CORRESPONDENCE

SIR,

Journal of Naval Engineering

As the Editor of the last issue of *Papers on Engineering Subjects* and the first Editor of the *Journal* I should like to express my appreciation of having been permitted to receive regular copies of your publication since I left the Navy nine years ago.

During this time I have been associated with the training of navigating apprentices, engineer apprentices and, to a smaller extent, engine-room ratings in the Merchant Navy. In addition to its wide technical coverage, the articles which have appeared from time to time on technical training have been of special interest and value to me.

I am sorry there has not been a closer link between the Royal and Merchant Navies in the training of their engineer officers. An experiment was attempted but we were defeated on the question of costs which in the commercial world has defeated or delayed so many good intentions for the training and education of young men.

However, it has been a very interesting period and when I first met the Minister of Transport's advisers as a representative of the Shipping Federation in 1957 there wasn't a single specially-equipped marine engineering centre for the Merchant Navy. By the end of 1964 there should be five, one each in Clydeside, Tyneside, Merseyside, London and Southampton. These should not be confused with the basic training workshops. The Royal Navy's pattern of training played an important part in bringing about this change in the Ministry of Transport's regulations. At present the most comprehensive of these training centres is at the South Shields Marine and Technical College.

While a broad basic technical education, with essential craft skills, is given to every shipowner's apprentice, the level of education reached during apprenticeship may be the Ordinary National Certificate, Ordinary National Diploma, Higher National Certificate or in a limited number of instances has been taken up to Honours 'A.R.C.S.T.' or Honours Degree in Applied Science (Marine Engineering). I had an apprentice who obtained his 'M.Sc.', but this was exceptional. There are very many able young engineer officers of good personality in the Merchant Navy at the moment.

It is however with a definite regret that I have decided to end what has been for me a very happy association. I think it is also time for me to ask you to remove me from your mailing list and to thank you very much indeed for having kept me supplied with the *Journal* so many years after leaving the Navy.

Before parting company, however, I should like to mention that in 1947, after discovering from the Record Office, Admiralty, that many of the technical decisions taken during the First World War had been, for some reason, drastically destroyed, and realizing that apart from C.A.F.O.s and A.F.O.s the technical information emanating from E.-in-C.'s Department during the Second World War had been somewhat scanty, I endeavoured, with the willing co-operation of a number of engineer officers, to attempt to fill in part of this gap. Hence a number of articles in the first three volumes of the *Journal* covering the period 1939–45.

I hope one day it will be possible to de-classify the *Papers on Engineering Subjects* and the early *Journals* and that copies will find their way to the Public Record Office or the British Museum for they form a valuable historical record of interest to students of technical research.

When in the Spa Hotel, Bath, in 1946, I discovered the Secretary of State for War's original patents, shared with a naval engineer officer, of what became the standard pressure oil-burning system. On checking with the Patent Office, these patents though over forty years old were still classified 'Secret' and details were not known to the Patent Office. I thought that was stretching secrecy a little bit too far!

I know one has to be careful and I hope you will always be spared my experience, after the first copy of the *Journal* had been circulated, to receive a telephone call from London reporting that a young gentleman had been seen showing certain illustrations in the *Journal* to his girl friend on a London bus!

With every good wish for the future.

(*Sgd.*) A. F. SMITH,
Commander, R.N. (*Rtd.*)

SIR,

Diesel Design and Maintenance

Commander May's article (Vol. 15, No. 1) is of great interest. In his conclusions, however, he does not go further than to say that there is a future for Diesel engines.

There are many reasons for supposing that in small surface warships, of, say, up to 60,000 s.h.p., there would be considerable gains from fitting a 'self-contained' plant, such as Diesel engines or gas turbines; among them are:

(*a*) Small size of components requiring replacement or repair, and possibility of complete replacement

(*b*) Reduction in number of components and hull connections, and therefore in radiated noise

(*c*) Reduction in number of auto and remote control boxes, because such matters as air/fuel ratio are built in, and there is no requirement for the feed water cycle.

This is however far from saying that a particular type of plant—say, Diesel engine—will be the best in any particular application. The main and generating machinery is only part of the ship; and I believe that on present knowledge a combination of Bristol Olympus main engines (rated at 12,500—15,000 s.h.p.) and Bristol Proteus alternators (running at 3,600 r.p.m. and rated at 1,800—2,000 kVA) may well provide a better answer in most cases.

I think it is time that the *Journal* had another article from the Project Group, not necessarily on particular designs, but on the problems of matching machinery to ship designs, and taking into account the necessity for a continuing plan of development, and the possibilities of repair in dockyards. We have dropped Diesels once; their merits have forced them once again to our notice, though they do perhaps still fall short of our requirements. Can we afford to neglect them—or any other system of propulsion and generation—merely because no immediate requirement can be foreseen? Even surface nuclear machinery?

If the answers to these questions should be as I suppose, how do we get the money and where do the design staff come from?

(*Sgd.*) P. L. CLOETE,
Captain, R.N.

SIR,

Helicopter Engines

Perhaps I may add a few notes to Lieutenant-Commander Simpson's comprehensive article on helicopter engines, published in the June issue of the *Journal.*

With respect of the advantages of multiple-engine installations, although in-flight shut down would result in an improved s.f.c., this cannot, of course, be compared favourably with the single-engine installation. In the Wessex Marks 2 and 5, the twin Gnome power plant is particularly inefficient since the rotor and transmission are incapable of absorbing the total output at any point in the flight envelope; the single Gazelle 13 and 18 engines in the Marks 1 and 3 however, offer s.f.c.s of 0·71 and 0·68 respectively for a much lower installed weight. Furthermore, multiple engines require heavy coupling gearboxes and the present twin Gnome box is not designed to accept prolonged assymetric driving.

However, single-engined aircraft have a serious accident rate some 13 per cent higher than twins (this figure is based on American statistics for fixed-wing aircraft). To achieve successful recovery from an engine failure in any

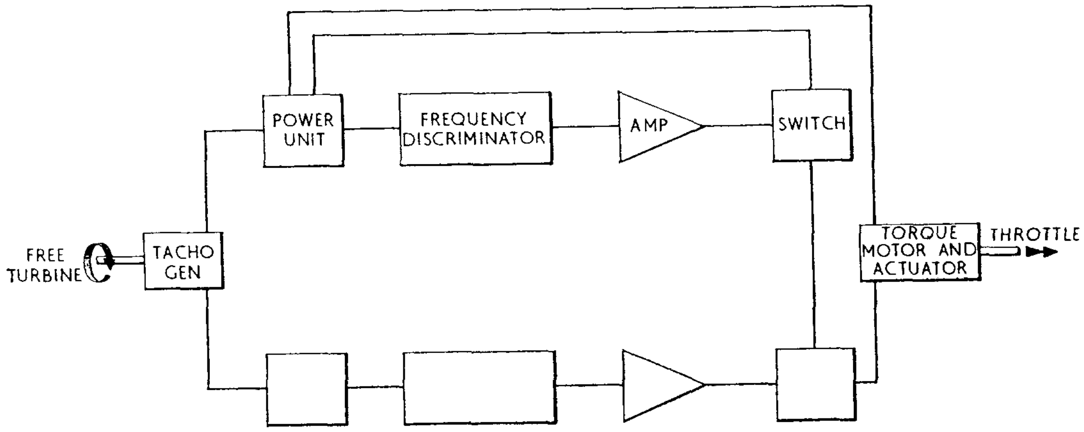

FIG. 1—ROTOR OVERSPEED PROTECTION

flight condition, it can be shown that the helicopter requires four engines; even with the excess power available, the Wessex Marks 2 and 5 cannot meet this 'engine out' requirement in full.

On the subject of engine/rotor governing, there are a number of aspects at present under investigation. Fundamentally, the Gnome fuel system computors have proved highly successful, though the engineering design is capable of further development. High accuracy of definition of the engine limitations has called for numerous pre-set circuits and a very rigorous production clearance. The design is a little unusual in that it employs transductors throughout; among other advantages these are rugged and reliable, but they are also heavy. Electronic governing systems are here to stay and fortunately simplicity is not the only way of achieving reliability. Transistorized systems will be sufficiently small and light to justify the application of redundant circuit and component techniques.

As stated in the final section of the article, '. . . limiting devices should obviously be included with the safety of the complete aircraft in mind . . .'. It has recently been demonstrated in flight that a pilot can contain the Wessex 5 rotor r.p.m. to 260 when one engine runs away from minimum collective pitch at 226 r.p.m.; his reaction time is in the region of $1\frac{1}{2}$ seconds, responding to changes in transmission vibration and noise, rather than instruments. While it is preferable to allow the pilot to recover control rather than to shut down one engine automatically, one could not rely on the reaction stated above. For this reason engine/rotor protection systems are undergoing further developments. In general, mechanical engine overspeed trips are inadequate for rotor protection since the tolerances are too great; a further difficulty is that the datum must be higher to allow for transient overspeeding, e.g., 23,100 r.p.m. is the present limit for the Gnome and this is equivalent to approximately 272 rotor r.p.m.

The main system under development at present is depicted in FIG. 1. This employs a tacho-generator, on the rotor side of the coupling gearbox, which feeds a signal to a frequency sensitive switch unit. The circuits of this unit are transistorized and triplicated: any two channels must be triggered to make the switch, hence it is protected against inadvertent tripping or circuit failure. The 'shut down' signal is then passed to micro switches, on the inlet guide vanes of each gas generator, to detect which engine has opened up. The switch which is made passes the signal to its own solenoid-operated fuel dump valve and also to an isolating relay on the opposite system (to ensure that the other engine is not shut down). From a datum of 255 rotor r.p.m. this system achieves shut-down in 40 millisecs, which is equivalent to a rise of 5 r.p.m. in the worst case.

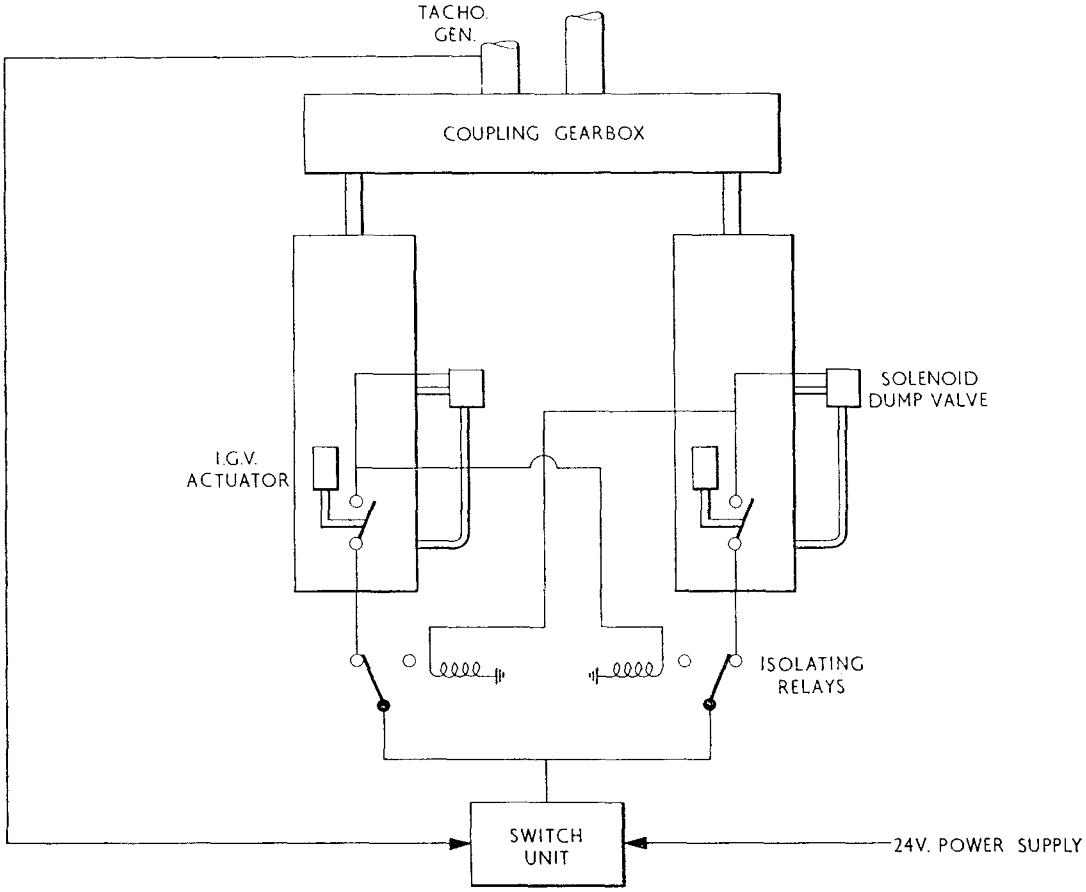

FIG. 2—ENGINE OVERSPEED PROTECTION

A further system also under consideration is shown in FIG. 2. It is intended that this should combine the functions of the existing O.T.G. with rotor protection. A free turbine tacho-generator would supply both the frequency signal and the electric power for the system, thereby improving integrity. Both channels must operate to switch on the torque motor: this releases an actuator which closes the throttle. This system is lighter, more compact, wholly engine mounted and free from micro switches and extra relays. However, even though the accuracy is better than 0·5 per cent, the datum cannot at present be lowered far enough and this might necessitate investigation of handling problems between 260 and 270 rotor r.p.m.

In addition to the work outlined above it is hoped that a fundamental computor study of engine/rotor dynamics will be initiated in the near future.

(*Sgd.*) R. V. HOLLEY,
Lieutenant-Commander, R.N.

SIR,

Complement Evaluation

I was very interested in the article on the calculation of engine room complements in the December, 1963, issue of the *Journal* and am glad to see that this important aspect of a ship's upkeep capability is now being worked out on a rational basis.

Last year, when in the 24th Escort Squadron, I carried out a similar exercise for the ships in the Squadron and readers may be interested in a comparison of the method used with that described in the *Journal*.

From Squadron records the number of P.M. items of 3M and above and defects which had been carried out in each quarter over the period of a year were abstracted. From these totals were subtracted the number of items done by F.M.U. (repair ship) and an estimated number done at sea (20 per cent). The final total was divided by the number of E.R.A./days in harbour to give a work factor. This work factor of number of jobs per E.R.A./day in harbour varied from 0·5 to 1·17 and averaged out at about 0·8 for most ships. From knowledge of these ships, a factor of 0·5 represented a fairly light work load, some overbearing of E.R.A.s, and probably not a comprehensive recording of all defects completed. On the other hand, a factor of 1·17 represented a considerable degree of working over normal working hours.

It was then necessary to establish a defect factor in number of defects per day at sea so that the defect load could be estimated for a given usage. The defect factor was found by dividing the total number of defects arising in each quarter by the number of days at sea and although it varied for the various classes of ship, over a year the defect factors of each ship were remarkably consistent—where good records had been kept.

By applying these factors, the number of E.R.A.s required could be found from the equation:

Total upkeep load = Work done at sea + work done in harbour + F.M.U. assistance.

That is:

$$M + SD = (N - NW)WS + NW(91 - S) + F \text{ (over a 3-month period)}$$

where M = P.M. load
D = Defect factor
W = Work factor
S = Number of days at sea
F = F.M.U. assistance
N = Total number of E.R.A.s
Nw = Number of watchkeeping E.R.A.s

From this equation:

$$N = \frac{M + SD + NwWS - F}{91W}$$

Such records as were available for the Squadron showed that the average F.M.U. assistance per quarter was 55 items and 'S' was taken as 50 days, which is not an uncommon usage on the Far East Station. For a Type 12 frigate with a defect factor of 4 and a P.M. load of 210 items per 3 months, after A.F.O. 1694/63, the required E.R.A. complement was 7 E.R.A.s, to the nearest whole number. For the purpose of convenience and comparison with previous records, the P.M. load was scaled down for a 3-monthly period instead of using a 4-monthly period.

If there were no F.M.U. assistance, an extra $\dfrac{55}{0{\cdot}8 \times 91}$ E.R.A.s would be required, i.e., 1 E.R.A. to the nearest whole number, and then the E.R.A. complement would be 8. The article in the *Journal* does not state the class of ship to which its calculation refers, so it is impossible to compare its figure of 9 skilled men with 8 E.R.A.s for a Type 12 frigate obtained by the method described above.

Readers will be able to see for themselves the many assumptions and approximations made in the above method yet, over a long period of time, the consistency of the factors obtained was remarkable and I believe they are valid when applied to the usage and upkeep of ships over comparably long periods. Because this method was applied to ships on the Far East Station, no allowance was made for leave but this could easily be included in the equation.

Although the method described in the *Journal* may appear more accurate than the one described above, because it uses detailed figures of man-hours required for each job, it makes three broad assumptions itself, viz:—

(*a*) A weighing factor is applied for non-availability of machinery after shutting down
(*b*) A weighing factor is applied for the effectiveness of man-hours put in
(*c*) Defects are estimated at 33 per cent of the P.M. load.

In the method described in this letter, (*a*) and (*b*) above are allowed for in obtaining the work factor of 0·8 since it is derived from results actually achieved in ships, and records of the 24th Escort Squadron showed that the defect loads in these particular classes of ship are much greater than 33 per cent of the P.M. loads for a 50 per cent usage. Comparable figures in numbers of items, after scaling P.M. loads as previously described, are shown in the following Table.

Class	*50 per cent usage*	*Defect factor*	*No. of defects*	*P.M. load*	*Percentage defects/P.M.*
Daring	45 days	6·7	301	400	75
Ca.	45 days	2·8	126	150	84
Type 12	45 days	4·0	180	210	86
Type 61	45 days	6·0	270	300	90

Although this Table lists number of items and not man-hours, there is no reason to believe that the average defect takes significantly less time to complete than the average planned maintenance item, and so it is believed that this Table accurately reflects the proportionate efforts required for P.M. and defects.

There is a further aspect of E.R.A. complements which is not covered by the method described in the *Journal*, and that is the need to ensure that daywork E.R.A.s can be fully employed at sea. In the case described requiring 9 E.R.A.s, and reducing this to 8 E.R.A.s to allow for F.M.U. assistance, 5 will be daywork and 3 will be watchkeepers. It must therefore be possible to make machinery available at sea for upkeep to employ these E.R.A.s fully, i.e., to enable them to carry out 5/14 or 36 per cent of the total upkeep load for a 50 per cent usage. Analysis of *Daring* and Type 12 planned maintenance schedules and defects indicates that 40 per cent of the upkeep load could be carried out at sea, so in the case described there would probably be no underworking of daywork E.R.A.s at sea, provided machinery could be made available.

Using the factors described in this letter, the number of E.R.A.s who can be fully employed on daywork at sea can be easily calculated as follows:—

Upkeep load at sea = Upkeep effort at sea
Then $0{\cdot}4(\mathrm{M} + \mathrm{SD}) = \mathrm{NdSW}$, where Nd = No. of daywork E.R.A.s

$$\text{From which } \mathrm{Nd} = \frac{0{\cdot}4(\mathrm{M} + \mathrm{SD})}{\mathrm{SW}}$$

In conclusion, I would suggest that in applying the formula described in the *Journal*, the allowance for defects be increased to at least 70 per cent of the P.M. load unless it can confidently be predicted that the defect load of new ships will be considerably less than in existing ships. Also that the results obtained should be checked to ensure that daywork E.R.A.s at sea can be fully employed. If not, then the numbers allowed must be reduced and additional F.M.U. assistance provided during maintenance periods to compensate.

(*Sgd.*) R. G. J. PEAVER,
Commander, R.N.

Departmental Comment

The method expounded by Commander Peaver has a limited application because it can only be used for evaluating the complement needs of limited parts of a ship's 'running life'. Additionally, at the time the evaluation is required within D.M.E., F.M.U. support is an unknown factor.

The method described in the *Journal* is the first stage in the evaluation and allows a basis on which to form a Scheme of Complement. This basis is the number of fully trained men necessary to the average needs and conditions pertaining during the ship's 'running life', this being all time except that under modernization, conversion or long refit. This basic complement is later expanded into a Watch and Quarter Bill which allows some skill dilution and adjustments for other reasons, within the parameters stated. The economical seagoing complement is considered at this stage, it being the minimum number for any rate, expressed within the parameters quoted.

It should be noted that since the article was published and because routine periodicities have been extended into a '4-month multiple' system, the proportion of breakdown to planned-maintenance load is now assessed as 50 per cent. The variance of the 70 per cent figure recommended by Commander Peaver is not so great as it appears. His method disregards all routines below 3-4 months; D.M.E.s does not. The shorter periodicity routines amount to a large proportion of the total P.M. effort.