POWER BOATS AND CRAFT

BY

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This article deals with the new construction, maintenance, modifications and new developments concerning power boats used in the Royal Navy. It attempts to show how the engineering aspects of the above subject are dealt with at the Admiralty.

The Author was from May 1957 *to December* 1959, *the Assistant Inspector dealing with these matters.*

NEW CONSTRUCTION

Well over 150 new power boats and small craft are built annually. This number, which varies and is at present dropping slowly, meets requirements to equip new construction ships ; it also makes good depreciations through old age and wear and tear in the Fleet, by replenishing the Dockyard Boat Pools. The numbers for the above purposes are estimated in annual Boat New Construction Programmes. Once Admiralty Board approval to proceed with construction has been received then relatively large numbers of suitable firms are invited to tender competitively. The boats are built in batches varying from two or three to two or three dozen, according to requirements, but each boat-builder seldom receives a contract to build more than half a dozen craft of any one group of new boats. Although this policy has disadvantages concerning office work and standardization it does ensure that a large pool of boatbuilders familiar with Admiralty work, is available, should large numbers of small craft be required in an emergency.

From the engineering point of view the small size of the I.C.E. Ship Design staff available in Bath for initiating and controlling this work does not permit the carrying out of the whole of the detail of the installation planning and drawing effort required. In the case of a completely new type of boat or small craft a Machinery Specification is prepared and from the list of successful tendering firms one firm is selected as having the best drawing office facilities. This firm has written into its contract a clause to prepare detailed engineering installation drawings for approval by the I.C.E. Ship Design Section at Bath. In certain cases, for the larger craft, the Marine Engineering Division's Project Group would carry out preliminary investigations of alternative installations, and would make recommendations which would greatly assist in finalizing the Machinery Specification.

In the course of preparing the Machinery Specification the I.C.E. Ship Design Section would consult the Engine Design Specialist Section, Diesel or Gas Turbine, together with any other specialist section as necessary, for the solving of noise, vibration, gearing problems, etc. While the above was proceeding, the engineering financial position would be cleared. With the completion of these technical and financial preliminaries the I.C.E. Ship Design Section would then initiate contract action for the purchase as necessary of engines and initial stocks of spare gear, together with separate contracts for stern gear, exhaust systems, controls, etc. Some of this equipment may have to be tendered for by several suitable firms ; some of it may be made available by the engineering Spare Gear Section from stocks held surplus from earlier contracts. The final contract action will leave the Ship Department through the Finance Section concerned and another section will progress these Admiralty supplied items through to their delivery to the boatbuilders, assisted as necessary by the local Admiralty Engineer Overseers.

As few engineering firms building small I.C. engines now consider it prudent to carry large stocks on their shelves and as small craft are usually built comparatively quickly, whereas the production of engines is a much more lengthy process, it will be appreciated that the financial and contractual sides of small craft new construction, with all their many possible delays, give rise to as many problems as those which occur on the technical side. This is especially so as it is generally difficult to obtain early enough financial approval to order engines, etc., in advance of Admiralty Board approval to place firm contracts for a definite number of boats.

While the new construction preliminaries proceed within D.M.E., discussions take place concurrently with the Constructive and Electrical Divisions of the Ship Department. The inter-departmental problems of weight, space, maintenance accessibility, etc., are as much with the small craft designer as they are with the designers of larger craft and there has to be a great deal of give and take before the first design is agreed. It is the general practice to prove a new design not only by extensive trials at the builders but also by means of prototype trials over a period of months at sea in one of H.M. ships. From the answers received to the Admiralty Trials Questionnaire, made out by the Constructive, Engineering and Electrical Divisions of the Ship Department, the craft is modified as necessary and tried again at sea before the design is considered as finalized.

The Naval Group within the Ship Department sponsors the foregoing sea trials. This group also sponsors the Admiralty Boat Panel Meetings which take place several times each year. This Panel has representatives from all the Departments in the Admiralty in any way concerned with boats and small craft, from either the operating, designing, maintaining and repairing, or stores aspects. The requirements for amphibious warfare craft are similarly dealt with by the Correlation of Development Committee sponsored by the Chief of Amphibious Warfare. The regrouping in October, 1958, of the old separate Constructive, Engineering and Electrical Departments and of D.N.E. into the one Ship Department has, it is considered, proved to be most effective in cutting out delays in the field of work under discussion ; a ' united front ' on policy and finance can now be presented by D.G.S. Many small craft design problems are now settled ' out of court ' by personal discussions ; in the past they would certainly have been the subjects of many long minute sheets.

Once new construction work has been started, its progress on the engineering side is watched by the local A.E.O. As the firms concerned are usually very small many of them have little in the way of engineering resources. In some boatyards the Managing Director is sometimes to be seen spurring on the good work by personal example, with more often a wood chisel than a spanner in his hands. Hence satisfactory results, and the achievement of a reasonable degree of standardization, often depends on the ' presence ' and the initiative of the A.E.O. ; much more so than would be the case with larger firms equipped with trained engineering staffs, drawing offices and well equipped workshops, etc.

Since the end of World War II, as part of an Admiralty Policy, an attempt has been made to standardize on to the following seven types of boats for use by the Fleet :

45-ft Motor Launch	One 100 h.p. Foden FD6 (Diesel)
36-ft Motor Pinnace	One 43 h.p. Perkins P4 (Diesel)
35-ft Medium Speed Motor Boat	Two 70 h.p. Foden FD4's (Diesel)
27-ft Motor Whaler	One 11½ h.p. Enfield HO2 (Diesel)
25-ft Motor Cutter	One 11½ h.p. Enfield HO2 (Diesel)
16-ft Fast Motor Boat	One 50 h.p. Coventry KF4/178/1 (Diesel)
16-ft Slow Motor Boat	One 5½ h.p. Enfield VS1 (Diesel)

From the above list it will be seen that petrol installations have been dropped in favour of the heavier but safer and more economical Diesel engines. Apart from the 16-ft F.M.B., the ' skimmer ', whose future is in any case in some doubt, it will also be seen that hard-chine F.M.B.s have been replaced by slower but sturdier round-bilge boats. Wherever the shape of the stern and the shaftline permit 2-to-1 or 3-to-1 reduction gearing to be fitted, then larger and slower running but more efficient propellers are used —e.g. this was carried out with success with the 25-ft M.C.s but it is impracticable with the 27-ft M.W. owing to its fine lines aft and to the need to fit the smallest possible propeller in order not to spoil the good sailing qualities of this new boat.

In practice, well over seven different types of new boats are always under construction. Specialized designs are required in quite large quantities for many different services e.g. surveying ships have their own types of boats. The Amphibious Warfare world has a whole range of specialized craft, from fast outboard-driven Gemini rubber built assault craft to 42-ft landing craft, raiding craft and navigational leaders. There are hospital launches, naval servicing tenders, passenger launches and many other varieties, including, in 1960, the need to design a satisfactory replacement for the vintage 1939 Royal barge. As many of these additional craft as possible use Admiralty standard range engines. A number of ' out of date ' craft that are still serviceable, are engined or re-engined with Admiralty standard or interim standard engines, again as far as possible.

MAINTENANCE

Well over 3,000 power boats and craft are either in service or in reserve throughout the world. The whereabouts and the basic data concerning every one of these boats is shown in B.R.1315, which lists well over 80 varieties of power boats and small craft, some dating back to the 1920's and still in use. This B.R. is under constant revision and is re-issued annually. The boats are listed not only under their Year/Serial Number but are also shown under their parent ships.

The maintenance of boats and their associated engineering installation equipment is carried out using Defect List procedure, whenever dockyard assistance is needed. In emergencies away from dockyards, should repair work be both urgently and operationally essential, then the local A.E.O. is called upon to assist. In the case of engines and their associated gearboxes the policy of maintenance by replacement is now firmly established for the Admiralty Standard and Interim Standard Ranges of I.C. engines. These engines are listed in appendices at the back of B.R.1986. Though much shorter than the Engineering Manual, B.R.1986 has much of interest for the operator/maintainer of I.C. engines, including the signal procedures for demanding replacement engines and also for returning defective engines to the in-line-maintenance depots.

Defects are often detected by seagoers, which they either suspect or know are not isolated incidents peculiar to their own boats but which could be damaging other craft of the same series. When this happens, for the good of all possibly still unsuspecting boat E.O.s, it is a great help if the easily compiled reports, as made out on Form S.2022, are rendered to the Director General of Dockyards and Fleet Maintenance, Fleet Maintenance Division, Empire Hotel, Bath. These reports are passed to the I.C.E. Ship Design Section of D.G.S. whenever investigating action is required. In the case of pure engine, engine auxiliary or gearbox defects, the report is passed on to the appropriate specialist section at the Admiralty. Consultations with the firm concerned then proceed with the object of finding a satisfactory remedy. Once this has been determined, information is passed back to the originator and at the same time

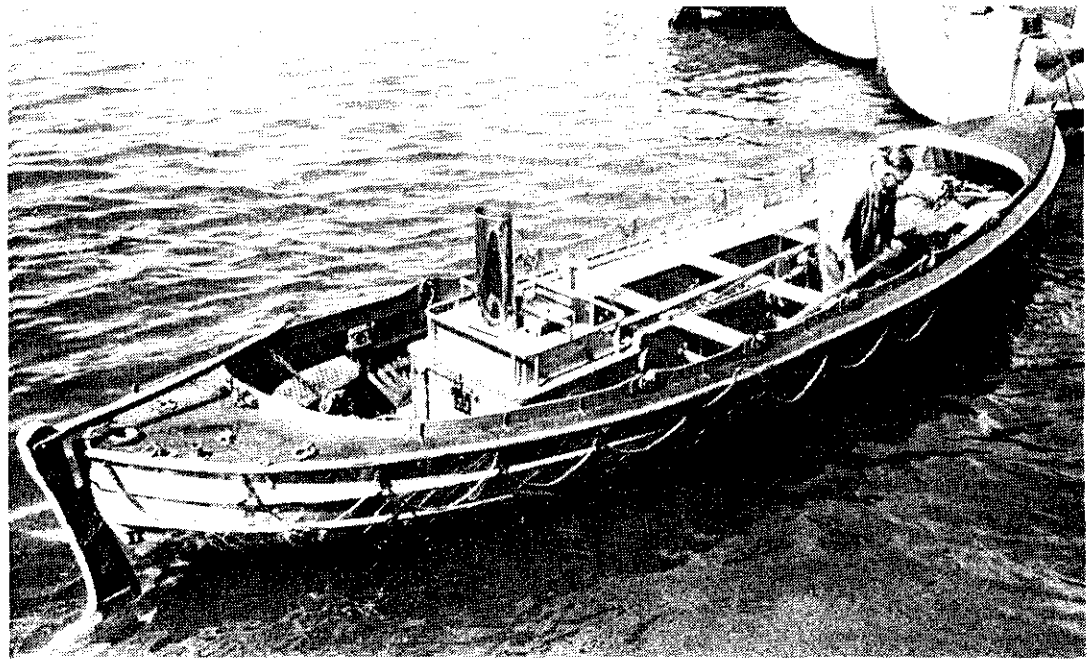

FIG. 1—1954 PHASE I MOTOR WHALER

general action for the rest of the Navy is taken either by Admiralty Letter to administrative authorities or by means of an A.F.O.

The arrangements for the supply of spare gear, tools and drawings, together with their supporting documents (Forms D.787, etc.) are basically similar to those made for ships. Every effort is made to provide spare gear backing at the S.P.D.C. and for base spares at the same time as the new craft or engine comes into service. In the past, the boat and small craft maintenance problems which have concerned the Fleet, as shown by some of the 'Notes from Sea' published in earlier issues of the *Journal of Naval Engineering*, have sometimes, for one reason or another, been very slow to reach those engineering sections in the Admiralty which stand ready and able to investigate and to take action leading to improvements. The Form S.2022 is intended to remedy this matter and to cut down paperwork to a minimum.

MODIFICATIONS

As experience at sea is gained, the need for modifications may become apparent, despite the general practice of carrying out prototype trials before building new Classes of boats. A case in point which provides a topical illustration concerns the 27-ft motor whaler. This boat replaces the Montague sailing and pulling whaler and as originally designed it was intended that it should be capable of efficient use in the three roles of pulling, sailing and power. For this purpose it was fitted with a lightweight reversible and fully feathering propeller gear of Watermota manufacture and the Enfield HO2 engine was set in an aluminium frame, with the intention of making the power unit readily removable from the boat.

The first boat was built in 1954 and was sent to H.M.S. *Cumberland* for sea evaluation trials. Here it was tried and reported upon, with a long list of recommendations for modifications. Reports from sea began to accumulate and showed that the controllable-pitch propeller gear was of a too lightweight construction for general service use and that excessive maintenance efforts were required. The ungainly exhaust system, which ended in a wide brass funnel, was also unpopular (see FIG. 1). In 1956, improvements were

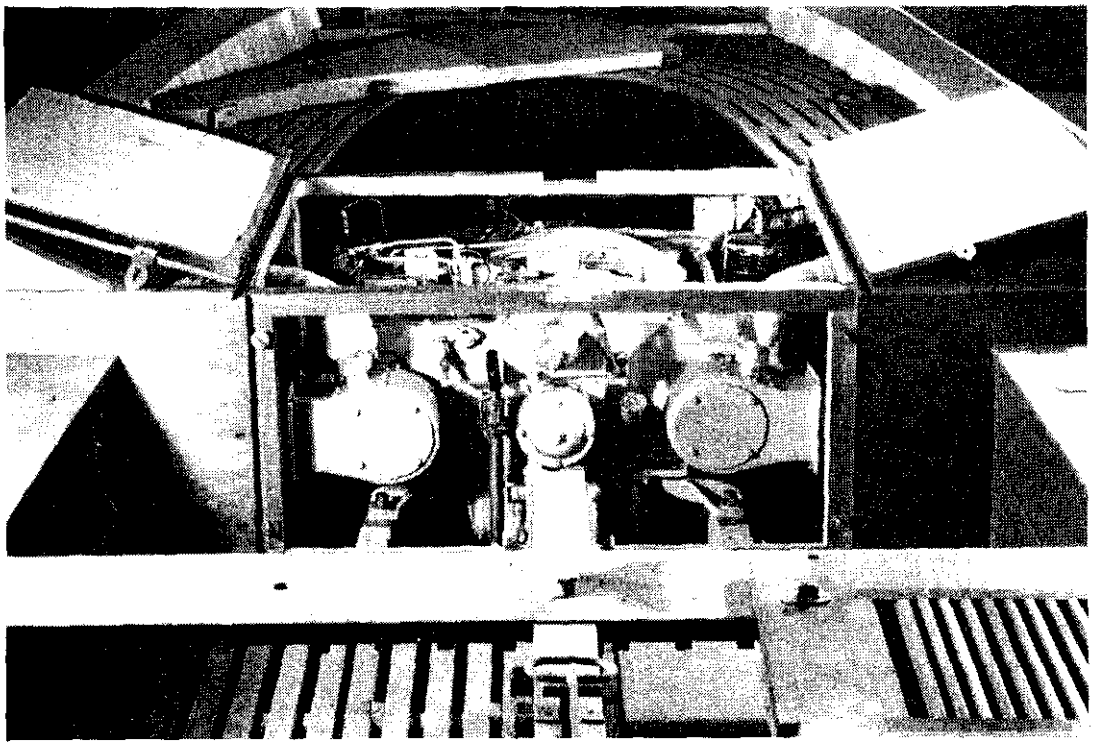

FIG. 2—1958 PHASE III MOTOR WHALER

incorporated into the Phase-2 boats then building, consisting of a more robust Watermota C.P. gear and a stern exhaust system.

By this time it had been established that the M.W. sailed as well if not better with the engine in as with it out, so the attempt to make the engine easily removable was dropped. The improved Watermota gear in the 1956 (Phase 2) M.W. did not come up to expectations and the problem of the disposal of the large quantities of hot cooling air produced by the air cooled Enfield engine had still not been satisfactorily solved. This air was discharged into the sternsheets —ideal for wintry English or arctic weather but far from ideal in tropical conditions.

In 1958 a new design—the Phase 3 M.W.—completed its sea evaluation trials and 20 of these boats were built by Messrs. J. S. White, of Cowes, I.O.W. This group is now being followed by other large batches and steps have been approved and are being taken to bring all the earlier boats to the Phase 3 standard—A.F.O.464/60 refers. The Phase 3 design has the same engine but it is fitted with a conventional Parsons gearbox and clutch and drives an ordinary two-bladed propeller. In this new design a sided air exhaust system is fitted which has the effect of ejecting the hot cooling air outboard well clear to port and starboard of the engine compartment. The engine exhaust is also sided and the final result has given a much improved maintenance accessibility to the machinery (FIG. 2). A single-lever control gear operates off the gearbox cross-shaft, enabling one man both to control the combined throttle and gear lever and also to steer the boat. Grease-lubricated whitemetal sterntube bearings, fitted with an inboard grease gun, now replace the unsatisfactory water lubricated bearings fitted in the 1954 and 1956 designs. The machinery can now be run, within reason, for trial with the boat at the davit's head—in the earlier design boats one or two expensive and complete controllable-pitch propeller hubs and blades whirled off as total losses, fortunately outboard, following shaft failures in way of red hot plastic sterntube bearings. Prototype sea evaluation trials of a motor whaler and a motor cutter fitted with the electric start version

FIG. 3.—GEMINI MEDIUM AT SPEED—35 H.P. JOHNSON PETROL OUTBOARD ENGINE

of the Enfield HO2 engine have been satisfactorily completed in the Dartmouth Training Squadron. An A.F.O. will shortly be promulgated detailing arrangements to fit electric starters to all motor whalers and 25-ft. motor cutters.

Another boat which has undergone a number of engineering changes since 1945 is the 16-ft F.M.B. the ' skimmer '. This craft began life with a Scammell petrol engine. When the policy concerning the use of Diesel engines was introduced a special lightweight 2-stroke supercharged 4-cylinder Diesel engine was developed by Messrs. Coventry Ltd. (the Coventry KF4/178 engine). This engine gave a good deal of trouble and was later replaced by the KF4/178/1, which is the engine fitted in all the later skimmers. In 1956 a plastic hull version of this boat was also produced with the engine in the sternsheets, driving the propeller shaft through a V-drive gearbox. Following evaluation trials in H.M.S. *Cumberland*, which were only fairly satisfactory, trials were completed in H.M.S. *Tyne*, which were more satisfactory. However in 1958, it was decided on recommendation from the Fleet, to start disposal action for all the direct drive skimmers A.F.O.2818/58 refers. The 16-ft. F.M.B. is handicapped by the fact that the engine has to develop nearly full power before the hull will rise to the planing position (once there, less power is required, though overloads occur during sharp turns). The lightness of the engine has meant that its normal treatment at sea, i.e. straight up to full power, often results in breakages of piston rings. The ease with which the relatively exposed propeller shaft and propeller can be damaged by small debris while at speed forms another unsatisfactory operational and maintenance feature of this boat. 'Repeats' of the ' V '-drive version and the position regarding future new construction of this size of boat will be reviewed later.

Consideration is also being given, in the 16-ft size, to the greater use of a slow in lieu of the fast design of boat landed from many ships. The present 16-ft S.M.B., though only capable of six knots, has proved to be a robust and reliable craft. Modifications to improve its usefulness and to reduce its crew to

one, by providing it with forward steering and forward controls, are being evaluated at sea.

Interest is also increasing in small gas turbine installations for main propulsion.

In the past these have proved to be relatively very expensive financially. Their fuel consumption was also high, particularly at partial powers. Improvements in both directions have now been achieved ; progress will be confirmed by means of trials in modified boats used as floating test-beds.

Water jet propulsion for small craft is being investigated but at present the low efficiency with this method of propulsion is a big disadvantage.

NEW DEVELOPMENTS

A major new development during the past few years has been the rapid increase in the use of rubber craft equipped with petrol outboard engines. These began with the French designed ' Zodiac ' rafts which have become known in the Service as Gemini Craft. When fitted with outboard engines, 10 h.p. for the ' 6-man Gemini—small ', and 35 to 40 h.p. for the medium and large sizes, it has been found that good speeds are practicable in the lightly-loaded condition. In addition, size for size, these craft are a great deal more seaworthy than conventional boats. FIG. 3 shows a Gemini medium craft underway.

The major disadvantage of all the present outboard engines is that they use petrol. The unpopularity of this fuel for storage and for dispensing and for striking down again at sea, in large or small quantities, hardly requires emphasizing. Every effort is being made to develop outboard engines which burn safer fuels, such as Diesel oil. The Service already use 100 h.p. Foden Diesel engined Harbormaster units to propel side-lift pontoons off L.S.T.s, etc. The Harbormaster unit is completely self-contained and drives its propeller at the end of a vertical stalk. This stalk can be rotated through 360 degrees, and can also be raised for propeller repairs or renewals. These units, though removable, weigh 6 tons and cost about £6,000. The requirement is now to encourage development in something less expensive and much lighter in the 10-40 h.p. range ! The design of ultra-lightweight Diesel installations of very small size presents many problems but progress is now being made.

Developments proceeding in a different field concern the use of plastic propellers for small craft. When an underwater obstruction is met these tend to flex at the blade tips, rather than to break, as would a metal blade. When ordered in quantity a big saving in costs is expected to result. To date, fibreglass has been proved a satisfactory material, and nylon is showing promising results.

CONCLUSION

Every effort is made to keep the staff at Headquarters fully aware of the Fleet's problems and requirements. A practical perspective on maintenance accessibility, on alignment problems in lightly-built small craft, and on the need for reliability in starting and running, is inculcated by despatching the ' chair-borne experts ' to sea as often as possible in order to attend acceptance and sea evaluation trials. In many other countries interest and experience in small craft machinery is relatively slight, even in the Navies concerned. In the United Kingdom the great wealth of experience and interest available all round the coast provides very useful background guidance in keeping the Navy's power boats and small craft up to date with the latest trends in design.