TRAINING ENGINEER OFFICERS

BY

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It will be realized that the members were, for the most part, civilian and it was therefore necessary to expain the meaning of the new Officer Structure. It was not appropriate to discuss the pattern of training at H.M.S. Thunderer *which is being considered for officers who will join in* 1959, *after being trained under the new Dartmouth scheme. Much thought is being given to this at present.*

Much of the substance of this paper has already appeared in articles in the Journal.

CHANGES IN OFFICER STRUCTURE

These changes are required to compete with the revolutionary advances in ships, weapons, and aircraft. They are directed towards the ultimate improvement of the career prospects of all specializations, and in particular towards making full use of the experience and knowledge of more senior officers of the engineering, electrical, and supply specializations, who it was felt could play a more important part in the higher administration of the future Navy, given the chance of more experience in the junior ranks outside their special technical fields. This, indeed, accords with the trend of industry in this country.

Any cadet now entering the Navy does so as ' an officer —which is his prime function, and his early training is, to the greatest possible extent, common (except at present for the electrical specialization) whether he is eventually to become a seaman, engineer, or supply specialist. After later training for his specialization, every junior officer will, so far as his specialist duties permit, take part in the day to day duties of running a ship in harbour or a shore establishment. In the same way, however, as only a qualified aviator can command an aircraft, whatever the seniority of his passengers, so only a seaman specialist will be appointed to command seagoing ships. But for other normal working command problems, all cadet-entered officers of the four specializations are now included in a single General List and will be placed on a similar footing. In fact, in the close confines of a modern warship, the interdependence in action of one department and another must be such that officers and ratings are ' all of one company '.

At the same time it is intended that improved careers should be offered to those promoted from the lower deck, whose undoubted specialized practical experience has proved invaluable through two world wars. Such officers, formerly known as Warrant and latterly Branch Officers, are now included in the Special Duties List with titles Engineer Sub-Lieutenant, Engineer Commander, etc. (their sub-specialization being denoted by a suffix M/E, A/E, or O/E, which is explained later). They are generally interchangeable within their own sub-specialization with the General List officers in the lower ranks. There are, in addition, a few exceptional ratings called Upper Yardmen who have been selected at an early stage for promotion to the General List. The

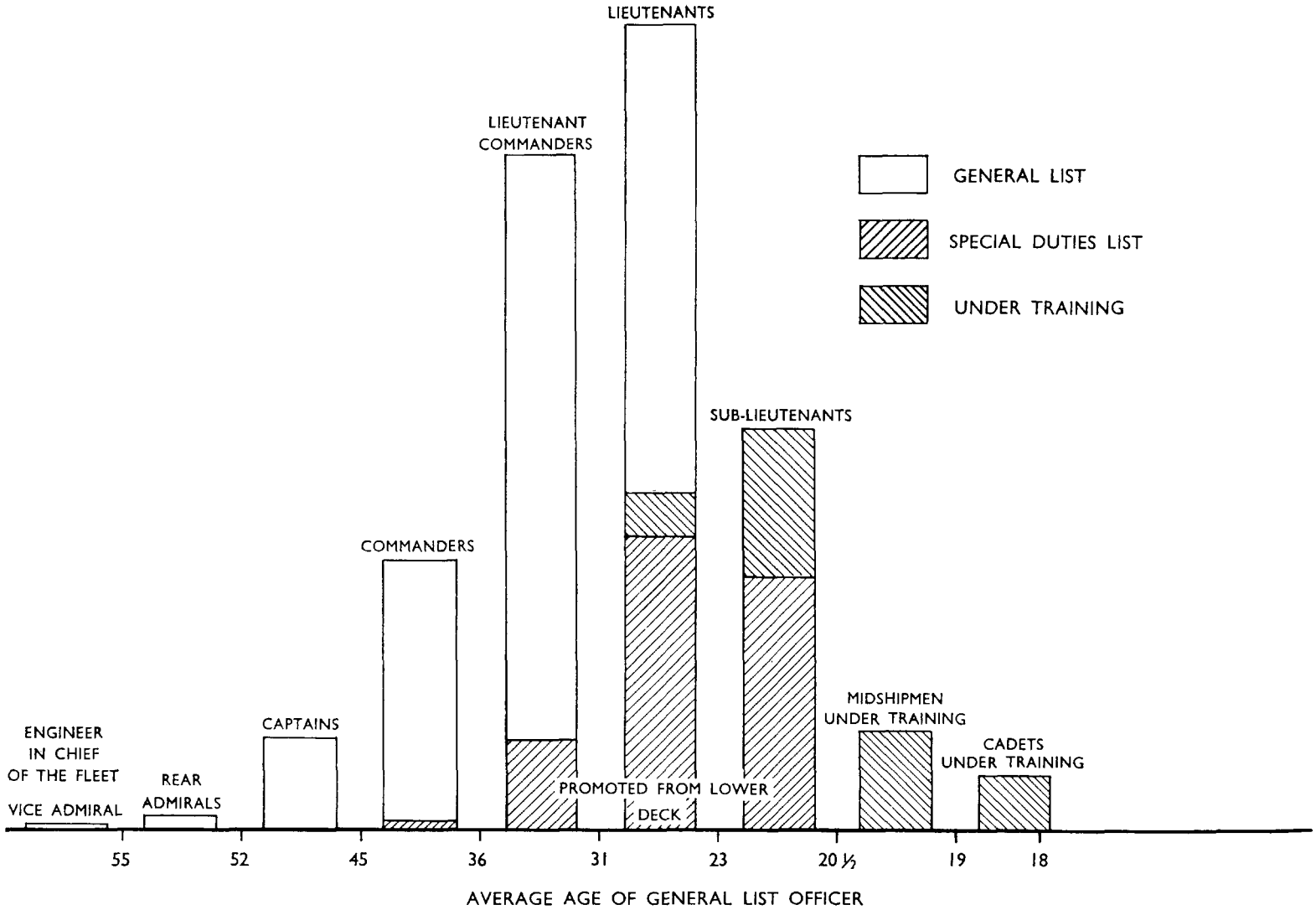

FIG. 1—GENERAL AND SPECIAL DUTIES LIST OFFICERS OF THE ENGINEERING SPECIALIZATION

relative number of officers of the engineering specialization at present in each rank, and the relationship between the ' General ' and ' Special Duties ' lists are shown in FIG. I.

Substantial changes of this nature will take some years to implement fully, but they will be progressive and indeed have already started to take place.

NATURE OF DUTIES

The engineering specialization is at present split broadly into three : marine engineers (M/E), air engineers (A/E), and ordnance engineers (O/E), with a fairly free interchange in the higher ranks. On the material side the marine engineer sub-specialist deals mainly with the propulsion and the associated auxiliary services of ships, submarines, and coastal craft ; the air engineer deals with aircraft, airframes, and engines and he may be a qualified pilot; the ordnance engineer deals with gunnery equipment, torpedoes, and guided missiles. All are responsible for their own personnel in the performance of their technical duties.

The approximate distribution of duties in the various ranks of the General List is shown in FIG. 2.

It will be seen that a good deal of the time up to the rank of Commander is spent afloat (or, for air engineer officers on air stations), initially in a watch-keeping or junior capacity, and later in entire charge of main propulsion and auxiliary machinery, or of mechanical maintenance of aircraft, or of weapons, together with all associated personnel.

As an example, H.M.S. *Eagle* (152,000 s.h.p.) carries the following engineer officers :—

TABLE I

	Cdr.	*Lt.-Cdr.*	*Lt. or S/L*	*Under Training*	*Total*	*Duty*
M/E	1	3	14	7	25	Main and auxiliary machinery. Flight deck machinery. Damage control.
A/E	1	2	5	1	9	Maintenance of aircraft squadrons.
O/E	—	1	1	1	3	Maintenance of weapons.

A *Daring* Class destroyer carries as engineer specialists one commander and one lieutenant for the main and auxiliary machinery, and one lieutenant for weapon maintenance.

A ' T ' Class submarine carries one lieutenant or sub-lieutenant.

In seagoing appointments, any of the commanders and below may be General List or Special Duties List.

The most senior seagoing appointment is that of Fleet Engineer Officer who is generally of captain's rank, serving on the Staff of a Commander-in-Chief.

Dockyards and Air Repair Yards

Each Royal Dockyard, which may deal with the entire modernization of a carrier and the major repairs to all classes of ship, has a rear-admiral or captain as Manager of the Engineering Department, with a staff of specialist officers. There may be as many as 4,500 civilian employees under his control, even under

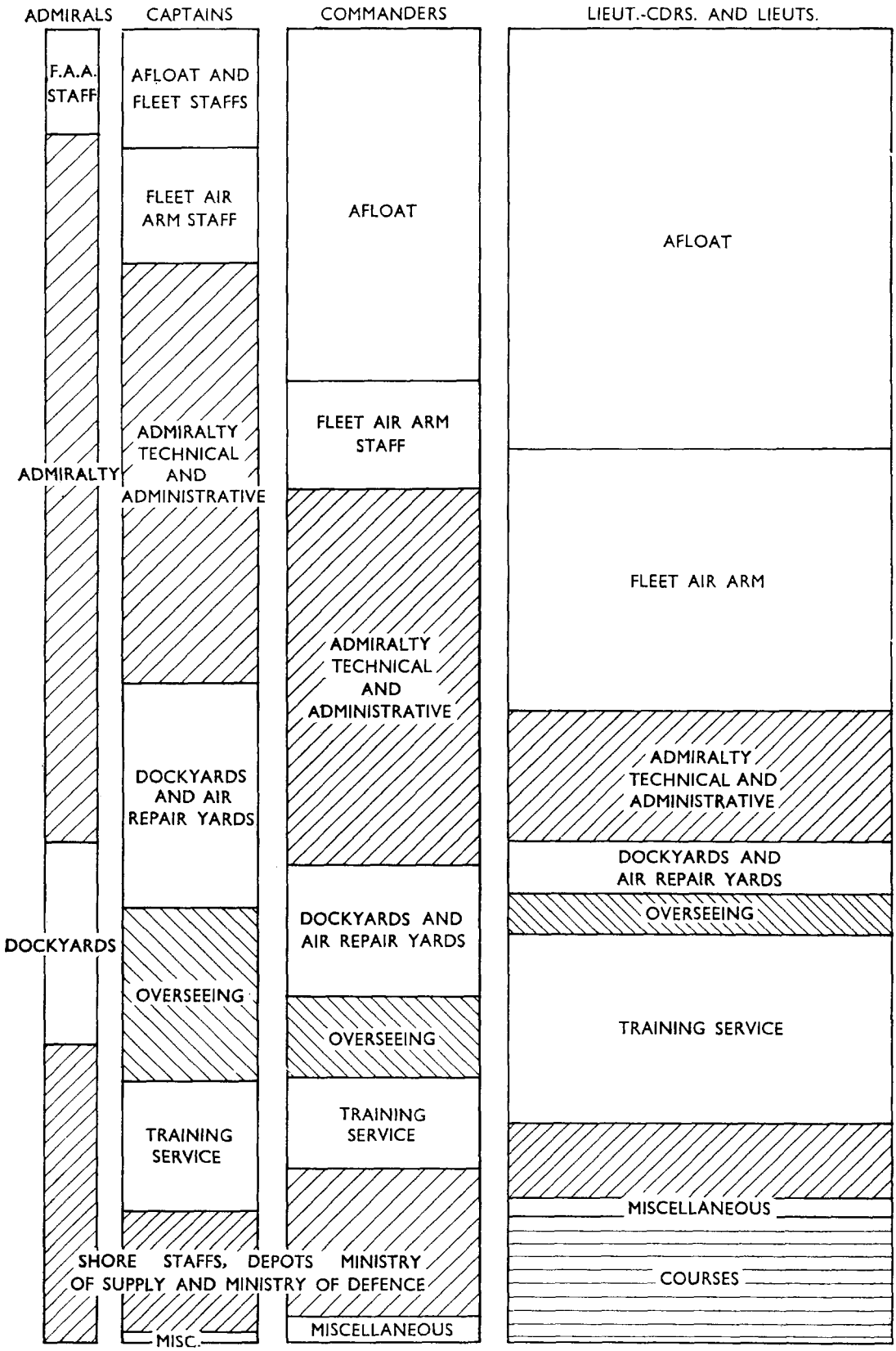

FIG. 2—PRESENT DUTIES OF GENERAL LIST ENGINEER OFFICERS

peace-time conditions, and his job is comparable with that of managing director of a large industrial firm. Similarly, the aircraft repair yards, under a captain of the engineering specialization, deal with repairs, modernizations, and conversions of naval aircraft, and employ civilian labour forces of up to 1,500 men. The Flag Officer Reserve Aircraft commands three air stations and three air repair yards, and he, the Chief Ordnance Engineer Officer, and the Assistant Director of Dockyards are rear-admirals of the engineering specialization.

Training

From FIG. 2 can be seen the heavy load carried by the specialization, assisted by the highly qualified instructor officers, in training its own officers and technical ratings. At any time there are some 3,000 personnel under training, from the age of 15 onwards. Of all tasks, it is perhaps one of the most exacting and the most rewarding. All engineering training establishments are commanded by an officer of the engineering specialization.

Technical Administration

The majority of these posts are in the Admiralty Departments of the Engineer-in-Chief, Director of Naval Ordnance, Director of Dockyards, Director of Underwater Weapons Material, Director of Aircraft Maintenance and Repair, and the Ministry of Supply ; the functions of these departments are generally to translate the requirements of the Naval Staff into technical terms, to guide the various contractors to produce these requirements in the desired form, and to ascertain by shore and sea trials that the equipment functions correctly. Subsequently they must ensure, by a carefully planned maintenance programme, that all such equipment is ready for immediate use in war. It is natural, therefore, that in these departments many of the more able technical brains of the specialization will be found. It must be emphasized strongly that the function of these departments and the engineer officers in them is not to design, but rather to guide, the designers and to criticize design proposals. They are enabled to do this by virtue of a high standard of professional training allied to wide technical user experience obtained at sea. There is but little scope for the purely ' back-room boy ', since his place (and a very important place it is) is properly in research work or industry where his specialized talent can be drawn on as required, and since the continuity required for this type of work is incompatible with the wide experience necessary for a naval officer in the higher ranks.

General Administration

Under this heading come a variety of important tasks, not necessarily purely technical, such as the Admiralty staffs dealing with engineering personnel whose function is to advise the Second Sea Lord on the correct training and employment of officers and men of the technical specialization—Commanders-in-Chief's Staff Engineer Officers, and officers appointed for intelligence duties, naval attachés, N.A.T.O. staffs, and so on.

It can be seen that a great variety of professional tasks may fall to a naval engineering officer. He may well find himself as the engineer officer of a solitary destroyer patrolling off Japan, then two years later training apprentices in Scotland, followed by taking charge of steam catapult trials in a new carrier. Or, as a more senior officer, he may be overseeing Admiralty gunnery contracts in the Midlands, followed by two years as the Fleet Engineer Officer in the Mediterranean and then in command of a training establishment of 1,000 young ratings. In general most appointments average two years, certain more specialized ones lasting three or four.

Ultimately he may rise to be Engineer-in-Chief of the Fleet, with the rank of vice-admiral ; under the General List concept, an officer of the engineering specialization will, on his merits, be able to rise higher than vice-admiral and play an even more important part in higher administration ; but at whatever age he retires, it can never be said that his life has lacked variety.

Woven through all these duties runs the vital thread of the leadership of men. He can never hope to command the loyal respect of the men under him (be they sailors, scientists, or Chinese dockyard workmen), unless he has been brought up to think in terms of human relationships. A knowledge and understanding of mankind is just as essential as professional ability, whether he is in charge as a junior officer of a small party of men cleaning boilers, or as a senior officer in discussion with a leader of industry. Be he technically a paragon, his own personal character is of equal importance.

Probably no other walk of life may involve such high degrees of responsibility —responsibility sometimes of life and death—at such a young age. A submarine commanding officer in war-time may be as young as 22, and his engineer officer about the same age. The engineer officer of a fleet carrier with machinery costing £3,000,000 may well be under forty. In many appointments the entire responsibility for welfare, discipline, and efficiency of many hundreds of men may rest with a technical officer—for whom technical training alone cannot be enough.

BROAD TRAINING IN FUNDAMENTALS

It can be seen from the above background that it is an obvious requirement for the naval engineer officer to be trained as broadly as possible. Mr. Love, in a recent paper,[1] used a quotation from Milton : ' I call therefore a complete and generous education that which fits a man to perform justly, skilfully, and magnanimously all the offices, both private and public, of peace and war,' which, if ' all the offices ' is taken to mean the many varied duties described above, fits the naval aim most aptly. It is essential that the early training in fundamentals as a mechanical engineer is not allowed to be obscured by a welter of practical detail. The technical complexities of modern warships and aircraft are indeed so great that the young officer could readily become ensnared in a web of such detail, which in any case may well be out of date by the time he meets it. The mechanics of solids and fluids, the laws of thermodynamics and electrics, the nature of materials and mathematical treatment do not change, whatever form of propulsion may be in vogue at the time, be it steam, gas turbine or nuclear, above, on, or below the seas. Without an understanding of such fundamental principles, coupled with training in *how* to think, or without the inculcation of creativeness and judgment, or without a knowledge of the humanities, the education will not be ' complete and generous '.

Professor Christopherson has given his opinion[2] that the standard of certain University examinations had risen by about one year for each fifteen that passed. This is probably true in most sciences, and certainly in relation to the technological advances in the Services. In eighty years a guided missile is replacing a muzzle-loading gun. Consequently the trend towards specialization becomes more and more compelling but, if the senior technical officer is to play an increasing part in the general administration of the Navy, it must be resisted. ' If his general experience and ability to take a broad view are proven, he will stay. If he takes a narrow technical view he will not. In addition, there will always be scope for the brilliant engineer who can carve a niche for himself, enjoying the advantages of being his own master, but running the risk of mental loneliness which can afflict men at the top.'[3] It is the general experience and ability to take the broad view on which the conception of the General List of naval officers depends.

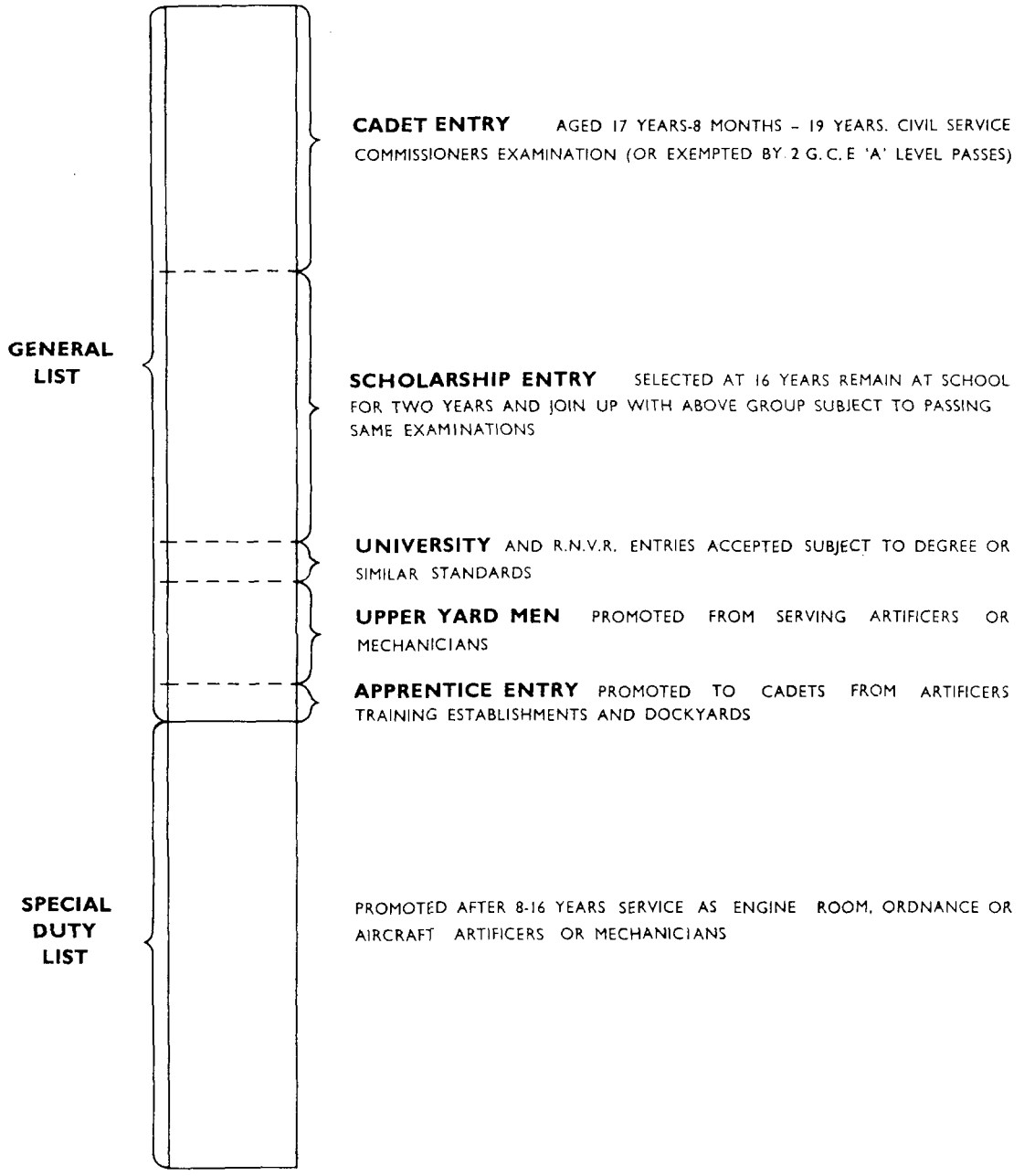

FIG. 3—SOURCES FROM WHICH ENGINEERING SPECIALISTS ARE DRAWN

At the same time, the principle that all engineer officers should sub-specialize in marine, air, or ordnance engineering is being retained, since it is not thought practicable for a young man to master the details of construction, operations, and maintenance of all three and to practise them effectively. Given a broad training in the fundamentals of mechanical engineering, with a sound grounding in one aspect of the whole profession, and his general naval experience, it is hoped to produce a man who can perform ' all the offices '.

TRAINING

The relative sources from which regular engineering officers are drawn is shown in FIG. 3.

The cadet and scholarship entries are drawn from all types of school ; at the moment it happens that independent schools are providing the majority, but

it is felt that there are many of the best boys from maintained grammar schools who are not coming forward as candidates.

For the scholarship entry and cadet entry, G.C.E. ' A ' level exemption by two ' A ' level passes (with three ' O ' level) has been only recently introduced, and may become increasingly popular with schools.

The pattern of training for engineer officers to suit these requirements can now be considered in four parts :—

(*a*) Early general naval training based on the Britannia Royal Naval College, Dartmouth, to give the schoolboy a sound background for his naval career.

(*b*) Sea training in the fleet.

(*c*) Professional engineering training ashore in the Royal Naval Engineering College, H.M.S. *Thunderer*.

(*d*) Advanced engineering training (for a few selected officers) at R.N. College, Greenwich.

BRITANNIA ROYAL NAVAL COLLEGE, DARTMOUTH

It would be hard to find anywhere in this country an environment better suited for any young officer to start his naval career than the B.R.N.C., Dartmouth. The setting, the amenities and, above all, the tradition of the college, which has supplied so many of our great naval leaders in the past, make it one of the most treasured possessions of the Service. But those who knew it of old will find great changes. It is no longer a school for bringing up thirteen-year-olds to manhood in a naval atmosphere ; it is now an adult establishment, greatly enlarged, with Sandhurst and Cranwell as its counterparts ; with its combined naval and civilian staff the atmosphere is attuned to the new requirements.

A proportion of the officers under training are from old and new Commonwealth nations ; all receive exactly the same training as officers of the Royal Navy.

First Period

For the first two terms, the aims are to inculcate in all cadets a general naval knowledge and discipline and, with the wide diversity of academic attainments of cadets on entry, to ensure an adequate scientific and mathematical background and an ability to express themselves clearly in writing and speech. Some engineering is taught to all cadets, so that, when they go to sea in their third term, they can understand the principal items of the ships' machinery.

Sea Training from Dartmouth

The sea training is carried out in a squadron of three modern frigates and two minesweepers attached to the college specifically for the purpose, and affords general familiarization with all subordinate duties. Cadets live and work under exactly the same conditions as naval ratings, the aim being to acquaint them with the ship's routine as it affects the sailor and conditions on the lower deck.

A short air course is also undertaken in this period.

Specialization

For the first year cadets will have been trained as officers unallocated to any specialization. After this they will become either seamen, engineer, or supply specialists according to their aptitude and, as far as possible, their preference,

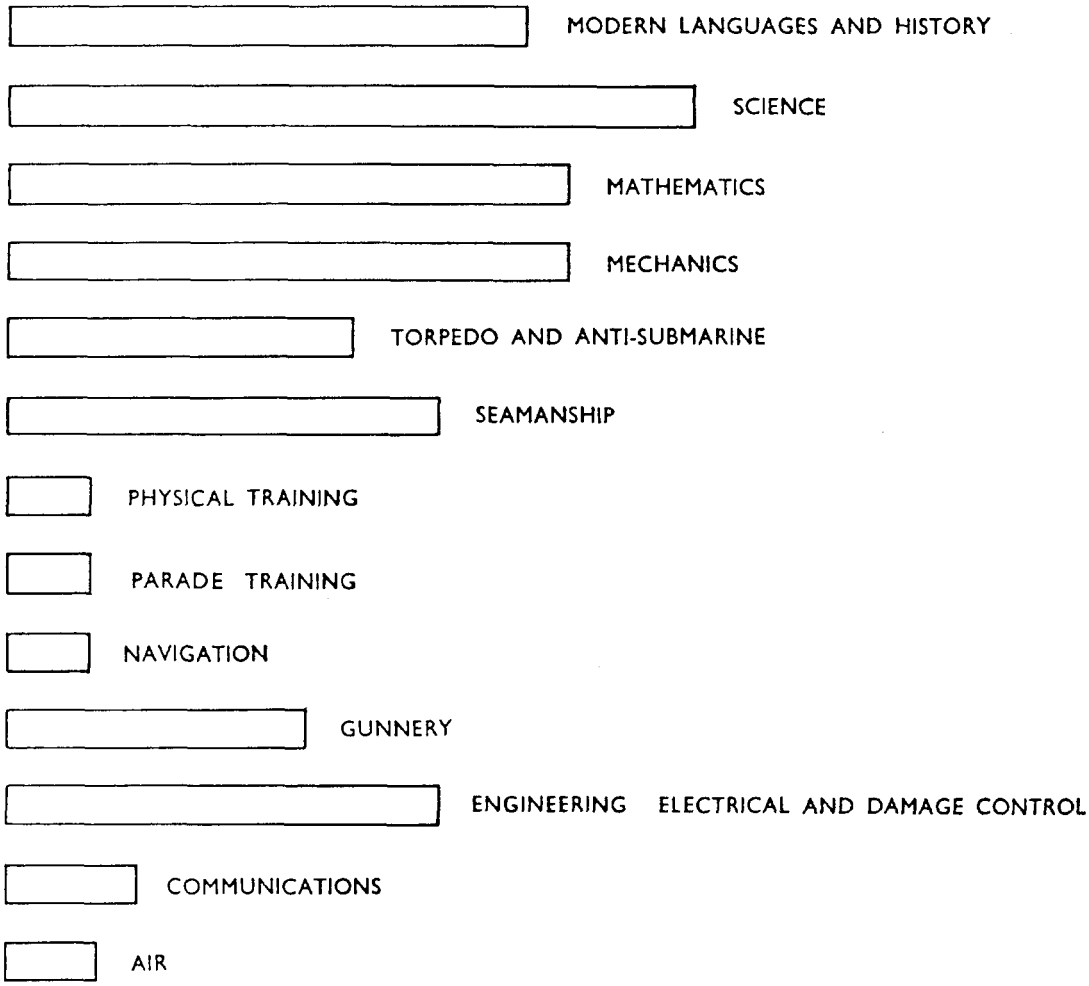

FIG. 4—DISTRIBUTION OF SUBJECTS FOR ENGINEERING SPECIALISTS IN THE LAST PERIOD (FOUR TERMS) AT THE BRITANNIA ROYAL NAVAL COLLEGE, DARTMOUTH

due account being taken of visual fitness and the need to have a fair share of talent in all specializations. (Arrangements for the electrical branch are still under consideration.)

Last Period

In the last period of four terms at the college, as a midshipman, training continues on a nearly common basis, the aim being to teach the professional and technical principles which a young officer must grasp before going to the fleet, thus forming a nucleus round which the practical knowledge to be acquired while at sea can accumulate. He should by then be an efficient and intelligent understudy to a qualified ship's officer.

The distribution of subjects covered in this period is shown in FIG. 4. There is a slightly increased emphasis on mathematics, science, and mechanics for engineering specialists, while the seaman specialist covers more ground in navigation and communications. Otherwise the syllabus is common for these two specializations.

It is at Dartmouth that the young officer's character will largely be developed. Great emphasis is placed throughout on getting to know the elements in small boats, on expeditions of an enterprising nature, and on a study of the humanities. This aspect will be referred to later.

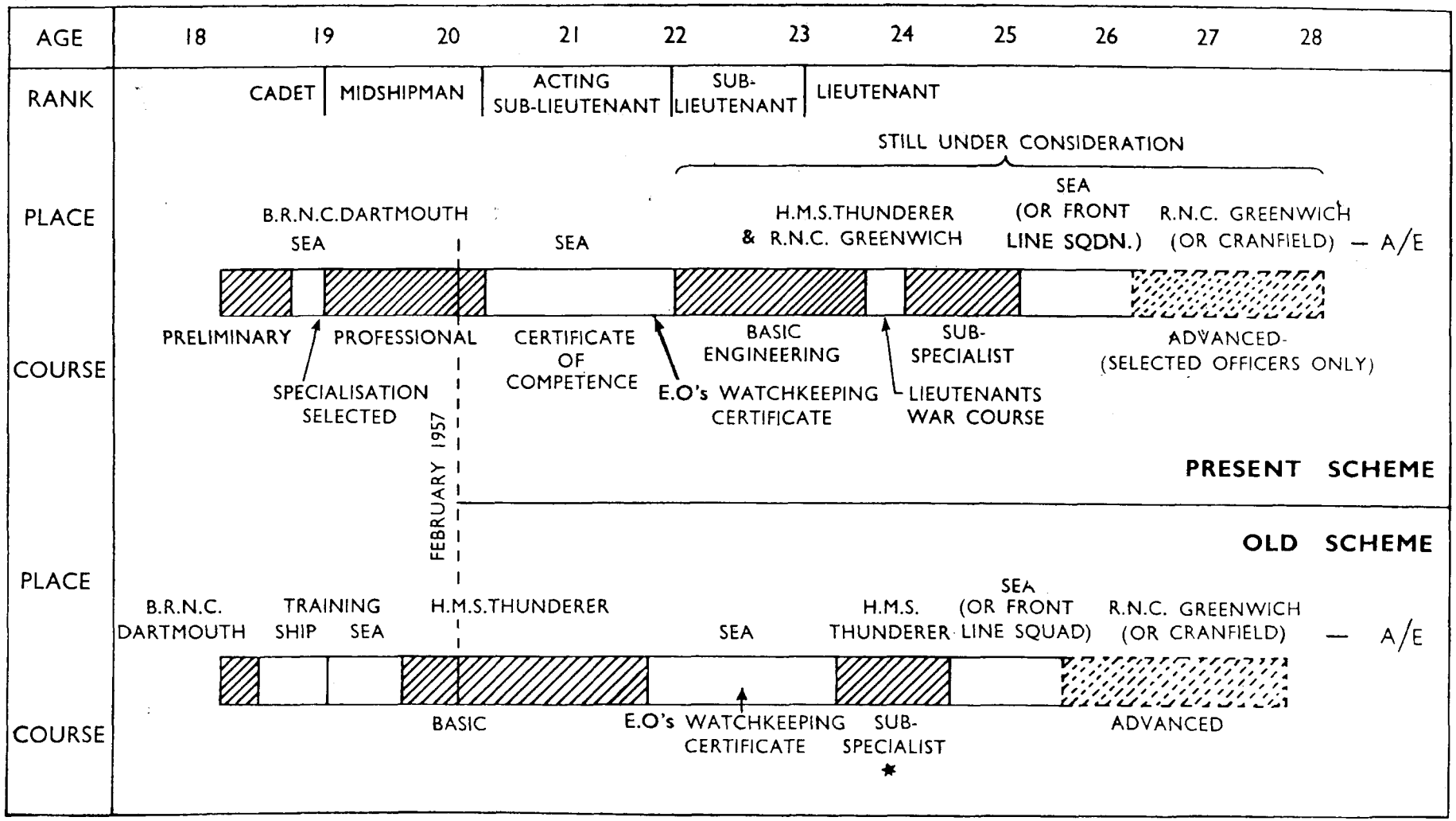

FIG. 5—THE 'OLD' AND 'PRESENT' SCHEME. THE O/E SUB-SPECIALIST COURSE, STARRED ABOVE, IS FOUR TERMS AND INCLUDES PERIODS AT H.M.S. 'EXCELLENT' (GUNNERY AND GUIDED WEAPONS) AND H.M.S. 'VERNON' (TORPEDO AND ANTI-SUBMARINE)

SEA TRAINING IN THE FLEET*

On leaving Dartmouth, seamen, engineer, and supply officers will go to sea in the fleet as acting sub-lieutenants for a period of some eighteen months. This will be their first real contact with ships and naval ratings apart from the term in the training squadron, and it is a vital period. They will be required to obtain a Certificate of Competence to cover general experience in all departments of the ship, understudying on the bridge, in the supply and electrical and weapon organizations, and in the machinery spaces. The engineering specialists will devote the last twelve months to the engineering side of their profession. They will be required to prove they are capable of taking charge of a steaming boiler room, of watchkeeping on all varieties of auxiliaries, taking charge of a unit of the main engines, and finally obtain an Engineer Officer's Watchkeeping Certificate, signifying that they are qualified to perform the practical duties of a junior officer of the watch. It could be argued that it is anomalous to award an Engineer Officer's Watchkeeping Certificate before professional engineering training. This is not so, since the officer's earlier Dartmouth training will have covered the practical side to some extent, and there is much advantage in practical experience forming a first side to the training ' sandwich '. It may be compared with learning to drive a car before absorbing the mechanical details. Officers learn the principles of operation and maintenance of machinery, and become versed in lighting up and shutting down routines and rapid power changes while manœuvring. They emerge from the school atmosphere and learn to take responsibility.

PROFESSIONAL TRAINING

At this point it is necessary to depart from discussing the present scheme of training, because the final pattern of future professional training has still to be determined. The transition is now taking place—the old scheme is still running with some years' worth still in the ' pipe line '. FIG. 5 illustrates the old and the possible development of the present scheme. The old scheme will, therefore, be described, since it will not finally die out until 1961, and the new final product will not differ greatly *technically* from the old, the aim being to enhance the present high professional standards of General List engineer officers.

H.M.S. ' Thunderer '

Professional training is carried out mainly at the R.N. Engineering College, Manadon, the Alma Mater of the engineering specialization. It offers, with its extensive workshops, laboratories, demonstration rooms, hangars, test shops and playing fields in its 100-acre site, as fine a training for mechanical engineering as any in the country. The old R.N.E.C. at Keyham, which has trained engineer officers almost without a break since 1880, will be taken over for other purposes.

The total officer complement at present is about sixty staff with 360 officers under training.

Professional training falls into two main phases, a common basic course covering 7 terms ($2\frac{1}{3}$ years), at the end of which the sub-specialization in marine, air, or ordnance engineering is selected, followed later by a sub-specialist course of 3 terms (or 4 terms for ordnance engineers). Between these two courses 5 terms are spent at sea in the Fleet (which under the newer scheme will have already been served before joining H.M.S. *Thunderer*—see FIG. 5).

Basic Course

This course was evolved in consultation with university and other authorities to provide a sound grounding in mathematical and mechanical sciences, to

* Details have not yet been promulgated.

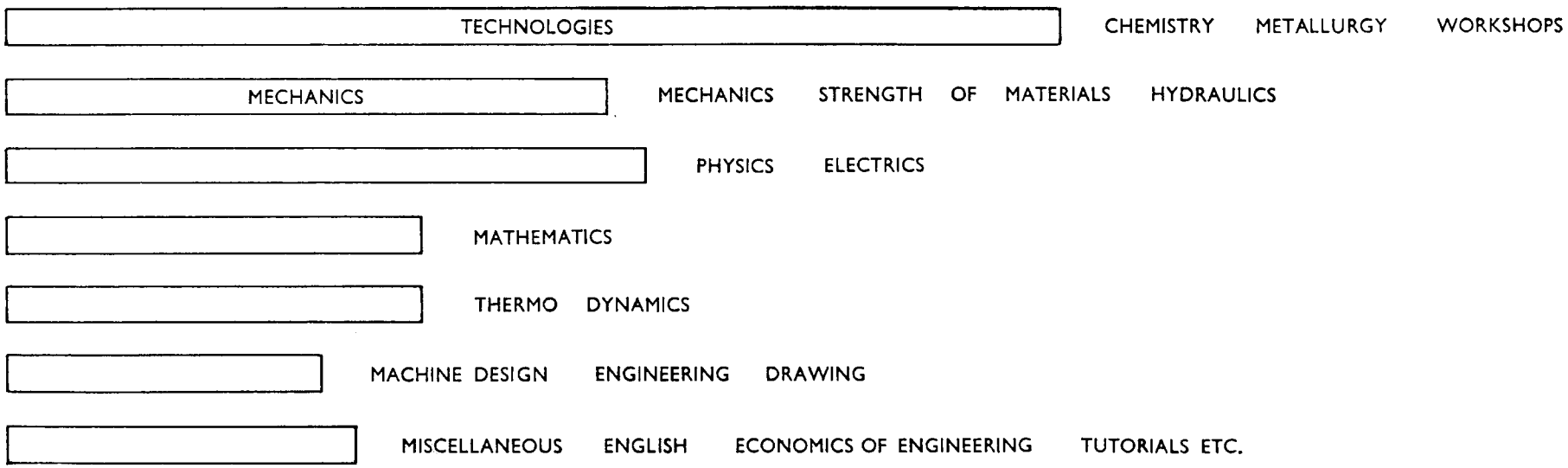

FIG. 6—DISTRIBUTION OF SUBJECTS IN THE BASIC COURSE. H.M.S. 'THUNDERER'
(7 Terms of 14 Weeks—33 Periods : 55 minutes per week)

aim to teach *how* to think, to develop a broad understanding and sense of judgment, and provide the requisite background of knowledge for later courses.

Study during working hours is divided into lectures, practical laboratory work, workshop practice and technique, and tutorials. All officers require a number of hours of private study each week according to their ability, to keep abreast of the syllabus. Failure at progress examinations entails back-classing and special coaching in weak subjects.

The distribution of academic subjects taken is shown approximately in FIG. 6. In 7 terms of 14 weeks each, the pace of which is intensive, some 2,360 hours' instruction is given, which is a little less than that given at London University and technical colleges—but further instruction in the later sub-specialist course, especially in chemistry, metallurgy, and design subjects, brings this total to about the same.

Mention has previously been made of Upper Yardmen promoted from the lower deck on passing a stiff educational examination and the Admiralty Interview Board. They phase into the last four terms of this basic course, and thereafter are indistinguishable from their contemporaries.

Standards

It has always been the policy of the Engineer-in-Chief of the Fleet that all cadet-entered engineer officers must be trained to professional standards generally recognized in the country. Without such a background they will not be able to talk on level terms with their colleagues in industry, nor indeed to carry out the many varied duties which will later be their lot. The final examinations of the basic course are therefore keyed to those set by the Institution of Mechanical Engineers. All papers are set by examiners from Cambridge, London, or other universities or the Royal Naval College, Greenwich, to satisfy these minimum standards. Those who fail the progress or the final examinations at a second attempt are withdrawn from the Service. It follows that after the further requisite practical experience, all officers qualifying are later eligible for associate membership of the Institution of Mechanical Engineers if they wish it, being exempted from the qualifying examination for graduate membership by virtue of passing the Admiralty examination. They are similarly exempted for admission to the Institute of Marine Engineers, the Institution of Naval Architects, or the Royal Aeronautical Society, as appropriate.

Nearly all academic and laboratory instruction is given by serving officers of the instructor specialization (most of whom possess First or Second Class Honours degrees) or fellow engineer officers. With a 2–3 year tenure of staff appointment, a degree of continuity as well as a ' feed-in ' of recent sea or air experience is assured.

Sub-Specialist Courses

After the period of sea training mentioned above, about 50 per cent and 30 per cent undertake the marine and air engineering three-term course respectively, and about 20 per cent the four-term ordnance engineering course. These courses are more practical than academic, although principles of machinery are learnt rather than details of individual equipment. It will be noticed from FIG. 6 that an appreciable amount of time is spent on electrical subjects. Although of major importance for the ordnance engineer specialist, the principles of electronics and automatic control of machinery are now considered as the tools of all.

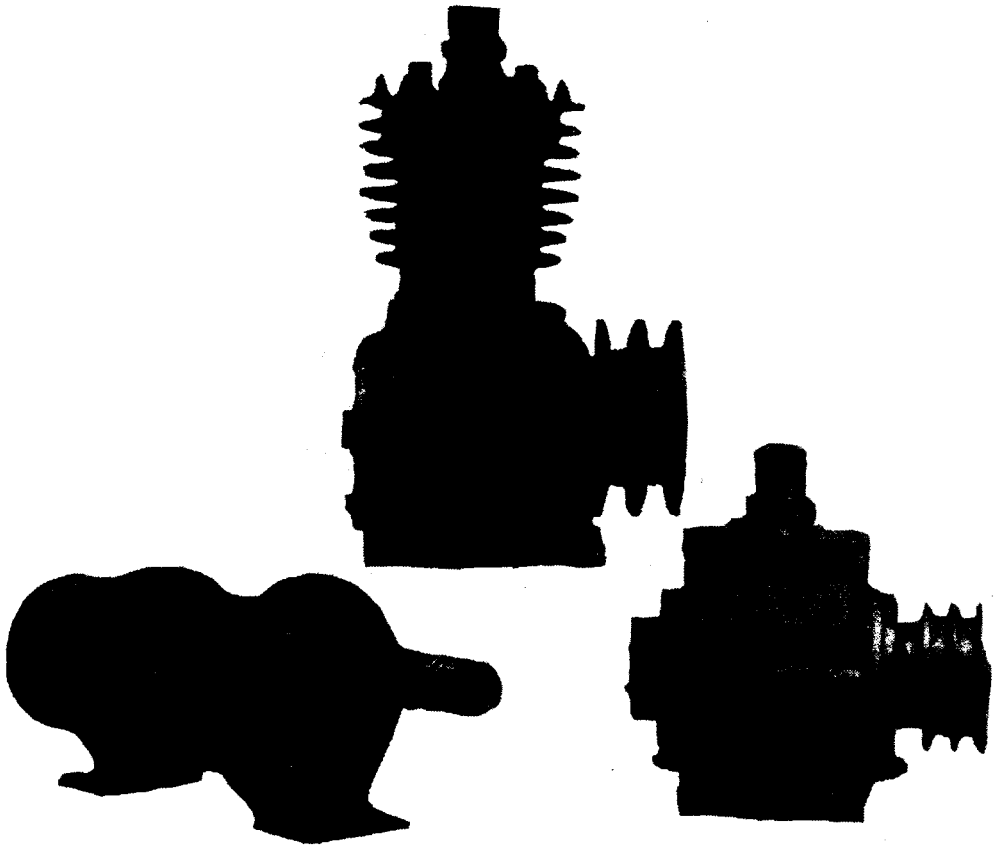

FIG. 7—' DESIGN AND MAKE' TEST WORK. THREE DESIGNS OF L.P. AIR COMPRESSOR

The general aim of these courses is to equip officers with the ability to maintain overall operational control of machinery, based on a sound understanding of its design, its limitations, and its construction.

An interesting final task in the course has been to give to small syndicates broad requirements of a piece of equipment to fulfil a specified task. They are then required to devise, design, make completed drawings, cast and forge the necessary components, carry out all machining processes, and finally test the finished equipment to meet the required specifications. A cost analysis and a sales brochure is prepared, as if intended for production. The variations in approach have proved most illuminating, and valuable experience of the proper perspective of design and development has been gained (FIGS. 7 and 8).

During these courses some practical experience is gained in running, under test conditions, auxiliary machinery likely to be met in the Service. The air engineer officers have the use of a Bolton and Paul ' Balliol ' and an Airspeed ' Oxford ' aircraft at a nearby airfield as ' flying test shops '. (Those selected and who volunteer may later qualify as front-line pilots, and may ultimately become maintenance or Empire Test Pilots.) The ordnance engineer officers spend part of their course at other specialist schools learning the intricacies of guided weapons, conventional gunnery and torpedoes.

At the end of these courses officers are generally considered fitted to go to the fleet or air stations in a junior complement billet, carrying with it definite responsibilities. It is impressed on them that learning is a continuous process, and all their former training has been directed towards enabling them to learn for themselves thereafter.

The advent of a small ship fleet has brought with it considerable accommodation problems. There is now little room to carry officers or men under

FIG. 8—' DESIGN AND MAKE ' TEST WORK. A 250 C.C. AIR COOLED ENGINE IN A TEST VEHICLE

training at sea—and however much one may wish to carry round supernumeraries for training, it is only possible to a limited extent. Every man must go to sea ready to assume a responsible job.

Leadership Training

*At this point it is appropriate to mention one of the most important aspects of the training of engineer officers—indeed, of all officers—not only in the Navy but in all the Services where man himself is the vital factor. This is the training in leadership. The problem is not entirely analogous to that obtaining in industry, where employers and employees do not live together, and where a man can usually give up his job at short notice to seek a better one. Nevertheless, industry has considered it necessary to make vast strides in caring for the well-being of its employees, and great pains are taken by most firms to foster loyalty which can only stem from contentment in the job under wise leadership, stemming, in turn, from confidence based both on mutual respect and on the superior professional ability of the leader. How much more necessary must be this leadership in a ship, where men are living for long periods at very close quarters, and where the ultimate trial in battle can only be successfully achieved as a result of ordered preparation, perfect discipline, and confidence in the officers ; nothing will be achieved without leadership of the highest order at all levels.

There can be no formal way of developing leadership—it cannot readily be taught in a classroom or from a book, since the prime requirements are those

* This subject has been excellently discussed in an article ' " Officer " Training at the Royal Naval Engineering College ' in Vol. 10, No. 1, p. 95. A rather gloomy picture was painted of the present accommodation and it should be borne in mind that the new Mess Block, shown in the frontispiece of the same issue, is designed as a start towards overcoming some of the existing deficiencies and it is hoped, in time, that the huts will be replaced.

which should develop naturally in an early background in which the value of Christianity and human relationships are constantly stressed, coupled with self-confidence, readiness to take responsibility, initiative, and courage.

Discipline is comparatively easily instilled ; the normal formal parades and physical training instil, in addition, a high degree of self-confidence in the young officers placed in charge. Ability to take responsibility is not so easy to inculcate in what is normally a well-regulated shore establishment, nevertheless, the out of working hours organization of 360 junior officers in H.M.S. *Thunderer*, some of them Asian and foreign, allows a good deal of scope, and towards the end of their training period officers under instruction are in entire charge of everything which happens in the establishment out of working hours, as well as all the normal extra-mural activities common to a university. It is naturally these officers who set the tone and standards of behaviour for the more junior officers.

Some 60 or 70 periods during the course are devoted to the pure mechanics of being a divisional officer in charge of ratings, every aspect possible being covered. Each officer spends one week as an assistant to a divisional officer for engineering mechanics in H.M.S. *Raleigh*.

One important innovation has recently been made. In their early terms all officers spend at least one week-end (including a night) on Dartmoor, regardless of weather, with some definite organized objective. The members of the third term then themselves organize an expedition to Scotland, usually to the Cairngorms or Glencoe, where the most rigorous conditions of ice and snow are sought, and set tasks are performed in groups of two or three. In their last terms they organize further expeditions on Dartmoor in charge of small bodies of naval apprentices or engineering mechanics.

Officers qualifying as skippers are encouraged to take the college yachts across the Channel during the leave periods, and have been very successful in the Royal Ocean Racing Club races.

The value of such character training is untold, in increasing self-confidence, in learning to plan ahead, and in stimulating the will to endure by presenting the opportunities of developing capacity to face hazards, hardships, and difficulties.

Lastly, opportunity is taken to present lectures and talks on subjects of current interest outside naval affairs ; every attempt being made to interest officers in such vital subjects as ' the Christian answer to Communism '.

To quote from John Buchan[5]:—

> ' The sea has formed the English character, and the essential England is to be found in those who follow it. From blue waters they have learned mercifulness and a certain spacious tolerance for what does not affect their craft, but they have also learned in the grimmest schools, precision and resolution. The sea endures no makeshifts. If a thing is not exactly right, it will be vastly wrong. Discipline, courage . . . and contempt for all that is pretentious and insincere are the teaching of the ocean and the elements, and they have been qualities in all ages of the British sailor.'

The final aim is to produce a young officer who, as well as being technically sound (and certainly occasionally capable of improvising makeshifts!), is essentially balanced in outlook, and able to measure up to the high words of praise given by John Buchan to the seafaring community of Britain.

Advanced Courses

After one or two years sea experience about 10 to 15 officers yearly are selected as a result of their performance at H.M.S. *Thunderer* and at sea, to

undergo two-year advanced courses at the Royal Naval College, Greenwich (or at the College of Aeronautics at Cranfield in the case of air engineer officers). Their ages range from 25 to 27 at the start of the course. They are indicated in the Navy List by a dagger against their names, and hence are known as ' dagger ' officers.

The aim of the advanced engineering course is to equip officers for leadership in research, development, and design which in later life they will be required to initiate, administer, and criticize. While they will not actually execute designs themselves, they will need experience of design work coupled with judgment and a broad background, including acquaintance with industry.

Hence the scope of the course is similar to that of an honours degree with additional emphasis on design methods, particularly towards an analytical approach to varied problems.

Advanced teaching in subjects such as mathematics, applied mechanics, physics, and chemistry is given by civilian professional staff, while serving engineer officers give instruction in design work and related subjects and administer the course as a whole.

Close contact with industry is fostered by visits to firms engaged in Admiralty work and by lectures at the college from members of the firms and organizations concerned. It is appropriate to record here the Admiralty's great appreciation of the very willing help that is given by industry in this way.

Installation design for warships' machinery is a prominent feature of the second year work. This is done in conjunction with students of the naval architecture department, future members of the Royal Corps of Naval Constructors. Many of the Royal Corps of Naval Constructors have already spent a year living in H.M.S. *Thunderer* while studying in the constructors' training office at H.M. Dockyard, Devonport, before going on to Greenwich, and thus the early acquaintance of these two closely coupled branches of the Service is fostered into co-operation.

The ordnance engineers study advanced gunnery techniques and guided weapons, while the air engineer officers study advanced aeronautical engineering design and production problems at Cranfield.

Comparison with the United States Navy

It may be of interest to compare the system in force in the United States Navy.

It is considered that all officers must have a sound technical background. All regular officers undergo a four-year graduation course at Annapolis (or other civilian university) of which about half is devoted to mechanical engineering.

They then proceed to sea as Line Officers and may undertake any junior duty on board, from the bridge to the engine room. After two to three years, those interested in mechanical matters apply for a course at the Massachusetts Institute of Technology : those who qualify become engineering duty officers (E.D.O.) and, with few exceptions, after reaching the rank of lieutenant-commander are employed in the Bureau of Ships, shipyards, in laboratories, or overseeing. The posts of Engineer Officer of most ships and all commands at sea are filled by Line Officers, who normally will not have had formal technical training beyond that at Annapolis : they will have had wide technical experience of all parts of a ship from the radar to the turbines and their specialized technical staff may consist largely of officers promoted from enlisted men.

It is noted that this scheme denies to the E.D.O. above the rank of lieutenant practical experience of administering a machinery installation and the handling

of technical ratings at sea. Recently an E.D.O. has, however, for the first time been appointed as Engineer Officer of a fleet aircraft carrier.

The E.D.O. is indistingishable from the Line Officer. He may be a dual constructor-engineer specialist. (The ordnance and air specializations are quite separate.)

The U.S. Navy scheme is somewhat similar to our own Selborne-Fisher scheme of 1902, whereby all except a very few selected (E) officers were interchangeable in any duty, command or technical.

Comparison with the German Navy

It is of interest that the new German Navy has quite independently evolved a scheme for officer training not unlike our own. Its main features include entry to a common list and common training for the first three years, including 4 months' training under sail and $3\frac{1}{2}$ months' workshop training for all.

SPECIAL DUTIES LIST OFFICERS

From FIG. 1 it can be seen that these officers comprise over 25 per cent of total strength of the engineering specialization. They are promoted as a result of a professional and educational examination and on their personal qualities. Their considerable practical experience at sea and in air stations is of the greatest value, and they are regarded as a most important mainstay of the Navy.

On promotion to officers they, also, are trained at H.M.S. *Thunderer*, where they play a very full part in the life of the college. Their six-months' course in their own specialization brings them in close contact with their contemporaries on the General List, broadens their somewhat limited technical knowledge, and enables them to acclimatize themselves to their new role. Thereafter they are generally interchangeable with their General List equals in rank for most appointments of a practical nature but, because they have not had the advantage of the wider earlier academic training and are older, their career is limited.

Due to their proved services, it is intended that a still greater proportion of Special Duties List officers will be borne.

THE PAST AND THE FUTURE

How has the training in the past stood up to the requirements of the Service, and of the country as a whole ? Although it is axiomatic that the technical standard of a Service cannot rise above that of the industry upon which it depends, the use to which the achievements of industry are put in development and design for the Navy is the responsibility of its technical officers. Under the guidance of naval engineer officers some conspicuously successful projects have been carried through—the mirror sight for deck landing on carriers, the Deltic light-weight Diesel, the steam catapult now in use in the United States Navy and the Royal Navy, and the light-weight Y.100 steam installation for new frigates, to mention a few : and in the gas turbine world the *Grey Goose* was the first ship to be driven solely by gas turbines. There are many other examples in the ordnance and air worlds. Their success shows that the early training and experience of the officers concerned enabled them to make contributions, in their own spheres, towards the engineering and general industry of the country, on which the life of the Navy depends. And perhaps the results of two world wars have been appreciably affected by the role of the Navy, including its technical officers.

In 1828 the First Lord of the Admiralty, Lord Melville, wrote : 'Their Lordships feel it their bounden duty upon national and professional grounds

to discourage to the utmost of their ability the employment of steam vessels as they consider the introduction of steam is calculated to strike a fatal blow at the supremacy of the Empire.'

Happily Their Lordships of today are of a different mind and now encourage to the utmost the employment of advanced methods of propulsion and new weapons. Their acceptance of a concept of a General List of officers has shown the value they have put on the achievements of technical officers in the past, and by this recognition, the trust they put in the technical officers of the future being able to play an even greater role. It is to fit them to be ' all of one company ' not only within the Service, but in the technical life of the country as a whole, that the training of officers is now directed.

References

(1) ' A Criticism of Technical Education of Recently Qualified Engineers ', read by P.P. Love, B.Sc., Wh.Sc., before the Institution of Mechanical Engineers on November 11, 1955.

(2) ' Reflections on the Education of Engineers in a University ', read by Professor D. G. Christopherson, O.B.E., Ph.D., A.M.I.C.E., A.M.I.Mech.E., to Imperial College of Science and Technology, University of London, February 14, 1956.

(3) *Engineering*, Editorial, July 13, 1956.

(4) *The Engineer*, August 6, 1954, pp. 201–4;
Shipbuilding and Shipping Record, July 29, 1954, pp. 139–140.

(5) BUCHAN, J. : *Naval Episodes of the Great War.*