech when introducing them. Comparing 1911-12 with this year, it is found that in the three years covered by those dates there is an increase of 6¼ millions (sterling), and this without counting the part for new construction. The increase for extra pay, wages and victuals equals £2,140,000; £1,500,000 for oil reserves; and £900,000 for air service—an arm of the service which, three years ago, was non-existent; whilst £1,750,000

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* The actual increase of A.E.'s should be greater than 70, as 38 A.E.'s will be promoted to Chief A.E.'s during the present financial year, thus making the actual increase 108; there will, too, be additional wastage by removals and other causes.

goes to meet the normal demands of a larger Navy, more expensive ships, and an increased scientific development of the naval service as a whole.

The aggregate horse-power of the Navy three years ago was 4,478,000; while the present aggregate is 6,712,000.

Dealing with the air service, Mr. Churchill's speech was pitched on an optimistic note, and he foreshadowed still greater possibilities for the sea-plane as a useful auxiliary to the battle-fleets. In this arm of the service we are pre-eminent amongst all the great naval powers.

So far as the further use of oil is concerned there is nothing of a revolutionary nature to chronicle, for the trail of the dividend-hunting oil rings dominate and govern the situation. For the fastest large cruisers requiring great power oil will be used as fuel solely, but in the ships designed to act as units of homogeneous fleets coal and oil, as heretofore, will be the fuels used. In the portion of his speech dealing with the oil question, Mr. Churchill read a statement which had been prepared for him by the Chairman (Lord Fisher) of the Royal Commission on Fuels and Engines, and as this is the first communication of the Commission's finding made public, we give it here as it was given to the House of Commons. It contains many points of supreme importance, and points that may govern the Admiralty design of ships for many years to come; for the hoped-for advent of the Diesel engine of large power is still only a nebulous speculation:—

"There is no doubt that, with otherwise similar warships, the one that burns only oil possesses a large excess of speed over that which burns only coal, and even exhibits superiority in this respect over that which burns coal and oil. The radius of action when using oil in place of coal is increased at least 40 per cent. for the same weight of fuel. The use of oil enables a fleet to refuel at sea with great facility. With coal this is impracticable, except under very favourable weather conditions. The special advantage to the British Fleet of not being forced to leave its fighting position in order to refuel need not be enlarged upon. The strength of the British Fleet is thereby increased by at least 25 per cent. (while not adding that percentage of strength to the enemy's Fleet), as so large a proportion of the coal burning ships have to be absent refuelling. This also leads to a large unnecessary expenditure of fuel going to and returning from the coaling base, and additional wear and tear of machinery. Oil bunkers can be replenished with great rapidity, and without interfering with the fighting efficiency of the ship, and a few men suffice for the work. On the other hand, the operation of coaling is lengthy and laborious, necessitating the exertions of the whole of the crew; with the result that the men are physically exhausted by the operation, and the ship is rendered for a time unfit to fight. The use of oil is also attended by the saving of the large amount of labour involved in coal-trimming and stoking, as well as in the removal of ashes, clinkers and soot when coal is burned, and by a reduction in the stokehold of some 55 per cent. Oil gives the great advantage, as compared with coal, of admitting of a very rapid increase of steam production and of eliminating variations of steam pressure due to the necessity for the cleaning of coal-burning furnaces. In a coal-burning ship, after part of the coal has been used, the ship cannot attain her full power without taking men from the guns to trim the coal, whereas the oil is delivered to the furnaces with continuous facility until the whole has been consumed;

> moreover, oil can be stowed in some spare spaces in a ship from which it would be quite impracticable to bring coal to the furnaces, with the certainty of still further increasing the radius of action. The use of oil fuel instead of coal makes it possible in every type of war vessel to produce a ship which will fulfil given conditions of speed, armament, etc., on lesser dimensions and a smaller cost. Further than this, the great advantages which liquid fuel presents in the problem of naval design make it possible to obtain vessels of very high speed in relation to their dimensions, which would be wholly impracticable if coal were retained as the sole fuel."

It will be noticed that a vessel's radius of action can still further be increased by the use of oil as a fuel; such use also renders it possible to fulfil conditions of speed, armament, etc., on lesser dimensions and at smaller cost: and all this with a total abolition of the wear and tear which during the last few years has been so enormous on the human material which is the soul of the nation's Navy. All these factors, which mean diminished muscular exertion for the engine-room staff, will be hailed with enthusiasm; and when the excessive cost of oil fuel can be avoided, then indeed will the staff run upon oiled castors.

* * * * *

The "Marlborough's" Trials and its Discomforts.

In another part of this issue we publish a communication from an esteemed and trustworthy correspondent which describes, in remarkably moderate language, a disgraceful state of affairs, so far as accommodation is concerned, which happened on H.M.S. *Marlborough* during the trials of this ship in March last.

There is no excuse whatever for these scandals, which are continually occurring on vessels during their steam trials. Ample notice is always given when these are to take place, and those in authority should see to it that ample messing and sleeping accommodation is provided for all hands who are detailed for trial duties. Under the best of conditions a new vessel is not exactly on a par with the Ritz or Cecil Hotels, but certainly it is up to the responsible officers to see that overcrowding is avoided by the erection of temporary mess and sleeping places. Of all hands on board when official trials are taking place, the engine-room complement have the most strenuous and arduous duties to perform, and it is essential that they should not be herded like pigs in a mess place which must have been as foul as the Black Hole of Calcutta.

We do not blame the Admiralty for such a state of things, for if it were brought to the notice of the Board we are certain that stringent orders would be given for proper and adequate temporary mess places being arranged for. No; it is the officers (we are not sure whether they are Naval or Dockyard) at the local ports who fail in their common duty for not seeing to it that what our correspondent describes is avoided, or at least the discomforts reduced to a minimum.

Naval ratings should be properly berthed and all reasonable precautions taken to ensure adequate sleeping accommodation being provided. When the communication reached us we were sorely tempted to send it direct to the First Lord, so that he, too, might have first-hand knowledge of naval conditions that are not set forth on public posters which give glowing accounts of life on board of a man of war.

A somewhat analogous state of affairs, so far as the messing arrangements of Engine-room Artificers are concerned, obtains from the submarine flotilla at Harwich, and as these appear to be of a permanent nature, they are in this sense worse than what is described by our correspondent as happening on the *Marlborough*.

There are, roughly, about 34 Chief and Engine-room Artificers in the submarine section at Harwich, and when the two parent ships, *Thames* and *Bonaventure*, are there the thirty-four units are distributed between the two vessels for messing purposes; but when one of the vessels happens to be away, which is frequently the case, then all the Chief and Engine-room Artificers are dumped into the ship remaining, which means that thirty-four men—all engineers in charge of their own boats—have to find accommodation in a mess designed to hold sixteen men. Local protests have been made against this abominable state of affairs, but up to the time of writing these notes they have been unavailing.

Eight stokers on the *Zealandia* were recently sentenced by court-martial to two years' imprisonment for refusing duty. Refusing duty is the most serious crime in the Navy decalogue. Following on this sentence the Commander has been relieved of his ship, and since then the sentenced stokers have been liberated. The particular duty which these men refused to perform must have been of an arduous nature, or the order to do it must have been the culminating point of several things which had driven these hard-worked and patient men to mutiny.

The commander being relieved of his appointment and the mutineers being liberated, indicate acts of petty tyranny being more common on the *Zealandia* than is usually the case, or the Admiralty would not have acted as it has done. Now it is not our desire to show that the messing on the *Marlborough* and *Bonaventure* as being on parallel lines to what existed on the *Zealandia*, but we do desire to emphasise this, that nearly all the friction in the Navy is caused by enforcing conditions which are altogether unnecessary and avoidable.

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The Marrack Prize.

This issue of the REVIEW contains two of the seven essays sent in for the Marrack prize, the winning one, "About Turbines," and the next in order of merit, "The Petrol Engine for Aeroplanes, Motor Boats, Motor Cars, etc." As a reference to the Adjudicator's report, which appears on another page, shows, Engineer Rear-Admiral Westaway, who so kindly acted as judge in the competition, had considerable difficulty in assessing the merits of the seven essays sent in for the competition. The Admiral states: "Where all have done well it has not been an easy matter to pick out the best paper. The experience of this, the second year of the competition, goes to prove what we have repeatedly stated in these pages, that there is a superabundant store of professional knowledge amongst the Chief and Artificer Engineers, and the Chief and Engine-room Artificers of the Royal Navy. If the bulk of our readers could only get over their diffidence about facing a sheet of writing paper we should be inundated with valuable papers competing for the Marrack prize.

The fact that the younger members of the corps have now an opportunity of becoming ward-room officers at the age of twenty-six should prove an additional reason for more papers being sent in. The fight for the epaulettes is going to be a very stiff one. It will mean a lot of slogging at bookwork, and, what is of even more importance, a great amount of observation on the part of those who desire to rise rapidly in the profession. In this respect to have won the Marrack prize will hall-mark its recipient with efficiency on the professional side of his character, and therefore makes the prize worth the winning. In connection with the competition which has just been held, the prize has gone to an experienced officer, Chief Artificer Engineer W. G. Harding; but it will be a solace to the junior competitors to know that the second essay in order of merit was written by an Engine-room Artificer, Mr. W. F. White. It is our intention, in future issues, to publish the remainder of the essays, when our readers will have opportunities of judging for themselves the difficulties which presented themselves to Admiral Westaway when he had all the papers before him.

One more word, and that to the unsuccessful gentlemen who competed. Be not dismayed or disheartened because after much trouble and work you failed to win. The effort alone is a prize in itself, and one infinitely greater than the intrinsic value of the money offered. There can only be one winner, but where all did so well "honours are equal."

Chief Artificer Engineer W. G. Harding, R.N.

CHIEF ARTIFICER ENGINEER W. G. HARDING, R.N.

As Mr. Harding is the winner of the "Marrack Memorial Prize" for this year, we have the greatest pleasure in presenting his portrait in this issue, and also in giving the following brief notes on his professional career.

Mr. Harding, who is a native of London, served his apprenticeship as a fitter and turner at the locomotive shops, Bricklayers' Arms Railway Depôt, London. After completing his apprenticeship, and having a desire to go to sea, he joined H.M. Navy as an engine-room artificer in the year 1891. Having served through all the grades of E.R.A., he was promoted to C.E.R.A. in 1900. He only served in this rating for two years, as he sat for, and passed successfully, the examination for artificer-engineer rank, and in the year 1911 was promoted to Chief Artificer-Engineer.

During the Service career of Mr. Harding he assisted, whilst at Simonstown Naval Yard (1898), on the gun mountings of the 4·7 gun that Admiral Sir Percy Scott had fitted for land purposes, and which ultimately played such an important part in the defence of beleaguered Ladysmith.

Whilst serving as an E.R.A. on the *Sans Pareil* in the Mediterranean, between the years 1892-95, his ship took part in the evolution which ended with so much disaster and appalling loss of life, due to the ramming of the *Victoria* by the *Camperdown*.

Whilst in the *Dartmouth*, between the years 1911-13, he took part in the International blockade off Montenegro. He has served successfully as engineer-in-charge of many of the smaller vessels in H.M. Navy, such as the *Sturgeon*, *Janus*, *Hardy*, *T.B.* 33, and *T.B.* 1, where he now has the honour to be serving. Being an engineer to his finger tips, Mr. Harding would have gained more kudos and material advantages had he carried his undoubted abilities into a wider sphere than the Ropal Navy offers. It is a pity and misfortune for the Navy that the age limit for Mate (E.) shuts him and other chief and artificer engineers out for selection, when it is considered that there are at the present time chief and artificer engineers in charge of vessels whose aggregate h.p.=940,000.

WINNING ESSAY SUBMITTED FOR THE "MARRACK MEMORIAL PRIZE" FOR THE YEAR 1913-14.

ABOUT TURBINES.

By Chief Artificer Engineer W. G. Harding
("Practice").

It having been suggested that the beginner—until he has seen the actual thing—finds it less easy to read about the turbine than the reciprocating engine, perhaps the following notes may be of use:—

The "Dummy" A.B.C.

The conception of the Dummy, as a balance piston, in a Parsons turbine, is apt to be, at first, a trifle hazy; yet, if we apply a simple "A.B.C." to the forces which inside the turbine are acting in conjunction with, or opposition to, each other, the function of the dummy in the various turbines is seen at a glance:—

Let A = Steam pressure acting axially on the rotor blades;
B = Propeller thrust;
and C = Balance steam pressure acting on the dummy, or on the rotor body, as designed.

Commencing with the H.P. ahead turbine (Fig. 2), if we imagine A = 90 tons, and B = 100 tons, there will be a forward thrust of 10 tons. To neutralise this inequality the diameter of dummy is designed less than that of the rotor, and allows the initial steam pressure to exert a force C = 10 tons on the body of rotor.

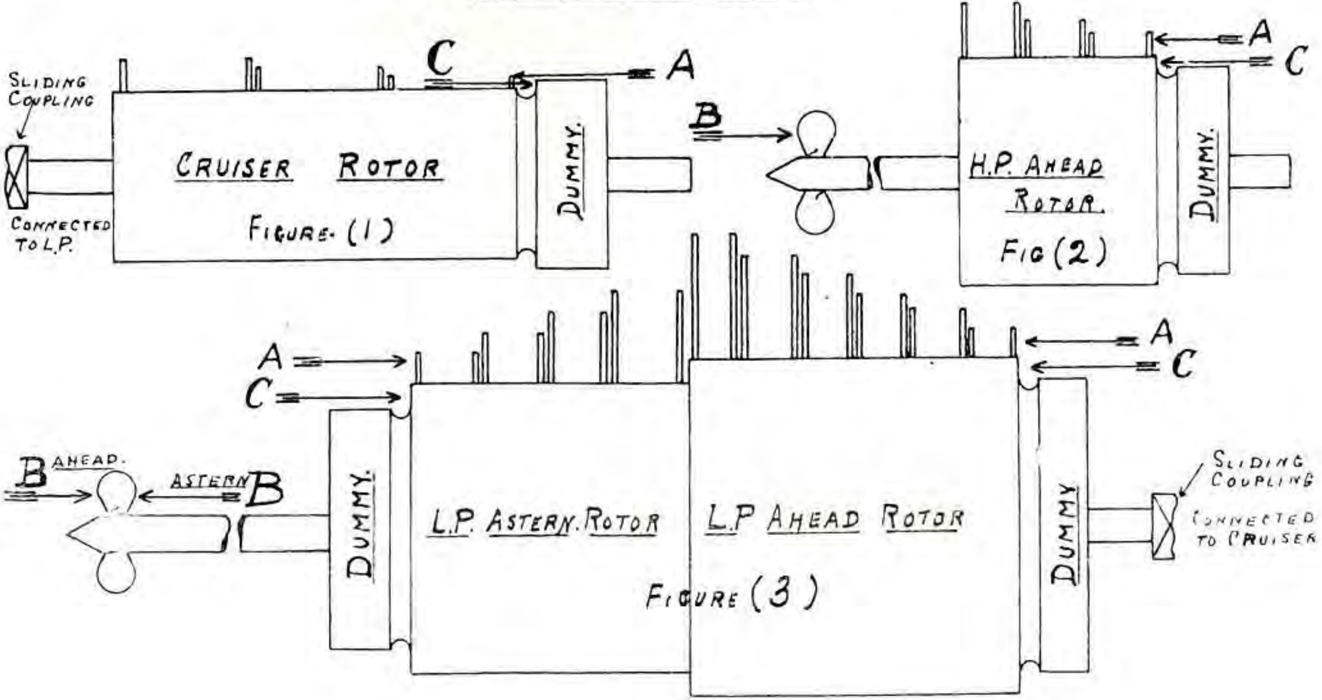
Then $A+C=B$, and $A+C-B=\text{Nil}=\text{equilibrium}$. Note.—The balance pressure C is termed "steam thrust."

Where two ahead turbines are fitted on one line of shafting, as the cruiser and L.P. of a torpedo boat, their rotor spindles are connected by means of a sliding coupling (Figs. 1 and 3), consequently the propeller thrust is communicated to the L.P. only. The cruiser (Fig. 1) has no propeller thrust, or B, and in this case the dummy is made larger in diameter than the rotor to give $C=A=\text{nil}$ and balance.

The action in the L.P. ahead (Fig. 3) is similar to that in H.P. ahead, except that the values are different: the blade area is large but steam pressure is low, and the power developed is enormous by comparison (see Fig. 5), consequently C must be large and must assist A.

In the H.P. astern (Fig. 4) steam enters at forward end and

THE "DUMMY A.B.C."



acts in conjunction with propeller thrust, necessitating a large C to equal A + B; while in the L.P. astern (Fig. 3), although steam is admitted at after end and in opposition to B, A is so weak, owing to the low steam pressure, that dummy is designed to obtain A + C − B = nil as before.

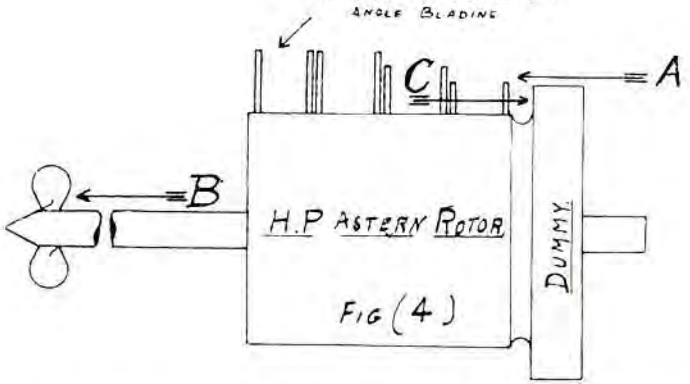


FIG (4)

The foregoing will serve to convey the text; perhaps the reader will have noticed that with the solitary exception of the independent cruiser turbine, *the balance pressure or steam thrust* C *is always in opposition to the propeller thrust* B, no matter if going ahead or astern, and irrespective of whether steam is admitted to forward or after end of the rotor.

THRUST BLOCK.

The thrust block becomes partly operative as such when towing, due to increased slip, etc., and has to withstand such shocks as are inevitable when steam is suddenly applied to the rotor on getting under way due to A + C, or inconstant pressure on the propeller, due to racing, etc.; but—except when towing, or racing—as soon as ship is properly under way, the propeller exerting its power restores balance, from which moment, theoretically, no thrust should be borne by the block itself; the sequence of transmission now would be from the propeller to the steam cushion C, and thence through the rotor casing to the "anchor" holding-down bolts which secure the casing to its seat on the body of ship.

It is perhaps better understood if regarded as a rotor adjusting block: by preventing longitudinal movement it maintains the dummy clearance as originally set, which clearance it may be said mechanically to control, any desired increase or decrease of clearance being brought about by the substitution of a thicker or thinner liner for the one fitted.

In the separate cruiser turbine of a torpedo boat (Fig. 1) having no B, or propeller thrust, and in the more modern practice of geared turbines having an ordinary thrust block secured to ship abaft the gearing, it is an adjusting block pure and simple; except for initial shocks it has no fluctuating stresses, and even towing or racing has comparatively little effect.

We ordinarily might assume that in a four-shaft ship having all propellers of the *same pitch* the surface area of the thrust block would be equal for each shaft, or, at any rate, proportionate to the power; but this is not always so.

The appended table shows the actual design of a light cruiser wherein the outer shafts, to which are attached the H.P. ahead and astern rotors, are provided with a greater thrust area than the inner shafts carrying the L.P. ahead and astern rotors, although the latter develop by far the greater power. The reason for this is apparent if we remember that whenever the turbines are started or reversed the outer shafts revolve first, and the resistance is partly overcome before the L.P.s get to work.

Referring to the table, the indicated thrust pressures (at column 7) are, of course, never reached, but are interesting from the point of view of design. The H.P.s are within the limits prescribed by Unwin and Wöhler, and show a large margin of safety where the greatest shock might be expected; while from the L.P.s we might assume that, relative to power, the turbine block will meet all requirements at about half the size and weight of the block used in reciprocating practice.

TABLE OF THRUST AREA IN A LIGHT CRUISER.

Turbine.	Pitch of Propeller.	Revs. per Minute at Full Power.	S.H.P.	Thrust Collar.		
				Number of Collars.	Total Ahead Surface (bottom half only).	Indicated Thrust at 90% Mechanical Efficiency. (If acting as an ordinary Thrust Block.)*
	ft. in.			No.	Sq. In.	lbs. per sq. in. on Collars.
S.H.P. (Outer) ...	7 0	460·4	4,640	16	664	64·3
S.L.P. (Inner) ...	7 0	504·4	6,654	12	498	112·2
P.L.P. (Inner) ...	7 0	512·6	7,258	12	498	120·2
P.H.P. (Outer) ...	7 0	464·7	4,915	16	664	69·5

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* Unwin's allowance=50 to 70 lbs. per sq. in.

EXPANSION.

Expansion in turbines is of such importance as to be almost paramount to the other forces working within.

Normally it considerably affects the accuracy of the finer measurements, and, owing to its distortive effect when irregular, the turbine must be considered as having only two conditions at which a movement is safe or a measurement reliable—*i.e.*, HOT or COLD. *There is no half-way.*

To turn a rotor by hand when only partly warmed, or before properly cooled, might easily result in damage to blade tips and consequent permanent loss in future economy; trying turbines under steam before they are fully expanded may be equally disastrous.

Turbines are *uniformly* "warmed" much above the running temperature, and necessarily so; but when under way the linear expansion will adjust itself to the temperature of the steam at the various stages causing the "expansion pointers" on turbine feet to show contraction, although they were fully expanded when turbines were tried.

We know that steam at any given pressure has an analogous temperature, and so, allowing for heat drop at the various stages, it is easily seen that the working temperature existing throughout length of rotor assumes the form of steps (Fig. 5).

The total lateral expansion of the rotor is invariably more than that of the casing, but our chief concern is with the length of rotor spindle lying between the thrust block and the dummy, together with that portion of the rotor casing—forming main and thrust bearings, oil well, etc.—which supports it. These parts are situated outside the actual rotor, and peculiarly subject to extraneous influences, which latter, by affecting its length, cause a corresponding variation in the dummy clearance.

DUMMY CLEARANCE.

Being subject to local influence, the clearance becomes a question of the moment as representing the state of affairs, under working conditions, at that moment, and for this reason should be measured and compared *hot*.

Briefly, local expansion of the spindle or contraction of the casing will increase the distance between thrust block and face of the dummy, thereby increasing clearance, and *vice versâ*.

To summarise a few causes of fluctuation:—

Increase:—

(*a*) *By contraction of casing.*

Cold air from a ventilating fan playing on bearings.

(*b*) *By expansion of spindle.*

Too much steam passing through the gland.

Decrease :—

(*c*) *Expansion of casing.*

Rise in temperature of lubricating oil, due to faulty water circulation in coolers, air pockets in bearings, etc.

(*d*) *Contraction of spindle.*

Cold air drawn into gland due to insufficient gland steam.

Also, changes of speed may have a *temporary* effect owing to alteration of receiver and gland-steam pressures, but after a time at the new speed there will be a return to the normal.

In large steam-belted rotors, usually placed low down in the ship, the casing does not radiate its heat to any great extent, and at high speeds the clearance will probably either remain normal or slightly diminish, while in the small unbelted rotors of a T.B., practically open to the wind at high speed, it often slightly increases—about ·003 in., due to (*a*). In the latter more than the usual amount of gland steam will be required owing to condensation, and give fault due to (*a*) and (*b*).

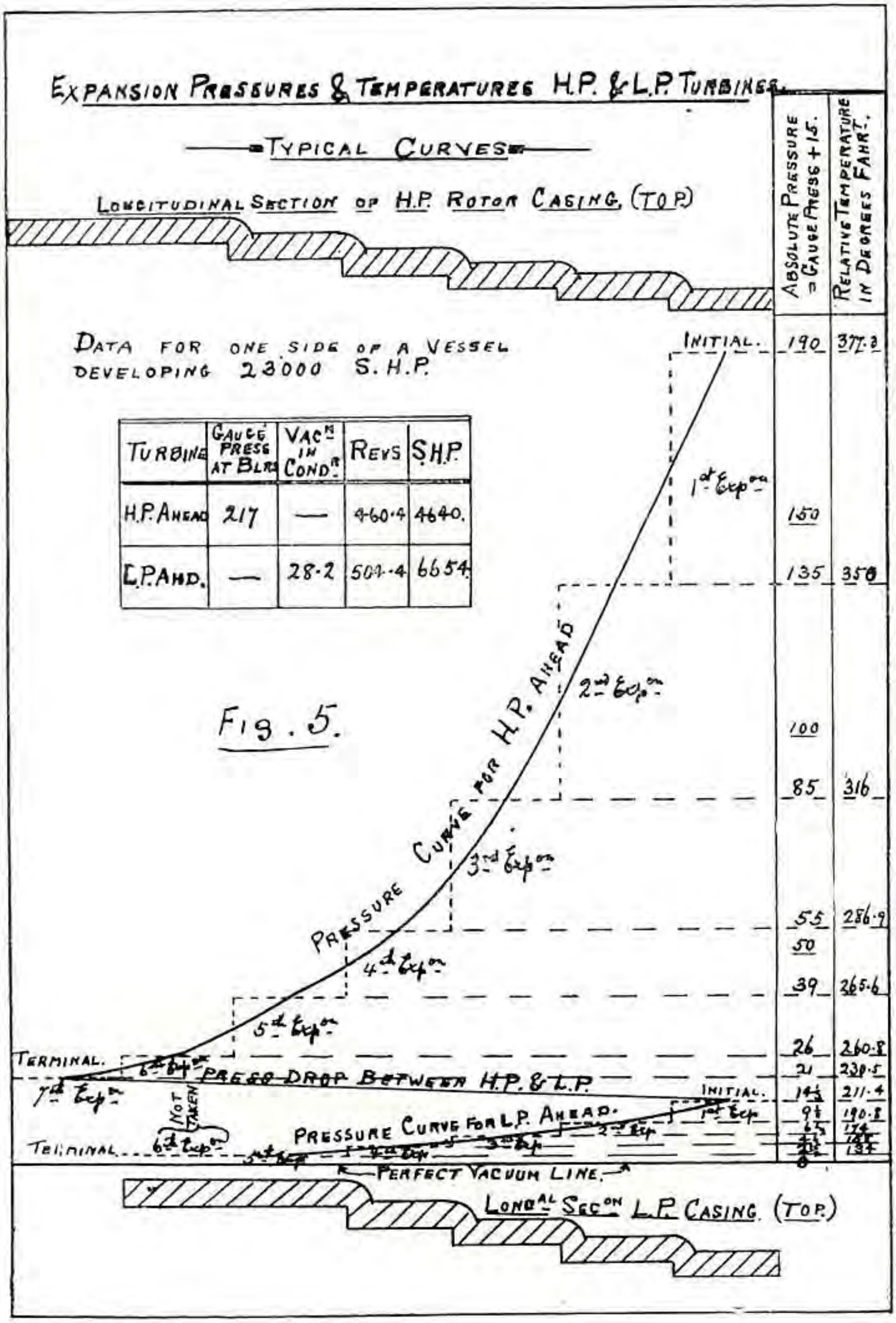
With the method of measuring the dummy clearance everybody is acquainted, and it is a matter of personal preference whether one places more reliance on the micrometer or on the finger piece.

From the writer's point of view the micrometer is all that can be desired, and the finger piece is useful, but only as a check, or for making rough comparisons.

PRESSURE CURVES.

What indicator diagrams are to reciprocating engines pressure curves are to turbines (Fig. 5). They are easily constructed, the original from figures tabulated in trial records, and subsequent ones by fixing pressure and vacuum gauges to rotor casing at the various stages.

These curves offer a ready means of detecting if the blades of one or more expansions are damaged, and a study of them will reveal some striking peculiarities, not the least of which is the performance of the L.P. ahead turbine (Fig. 5), developing 6,654 S.H.P. on vacuum alone, initial pressure being 1-in. vacuum (14½ lb. absolute), and terminal (at the fifth expansion), 25-in. vacuum (2½ lb. absolute); the sixth expansion is not recorded, but, by condenser vacuum gauge, pressure would be about 1 lb. per sq. in. The whole of this power is obtained



EXPANSION PRESSURES & TEMPERATURES H.P. & L.P. TURBINES.

—TYPICAL CURVES—

DATA FOR ONE SIDE OF A VESSEL DEVELOPING 23000 S.H.P.

TURBINE	GAUGE PRESS AT BLRS	VACM IN CONDR	REVS	S.H.P.
H.P. AHEAD	217	—	460·4	4640.
L.P. AHD.	—	28·2	504·4	6654

Fig. 5.

at a temperature less than atmospheric "water boil," and is for one side only, the total being twice this.

The curves also point the importance of maintaining a high vacuum in the condenser by any means possible, both from the point of view of power and economy. Approximately, all things being equal, and assuming the machinery to carry a working vacuum of 28½ in., the loss in power, under full power conditions, may be fairly averaged at 5 per cent. for 1-in. fall in vacuum.

In a ship developing 23,000 I.H.P., as in Fig. 5, this would amount to 1,150 I.H.P.; and, taking the fuel consumption at the moderate estimate of 1·8 lb. per I.H.P. per hour, would entail a loss of 22·17 tons per day for every inch of vacuum below the normal.

Obviously, the ultimate reduction of speed and radius of action would, in time of war, prove a serious handicap.

WEAR "UP."

The statement that certain rotor spindles are wearing "up" is usually accepted, without question, as being the natural effect of steam entering below the rotor and "floating" it, thus causing wear to take place in the top brass.

A little consideration of this vexed subject, however, may lead us to regard such indications as false until proven.

Unfortunately for believers in wear up, the decision is generally the outcome of a bridge gauge reading, taken while turbines are at rest, and giving a space between the top of the rotor spindle and the steelpoint face of bridge (G, Fig. 6) less than the original—*i.e.*, that taken in contractor's shop on the occasion of fitting and gauging the working and spare brasses for interchangeability, *not* those taken after trials, when presumably some wear had taken place.

Now when turbines are not running the rotor spindle will rest on the white metal of bottom brass, and, obviously, the only indications possible by bridge gauge are "nil" or "down." Under the same conditions, a lead taken between the top of journal and top brass, if thicker than the original lead, *might* suggest wear up, but wear down would also give a thicker top lead, so even this method is not reliable of itself.

More often than not wear up is only "apparent," and attributable to the expansion and consequent slight increase in diameter of the rotor spindle, thereby lessening the space between spindle and bridge.

As proof of this an experiment carried out by the writer may be of interest:—

The H.P. and L.P. spindles, 3¾ in. and 5½ in. diameter respectively, as "cold" bridge gauged in contractor's shop during February at a temperature of about 32 deg. Fahr., were :—

H.P.	Forward = ·0095 in.	L.P.	Forward = ·013 in.
	Aft = ·0095 in.		Aft = ·013 in.

On a hot day eighteen months later, after considerable running, including contractor's, and five quarterly full power trials, the cold readings obtained at 97 deg. Fahr. were :—

H.P.	Forward = ·008 in. = ·0015 in. up	L.P.	Forward = ·0115 in. = ·0015 in. up
	Aft = ·0085 in. = ·001 in. up		Aft = ·0135 in. = ·0005 in. down

Band gauges (privately made), the ends of which butted "snug" in the shop, were now cooled to 32 deg. Fahr., and applied to the spindles, showing an increase in diameter for the H.P.s of $\frac{\cdot005}{\pi}$ in. = ·0016 in. (say ·0015 in.), and for the L.P.s $\frac{\cdot0075}{\pi}$ in. = ·0024 in. (say ·0025 in.).

Deducting this increase in diameter from the original bridge gauge reading (G, Fig. 6), the approximate "real" wear became :—

H.P.	Forward = Nil	L.P.	Forward = ·001 in. down
	Aft = ·0005 in. down		Aft = ·003 in. down

As opportunity offered, the bottom brasses were turned out and examined, the height of white metal showing a depreciation very nearly corresponding to the above; faint traces of scraper marks could be seen in bottom brass of H.P. forward, which was accepted as conclusive testimony that high-pressure steam entering at bottom of forward end had *retarded* wear down, but had not caused wear up. Moreover, except for a slight touch here and there, the white metal in all top brasses showed no wear whatever.

The differences shown are admittedly small, but by no means negligible; a large spindle of, say, 18 in. diameter would increase about $\frac{8 \text{ in.}}{1000}$ for the same range of temperature.

Before allowing that the above is a correct assumption, we must tackle the question of whether the face of rotor casing to which the bridge is secured also expands and so raises the bridge. If it expanded by the same amount as the spindle the readings would remain constant at any temperature, which is absurd. In practice it does not seem to have much effect, and its neutralisation is probably brought about by :—

(*a*) Being external, it parts with its heat more readily than the spindle, and therefore expands less.

(*b*) Its linear distance is only half the diameter of rotor spindle (*b*, Fig. 6).

(*c*) The amount it does expand is compensated for by the increased rate of expansion in the "thickness" of bottom brass with its white metal (*a*, Fig. 6), having a conjoint average of about $\frac{5}{3}$ that of steel.

MEASURING WEAR.

The temperature at which the original readings were taken should form the base for all subsequent ones, and in this respect "cold" readings are preferable to "hot," in that, if not recorded, it may be approximated by looking up the month turbines were placed on board. Conversely, the temperature of hot originals is seldom recorded, and steam used for the purpose may have been anything between 10-lb. gauge (240 deg. Fahr.) and 100-lb. gauge (338 deg. Fahr.).

Moreover, with "cold" readings, if turbines have been idle long enough to be considered "cold," the forced lubrication oil in bearing well should be practically of the same temperature as the bearing, affording a convenient method, by using the thermometer, of ascertaining the temperature when about to take a reading.

The two following methods are suggested as giving fairly accurate results:—

First Method by Bridge Gauge "Cold."

Let t = Interval of temperature (Centigrade) between original and present;

d = diameter of spindle in inches;

C = coefficient of linear expansion of steel for 1 deg. Cent. = 0·000012 in.;

and G = original "cold" bridge-gauge reading:—

*(1) Turbines being fairly cold, obtain t; then $d\,(1+C\times t)$ = D = expanded diameter of spindle; $D-d=h$ = actual increase in height of spindle; and $G-h=x$ = the corresponding bridge-gauge reading if no wear had taken place.

(2) Take a bridge-gauge reading in the ordinary way. If

---

* Apologising for making ("1") thoroughly clear:—

If $t=36°$ Centigrade, $d=12''$ and $G={}^{\cdot}025''$

$12''\,(1+0{\cdot}000012''\times 36°)=12{\cdot}00518''=D$.

$\because\ D-d=12{\cdot}00518''-12''={}^{\cdot}005''=h$.

$\therefore\ G-h={}^{\cdot}025''-{}^{\cdot}005''={}^{\cdot}020''=x$.

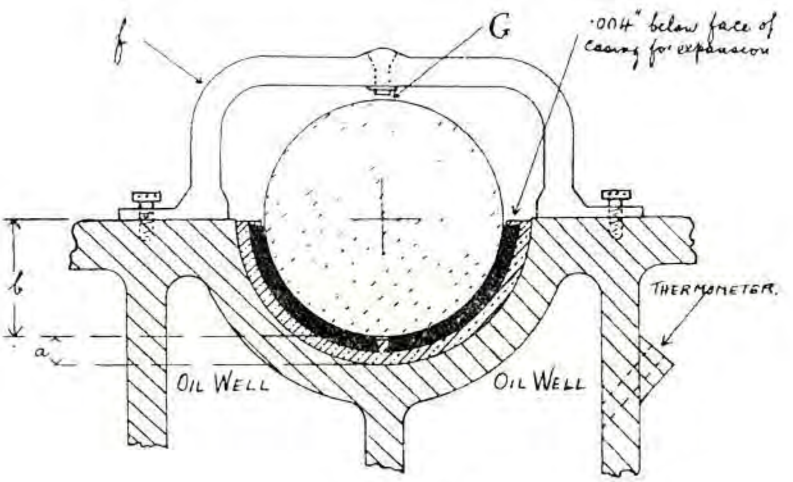
Re "t," of course, (Fahr. $-32)\times\frac{5}{9}$ = Centigrade.

greater than x, wear down has taken place by the amount it is greater; if less than x, it is possible t has not been ascertained correctly; because, as previously stated, bridge gauge cannot indicate wear up when turbines are at rest.

The bridge itself is often responsible for errors; its very form facilitates distortion.

A man holding it in readiness will generally grasp it at one corner (f, Fig. 6), and the heat imparted locally from his body

SECTION THROUGH MAIN BEARING



(FIGURE. 6.)

will sometimes warp it to an extraordinary extent: in fact, it can be so distorted while rigidly secured in position.

A good plan is to cool out the bridge between each operation, and when ready, take straight from the water, fix, and measure quickly.

Second Method, by Lead "Cold."

(1) Take a lead between top of spindle and top brass. If thicker than the "shop" lead, there is wear of *some* sort; therefore

(2) Support the end of rotor spindle and turn out the bottom brass. Measure height of white metal above the safety strips at ends of the brass. Should this happen to be still as in the ship's drawing, the wear *is* up.

It is more probable, however, that height of white metal will show a depreciation, in which case:—

(*a*) If decrease in white metal is *equal* to increase in lead, the wear is all down;

(*b*) If decrease in white metal is *less* than increase in lead, it denotes wear both down and up, the former by the amount of decreased height of white metal, and the latter by the amount of increase in lead minus decrease of white metal.

For this alternative or checking method, the turbines, preferably, should be as nearly as possible at the same temperature as the original; but if, say, the ship is on a hot station, this is not practicable, the expansion of rotor spindle must be obtained (*h*, for bridge-gauging) and considered.

The operation is not as lengthy as it might appear.

While not by any means asserting that wear up cannot, or does not take place, of the several turbine bearings the writer has seen opened up for examination (large and small), not one has shown signs of continuous or permanent wear on the white metal of the top brass, which is perhaps worthy of mention. Further, the theory of "the gyroscopic action of the rotor" sometimes adduced as causing wear up will not hold good, owing to the enormous weight of the rotors in modern ships and the comparatively slow speed at which they revolve when at full power.

Apropos of wear in bearings, "creep" or side wear sometimes takes place, usually in bottom brass; the principal causes to which it is attributed are:—Tendency of the rotor spindle to "climb" in the direction of motion; withstanding "whip" of rotor spindles when excessive helm is applied at high speeds; faulty white metal in bearings, etc. It is an insidious defect which exposes the risk of blades fouling in a like degree to wear down, and should be sought for on all occasions of examining the bearings.

ADJUDICATOR'S REPORT ON ESSAYS SENT IN FOR THE "MARRACK MEMORIAL PRIZE."

Engineer Rear-Admiral's Office,
R.N. Barracks, Portsmouth.
January 16th, 1914.

Dear Sir,—I have read the seven papers submitted to me, and I am very pleased to see the careful study that has been devoted by the competitors to their respective subjects. I consider it speaks well for the class as a whole when members can write papers such as these, and is an excellent sign that the latest engineering improvements and developments introduced from time to time in H.M. Service are very thoroughly and practically investigated. Where all have done well, it has not been an easy matter to pick out the best paper; but, after carefully weighing the matter, I am of opinion that the paper on Turbines by "Practice" is the best, and that the one on the Petrol Engine by "Petrol" is worthy of great commendation. The paper by "Practice" shows that the writer is a very observant man, and the information contained in his paper should be of great service to the Engine-room Department generally, especially as all new ships are now fitted with turbines. I also consider that the paper on Superheated Steam is also worthy of being published if room can be found in your admirable journal. It has given me great pleasure to read these papers, and if the Royal Naval Artificer Engineers and Engine-room Artificers progress in the manner shown by these papers a great future is before them.

I am, Sir,
Yours truly,
A. E. L. Westaway,
Engineer Rear-Admiral.

Editor, The Naval Engineering Review,
76, Manners Road, Southsea.

DISTILLING MACHINERY.

By P. P. P.

Of all the auxiliary plants fitted on board sea-going vessels, perhaps none is of such great importance to the marine engineer and perhaps none is so little understood as the much maligned distilling plant.

As indicated recently in the columns of this Review, the presence of salt in the boiler feed militates against efficient steaming owing to the priming thereby caused: in the instance quoted the presence of salt in the boiler feed of a T.B.D. being increased from the equivalent of 2 grains of chlorine per gallon to 17 grains per gallon, other things being equal, caused a fall in revolutions from 298 to 285 per minute.

Chlorine may, however, be present in the feed in a form other than that of salt—viz., hydrochloric acid—and this, although not causing the formation of scale on the heating surfaces and priming, with consequent loss of speed and economy, yet by corroding the boiler parts and reducing their useful life, causes a loss not only by increasing the expense of upkeep, but by reducing the period at the expiration of which the ship must be laid up for large boiler repairs. The presence of this acid in the water made by the distillers is frequently revealed by the presence of copper salts, which are sometimes sufficient to colour the water a characteristic greenish blue. This copper is picked up or dissolved from the gunmetal valves, brass and copper plates, etc., during the passage of the vapour from the evaporator to the distiller and of the water hence.

Should the boiler feed contain copper salts in solution the corrosion of the boiler parts will be intensified, since this copper will be deposited on the surface of the steel plates and on the zinc protectors and electrolytic action then started, in the first case owing to the steel and copper forming a galvanic couple to the detriment of the steel plates, and in the latter case by the protective action of the zincs being masked.

Although water containing chlorine is so objectionable for boiler purposes, it should not be assumed that when tests indicate that chlorine is present the water is valueless, for water containing quite considerable amounts of chlorine is quite potable, and an evaporator and distiller out of action, as far as boiler water is concerned, may quite safely be used for making water for culinary purposes.

The use of nitrate of silver solution for testing water is well known, but it is frequently asserted that this is a test for salt; this is not so. Nitrate of silver is a test for chlorine in any shape or form, and will indicate by the formation of a white cloud or precipitate the existence of chlorine in very minute proportions.

It may here be noted that when testing water drawn off from, say, the feed tanks with nitrate, the formation of a cloud does not necessarily prove the presence of chlorine. It is a universal practice to add to the boiler feed such substances as soda, lime, etc., to preserve it in an alkaline condition and also to assist in the separation of oil and grease. When lime has been used for this purpose a cloud of a brownish colour will frequently be observed under the nitrate test. This cloud is due to the formation of silver hydrate (Ag.H.O.) owing to the presence of the lime and effectually masks the test proper. This lime "effect," if it may be so called, can be eliminated by the addition of a few drops of dilute nitric acid, when, if no chlorine is present, the cloud will entirely disappear, but if chlorine is not absent it will either not entirely vanish or will reappear on a further addition of the nitrate solution.

If the water made is intended for culinary purposes it is well, in view of the poisonous nature of the salts of this metal, to occasionally test for the presence of copper, and, needless to say, if copper be found, or its presence even suspected, the water should be condemned as unfit for both culinary and boiler purposes and run to the bilge. A simple method of testing for copper is to add a little soap to the water to be tested, when if copper be present the curd formed will be of a delicate green colour.

It is an interesting fact that if the brine of an evaporator be tested with an indicator such as phenolphthalein it will be found usually to be alkaline. Sea-water being practically neutral this indicates that some acid property has been driven off. The loss of this acid property from the brine should be kept as low as possible, and if on so testing the brine it is found in a strongly alkaline condition, special attention should be paid to the nitrate test of the distilled water, for then the presence of hydrochloric acid may be suspected.

Should a cloud be observed when testing the distilled water with nitrate, there are three possible sources of the chlorine:—(*a*) evaporator priming, (*b*) evaporator making hydrochloric acid, (*c*) distiller leaking. If an evaporator feed heater be fitted, a fourth cause may be that the heater is leaking. This, however, only affects the coil drainage water from the evaporator, except in such cases where this water also enters the distiller and thus contaminates the otherwise good water.

To eliminate priming it is essential in the first place that the evaporator be of good design, for although much may be done with an indifferent plant by careful attention when at work, yet a badly designed evaporator will always be a source of trouble and anxiety, especially when forced to its utmost, by reason perhaps of some emergency.

Perhaps the question which requires first attention is that of circulation. Just as in ordinary steam boilers steady circulation is a great desideratum, so is it also in evaporators. Circulation is dependent to a large extent on the amount of heating surface and almost entirely on its arrangement. Too much heating surface, or too many coils for a given evaporation, will lead, other things being equal, to such a violent ebullition that the circulation in existence when working at low outputs will be entirely destroyed when working hard, with the result that brine will be forced past the baffles and even into the distiller.

Provision should be made in the water space of the evaporator for circulation by so shaping the coils that a comparatively large space is left between them and the shell. Water within the plan area occupied by the coils will, by virtue of the heat communicated to it from the coils and the bubbles of steam formed, be given a rapid upward motion and the space so provided for allows the return of the brine after the vapour has escaped from it to the bottom of the coils to recommence the cycle. In evaporators where insufficient space has been allowed for this return of the brine to the bottom of the evaporator case much may be done by slight alteration in the shape of the coils with a view to increasing this allowance, or by the provision of vertical guidance baffles to prevent the mingling of the up and down streams and so to assist the circulation. Further additions making the circulation directive will at once suggest themselves.

It will be seen that a rapid motion of the water being evaporated is caused over the heating surfaces when proper circulation is arranged for, and this tends towards reducing the size of the evaporator for a given output (or to increasing the output from a given evaporator) by obtaining the maximum duty from a given area of heating surface. This rapid motion also prevents to a very large extent the deposition of scale, which is held in suspension in the brine and so pumped away, the efficiency of the plant being thus maintained for a much longer time without cleaning.

In addition to a steady circulation a steady feeding and brining (including scumming) of the evaporator is essential, for if the feeding is irregular the water level may fall so low as to seriously interfere with the circulation, when the upper coils will rapidly scale up owing to the brine thrown on to them from below, with the possible formation of hydrochloric acid and its attendant evils. In proportion also to the amount of heating surface so uncovered or scaled up the output of the plant will fall off. Should, however, the feeding go to the other extreme and the water-level be too high, not only will efficient circulation be impeded, but the danger of salt water passing over to the distiller will be greatly increased owing to the tendency to priming introduced by the high water-level, poor circulation, and intermittent ebullition.

Similarly, irregular brining will have a perverse effect—if brining be too rapid the density will be too low for efficient working, owing to the loss of heat in the brine, and if too slow the density of the brine may increase to such an extent as to cause the heating surfaces to scale up very rapidly, with consequent loss of efficiency and increase in the labour of cleaning and scaling the coils.

Irregular brining combined with irregular feeding is perhaps one of the worst of the evils that may occur, since each aggravates the bad effects of the other.

All modern evaporators are fed through the medium of some form of automatic apparatus and every endeavour should be made to keep this apparatus efficient and in good working order. There are two leading types of automatic feeds in use on modern evaporators—the one has a dead cut-off and is similar in design to the Mumford feed regulator for boilers, the other is not unlike that of the Babcock and Wilcox boiler, and consists of a ported disc or sleeve rotating over or in a seating having corresponding ports through which the feed passes. Adjustment in the former is carried out by altering the point of suspension of the float lever, or by altering the point of cut off of the needle valve and in the latter by rotating the ported seating. From the point of view of steady feeding, perhaps the latter is the better of the two types. Both of these types of automatic feed apparatus are operated by a float, which, as in the case of the Belleville boiler, is contained in a float box separate from the rest of the plant and similarly is connected to the steam and water spaces by pipes of comparatively large bore. This arrangement is necessary, since it eliminates to a very large extent the effect of the rolling of the vessel and other irregularities to which the float would be subjected were it placed inside the evaporator.

Efficient separation of the water thrown up by the ebullition, from the vapour made, is perhaps, the next most important point. At quite a moderate rate of evaporation drops of water are thrown up with considerable force, and when the evaporator is being forced to its maximum output quite large drops are thrown up with such force as to strike the top of the evaporator—when the baffle is removed—even though the top of the shell may be as much as six feet above the water-level inside the evaporator.

A good baffle should embody the following points:—

(*a*) The passage of water from one side of the baffle to the other in a straight line without passing through a baffle plate should be impossible.

(*b*) The flow of vapour past the baffle should be compulsorily reversed in direction at least once.

(*c*) The baffle should be symmetrical and symmetrically placed as regards the axis of the evaporator shell and the vapour outlet, and the velocity of flow of the vapour at symmetrical points should be the same.

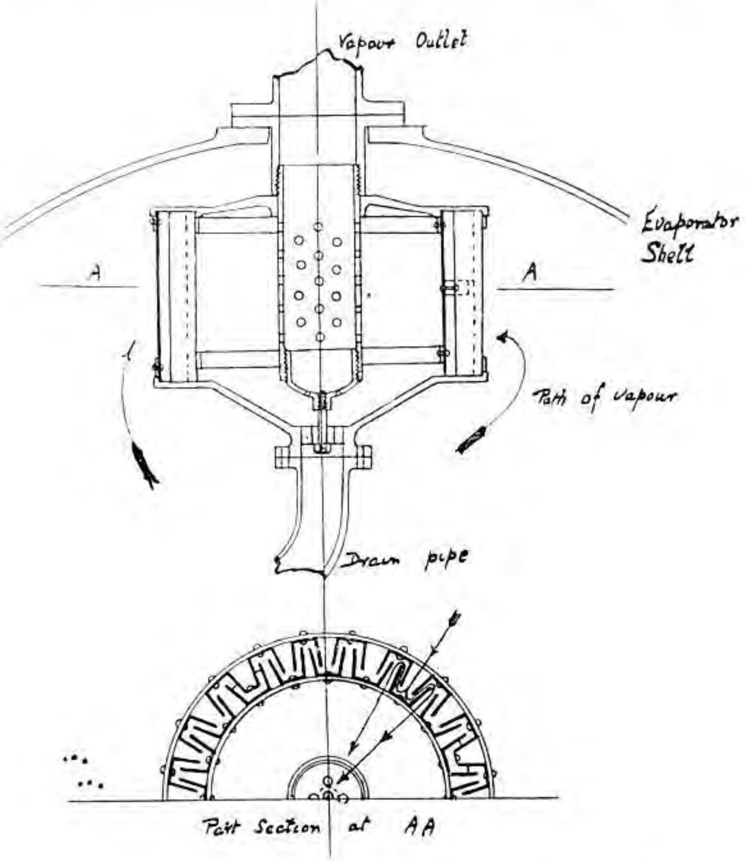
(*d*) The baffle should be carefully drained and so arranged that at no point can the drainage water become entrained in the rush of vapour.

Perhaps one of the simplest and best baffles that embodies these points is that recently patented by Messrs. Caird and Rayner, the construction of which will be readily understood from the sketch on page 32.

Every attention should be paid to the fitting of the pipe which serves to carry off the baffle drainage water, in order to prevent its becoming an upcast for the brine and so short-circuiting the baffle itself. Many persistent cases of priming have been cured by lengthening this pipe slightly so as to ensure the drainage water being carried away. It will be obvious that the end in view is materially assisted by keeping this drainage pipe well clear of the coils so that a counter circulation may not be set up in this pipe owing to the heating of the drainage water.

Baffling being so important, care should be taken that the material used should have great resistance to corrosion and the baffle itself of simple construction and easily removed and replaced in the evaporator case.

As already indicated, the water-level in the evaporator is of great importance. To show this a water gauge glass is fitted. To obtain a steady reading unaffected by the motion of the ship and minor irregularities inside the evaporator shell this should be fitted on the automatic feed float case as in the case of the Belleville boiler, or connected in a similar manner to the steam and water spaces by separate pipes. It must not, however, be thought that the level of the water inside the evaporator is the same as that shown in the gauge glass. The water inside the evaporator when at work is in a state of violent ebullition combined with a more or less steady motion already referred to as circulation; we have therefore a solid column of water in the gauge glass and gauge mounting balanced against a column of rapidly moving frothy brine, the density of which is less than that of the solid column to an extent depending upon the rate of evaporation, with the result that the actual level of the water in the case may be as much as 2 ft. or more above that shown in the glass. This is again in agreement with the experience with Belleville boilers. This difference is also dependent on the nature of the mixture being dealt with and herein lies a source of trouble. Suppose the plant has been tried at the maker's works with an artificial sea water, as is the usual practice, and so adjusted as to give satisfactory results, and then



with the same adjustment tried at sea—the result will be almost invariably complete failure. Sea water contains a larger proportion of air and minute quantities of various salts in solution which are not found in the artificial solutions used, even when made with a good sea-salt, and this causes the boiling to be much more violent than when the artificial solution is used, with the result that when the apparent level is the same as on the shop trials the actual level in the case is much too high and priming results. This difference is known from experience, and depending on the design of the plant, the automatic feed and the gauge glass are lowered so that when at sea the same amount of water as on the shop trials is showing in the glass, the water level inside the evaporator is about the same. This level should be high enough to cause a steady flow of water over the highest parts of the heating surface to prevent the formation of hydrochloric acid. This acid results from the decomposition of the scale on the coils by heat and is thought to be due to the interaction of the magnesium chloride contained in the scale upon its other constituents. By keeping a good wash of water over the coils scaling is to a large extent prevented and the making of good water assured.

Upon the scaling—*i.e.*, the cleaning—of the heating coils a great deal of labour is frequently wasted. The usual practice is to lay them out on the floor-plates of the stokehold and to knock the scale off with chipping hammers, or any other implements handy. This leads to rapid deterioration of the coils. Much of this labour may be avoided by arranging for a good circulation and so preventing such rapid scaling up of the coils as already indicated. If the coils are well polished with blacklead before starting distilling, formation of the scale is still further retarded, and then when the coils are dirty, if they are slung over a fire and scrubbed with wire brushes, the heat and the blacklead combined will render the removal of the scale easy without any harm to the coils resulting.

If the distilling condenser or feed heater be suspected of leaking it should be tested by water pressure and the defective tube plugged, or if time permit, a new tube fitted. Distiller tubes fail sometimes by splitting and sometimes by corrosion in the form of pitting. Splitting is usually due to vibration and to the material of the tube being more or less defective at the point of failure. Failure by perforation is due to a variety of causes, the principal of which may be said to be non-homogeneity of material and the lodgment of impurities, such as ashes in the tubes, which set up local electrolysis.

The tubes may be protected from this corrosion to a large extent by the fitting of steel or iron slabs in the water spaces.

Just as zinc slabs suspended in boilers have a protective action on the steel tubes and plates, so have steel slabs a protective action on the brass tubes. Zinc slabs would be still more effective whilst active, but when in sea water the zinc becomes coated with an oxychloride of zinc which is practically insoluble in cold water, with the result that the protective action is soon masked, and even if the circulating water is warm enough to dissolve this coating the zinc would last so short a time as to require almost constant renewal.

A case which came within the writer's personal observation was that of a plant having originally no protectors at all. Failure of tubes by perforation was of frequent occurrence and a week rarely went by without at least one tube requiring renewal. Protectors in the form of steel clips, some 3 in. wide, $\frac{5}{8}$ in. thick, and about 7 in. in diameter, were fitted and no further failures took place until more than six months later, the plant being in almost constant use. It was then found on examination that these clips had completely corroded through and although retaining their form were but a solid mass of iron oxide. As a result of this experience similar clips were fitted and renewed at intervals of slightly under six months, no further troubles due to this cause arising.

The following are points to which too little attention is usually given in the ordinary working of distilling machinery to ensure the very best results.

(1) All parts should be kept in constant adjustment, including the pumps, all springloaded valves, and particularly the automatic feed.

(2) Before finally closing up after cleaning or repair, the coils should, if possible, be tested by steam pressure and any found defective replaced. If distilling be carried out with a split coil in the evaporator the made water will frequently be found to have an indefinable bitter taste which renders it quite unfit for drinking. There is also the risk of getting the concentrated brine into the coil drainage system when blowing the evaporator down.

(3) The plant should always, for the greater economy so obtained, be worked at its maximum output and with the highest vacuum permissible in the evaporator case.

(4) Steadiness in working is essential, and large and rapid alterations in the setting of valves, speed of pumps, etc., should be avoided except when starting up or stopping.

(5) The made water should be frequently tested for salinity and the brine for density, which should on no account be allowed to exceed 30 deg.—*i.e.*, three times that of sea water.

(6) When making water for boiler purposes the aërating

valve on the freshwater pump suction from the distiller should be kept shut unless the distilled water cannot be kept reasonably cool, when it should be kept as nearly closed as possible. This prevents the aëration of the feed water and eliminates one of the causes of boiler corrosion—*viz.*, air being carried into the boiler in solution in the boiler feed.

THE PETROL ENGINE FOR AEROPLANES, MOTOR BOATS, MOTOR CARS, ETC.

[*Essay submitted for "Marrack Memorial Prize."*]

BY W. F. WHITE, ENGINE-ROOM ARTIFICER ("PETROL").

THIS century has seen a wonderful discovery brought nearer to perfection from a mechanical engineering standpoint which gives one general satisfaction in recording it—The oil age. Practical engineers of the past fifty years have perfected (as far as human ability will allow) the steam engine, and by constantly associating themselves with it have, it is feared, fallen into a deep groove. By the adjective, "practical," reference is made to the artisan who has not had the advantage of present-day education, but has gained his knowledge absolutely from years of manual work in an inland shop. The idea of this metaphorical groove is best conveyed as being a state of bigotry from the assumption that the inevitable conqueror and superseder of steam is regarded with impunity, and owing to the even chance of unemployment during his advancing years he refuses to put off the old favourite for the new. This feeling is easily understood, and it is well for me only to mention this state of conservatism and remind the intelligent reader that, as steam, through coal, was found to lift the proverbial kettle lid, so has oil shown indirectly an equivalent lifting power.

The number of items on which one is eager to expand in connection with oil is so numerous that the writer is reluctantly compelled to confine this article to "Petrol Engines," and merely a few interesting and practical particulars will be given, the digestion of which I know will give readers more respect for this type of engine than hitherto.

Petrol engines, so far, have been used almost solely for locomotion, but my experience rather allows me to decide that they are also suitable for stationary purposes. The principle of the engine is well known as that of the Otto cycle—

namely, four complete strokes being the cycle. We have admission, compression, expansion and exhaust respectively through each stroke in the two revolutions, thus having one productive and three non-productive strokes. This is elementary knowledge, so we must go a little further into the more intricate interior to gain the actual foundation.

The engines are adapted to aeroplane, marine and motor-car work. The last-named may affect us more, however, than is at first apparent, as I know personally quite a number of the engine-room staff who are enthusiastic motorists. Those three types are, except for a few details, identical in construction, so a general description will suffice for each.

Tracing the path taken by the petrol—which is either under pressure or has a head equivalent to not more than three atmospheres—it first enters the carburettor past the throttle (which is sometimes of the butterfly type) and through a fine hole known as the jet, and mixes with the air in the proportion of about 13 of air to one of petrol to form a convenient explosive mixture. This first stage is associated with the carburettor, which is in itself worthy of a minute study. In the larger firms experts are employed expressly for adjusting them, as upon the efficiency of this mixing box does the safety and the reliability of the engine depend.

The mixture on leaving the carburettor passes through an induction pipe which is purposely situated close to the hot exhaust pipe. The result is that the exhaust pipe heat is radiated to the induction pipe and so on to the gas, so that by the time the gas enters the cylinders its viscosity and temperature are at that required. Sometimes a pipe connects the exhaust pipe with the body of the carburettor, forming a sort of bypass, and the hot exhaust thus raises the temperature of the petrol, facilitating vaporisation and mixing with the oxygen of the air.

Drawn into the cylinder by the admission stroke, the mixture is compressed to about 12 c.ins. and about 5 deg. before top centre; an electric spark ignites the gas which explodes and drives the piston downward. The final stroke of the cycle exhausts the spent gases through a mushroom valve either into the air or into a silencer. The spark is obtained by the magneto,[*] which is of small proportion, but is the result of a well-thought-out scheme, and simplifies what would otherwise be an intricate and more costly affair. This magneto is seldom out of order, and no unusual fault is found with it as a rule for years after it is fitted to the engine. It is usually driven

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[*] For all that there is to be known about the magneto, see January issue (1914) of this Review.—EDITOR.

off the crankshaft by means of accurately cut gears at engine speed, the reason being obvious. In one revolution of the magneto spindle we have the "make and break" completed twice, so that in this revolution two sparks are generated at the sparking plug, and in two revolutions of the spindle we get four sparks. The engine requires these four sparks in two revolutions of engine, therefore the magneto is geared to run at engine speed. The wires and sparking plugs may sometimes cause minor troubles which are easily remedied. If the wires have been disconnected it is necessary to connect them up so that the plug will "fire" or "spark" on the number of cylinder in this order—1, 3, 4, 2, when it is a four-cylinder engine and when the piston of the particular cylinder is about the top of its stroke.

The valves, both exhaust and inlet, are interchangeable, and are made of mild steel, and, as before stated, are of the mushroom type. In aeroplane engines they are usually overhead—that is, on top of the cylinder—but in marine engines are parallel to the cylinder; in fact, lie in a line with the piston path. They are operated by a camshaft on which is a plunger working in a guide, adjustment being made by means of lock-nuts, or tappet nuts, between plunger and valve stem. The usual clearance allowed here is ·003 in., but the finer the adjustment the less noise made.

The camshaft is geared half speed to the engine, so that in four strokes the valves each lift once. There is immense speculation as to the correct timing of an engine, and this is governed by two things. Firstly, the design of the cams affect the timing as well as the silence of the tappets. Secondly, whether the camshaft is gear driven or chain driven, the position of the shaft relative to that of the piston varies several degrees on the flywheel, and no two engines are exactly alike.

The crankshaft, rods and bearings, as in the case of the Diesel engine, are similar in many respects to those of a small steam engine, and no description is necessary. The piston, however, is certainly entitled to a brief survey. It is usually made of cast iron, sometimes cast steel, and is ground ·003 in. smaller than the cylinder bore. It has one groove turned on its diameter to allow the oil access to the cylinder walls. At the top end are three grooves turned to receive split rings. The collars separating the rings are ground with ·004 in. to ·006 in. clearance. The rings are ground ·001 in. larger than the diameter of the cylinder to ensure them touching on the cylinder walls. When the ring is in position in the cylinder about ·006 in. is allowed as clearance in the slot where the ring is split. The piston is turned and finally ground to size.

Several Papers have been read before the Institute of Automobile Engineers on "The Correct Design of Pistons" in order to rectify a most troublesome evil. When new, the piston is always liable to seize on the cylinder walls in spite of efficient lubrication. The reason is readily apparent. In fitting the gudgeon pin in the piston it is necessary to have two bosses cast with the piston, each of about $\frac{3}{4}$ in. diameter, protruding about $\frac{1}{2}$ in. into the interior of the piston with holes drilled in line in order to receive the gudgeon pin with a keen fit. There is then a considerable amount of metal in two places, and comparatively a small quantity in the rest of the piston, part of which has been drilled for lightness; hence uneven expansion takes place, with the inevitable and tiresome result that the piston seizes the cylinder walls. A carefully designed piston is chiefly the result of practical experience.

Practical experience is the keynote to the design of petrol engines, and a little thought will demonstrate this in no uncertain degree. Take the case of the lift of valves or the timing of the engine. It is only decided by practical experiments and previous results what actual lift is most effective; similarly, what time the valve is to be open, or what timing will give most satisfactory effects.

Lubrication in the petrol engine is most important, and is the source of apparent endless trouble. Articles on lubrication often appear in The Review. "The Waste in Industry," in the October edition, gave a fine idea of lubrication, and it seems almost impossible in dealing with another subject to give any fresh information. I think without exception all systems are forced by means of some sort of pump. Generally speaking, however, it is not the system which is at fault, but the oil. The heat generated by the engine and the high speed attained make it essential that the properties of the oil shall be heavy at low temperatures, thinner at high temperatures, but not so thin as to lose all "body," neither should it carbonise nor evaporate. Most firms advise certain makes of oil which they have proved to be most fitted for their particular design of engine, but it is an all-important question which is being answered by the extensive laboratories specially devoted to that problem and by enthusiasts who are often enlightening us in the manner of the author of the article mentioned above.

Those who observe the interior of the crank case of a petrol engine for the first time will no doubt be surprised to see the small troughs and corners where oil is intended to collect, and if the course taken by the oil is traced from pumps to place of application they will remark that it ought to be adequate.

Another pump is necessary in addition to the oil pump. It is of the fan type, and circulates the water supply for cooling the cylinder near the valves and round the parts where the greatest heat is generated. In aeroplane engines copper sheet is placed on the exterior of the cylinder to assist radiation. The engine must not be subjected to excessive temperatures, high or low, but works better at a temperature when the hand, placed against the cylinder water jackets, can just endure the heat there radiated. In smaller engines cooling takes place by water being circulated on the thermo-syphon principle. As the water becomes heated it rises, and so a sufficient circulation is obtained.

The actual difference between aeroplane, marine and motor-car engines is, as before stated, almost negligible with reference to principle; and even in design and construction no great alterations are made. Of course, lightness is one of the first considerations in the aeroplane engine, and with this in view the piston, crankshaft and rods are hollowed. The cylinders are sometimes situated in the form of a "V." The crank-case and bottom half are of aluminium as in the automobile. Messrs. Vickers, Sons and Maxim (now Vickers, Ltd.) patented a new metal called Duralumin which has the same appearance and weight as aluminium; it is also reported to be just as easy to cast and machine with no additional cost. I understand they use it for their petrol engines.

The marine engine is slightly different in outward appearance, as the crank case, bottom half and gear cover, are made of cast iron giving additional stability where weight is of secondary importance. The starting handle is placed in a line with the top of the cylinders, as the engines are low in the boat, and so, by means of a chain and gears, the starter is allowed to have additional power to start up. The ordinary type of engine is slow speed. Racing engines attain a tremendous speed. The Duke of Westminster's *Ursula*, built by Vickers, Ltd., some few years ago, attained a speed of 50 kilometres in 50 minutes in the Mediterranean, setting up a world's record. This has since been beaten, but at the time was considered an astonishing performance.

I have seen several experiments with marine oil engines, but the one which impressed me most may also interest the reader. It was a standard 20 h.p. petrol engine; Texas oil was employed as fuel. It was found that the viscosity of the oil was too great; therefore, with the idea of forcing it through the carburettor the supply tank was elevated six feet. This did not have the desired effect, so a lamp was placed under the induction pipe to reduce the viscosity of the oil. By this method the engine overcame its own friction. A new carburettor was substituted and made a great improvement—in fact, sufficient for a brake test to be made.

Several of the largest firms in this country have a weekly output of 100 engines, and with them it is essential that every part should be standardised. Economy in production is studied rigidly, and a good idea which is adopted will illustrate this. The cylinders are cast in pairs and sometimes in fours. In grinding out the bore the workman may possibly be ·001 in. too much out in the diameter, or the finishing cut may be rough. Instead of making this defective cylinder scrap it is bored out from the A size to size B, which is ·010 in. larger in the bore, and corresponding parts are marked B as they progress through the shops. This always proves successful, but on one occasion trouble arose. A 14 h.p. engine was built to drive a lighting set for a private house, and it was handed over to the tester. On starting up, a noise was heard of a "clattering" nature, and at first it was thought to be a piston seize. The cylinders were removed, but nothing extraordinary was discerned. After the initial test the engine was stripped, and it was found that A pistons had been fitted to B cylinders!

The method of testing may be worth recording. The engine is bolted to a stand and given an eight hours' run, averaging half load. It is then stripped, big and small ends taken up, valves ground in, the timing checked, and a general examination made. It is then reassembled and a full load test made of four hours' duration, at the end of which the B.H.P. is taken for speeds ranging from 500 to 2,000 R.P.M. and particulars with reference to fuel consumption noted.

The brake sometimes used is a dynamometer in which work is done by the engine against an electrical resistance. The most common form of brake used is the pony brake, and the B.H.P. is determined by the well-worn formula :— $\frac{2\pi \text{ R.P.M.}}{33{,}000}$

Considerable amusement is sometimes the outcome of deception practised while this brake test is being carried out, and it not only produces *bonhomie* among companion workmen, but tends to keep the whole shop assiduously attentive. These tricks are extremely simple to manipulate in order to place a fellow-worker in difficulties, but hard for him to discover. The most often tried, and one of the most annoying, is turning off the petrol supply, which can be done either at the engine or at the main. The unsuspecting victim finds his engine stop abruptly with a backfire without any apparent cause. Should he be absent any length of time he may, on returning, find his wires altered, magneto turned half a revolution, dual connection taken away, his valve tappet clearance made negative, so that the valves do not find their seats, or a small piece of paper placed over his jet. There is then no wonder that his engine refuses to start; but if he is familiar with the mechanism which to the unaccustomed observer appears like clockwork, these few temporary defects will soon be rectified.

The tester contends that the following is necessary sometimes to pass an engine satisfactorily, but of course it is not generally commended. If the engine is not up to standard he may be expected to work until it reaches the required state of efficiency, so to assist his engine he will arrange for his hot water on leaving to flow over the petrol pipes and so give the fuel a high temperature before entering the carburettor. He will also allow as much water as convenient to pass over the brake in order to flow to a certain place where it collects and acts as a force on the opposite side of the fulcrum to that at which the spring balance is fixed. Occasionally with a troublesome engine a wedge is placed in the balance weight on the brake, and, in addition, the spring balance fixed further away from the flywheel than the distance allowed, so that the radius "R" in the B.H.P. formula already mentioned may have a greater value, and thus give a false horse-power.

In conclusion, I may add that predictions are being forced home on all sides that oil is one of the sources of power of the age, and if we consider the work so far accomplished, and allow time for its expansion (as it is quite conceivable that the stock of ideas is not nearly exhausted), we have every hope for the future. One of the latest triumphs testifying to the possibilities of petrol as fuel has been accomplished by Captain Nilsson, one of the Messina earthquake heroes, who crossed the Atlantic in 24 days from Penzance to Fort Churchill, in a petrol motorboat.

In an essay of this description it is necessary to convey, when possible, practical information, and although the subject may not appeal to some in the same way as it does to others, it will I hope be of no disadvantage to wade through its lines, as it should be the aspiration of all engineers to know something about everything and everything about something.

SUPERHEATED STEAM.

[Essay submitted for "Marrack Memorial Prize."]

By Artificer-Engineer C. F. Langmaid, R.N.
("Superheat").

The selection of an essay subject from so wide a range as that offered is extremely difficult. In view, however, of the large and increasing attention now directed to superheated steam, no apology would appear necessary for the introduction of a topic so essentially "dry."

The keenness of competition in the manufacture of machinery details, and in the use of motive power generally, is so great at the present time that engineers and steam-users are diligently seeking improved methods for economising fuel. With regard to our naval service, the orders relative to fuel consumption as embodied in the steam manual, together with others promulgated from time to time, have as their basis the exercitation of rigid economy. The most important item of expenditure that concerns the engineering department is fuel; and instructions are given that every endeavour is to be made to obtain the best results with the least expenditure. The advance in the methods by which fuel has been economised, from the first introduction of the steam engine to the present day, has been throughout a logical process. Each step represents an endeavour to utilise more fully the heat energy contained in the fuel, and to transform it into power in the most efficient manner. Before the introduction of the compound reciprocating engine, with its high pressure steam and stage expansion, the most economic type of engine in use was fitted with both steam jacket and superheater, working with steam at pressure of about 30 lbs. per square inch.

Superheat is an old subject, and the development of its use in connection with the steam engine has been slow; but the same may be said of many established improvements in the world of mechanical engineering to-day, some of which have had a more or less chequered career before ultimately justifying their continued existence. Superheated steam may now be fairly said to have come into its own, as evidenced by the recent rapid strides by which its use has been extended in steam plants, more particularly at present on shore.

It may be instructive to briefly note the history of the use of superheated steam. It was recognised from an early date that economy would result if the saturated steam as generated at the boiler was converted into dry steam, or, still better, into steam in a superheated condition. In 1736 John Payne undoubtedly produced superheated steam in his Flash boiler. About 1821 Sir William Congreave treated steam in a special manner after its formation in the boiler; and Jacob Perkins produced superheated steam in 1822. About ten years later the economy derivable from its use became more generally known as the outcome of patents by Trevithick, but for the first really useful trials and scientific explanation of the properties of superheated steam we are indebted to Hirn. About the same time, 1854 to 1864, a series of experimental researches to ascertain the comparative economy of steam with different measures of expansion, the causes and quantities of the condensation in the cylinder, and the economic effect of steam jacketing and superheating, were made in the United States Navy, from which much useful data were obtained. In 1857 a superheating apparatus was fitted to a steam vessel by John Penn of Greenwich which effected a saving of twenty per cent. of fuel. From this time, for a period of about twelve years, engineers having followed Penn's example, superheaters were in popular use in connection with marine engines. In 1868 the further development in the use of superheated steam was retarded by the successful introduction and application of compound marine engines by Randolph ot Glasgow, who conclusively proved that better commercial results could be obtained and less difficulties experienced with his engine than with any known combination of superheaters and simple condensing marine engines. From this time superheating fell into disfavour, until again revived about 1895. The use of high-pressure steam, with the advent of the water-tube boiler, was also a big factor in retarding the further progress and general use of superheat.

It is a noticeable feature in the past history of superheated steam that it has never met with very tenacious handling: for whenever an alternative method of effecting economy was introduced, although it may have been to a lesser degree, the further use of superheaters was abandoned. It does not appear to have occurred to the engineer of those times that advancement was possible along two different roads at the same time.

Our present precise knowledge of steam in superheat condition is by no means great; but this, however, is no deterrent to its application, for may not the same be said of the science of electricity? The results so far achieved fully warrant its adoption, and point the road to further progress when an increased knowledge is available. Superheat may be said to have entered upon a new era, and to have given the engineer a considerably enlarged scope for economical results.

A general comparison between the characteristics of saturated and superheated steam may be useful. We have in the former a fixed relationship between temperature, pressure and density; whilst the latter has a higher temperature than saturated steam at the same pressure. Superheated steam is independent of pressure, since at any pressure the steam may have any desired temperature within the reach of artificial production. In practice the superheater is an extension of the boiler steam space, with which it is in open communication, and the pressure of steam in the superheater is practically the boiler pressure. The volume of superheated steam is greater than that of saturated steam at the same pressure, and it can be transmitted at much higher velocities, due to the relatively smaller frictional resistance present. The friction of a gas is much less than that of a fluid. The properties of superheated steam tend to approach those of a perfect gas, and the resemblance becomes greater with increased amount of superheating. Saturated steam may be generally likened to a mixture of gas and fluid, and it retains many of the objectionable features of the latter.

The last decade has witnessed a considerably increased economy resulting from the use of superheated steam in reciprocating engines at large electric generating stations on shore. In some cases the superheat—or "sting," as it is colloquially termed—is put into the steam by means of separately fired superheaters, these being altogether independent of the boilers. In others the superheat is obtained by placing the superheater in the boiler itself. The reaction of shore on afloat practice led the Admiralty to try the latter system in a partial way in H.M.S. *Britannia*. The Engineer-in-Chief, in his lecture at the United Service Institution in November, 1909, stated that about one-eighth of the boiler tube surface was removed and replaced by superheat surface in six boilers of this ship. It was found on running comparative trials between the six boilers which carried superheat of 93 deg. Fahr. and the boilers with no superheat that a gain of 13½ per cent. was obtained. In practice, however, it was found that the phosphor-bronze piston rings suffered severely, and ultimately a mixture of superheated and saturated steam was used, which reduced the economy. Nearly ten years have now elapsed since this experiment was made in H.M.S. *Britannia*, and meanwhile superior metals, resisting deterrent effect, have been introduced, as mentioned later.

There are considerations affecting warship design which do not obtain elsewhere. The whole matter may be described as a compromise between various desiderata, and the question of weight must necessarily be taken into consideration. This has probably retarded the general adoption of superheaters in H.M. Navy, but at the present time is well worth special notation that they are included in the machinery equipment of some of our recent light cruisers and destroyers. There are difficulties with respect to the efficient use of superheat in reciprocating engines which are peculiar to their design. Although, as stated, a large economy resulted from the use of superheat in the shore electric generating stations, it must not be forgotten that these have very special oil eliminating plants of much more elaborate design than could be adopted afloat. With the water-tube boilers in naval service it is necessary to curtail the use of internal lubricants by all possible means. It placed the reciprocating engine at a great disadvantage, for the efficient use of superheat necessitates the absence from the cylinder of those particles of moisture which are found beneficial as a substitute for oil lubrication. This led to close investigation into the properties of internal lubricants, having in view the production of good grade, high flash-point oils. Speaking generally for the reciprocating engine, it may be said that a considerable gain is obtained by the use of a very small superheat, such as to ensure that dry steam is delivered to the engine, amounting to as much as five per cent. From the higher temperatures above dry, it has been found that for about every 10 deg. Fahr. the steam is superheated an additional economy of 1 to 1½ per cent. is obtained. The highest superheat that can economically be used is at about 500 deg. Fahr. Higher temperatures than this are obtained, but with an expansive engine the additional heat may be absorbed out of the steam by first reheating the high-pressure exhaust, thus effecting increased economy. A point that should not be lost sight of, however, with higher temperature superheat is, that the loss of heat is also increased, due to inefficient lagging of the steam-pipe line; hence upkeep in this direction requires particular attention.

The advantage to be gained by superheating is not due to increased thermo-dynamic efficiency; there is some increase, but it is comparatively small. The economy which results from the application of superheated steam is due to the suppression of the difference between the actual steam used and that shown by the indicator diagram; this loss being primarily due to condensation in steam-pipes and cylinders, valve and piston leakage. The loss varies from 15 to 50 per cent., but is rarely less than 20 per cent. of the actual steam used. It has been demonstrated that about 6 deg. of superheat are required to reduce this loss by 1 per cent., so that even moderate amounts of superheat effect a considerable economy. A saving in steam of 10 to 12 per cent. can often be effected by a superheat of 80 to 100 deg. Fah. The introduction of satisfactory metallic packings and lubricants, which remain efficient at 600 deg. Fahr., has greatly facilitated the development of the extended use of superheated steam with the reciprocating engine.

The advent of the steam turbine has given a great impetus to research and experiment with superheat, as this design of marine steam motor can carry " sting " much better than the reciprocating engine. It should be noted that although steam turbines benefit less than reciprocating engines by the employment of very high steam pressures, yet their output per pound of steam is greatly increased by the employment of superheated steam and a good vacuum. Although both types of steam engines improve in efficiency by the use of superheated steam, the reasons for superheating in the case of the turbine are not the same as for the reciprocating engine. The latter gains primarily by the suppression of initial condensation. The application of superheat to the steam turbine results in one special advantage over the reciprocating engine, in that any difficulty experienced from internal lubrication is absent in the turbine, as with the latter no lubricant is required to be added to the steam. The danger arising from unequal expansion is also small, and can more readily be provided against. The condition of steam in passage through a turbine is totally different from that in a reciprocating engine. In the former, at high speeds, there exists very great friction between the rotating parts of the turbine and the medium in which they revolve, even if the medium be fairly dry steam at a low pressure. At extreme velocities, and with the use of saturated steam at high pressure, this friction is enormous. Even if the steam when passing the turbine stop-valve be dry, as useful work is performed by its expansion it will naturally approach the saturated condition and will become saturated unless initially superheated, or other means adopted to prevent condensation. In the mutiple expansion type turbine, such as the Parsons, the heat generated by friction is not altogether lost, as the resultant of this additional heat is increased energy obtained from the raised temperature of the steam, and utilised at a later expansion stage. The results of tests with both the Parsons and Curtis turbines seem to show that by the use of superheated steam and a good vacuum about the same increased efficiency is obtained, and with moderate superheat about 1 per cent. increase may be expected for every 8 or 9 deg. Fahr. up to at least 200 deg. Fahr.

The principal reasons for retardation in superheating in the past were due to troubles experienced with material and lubricant, erosion and corrosion of superheater tubes, and pitting, with failure of connections and valves. As usual, the patience and perseverance of our experts have triumphed and materials are now available which give great, if not every, satisfaction. The superheater tubes are now solid cold drawn of best steel, and their most efficient form of attachment is still the old-fashioned boilermaker's "expanding and rolling-in" process. The boxes or headers are stamped as far as practicable in one piece of steel, and then, according to design, if necessary welded by special process. Regarding the valves, these are now made either of cast steel bodies with "Immadium" bronze seatings, or wholly of "Immadium." Alternative metals which have also given good results are "Platnum," much used in shore generating stations, and also another metal, one of whose constituents is 5 per cent. of nickel steel. As far as our naval service is concerned, the frequent examinations of superheaters, as directed to be made (*vide* Article 227, Addenda to Steam Manual, 1910), should ensure a big margin of safety and immunity from defect.

The position of the superheater in the boiler is a matter of prime importance, and it is necessary to place it so that it shall be accessible for examination, overhaul and repair. It must not be placed so as to get a direct impingement of flame or gas, but should be situated so that, as far as practicable, it gets a constant and not too violent heat. These conditions are fulfilled if it be placed above the boiler generator tubes. If there is a generator and economiser section in the boiler, as is usual in shore practice, then its best position is between the two. If, as in the Yarrow or Thornycroft boiler, there is no special separate economiser section, then the superheater is placed on the side of the boiler tubes remote from the fire.

For recent experience in superheated steam the reader is referred to the very interesting summary of a paper by Harold E. Yarrow, Esq., on "Superheating Experiments with a Water Tube Boiler," which appeared in Part I. of this year's NAVAL ENGINEERING REVIEW. Of the many improvements introduced with a view to economy in connection with steam engineering, there are some that have been viewed by the practical engineer as resulting in only a hypothetical gain. This, however, cannot be said of superheated steam. It is not a means of obtaining something for nothing, and if the signs of the times are read aright, it is highly probable that in the near future superheat will be the principal medium for converting the heat of fuel into efficient mechanical work.

Superheat has made it possible for the steam engine, especially of large power, to compete successfully with the internal combustion engine, and there are those also who state that, whatever there may be in the latter, we have not yet done with the former until superheated steam has been fully exploited. The general advantages, convenience, and flexibility of superheated steam have made its position, as far as the future can be foreseen, a very safe one. The increase in price of oils alone is already having a marked effect on the internal combustion engine from a manufacturing standpoint. We are far away yet from dispensing with the steam engine in the Navy, particularly where large powers are involved, and although "he who lives longest will see most," it cannot be gainsaid that the line of steam development is by way of superheat, and with an efficient superheater there is long life for the "steam twister" yet. For the enormous powers required in battleships and big liners large units are essential, and there are overwhelming objections to the employment of a great number of small units, as would be required if internal combustion engines were brought into use for the purpose at their present stage of development. In such cases reliance must still be placed upon steam as the motive power, and, moreover, there is no other improvement at present known to afford such certain gain as the use of "superheated steam."

HOW AN ENGINEER SAVED HIS SHIP.

Marine engineers perform deeds of heroism in the ordinary routine of their duties which, if they were known, would win the plaudits of an admiring public. Unlike the railroad engineer, whose many deeds of heroism are all necessarily performed in the limelight, the marine engineer works below decks, out of sight, and at sea, where comparatively few persons come in contact with him, so that, while both classes of engineers do their duty without any hope or expectation of fee or reward, the marine engineer seldom gets credit for the many deeds of valour he performs.

During a heavy gale the tail shaft of a transatlantic steamship broke obliquely in the stern tube, so that one section of the break rode on top of the other section as the propeller revolved in the seaway, breaking the stern tube and tearing the flange on the end from the watertight bulkhead in the after end of the shaft tunnel. The water poured into the tunnel in torrents through the bulkhead and it immediately became apparent that a serious condition of affairs existed.

The watertight door in the engine room bulkhead at the forward end of the tunnel, of course, could have been closed, but the chief engineer was sure that this would not do, as he had grave doubts as to the ability of the tunnel casing to withstand the pressure of the water when it filled. He knew that if the tunnel casing gave way the ship was doomed, for the reason that when the after hold filled the engine room bulkhead would go. In the days when this ship was built watertight bulkheads were a delusion and a snare.

He was reasonably sure that the after bulkhead would hold, as it was of small area and more substantially built and securely fastened to the frames of the ship than the larger engine-room bulkhead, so he decided that the proper thing to do was to get the stern tube back in place, thus stopping the leak.

Most engineers can imagine what a task this was, working in such cramped quarters, water pouring in around the tube, which was in constant motion with the working of the shaft, with only such appliances as were to be found aboard a ship to work with, and time so limited that minutes were precious. Little time was wasted in discussing the question as to what was the best thing to do. Not a man in the engine-room force faltered or questioned the advisability of the chief engineer's decision.

Several pieces of 6-inch by 6-inch scantling, together with blocking that was kept in the engine-room for various purposes and some screw-jacks from the store-room, were hastily secured and, led by the courageous little Scotch chief, the engineers started back through the long shaft tunnel for the scene of operations.

By the time they had reached the after end the water was up to their knees and rising rapidly, in spite of the fact that all of the pumps that could be used were working on the after compartment.

It was a heartrending task that confronted these heroic men. The propeller was threshing around in the seaway, causing the end of the tube in the shaft tunnel to jump around pretty lively; the ship was pitching and tossing in the heavy sea and every piece of wooden blocking had to be firmly held on to. One piece that slipped from the hands of one of the men narrowly escaped dashing the brains out of another man as it rushed by his head, floating on top of the water while he stooped under the shaft.

Several attempts were made to get the ends of the pieces of scantling against the flange on the end of the tube, the intention being to block between the other ends of the scantling and the foundation of the after spring bearing and force the tube back in place with the screw-jacks. This sounds simple enough, but almost any mechanic can see what a troublesome task this would be alongside of a dock in smooth water, holding the scantling in place, placing the blocking and setting the screw-jacks, but under the conditions then existing it seemed as if it would be impossible to do it. About the time the blocking would be adjusted the tube would jump and throw the ends of the scantling off, or just as the screw-jacks were to be put in place a hand would be taken off the blocking, which was entirely under water, and it would all float adrift and would again have to be replaced.

However, these men were of the type who never say die—most marine engineers are—and they kept at it. During a momentary lull, such as is customary even in the heaviest sea, the scantling and blocking were held in place long enough to get the screw-jacks in and a strain taken on them, and then the rest was easy. The screw-jacks were rapidly set up, although the men operating them had to go entirely under water to do this, and when the flange had been forced back in place on the bulkhead the water had risen so that the heads of the men were just out of it.

It required only a few minutes for the pumps to clear the shaft tunnel when the opening was closed, and then the tube was more securely shored and braced and the engineers were enabled to change their wet clothing and get a respite from their arduous labours. There was no real rest for them even then. The shores had to be constantly watched and, as they loosened up with the vibrations caused by the threshing around of the broken shaft, they had to be tightened up and sometimes replaced, although, fortunately, as all of them would not get out of place at the same time, the tube was not again forced out of its position.

Another ship belonging to the same company happened to come near enough to see the signals of distress (this was before the days of wireless telegraphy, with its S.O.S. call for assistance so promptly answered by other ships which otherwise would know nothing of the trouble), and after as pretty a piece of manœuvring as had ever been seen at sea, passed a line and towed the disabled ship into port.

The writer had the opportunity of examining this, to him, splendid feat of marine engineering, on the arrival of the ship in Antwerp, where she was taken for repairs, and the one thing that impressed him most, aside from the difficulty of the task as performed, was the extreme modesty and indifference to praise displayed by the chief engineer, who was the brains of the whole operation, as well as the leader in the actual doing of the work. He acted as if it was all in the day's duties and called for no special commendation or notice, although there is hardly a doubt that if he had decided to do what many men would have done under the same circumstances—close the watertight door in the engine-room bulkhead—the ship would have been lost, because investigation showed that neither the tunnel casing nor the engine-room bulkhead would have withstood the pressure had the tunnel been allowed to fill.

Marine engineers have not in the past received, nor do they get now, the credit that is due them for the many deeds of valour they perform, although in later years they are receiving more recognition than they did 25 years ago. However, like all courageous men, they are not brave because of the recognition it brings. They are brave simply because they are brave.—*International Marine Engineer.*

TRIALS OF LIFE ON THE TRIALS OF THE "MARLBOROUGH."

By One of the Tried.

When the *Orion* was doing her steam trials off Portsmouth some two years ago, Mr. McKenna, then First Lord of the Admiralty, paid a surprise visit on board one night when the ships happened to be berthed alongside the dockyard wall. Half the ship's company were ashore, including contractors' men. The ventilating fans for the mess deck were not running, and although comparatively few men were sleeping in their hammocks, the conditions were such as to draw from him some scathing criticisms as to the manner in which the men were herded together. He remarked that whilst thousands of pounds were being spent on guns, armour, and turbines little or no care or thought appeared to be spent on making life aboard more endurable for the " man behind the gun " and the " man behind the man behind the gun." Needless to say, the fans were soon started, and some attempt was afterwards made towards keeping the mess decks as clean and as well ventilated as possible.

The *Marlborough* was running her trials off Plymouth during the month of March, and the conditions, generally, of some of the living quarters of the steaming parties were worse than those of the *Orion* when on her trials.

Take the case of the E.R.A.'s mess for a typical example. In commission there will probably be twenty-four men accommodated in the mess, but during the trials there were forty odd men victualled there, and it had been arranged to put eight others there also. As about thirty were in two strict watches you may be sure the mess was hardly ever free from some one getting his food during the day, and also trying to get snatches of sleep when he could, for, besides in two watches, those who were lent to the ship for duty with the Record Party were ordered down below many times a day when they were nominally off watch, and therefore had to get food and sleep when and where they could. During the night the conditions were worse and therefore beggar description.

The Commander of the ship, who appears to be a very good type of officer, complained about the condition of the mess (he has, I think, been used to the Boy Artificers' Ship), and one of the older hands, so far from disagreeing with him went further, and described it as a pigstye and far different to what the E.R.A.'s wanted, or had been used to, or were led to look forward to. It was utterly impossible to observe anything like ordinary service routine and cleanliness, and everyone prayed for the day when the trial would be over. If only we had been allowed ashore when the ship was in harbour it would have eased the strain a bit, but it was not so. During the eleven days we were on board we got ashore once, and on more than one occasion when we could have gone ashore we were kept on board with absolutely nothing to do. No organised attempt appears to have been made to provide liberty boats. If the Sound steamer came alongside we might or might not be allowed ashore; but there were occasions when we could have been ashore when no recognised liberty boat was available, neither were we allowed to use the dockyard boats which were running.

Imagine the conditions inseparable from a dirty unfinished ship running her trials: the steam from the galley condensing on the deck over your hammock and dripping all over your blanket as you slept unless you were fortunate enough to have somebody else's hammock slung over yours; double the men aboard than would ordinarily be the case in commission; coaling ship going on, in which we were asked to volunteer to help; the mess in a condition aptly described as a pigstye; and then imagine the feelings of the men kept on board while they saw dockyard boats leaving the ship with officers and contractors' men, and yet to be told, as some were when they "fell in" to see about it, that they would be coming up for leave if the ship were on the rocks. A boat routine of dockyard tugs could have been organised even if the Sound steamer could not be allowed to break through the cast-iron rule of leaving the

Sound at 4.30 p.m. in the evening, much less make the return trip at 10 o'clock at night, especially when it is remembered how many men were on board, the conditions under which they ate and worked and slept and the flimsy pretexts on which they were kept on board. I have seen some examples of overcrowding in Chinese lodging-houses with their tiers of bunks all round the room, and we know what common lodging-house accommodation is as a rule, but either would have been preferable to the accommodation provided on the above ship. If overcrowding and bad conditions of living generally predispose men to vice and dissipation, would it be any wonder if some of the folk in the *Marlborough* did have a debauch once they got ashore? Better accommodation could have been provided on board, and more leave be given ashore if the powers that be had arranged for it, as has been done on many another ship doing her trials. No one can expect a picnic on these occasions; but, on the other hand, you cannot get the best out of men, or smother the fires of discontent, if you herd them together like cattle or keep them locked up aboard like convicts in a transport ship whilst they are within sight and sound of their own homes.

We do not spend any too much time in harbour nowadays for anyone to go out of his way to pile on the agony; nor can the Admiralty expect to get the right type of man to join the R.N. if they persist in treating the men they have got like convicts or herd them together like cattle.

What is the good of flaunting this concession of Mate (E.) in our faces whilst the bulk are underpaid and indifferently treated? One reason, and maybe the principal one, why so many are volunteering for the new rank, and also why so many take the examination for A.E., is in the hope of getting away from such a state of affairs as I have described and into something, however much it may leave to be desired, which does offer them a better chance of their share of a place in the sun.

SOME TRIAL TRIP EXPERIENCES.

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs.

As it has been the lot of the writer to attend a considerable number of trial trips of vessels of very varied types, some of his experiences may be interesting and perhaps instructive. In view of the complexity of modern marine machinery it is surprising that trial-trip mishaps are not more frequent, more especially when one considers how most jobs are rushed at the finish up, although this rushing policy very often illustrates the truth of the ancient adage, " More haste, less speed."

In large vessels it is almost impossible for all the men operating the machinery to be familiar with the pipe connections, so they have to rely very largely on the nameplates attached to the various valves, and misplaced nameplates are a frequent source of trouble. The writer vividly remembers the trials of a certain torpedo-boat which affords an example of this.

After leaving the builder's yard and on approaching the measured mile the engines were gradually opened out and the signal sent to the stokehold for " more steam." The reply at once was a demand for " more feed," as the main feed pump was in the engine-room. The pump was speeded up and in a few minutes " more steam " was again asked for to meet the increasing requirements of the main engines. The reply was as before, " more feed." The feed pump was now going for all it was worth, but the stokehold people kept the telegraph going continuously with their demands for " more feed " till they finally signalled " stop."

The engines were stopped, the silent blow-off opened and we hurried up on deck to find the stokehold crowd tumbling out of the scuttles as fast as they were able. They had watched the water dropping in the gauges despite their appeals for " more feed " and when it had quite disappeared they had drawn the fires as far as possible, put on the extinguishers, speeded up the fans and cleared out. An investigation was made at once and the cause of the trouble was soon located.

A filter was fitted in the feed discharge system with an arrangement of valves whereby the feed water could go through the filter or bypass it, as required. In addition, there was a connection which reversed the flow through the filter and washed any sludge or dirt into the bilges. It was found that the nameplates on the valve controlling the feed passing through the filter and that on the sludge connection valve had been interchanged, with the result that the feed water had been passing into the bilges and was not reaching the boilers at all.

Another case of the same sort occurred on the preliminary trials of a cruiser. The trial had not been long in progress when the feed tank commenced to overflow and all speeding up of the feed pumps failed to stop it. So much water was lost that the trial was abandoned and on investigation it was found that the nameplates on the feed pump suction valve chests had been reversed so that instead of drawing from the engine feed tanks the pumps had been taking their water from the reserve feed tanks in the double bottom.

Another case was that of a vessel in which the starting and drain cock gear had all been dismantled during an extensive overall. When the overall was completed a turn was taken out of the engines and it was found that even with the regulator full open the engines only just moved slowly over the centres. Eventually it was discovered that by some means the "open" and "shut" nameplates at the throttle valve lever had been reversed, the throttle valve in its shut position being sufficiently open to enable the engines to move, although slowly.

By far the commonest result of rushing a job is found in badly made and leaky joints, and the engineers who take some jobs to sea must have anything but a happy time from this cause.

One cause of trouble which sometimes crops up (and which will no doubt be familiar to most engineers) is the omission to cut the centre out of a joint.

The writer remembers as an apprentice a case of this kind where the centre was left in an insertion joint in the main inlet pipe to the circulating pump. In consequence of this the condenser was so badly cracked on starting up that a new condenser with back columns had to be supplied.

Accidents sometimes occur through articles being left in the cylinders. In most cases a very careful examination is made before closing up the cylinders, but trouble may come in from the steam pipes. An instance of this took place on the trial of a large twin-screw vessel at which the writer was present. When on the measured mile a terrible banging started up in the high-pressure cylinder of the port engine. The engine was stopped at once and as soon as possible the cylinder cover was lifted, when it was found that the piston was smashed. The vessel returned with the power from the other engine to the builder's yard, where the piston was removed and a chisel was discovered in the bottom of the cylinder. Fortunately, the cylinder bottom was intact, so that only a new piston was required.

The chisel had evidently been left in the main steam pipe after joining it up, and had passed through the regulator valve (the seat of which was damaged) into the high-pressure piston valve. From there it had fallen down the steam passage to the cylinder bottom.

Great care is necessary when fitting out to keep dirt, grit, pieces of waste, etc., out of the system by leaving no open joints, covers or doors. At least these should be left open for as short a time as practicable, for nothing is more annoying than to have to stop a trial for a choked filter or heater, while dirt or grit in the system can do a great deal of damage to cylinders or slide-valve faces in a very short time.

An example of trouble due to "rushing" was that of an engine which refused to run on the morning trial. The trouble was soon located in the air pump, when it was found that the bucket valves had been omitted. It transpired that the night shift had left it for the day shift to do, while the day shift had assumed it done and closed up the pump.

Another incident which has its humorous side occurred on the dock trial of a cargo steamer which was completed in a great hurry. The first trouble was the failure of the vacuum. This was found to be due to the inlet grating being choked, and it was speedily cleared with a steam jet. Other minor troubles manifested themselves in the way of blowing joints, so that everyone was kept busy and worried. The climax came, however, when the reversing gear was run over to the astern position. In their new position the links got right under the middle or packing platform and lifted it bodily off the engine, to the extreme surprise of two greasers who were on it at the time. These gentlemen were deposited on the engine-room plates together with their pots of cylinder oil and swabbing-brushes. It may be mentioned that their language, when they recovered from the shock, did full justice to the occasion.

A very annoying instance of the result of carelessness came under the writer's notice on the trials of an oil-fired torpedo-boat destroyer. In one of the stokeholds extreme difficulty was found in keeping a satisfactory oil pressure at the burners. Eventually a spring-loaded escape valve in the oil discharge line to the burners came under suspicion. The escape from this valve was led to the suction side of the pump, and it was thought at first that perhaps some dirt or grit had got under the valve. It was found, however, that there was neither spring nor valve in the case, so that a large proportion of the oil had been simply returning to the suction side of the pump and bypassing the burners altogether.

Mishaps directly traceable to faulty workmanship are seldom met with in connection with the work of firms who have a reputation to lose, but the following incident, which took place on the trials of a small coasting steamer with a single triple engine, may perhaps be placed in this class.

Everything was going smoothly and the vessel had been run once over the "mile," when, without warning, the engine suddenly pulled up. The starting valves were manipulated, but the engine refused to move. It was suggested that the high-pressure slide valve had somehow moved on its spindle, but inspection showed it to be quite secure. The anchor had to be dropped and everyone moved round the engine, trying to locate the trouble, but without result. An attempt was being made to investigate the regulator valve, when the designer of the engine noticed something peculiar about the position of the high-pressure crank, and this soon led to the solution of the mystery.

The round keys securing the crank webs to the shaft had, for some reason, not been fitted, the only security being the shrinking. Thus, after running quite well for some time, the high-pressure crank had slipped forward sufficiently to neutralise the angle of advance of the eccentric—a very simple explanation of what seemed quite mysterious at the time.

The most exciting trials at which the writer has been present were those of naval vessels fitted with high-speed reciprocating machinery. The greatest degree of discomfort was reached with the engines of torpedo-boat destroyers. In those days the full power trials of these vessels were of three hours' duration, against the eight hours now required by the British Admiralty. It was, however, a very strenuous three hours and no one who went through them was ever heard to complain about the three hours being too short.

The water service, usually augmented by a hose or two, was in constant operation, so that everyone was soaked to the skin, while the air seemed full of oil and sea water thrown off by the flying gear. The roar of the engines at top speed was rather trying to the nerves, while the vibration, especially when the two engines got into step, made one wonder how the ship held together. In addition, the bilges had a way of quickly filling up, with the result that the aftermost cranks would send a continuous shower of water across the engine-room. Everything depended on lubrication and the slightest failure in this direction usually finished the trial in a shower of molten white metal.

When things happened with these engines they happened quickly. Thus an eccentric strap that had been running quite cool might heat and seize so suddenly that before anything could be done the valve gear would be wrecked and the eccentric rods almost twisted into knots. Although masterpieces of engineering in their way, no one can regret that reciprocating engines are no longer fitted for this class of work.

The conditions imposed by the British Admiralty for the conduct of the trials of the last reciprocating engines fitted to battleships and cruisers were exceptionally severe. A limited number of men were specified to attend to the engines, no water service was allowed and no more oil for the bearings than that supplied by the service lubricators. It can be readily understood that the job of getting naval engines with their high speeds and bearing presses through an eight-hour trial under these conditions was not always an easy one.

With the adoption of the steam turbine all that was changed and the trials of high speed vessels have become tame affairs compared with the conditions which obtained with reciprocating engines. Thus the writer some time ago attended the trials of a turbine-driven vessel where at one time there were only four men in the engine-room, in which about 30,000 shaft horse-power was being developed. When one considers what the maintenance of a corresponding power with reciprocating engines would involve, one cannot but be struck with the change.

Serious breakdowns with turbines are not common, especially on trial trips, where the men handling them are usually experts. When troubles do occur on a trial they are more frequently in connection with the lubrication or the vacuum. These two are most vital points in the running of turbines.

The slightest failure in lubrication is disastrous, as the writer can testify from more than one personal experience, and it pays an engineer to give great attention to his forced lubrication pumps, so that there is no liability of these pumps to "stick." In addition, the designers who arrange the machinery should endeavour to place these pumps in a position where they can be readily seen and their working observed. The best place is usually close to the starting gear, where the engineer is stationed.

A case which occurred on one of the earlier turbine-driven vessels may be mentioned. A cock was fitted at the oil inlet to each bearing, and in passing into the tunnel (where the space was very restricted) one of the greasers must have knocked against a cock handle, thus shutting off the oil supply to one of the after bearings. In a very short time the bearing ran out and the motor dropped, thus causing a complete blade strip. With later turbines, however, it is usually impossible to completely shut off the oil supply to any bearing except by a stoppage of the pump.

Economy on a turbine-driven vessel depends to such an extent on the vacuum obtained that careful attention to this point on the preliminary trials may save a great deal of trouble later on. A good plan is to go over all the joints subject to the vacuum with thin red lead paint while they are under vacuum.

Tracing the cause of a low vacuum is often a tedious job, and the most obvious places are the escape valves on the condenser and the valve which controls the turbine drain to the bilge. These may be tested with a flame. Another common cause is the leaving open of a drain cock on the exhaust valve of some auxiliary engine, and it is extremely annoying, after hunting round the engine-room for the cause of the trouble, to find it in, say, the open drain cock of the capstan engine exhaust valve. When (as in naval vessels) the closed exhaust system is used it becomes a simple matter to discover an open drain, for all that is necessary is to screw up the spring of the valve admitting the auxiliary exhaust to the condenser, thus putting a back pressure on the exhaust system. With a pressure of, say, 20 lbs. per square inch in the system the open drain cock discovers itself.

The mention of the closed exhaust system reminds the writer of an incident illustrating the necessity of familiarity with the various connections which happened on the preliminary trials of a certain naval vessel. On returning to the dock after the trial, " stop " was rung down to the engine-room and steam was shut off the turbines accordingly. Greatly to the surprise of the engineer in charge, the turbines continued to revolve, and it was only after some minutes of strenuous tearing round that he remembered about the auxiliary exhaust which was passing into the low-pressure turbine.

In conclusion, however, it must be said that although small but annoying examples of carelessness and forgetfulness are common enough, really serious mishaps are seldom met with on trial trips.

" REACTION."

[*International Marine Engineer.*]

QUESTIONS SET FOR EXAMINATION FOR THE RANK OF ARTIFICER ENGINEER, R.N.

March, 1914.

PART I.

Time allowed, 3 hours.

[*Not more than* SEVEN *questions are to be answered.*]

1. You are required to work a set of triple expansion engines at three-fifths power. Describe what adjustments you would make to ensure—

   (*a*) that the required horse-power is not exceeded;
   (*b*) that the engines are worked economically;
   (*c*) that the cylinders develop their fair proportion of power; and
   (*d*) that the engines run smoothly without undue noise.

2. Sketch and describe a connecting-rod of a fast-running engine, showing clearly how the various parts are secured against working loose, and how the crosshead and crankhead bearings are lubricated.

3. Sketch and describe a thrust block of any turbine with which you are acquainted, showing clearly how the ahead and astern collars are adjusted and secured from working loose. The path of the lubricating oil through the block is to be shown in detail.

4. Describe how, on the completion of an extended period of hard steaming, you would examine a set of main reciprocating *or* turbine engines for signs of wear, mentioning the gauges, etc., you would use, and the parts where you would expect to find the wear most marked.

5. Describe briefly the causes of the following occurrences, and state the steps you would take to prevent or arrest them:—

   (1) Difficulty in maintaining steam when the number of boilers alight should be sufficient.
   (2) Difficulty of maintaining air-pressure when the number of fans running should be sufficient.
   (3) Excessive smoke.
   (4) Overheating of the furnace doors.
   (5) Undue amount of ashes in the ashpans.
   (6) Dark ashpits.
   (7) Flaming at the funnel.
   (8) Furnace bars falling into the ash-pans.
   (9) Brickwork falling down.

6. Sketch and describe the uptakes of a boiler with which you are acquainted, giving typical examples of the joints secur-

ing the uptakes and casings to the deck coamings, funnel, and boiler respectively, indicating the method adopted for—

(*a*) allowance for expansion;
(*b*) prevention of buckling of the plates;
(*c*) prevention of overheating;
(*d*) securing the lagging.

The path of the cooling air through the casings should be clearly indicated.

7. Describe, with the aid of sketches, the circulating water arrangements of a main condenser, including the path of the sea-water from and to the sea.

What fittings are provided for the prevention of corrosion?

8. Where do you find the necessary instructions with regard to keeping Store Accounts?

What are the principal differences between fixtures, spare gear, permanent, consumable, petty consumable, and inventory stores? How do you replace or obtain them?

How do you ascertain what quantities of the various stores are allowed?

How would you obtain stores when necessary in quantities in excess of the allowance?

9. If 8 skids contain one ton of coal, and a vessel with 43 similar boilers and 30,000 I.H.P. burns coal at the rate of 1·9 lbs. per I.H.P. per hour, how many skids per hour are burnt per boiler at full power?

What is the coal consumption per day if this rate is maintained, and how far can the vessel steam at full speed of 23 knots if the coal capacity is 2,500 tons?

10. A boiler becomes short of water in spite of all efforts to feed it. Describe the immediate steps you would take in the matter, pointing out the difference in practice with regard to cylindrical and water-tube boilers in this respect.

PART II.

Time allowed, 3 hours.

[*Not more than* SEVEN *questions are to be answered.*]

1. Describe briefly the steps you would take as Engineer Officer of the Watch if left to your own resources in the event of

(*a*) An excessive loss of boiler water being reported;
(*b*) a rapid rise of density of boiler water being detected; and
(*c*) receiving orders to light up and connect as soon as possible an extra boiler in a boiler-room already under steam.

(2) Describe the process of getting the oil fuel under way, stating what tests and precautions you would take, either

(*a*) When the oil is burnt in conjunction with coal; or

(*b*) as the fuel only.

(3) As the Engineer Officer of the day, what precautions would you take in supervising:—

(*a*) The replacing of the cover and closing up of a high-pressure cylinder;

(*b*) the water test of a boiler and preparing same for steaming;

(*c*) the connecting up of a steering engine and trying the same under steam.

4. A valve spindle is firmly seized in the bridge of a main steam sectional or group valve of any ship with which you are acquainted. Describe, with sketches, the method you would adopt in removing the spindle and turning up a new one, stating what is the minimum time you would require for the job.

5. Describe any torsionmeter with which you are acquainted.

6. Describe, with sketches, any boiler automatic-feed apparatus with which you are acquainted.

7. A water-tube boiler of any type with which you are acquainted has been damaged through shortness of water and requires retubing. Describe the process of removing and renewing the tubes and preparing the boiler for steaming, enumerating the examinations, measurements and tests you would make.

8. Make a sketch of the governor valve, with its actuating gear of *one* (only) of the following, explaining its action when the load is put on and taken off the engine:—

(*a*) Hydraulic pumping engine;

(*b*) steam reciprocating dynamo engine;

(*c*) Diesel engine for dynamo;

(*d*) Turbo-electric generator.

9. Give a description of *one* of the following, stating what tests you would carry out to ensure that it is in good working order:—

(1) Turret-turning engine;

(2) torpedo air-compressor;

(3) magazine cooling plant; or

(4) steering engine and gear.

10. Enumerate the notations which must be made in the Engine-room Register every hour, every watch and every day. Describe briefly what should be recorded as regards the engine-room complement, examinations of machinery and treatment of boilers.

ADMIRALTY WEEKLY ORDERS.

Admiralty, S.W.,
20th February, 1914.

Syllabus of Qualifying Examination Afloat for Candidates for Acting Mate (E.).

With reference to Admiralty Weekly Order No. 837 of 30th January, 1914, the qualifying examination afloat to be taken by the candidates selected in each Squadron or Command for the rank of Acting Mate (E.) will consist of six papers in the following subjects:—

	Maximum Marks.
Engineering (I.)	300
Engineering (II.)	300
Heat and Steam	300
Mathematics	200
Applied Mechanics	200
General Science, including Electricity	200
	1,500

The general nature of the questions in each subject will be as follows. The particulars given are for guidance only and are not intended to be comprehensive of the whole syllabus over which questions may range.

Engineering (I.).—Descriptions and sketches will be asked for of the construction and arrangement of the principal parts of the main and auxiliary machinery of a warship, and of the boilers and fittings in connection therewith. A knowledge of the principles of working of the above, and of the fittings provided for their adjustment, and how these are used, will also be required.

Engineering (II.).—Questions will test the candidate's knowledge of the actual working on service of a warship's propelling machinery, boilers, auxiliary machinery, and engine-room equipment, and of the examinations and adjustments necessary to keep such parts efficient. Questions will also be set on the regulations ordered to be observed, and the precautions necessary in carrying out the various operations incident to the working of the engine-room department of a warship generally.

Heat and Steam.—The papers set will comprise questions on the elementary principles of heat engines, with special reference to their application to steam and steam machinery, marine boilers, and evaporators, air compressing and refriger-

CONDITIONS TO BE OBSERVED BY INTENDING COMPETITORS FOR THE MARRACK MEMORIAL PRIZE.

We have to announce that the Artificer Engineers and Engine-Room Artificers' Benevolent Fund have suitably invested the sum of £75 for the purpose above indicated, and the members of that Fund sincerely hope that the above amount will be added to by voluntary subscriptions, so that the principal may rise to at least one hundred pounds (£100).

The following are the conditions that are to govern the Memorial prize:—

(1) The essay sent in for the competition to be on an engineering subject, preferably in connection with marine practice.

(2) The essay not to contain more than 3,000 words, accompanied, if necessary, with rough explanatory sketches (uncoloured).

(3) All essays sent in to be the property of the Fund, and to be published (at the Editor's discretion) in The Naval Engineering Review.

(4) The prize to be in kind, not money, the winner to determine what would be acceptable.

(5) If possible, the essays to be typewritten, but where such facilities do not exist the MS. to be clearly and legibly written on one side of the paper only.

(6) Only members of the Artificer Engineers and Engine-Room Artificers' Benevolent Fund to be eligible to compete for this Memorial prize.

(7) The competing essays to be sent in to the Editor of the Review not later than December 31st each year.

(8) The names and addresses of competitors not to appear on the essay, but to be sent on separate sheets.

(9) The name and rank of the winning essayist to be published in the April issue of the Review.

Only those complying with the above conditions will have their essays sent on to the adjudicator.

Contributions intended to swell the Fund can be sent to either of the Branch Secretaries, or to the Editor of the Review.

	£	s.	d.
Amount already acknowledged	5	12	6
Inspector of Machinery C. Salmon, R.N., M.I.C.E., J.P.	1	0	0
Inspector of Machinery, J. Rice, R.N.	1	0	0
Engineer Rear-Admiral A. E. L. Westaway ...	1	0	0

Will engineering journals please copy?

ions of our two most important trades in *an*
g the year 1833 the following figures may be
shipwrights, 2,500; total millwrights, engine-
ounders, 13.

n the experiment of training naval architects
fficers together. This developed eventually
orough" and Keyham Colleges.

ex of the growing importance of the engineer-
d be furnished, perhaps, than the Dockyard-
y-lists during the last quarter of the 19th
e late 'seventies the number of fitter appren-
been counted on one's hands; and these went
e bottom of the list! In the early 'eighties
y increased in number, but few of the highly
es would choose an engineering trade while
cancy offered. The new century has brought
te inversion of this order of things, and the
ow scramble for the engine-fitter or similar
rapid rise of the electrical fitter and the intro-
aval shipwright and boy artificer are also note-
nents of the new century.

rs since, it will be remembered, the question of
ition of the Dockyard schools was seriously
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cational machinery had now rendered any
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schools have gone from one record success to
the present time seem more firmly rooted than
he permanent order of things.

of the record number of Whitworth Exhibi-
Scholarships obtained by apprentices in 1913
that these valuable means to greater ends were
own to students—south of London—before the
Such scholarships had been for many years
of engineering students from Bradford and
technical training colleges. A Portsmouth
tice—now a leader in Portsmouth educational
irst to mount these stepping-stones and reach
coveted prizes open to engineering students—
scholarship itself. This rapidly led to the
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With apologies for
London, Jan.
The Editor, NAVAL

A PREVENTATIV

THE question has oc
brother engineers sti
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I went through tw

ating machinery and to the combustion of coal and oil fuel. Also on the quantities of heat involved in the formation of steam, its expansion and condensation, the laws connecting the pressure, temperature and volume of gases, and the methods of obtaining the efficiency of steam machinery, boilers, or of a combined plant. The candidate's knowledge of indicators and indicator diagrams may also be tested in this paper.

Mathematics.—The metric system: conversion of units. Elementary geometry and algebra with practical applications. Simple problems of evolving equations. Plotting curves and use of graphs. Elementary trigonometry. Calculation of areas, volumes and surfaces in practical cases. Meaning of differential co-efficient: simple examples of differentiation with applications: maxima and minima. Meaning of an integral: simple examples.

Applied Mechanics.—Elementary principles of statics and dynamics treated with reference to practical applications. Force, effect of a force in causing motion. Moment of a force about a point. Conditions of equilibrium. Finding the resultant of given forces. Centre of gravity. Friction. Simple machines, mechanical advantage and efficiency. Velocity ratio. Instantaneous axis. Work, energy and power. Centrifugal force. Elementary notions of stress and strain. Hooke's Law. Ordinary tests of materials, properties of fluids. Hydraulic press. Equilibrium of floating bodies. Energy of fluid under pressure and in motion. Pressure exerted by a jet of fluid.

General Science, including Electricity.—Construction and working of cells in common use in the Service. Secondary batteries. Ohm's Law and its applications. Electrical instruments in common use: electric bells, telephones, arc and incandescent lamps. Specific resistance, divided circuits, shunts. Continuous current dynamos and motors, including general knowledge of types, management and maintenance. Electrical power and energy. Properties of the common metals. Production and properties of cast iron, the blast furnace, wrought iron, steel. Steel manufacture, Bessemer's and Siemens's processes, hardening and tempering of steel. Ship plates, boiler plates, armour plates, protection of steel from corrosion. Oxygen, hydrogen, nitrogen, production and properties. The common acids, their combination with different metals. Common materials, water, air, limestone, etc. Chemistry of combustion.

DOCKYARD SCHOOLS AND SCHOLARS.

Dear Sir,—May I congratulate you on your interesting page of "Notes and Comments" in the October issue, referring to Royal Dockyard Apprentices and their training? To many ex-apprentices in civil life your remarks have given much satisfaction, and I feel sure by the many ex-apprentices holding responsible positions in the Royal Navy they must have been heartily endorsed and appreciated.

Although some, more recent, systems of training Admiralty men and officers have yet to justify themselves, there can be no question of the unqualified success of the dockyard apprentice system. The combination of personal practical instruction in shop and ship with sound mathematical training—as far as the individual student is able or willing to follow—in day and evening schools has not yet been improved upon. The Admiralty may justly claim to have founded the first successful technical schools!

That the modern municipal technical colleges—now happily an educational asset in all large towns—can give "points" to the Dockyard schools in some departments of science teaching is true. The Admiralty themselves recognise this by arranging for special classes of their students to attend "outside" courses of study, and, of course, the enterprising individual himself often takes advantage privately of such supplemental study. Several of our great shipbuilding and engineering firms—such as Messrs. Wm. Denny & Bros., Dumbarton, and Messrs. Sir W. G. Armstrong, Whitworth & Co., Newcastle—have closely followed Admiralty practice by encouraging local schools and colleges for the use of their apprentices.

It may be interesting to recall that it was far back in the later stages of the Napoleonic struggle that the British Admiralty set about the task of giving systematic training to their Dockyard *personnel*. A college was founded at Portsmouth in 1811 for the teaching of specially chosen youths the higher duties of a ship-builder. These youths were required to spend three days per week on the building-slip. A seven years' course qualified them as assistants to the master-shipwright—the constructive manager of those days. A year or so at sea followed, and they then became fully fledged officers and open to the highest appointments in due course. Meanwhile the ordinary working apprentice had little or no chance of preferment. It was not until about 1848 that a more democratic spirit crept into the Dockyard educational scheme. Class distinctions were then abolished, and open apprentice-schools established at all the Government yards.

The Dockyard apprentice, too, is getting a wider outlook upon the world and having a firmer conviction of his national importance. He has been pressing for improved pay and privileges. Freeing himself from the old-time fetters of trade jealousies, he makes common cause with all his fellow-craftsmen, and ex-apprentice associations, with many influential patrons, are the result. This year's record of trifling concessions from the Admiralty is an augury that their tactics are sound and may be pressed further. The time should not be far distant when "ex-Royal Dockyard Apprentice" will be the guinea-stamp to a journeyman-mechanic's or draughtsman's credentials; while a four-years' course at a Dockyard school will be an equivalent to a degree or associateship of other educational centres.

With apologies for trespassing so freely upon your space,

London, Jan. 3rd. G. PINHORNE.

The Editor, NAVAL ENGINEERING REVIEW.

A PREVENTATIVE OF SCALE AND CORROSION IN BOILERS.

THE question has occurred to me, why do so many of my brother engineers still persist in using strong chemicals to prevent internal corrosion and for the removal of scale from boilers? I have had a great deal of experience on land and at sea, and have found that chemicals that are strong enough to loosen and dissolve old scale will also attack the boiler itself. They will eat the flange packings in your steam line, destroy the piston-rod packing and sometimes affect the rod itself. Now I had an experience some years ago which taught me a lesson. It taught me that there was a cheaper and more efficient way of removing scale and preventing same from forming than the use of strong chemicals.

We had just finished cleaning boilers after a lay-off of several weeks. I sent one of the firemen up over the tops of the boilers to get a small bag of graphite. He let the bag drop on top of one of the boilers, spilling about half of the contents of the bag, or about 20 to 25 lb., down through the manhole and into the boiler. I thought at the time that it could not hurt anything, so I did not bother to clean it out, but forgot the incident, and did not think of it again until I had it brought to my mind four or five months later, when we opened up the boilers for cleaning again.

I went through two of the boilers and found them in about

formed in a solid mass. On the shell and crown
re was from $\frac{1}{16}$ to $\frac{1}{8}$ in. hard scale. I put a
men in each boiler to scale and clean them, and I
the next boiler. You can imagine my surprise
ent into No. 3 boiler (on the same battery using
the same source) to find it almost entirely free
. What had settled in the bottom was soft and
rushed in your hand. Most of it could be washed
hose. I did not know what to make of conditions
them until I came out with a handful of sediment
hered up as I came out. Upon examining this I
as mixed with graphite, and then I remembered the
hen the graphite was spilled in the boiler.

sed graphite ever since as a preventative of internal
nd to prevent the forming of scale. The graphite
d has left the boilers clean and does not impair the
king or engines. No more chemicals for mine. A
phite that protects boilers, engines, etc., is good
me. W. V. Ford.

, Conn.

[*International Marine Engineer.*]

SCERTAIN THE DANGERS OF COAL,

Dennstedt & Schafer have designed an apparatus
hod by which coals may be tested and classified as
eir liability to self-ignition. Such tests would furnish
ta as to the safety or danger of storing and trans-
y particular type of coals. Coals which when heated
gs. C. in a stream of oxygen show no tendency to
f temperature are absolutely safe. Those which show
endency to heat up locally but fail to ignite within
re safe enough for storing and transporting on board
ose which ignite within an hour and below 150 degs.
atively dangerous coals. The temperature of self-
and the time of heating necessary, determine rela-
degree of danger. In general, the heat value of the
t an index as to its tendency to self-ignition: brown
much more dangerous in this respect than soft coals.
nce of finely divided particles in a coal pile increases
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tage of oxygen in the coal the greater the liability
ition.

We have to announc
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(1) The essay se
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(2) The essay n
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(3) All essays ser
to be published (a
Engineering Revi

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Membership of the Benevolent Fund means :

That for a small monthly outlay you provide a substantial amount in case of death to whomsoever you nominate to receive it.

That should you be invalided from the service, there will be a sufficient sum to help you through the first few months when you are either looking for, or getting installed into, civil employment.

That no longer is it necessary to send the "hat round" for a dependent widow and orphaned children when a mess-mate "slips out of the slings." By remaining outside you escape your share of fulfilling this obligation.

That the Benevolent Fund, through its death and invaliding levies, abolished this stultifying method of "raising the wind."

Membership of the Fund means even more than the foregoing, all important as the points enumerated are; for it means that you are a member of a guild of your own people; people with whom you have thrown in your lot for 22 years and possibly more of your adult life. Membership means the possibility of meeting your confrères on a platform other than that of the mess or the engine room. Have you ever asked yourself the question:— **"Is my present position such a bed of roses, so perfect in every respect, that I don't want to see it bettered?"** Questions such as this one is must have caused you an awkward moment occasionally. After all, Brotherhood should stand for something. If the Benevolent Fund does not offer you the complete idealisation of that beautiful word, you can always come inside and help in its realisation.

In other words: won't you bear your share of the burden? The Fund helps the widow and the orphan and it assists the "Casts" through a period of convalescence. By meeting together corporately, ideals can be established and the necessary machinery for their attainment put in motion. All this is what you can share in by joining the Benevolent Fund.

Ask your Mess-mates for Particulars about how to become a Member and then join up at once.

The sum of £104 has recently been paid to nominee of a deceased member, and £47 13 6 to a member just recently invalided.

Published for and on behalf of the Royal Naval Artificer Engineers and Engine Room Artificers' Benevolent Fund by W. STODDART, 76 Manners Road, Southsea.