THE Navy

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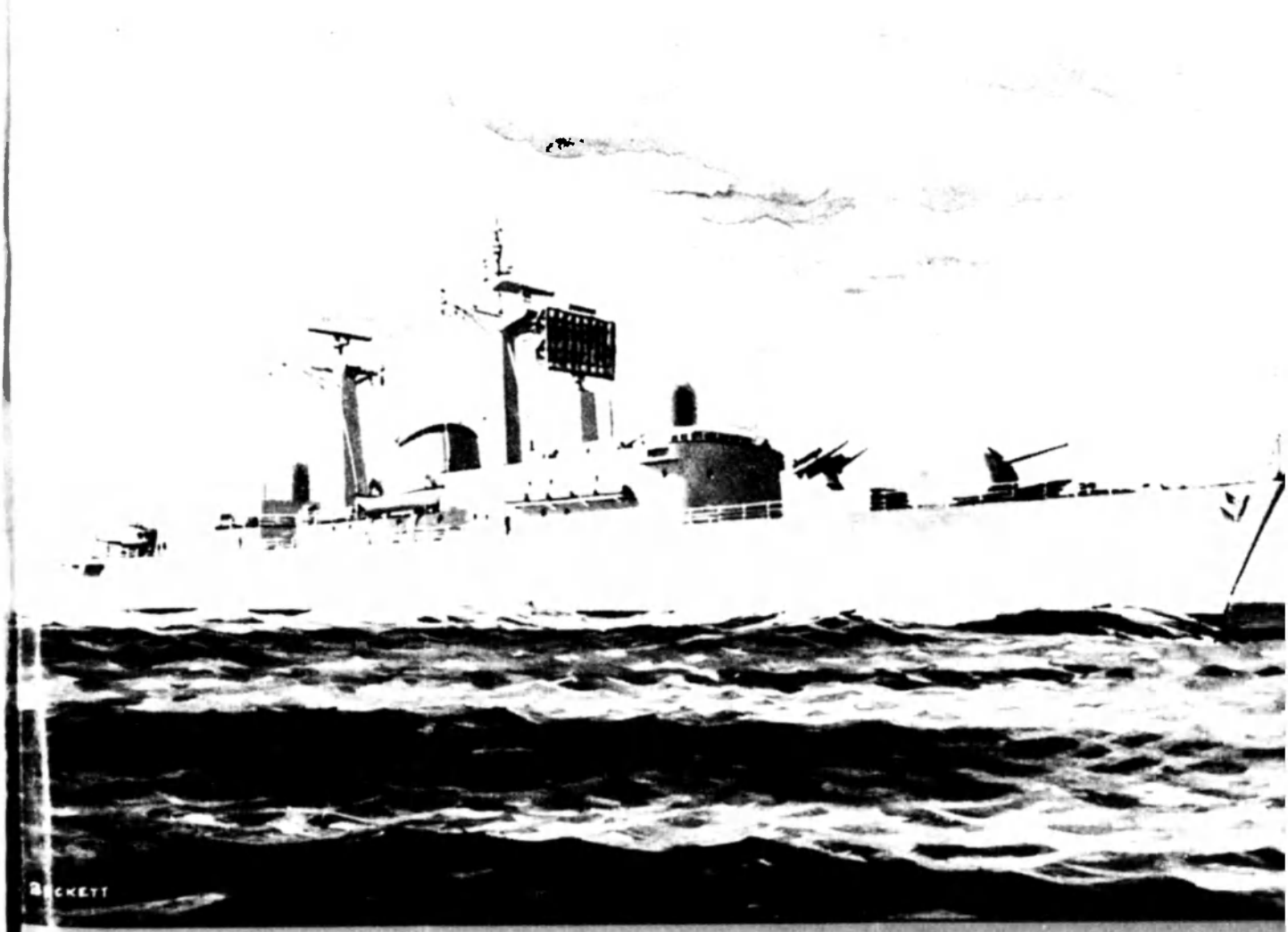

MAY — JUNE — JULY, 1969

THE NAVY

The magazine of the Navy League of Australia

(Registered in Australia for transmission by post as a Periodical)

Vol. 31 **MAY-JUNE-JULY, 1969** **No. 2**

CONTENTS

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Nautical Notes from all Compass Points

By SONAR

CANADA

Canadair V-Stol

First flight of the Canadair CL-84-1 tilt-wing V-STOL utility aircraft is planned to take place in June, following the roll-out recently of the first of three being built for the Canadian armed forces. In its military designation of CX-84 the type will be evaluated to determine the effective roll of such aircraft in a military environment. This will cover not only a range of land-based roles but also maritime operations from aircraft carriers and destroyers. In its production version the CL-84-1 has 7% more power, added avionics, external hard points and provision for greater fuel loads. Operating to a gross weight of 14,500 lb. (STO) or 12,600 lb. (VTO), the aircraft has a payload, with full internal fuel, of 4215 lb. (STO) and 2315 lb. (VTO); its cruise speed at 10,000 ft. is 300 m.p.h. (STO) and 305 m.p.h. (VTO), and range, with full payload and 10% fuel reserve, is 320 miles (STO) and 340 miles (VTO). An increased performance version of the type, designated CL-84-1C, will be available within about 20 months, and as a troop carrier will take 16 passengers plus the crew of two. Several growth versions, one powered by General Electric T-64 engines instead of the present 1500 shp Lycoming LTC1K-4C engines, have been studied by Canadair. The added power of the T-64s, combined with 16.5 ft. dia. propellers, and 5 ft. greater wing span, would permit a cruise speed at 20,000 ft. of 425 m.p.h., and a 575 mile radius of action without refuelling.

Reserve Force

Canada's 27,000 man Reserve Force will this year play an increased role in regular Armed Forces training operations at home and abroad.

The Naval Reserve will place about 80% of its officers and men on a minimum of two weeks' training with the regulars during 1969. Many will go to sea — 130 reservists served in ships taking part in Exercise Maple Spring off Puerto Rico — and a new west coast training squadron will give additional opportunity for training afloat during the summer months.

Nearly 200 militiamen are slated for three months of training with Canada's NATO brigade in Europe for the third consecutive year. An additional sixty militiamen participated for the first time in the smaller May-June exercises in Germany.

The 850 man Air Reserve, equipped with 30 Otter aircraft, will train this year with units of Mobile Command, carrying out light tactical transport and reconnaissance duties during field exercises.

The armed forces budget had not yet allowed Mobile Command all the light tactical transport and reconnaissance aircraft needed; the Air Reserve has stepped in for the interim. Thus, in addition to some of their former duties, the reserve's 100 pilots will take part in tactical field exercises during the year, building up operational experience while giving some needed support to the Command.

Naval reservists are trained to support the regular force in specific areas. This year about 50 reservists will take courses to become qualified divers. A further 950 will receive instructions in such varied trades as communications, finance and administration, cooking and seamanship. Training in Naval Control of Merchant Shipping will involve another 300. Last year 76 reserve officers and men participated m the large scale NATO exercise Silver Tower; this year, 100 reservists will be involved in another Naval Control of Shipping exercise.

The Regional Reserve, organised for home defence duties, will send about 4,000 men to five regional camps for collective training and about an equal number to regional schools for individual training. Both areas of training prepare each reserve group or individual for a specific job, such as protection of vital installations, national survival duties, or communications.

The Mobile Command Reserve is a land reserve concept announced in January, 1967. These reserve companies, batteries, and squadrons are earmarked for a single operational command, Mobile Command, which conducts their summer training. About 6,000 men in these reserve units will spend about a week at Mobile Command bases.

The third component, the Ready Reserve, is composed of soldiers who take advanced training with regular units in almost any specialty. The Ready Reserve provides these men with basic military and trade qualifications and all their advanced training is with regular units.

During 1969, the land, sea and air reserves will be working as close to the regular force as possible, establishing themselves as an effective resource for operational commanders.

International Fire Prevention Contest

Canadian Forces Base Cornwallis has won the Grand Award Plaque presented to the top entry in the Canadian Military Division of the 1968 International Fire Prevention Association's Annual Contest.

The competition provides recognition for excellence in the field of fire safety education and performance and has four divisions — Municipal, Industrial, Military and Government.

The award was presented to Lieutenant General M. E. Pollard,

comptroller general of the armed forces, by Mr. M. S. Hurst, Ontario provincial fire marshal, at a ceremony on Parliament Hill attended also by winners from all phases of Canadian fire prevention.

General Pollard in turn presented the award to Captain J. M. Paul, commander, C. F. B. Cornwallis and Mr. R. M. Atwell, base fire chief.

Defence Research Board Grants

Approximately $C3,000,000 in grants has been awarded this year to 40 Canadian universities by the Defence Research Board for fundamental research studies related to defence problems. The recipients, staff members of the universities, carry out basic research and are expected to publish the results of their investigations, which are not secret.

Other objectives of the programme are to develop an interest in defence science within Canada's scientific community, and indirectly, to assist in staffing the Board's seven research establishments with promising young scientists.

The grants may be used to pay research assistants, usually graduate students, and technical personnel, to purchase equipment and expendable materials and supplies; for travel connected with the research programme of the individual concerned, and to cover the costs of publishing the research findings in the scientific literature.

JAPAN

Choppers for smaller vessels

Planners of the Japanese Maritime Self Defence Force are reported to be increasingly interested in the possibility of equipping smaller warships with torpedo-carrying light helicopters instead of the earlier planned Goodyear DASH ASW drones, but are awaiting U.S.N. reaction to proposals by Bell and Hughes for such types. Bell is said to have approached the Japanese with a proposal for the Model 206A, equipped as an ASW variant with MAD gear, four sonobuoy sensors, and armament of one Mk 46 or two Mk 44 torpedoes. Similarly Hughes suggests an ASW version of the OH-6A, while Sud Aviation is proposing an Alouette 3 ASW development.

NETHERLANDS

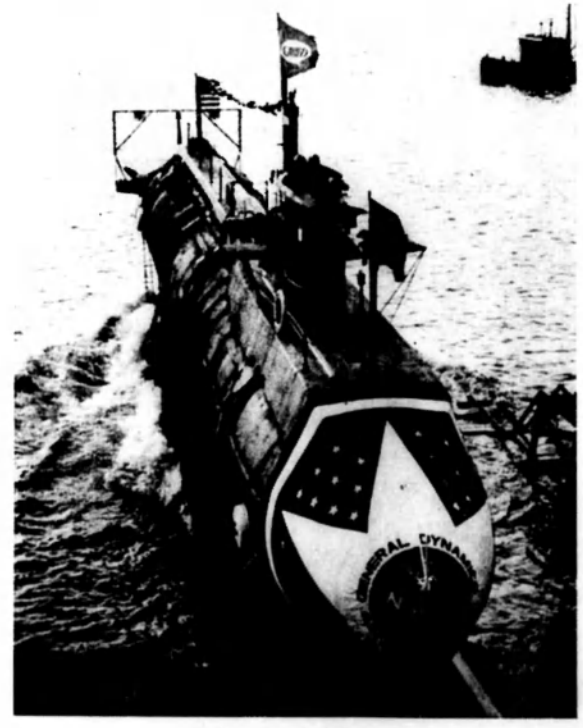
New Radar

Hollandse Signaalapparaten N.V. in Hengelo, the leading Dutch maker of radar, fire-control and similar electronic equipment, has designed a new radar in collaboration with the British and Netherlands Royal Navies. It gives a 3-dimensional picture on the screen of any object scanned. This radar will make it possible to observe aerial and surface objects simultaneously, and also allow altitude measurements. In other words, it will replace 3 conventional radar systems. The most likely application of this new naval radar is very early warning of missiles fired by enemy ships, combined with remarkably accurate determination of the missile's trajectories. In this way, evasive manoeuvring will become much more reliable.

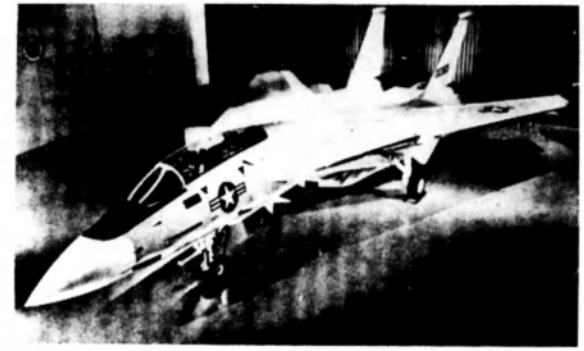
UNITED KINGDOM

H.M.S. Churchill

Britain's eighth nuclear-powered submarine was launched by the Hon. Mrs. Christopher Soames on 20 December, from Vickers shipbuilding works, Barrow-in-Furness. H.M.S. CHURCHILL is the sixth nuclear submarine to be launched by Vickers, which company has already completed three Fleet and two Polaris submarines. Speaking at the luncheon following the launching, Sir Leslie Rowan, Chairman of Vickers, referred to the long association between Vickers at Barrow and submarine building. H.M.S. CHURCHILL is the 302nd submarine to be built by the firm, and the 271st to be built by the company for the Royal Navy. Mrs. Soames, in her reply to Sir Leslie's toast of the ship and her sponsor, said she felt it would have appealed to her father that the men who



Nuclear Research Submarine



New Navy Fighter

manned the submarine must match their courage with the most advanced technical skills and knowledge.

UNITED STATES OF AMERICA
Nuclear Research Submarine

The first nuclear-powered research submarine, the NR-1, which was launched in January (see photo previous page), is 140' long, 12' in diameter, has a submerged displacement of 400 tons, and will have a crew of five, plus two observers. She will be propelled by twin screws, and will be manoeuvered by four ducted thrusters, two located in the bow and two in the stern.

System U.L.M.S.

Studies now being made by the U.S.N. to establish the configuration of a proposed new submarine, capable of launching big, longer-range ICBMs, are regarded as important to the future of United States missile defence programming because of growing problems related to land-based ICBM systems. Present Polaris and Poseidon missiles are comparatively limited in size and range because they are carried internally in FBM submarines and launched vertically. This fact is cited by commentators who suggest that the proposed new U.S.N. system, designated ULMS, will be based on a submarine configuration which may carry the new ICBMs horizontally and, perhaps, externally. In the current fiscal year about $U.S.5,000,000 is budgeted for study of the ULMS system, and the commentators note provision of $20,000,000 in the 1970 budget to prepare for "Possible engineering development" in 1971.

New Navy Fighter

Photograph is a full-scale mock-up of the Navy's newest carrier-based fighter, the F-14A. Powered by two Pratt and Whitney TF-30-P-12 afterburning-type turbofan engines, the Grumman-built plane will have a crew of two, seated in tandem. It was designed to provide high-speed and fast acceleration and is expected to be in the Fleet by 1973.

S-3A

S-3A is the official designation for the proposed new U.S.N. carrier-based ASW aircraft, formerly referred to as the VSX programme, and $U.S.165,000,000 has been requested in the fiscal 1970 budget for its development. Selection of the development contractor was expected to be made a short while ago and late reports suggested that Lockheed and General Dynamics' Convair division were nearly even in favouritism from a technical viewpoint.

Research Ship

Depicted in this artist's concept, the U.S. Coast Guard's most advanced oceanographic vessel, the WHEO-701 is a 387-foot high-endurance cutter, scheduled for completion in 1972. The ship displaces 3,945 tons, has a 51-foot beam and a draught of 17 feet six inches. A single steam turbine engine, delivering 10,000 shaft horsepower, will drive the ship at a maximum speed of 20 knots. She will have a crew of 133 men, including 14-16 scientists.

First of 17 LSTs Launched

Designed with a destroyer-type bow, the future USS Fresno (LST-1182), the first of 17 new tank ships started under a $250-million Navy contract, was launched late last year from the ways of National Steel and Shipbuilding Company, San Diego, California.

Research Ship

These "fifth generation" LST ships are expected to be faster, brawnier and more beach efficient than their predecessors because of the new bows. The Fresno is scheduled for delivery in April/June, 1969.

The vessel is equipped with a 112-foot-long aluminium landing ramp that will permit vehicles to be loaded or off-loaded over the bow. When stowed, the one-piece ramp rests on the main deck forward between guide tracks, attached to the inboard side of two permanently installed derrick arms protruding over the bow.

A stern ramp, which also serves as a watertight stern closure when retracted, is designed to launch or retrieve amphibian craft from the open sea. It can also be employed as a vehicular bridge between the vessel and various utility landing crafts or a pier.

The Fresno is 522 feet long. She has a beam of 69 feet 6 inches, a draught of 15 feet and a displacement of 8,302 tons. Six diesel engines will provide the propulsion and she is expected to average 20 knots with 16,000 s.h.p. NASSCO's contract price was $14.6 million.

New Versions — A-6 Intruder

Two new versions of the Grumman A-6 Intruder are to be produced for the U.S.N. One new version, designated A-16C, is being equipped with new technology infra-red and low light level TV sensors to give it a capability for night warfare missions not possessed by the A-6A version, which has otherwise proved itself in Vietnam the U.S.N.'s best all-weather bomber. About 15 of the A-6C's are being produced under a $U.S.50,000,000 programme, with first deliveries to be made soon. Under another programme, approved by the Defence Department for fiscal 1970 funding, a tanker version, designated KA-6, is to be developed to replace about 100 Douglas KA-3s. About 20 or 25 will be built initially. It is claimed that though smaller than the KA-3s, the KA-6s will not only be faster, but will carry about double the KA-3s fuel tankerage.

OUR COVER

JET-POWERED DESTROYER FOR BRITISH NAVY

The first of a new class of guided missile destroyers being built for the Royal Navy and claimed to be the world's most advanced defence ship. Designated Type 42, it will be the first major warship ever designed round gas turbines. Rolls-Royce Olympus engines will provide full power for high speeds (more than 30 knots) and the smaller type engines will be used for cruising. The ships main armanent will be the supersonic Hawker Sea-Dart guided missile with both surface-to-surface and surface-to-air anti-missile capability. It will also have a quick-firing 4.5 inch gun and an anti-submarine helicopter armed with torpedoes. The whole armoury will be guided by radar and controlled by a computer.

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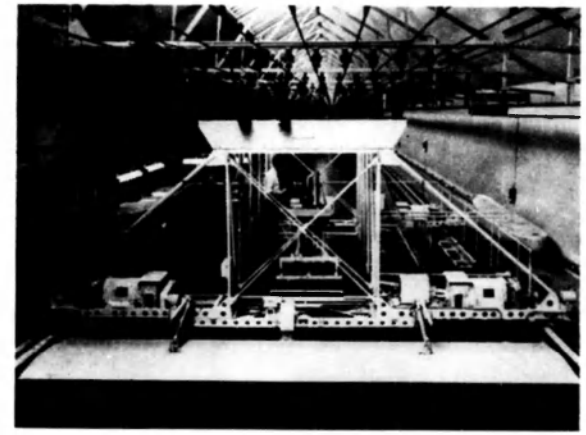
NEWS FROM BRITAIN

(The Editor is indebted to the officers of the Information Service of the British High Commission in Australia for their ready assistance in supplying these photographs).

BRITISH SHIPBUILDER'S DESIGN TESTS IN SHIP MODEL EXPERIMENT TANK

A view of the ship model experiment tank, showing the carriage and some of the electronic experimental equipment, at the St. Albans, south-east England, test centre of the Vickers shipbuilding group. The experiment tank, where investigations are made to cover hull design and resistance and propulsion tests in both still water and waves, is claimed to be the second largest privately owned facility of its kind in the world. It was here that the company pioneered design tests in waves as a logical extension of the long accepted still water tests. Its clients come from all quarters of the world, and as a result of the experiments able to effect detailed improvements in their initial design

The tank is equipped with a wave generator capable of producing regular or random waves to scales corresponding to the whole range of all seas ever likely to be encountered in practice. Work of this nature is now an increasing design demand in the field of commercial shipbuilding, both for technical and economic reasons. Investigations undertaken at St. Albans include a wide range of ships such as ferries, liquefied gas carriers, 250,000-tons dead-weight tankers, drilling rigs, and the Atlantic Platform designed jointly by Vickers and another British company, Standard Telephones & Cables Limited.



An instrument technician works on a fully operational radio-controlled model vessel built by Vickers, the British shipbuilding group, for the Department of Navigation at the Sir John Cass College, London. It was built at the company's ship model experimental tank unit at St. Albans, south-east England. The 4-foot long replica is designed to be operated in a specially designed tank with simulated river and dock systems by officer students who can control it as they will be expected to control their own ship. The model is packed with the most ingenious and elaborate electronic and mechanical devices which enable the operator to undertake to scale all movements concerned with the navigation of the vessel. The tank is equipped with a wave generator capable of producing regular or random waves to scales corresponding to the whole range of all seas ever likely to be encountered in practice. Work of this nature is now an increasing design demand in the field of commercial shipbuilding, both for technical and commercial reasons.

◆

A model of a British-designed Atlantic Platform being tested in simulated mountainous waves at the St. Albans, south-east England, ship model experiment tank of the Vickers shipbuilding group. The tests demonstrated the remarkable stability of the platform which is one of a series developed jointly by two British firms, Vickers Ltd., and Standard Telephones & Cables Ltd., to provide unbroken air navigation aid for aircraft crossing the Atlantic Ocean as well as meteorological data stations and oceanographic stations.

◆

CONTRIBUTIONS INVITED

The editor invites persons to submit articles, photographs and Drawings (Black Ink) for inclusion in the magazine, but regrets that no payment can be made for contributions submitted. Contributions should be addressed: The Editor, "The Navy", Box C178, Clarence Street Post Office, Sydney, N.S.W., 2000, Australia.

The Editor, does not hold himself responsible for manuscripts, though every effort will be made to return these with which a stamped and addressed envelope is enclosed.

HELICOPTER-DESTROYERS FOR THE ROYAL AUSTRALIAN NAVY

Dear Sir,

In reply to Cadet-Midshipman Dickkenberg's answer to Mr. R. J. Hallett's article on "Helicopter-Destroyers For The Royal Australian Navy" I would like to put forward the following ideas.

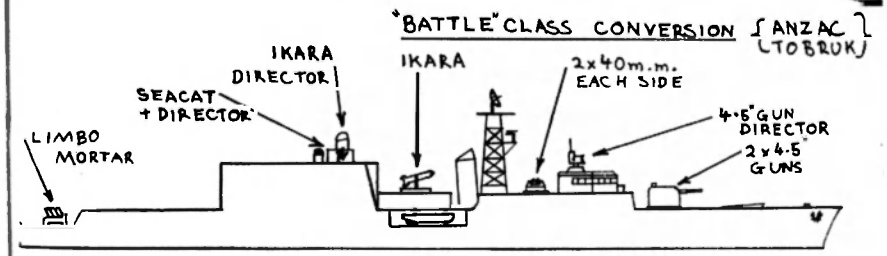
Firstly, Mr. Dickkenberg seems to think that these ships are too old to be converted to D.D.H. status. If so, then why does the Royal Navy still have most of its Type 15 and Battle class ships in full commission. This point aside, if he had read Mr. Hallett's article fully he would have noticed that Mr. Hallett stated that the conversion would also involve a major extended refit, meaning a possible renewal or reconditioning of the present set of machinery.

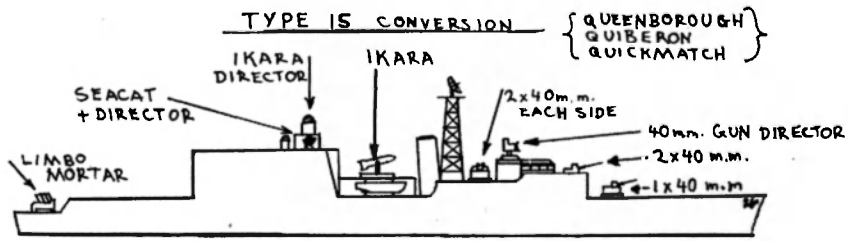
Also Mr. Dickkenberg states that the cost of these conversions would be almost that of new ships built for the purpose. But actually it would be more convenient and cheaper to use the Battle and Type 15 ships as the base for this type of warship; after all, they still have a great deal of useful life left in them. During the Second World War did Australia throw away its old "V and W" destroyers? No, it put them to work and they did as good a job as modern British ones. It is also a fact that this type of ship would suit our Navy's needs for patrolling the waters of Australia, as well as supplementing Australia's small naval force.

The one thing that I agree with from Mr. Dickkenberg's article is the need for the Australian anti-submarine missile, the IKARA, which is probably our best weapon against submarines. With this added piece of equipment the Battle class and Type 15 would have considerable striking power against a sub., not to mention its A/A capabilities.

The Seacat A/A missiles and the 40mm. guns provide adequate protection from air attack whilst the ship has the three previously mentioned ways of fighting submarines; by helicopter depth-charging, by Limbo mortars and by Ikara missiles.

Admittedly it would be better to build the already proven "Leander" class frigate, but it is also much dearer and would take a much longer time before they were completed, leaving Australia poorly





W. D.

patrolled and protected. So why not try this useful type of ship? Anyway, it would cost just as much to perform Mr. Dickkenberg's alteration as it would to build Mr. Hallett's or my conversion which use these ships to their best advantage. Mr. Dickkenberg has also omitted one of the best anti-sub. weapons (which Mr. Hallett has on his ships) from his designs. This weapon is the limbo depth mortar.

So from this I would have the ships emerge from conversion as follows:—

BATTLE class — Length 379 ft., beam 41 ft., draught 13 ft. 6 ins.

Aircraft — 1, Sea King, or 2, Westland Wessex helicopters.

Armament — 2, 4.5 in. dual-purpose guns; 1, Ikara A/S missile launcher; 4, 40mm. A/A guns; 2, Seacat A/A missile launchers; 1, Limbo A/S mortar.

TYPE 15 — Length 358 ft., beam 36 ft., draught 13 ft. 6 ins.

Armament — 1 Ikara A/S missile launcher, 7 40mm. A/A guns, 2 Seacat A/A missile launchers, 1 Limbo A/S mortar.

The Battle class would have its bridge removed and replaced by the modern frigate style bridge. The main deck would be raised one level, a hanger added, an Ikara launching stage and a flight deck. This would be broken at the stern by a quarterdeck, one level lower, on which is situated the Limbo mortar, and to port and starboard of the funnel for lifeboat davits. The Ikara would be mounted on a raised deck abaft the funnel. The Seacats would be situated on top of the hanger, while the 40mm. bofors would be displaced either side just behind the bridge. The 4.5 in. turret would remain in "A" position.

The Type 15 would be generally the same, except for the 4.5 in. gun, whose position is taken by the single 40mm. gun. Also there would be no well-deck for lifeboats.

Both are based on the design put forward by R. J. Hallett in May-June-July issue of "The Navy".

Personally I think this is a very good way to build up our navy's strength and to bring it up to date with the Royal and Canadian navies.

Finally, I wonder if R. J. Hallett would like to reply to the articles by John Mortimer, Midshipman Dickkenberg and also to mine.

Yours truly,

(Sgd): WILLIAM P. DART,
24 Russell Street,
Newtown, Geelong,
Victoria, 3220.

May 10, 1969.

Attention Navy Men

A number of Naval Cadet Units are in need of additional Officers and Petty Officer Instructors with Service background to instruct Cadets. Anyone who may be prepared to give of his time on Saturday afternoons is asked to please contact the Cadet Liaison Officer, Lieutenant McPherson, H.M.A.S. WATSON, telephone 37-1311 extension 256 between 0800 and 01530 for further particulars.

The Units concerned are:—

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T.S. SHROPSHIRE	Canterbury
T.S. WARREGO	Hunter's Hill
T.S. SYDNEY	Snapper Island
T.S. CONDAMINE	Manly
T.S. TOBRUK	Newcastle

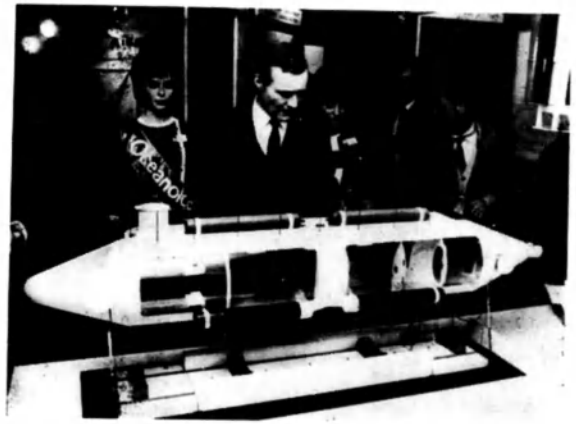
Cadets range from 14 to 19 years of age ond Units parade on Saturdays.

SPEEDING THE COLLECTION OF MARINE DATA

By K. BUDD

Considerable attention has been paid in recent years to space exploration; at the same time, but accompanied by far less publicity, developments have been made with the aim of improving man's relatively limited knowledge of 71 per cent. of the world's surface — the oceans. The vastly increased expenditure on exploring the oceans in recent years has not been directed merely towards the uncovering of academic information, for there is positive evidence that the resources of the sea, the seabed and its substrata could be of great benefit in respect of the world's needs for food, fuel, power, mineral resources and chemicals far into the future.

Britain has pioneered work in oceanography, marine biology and other studies into the nature of the marine environment. This basic research work is now being supplemented by British industry, which is playing an important role in developing and marketing equipment and services to explore and exploit ocean resources. An idea of the extent of these activities can be gauged from the large British participation in the International Oceanological Equipment and Services Exhibition and Conference held in Brighton, England, last February.



BRITAIN IS HOST COUNTRY FOR OCEANOLOGY INTERNATIONAL '69
Mr. Anthony Wedgewood Benn, Britain's Minister of Technology, seen here at Oceanology International '69 — the world's first international exhibition of underwater research equipment — at Brighton, Southern England, recently. Mr. Wedgwood Benn, who had earlier opened the exhibition, is inspecting a model of Bacchus (British Aircraft Corporation Commercial Habitat Under the Sea, a new, fully transportable device for underwater exploration which enables teams of up to six men to operate at depths of 600 feet or more for weeks at a time. Oceanology International '69 included equipment from 200 companies throughout the world displayed in 55,000 square feet of exhibition space. Special oceanographic research and survey vessels from Britain, Russia, America and Poland were on view at two nearby harbours. International organisations taking part included the United Nations Food and Agricultural Organisation, UNESCO, and the International Monetary Fund.

CHANNEL SURVEYS

There is an acute need for rapid gathering of data in the production of accurate charts of the seabed; the total tonnage of world shipping is rapidly increasing, and the introduction of huge supertankers means that depths of channels must be precisely calculated and charted. Some channels tend to silt up and change direction, so that surveys need to be carried out quickly and often to be of optimum benefit.

With this in mind, the Decca Navigator Company exhibited details of its joint project with the firm of Hovermarine to construct, equip, market and operate the world's first high-speed automated hydrographic surveying system. Designated Surveymarine, it utilises a sidewall hovercraft which will be capable of carrying out marine surveys at more than twice present speeds, and under automatic control.

The craft, built by Hovermarine, will cruise at 30 knots (55.5 km/h), while pre-programmed survey lines can be surveyed using the Decca Omnitrac 70 computer coupled to a Decca Arkas autopilot. Depth information is recorded by echo-sounder and displayed in analogue form on a chart, and

is then converted into a digital form to be recorded on punched tape together with the craft's position and time.

On completion of the survey a punched tape is fed into a shore-based computer which will "type out" the finished chart, making all necessary tidal corrections. The first order for a production Surveymarine has been received from the East Pakistan Inland Water Transport Authority.

FAST DATA-LOGGING

Another company concerned with the rapid processing of marine data is Dynamco, which has for many years supplied data-loggers to marine scientists. It displayed the latest addition to the Microscan range, the 6500 HiScan, a fast data-logging system capable of recording microvolt level signals at up to 150 channels/second on computer-compatible tape.

The HiScan uses the same scanning and serialising systems as the standard Microscan range, but has a modified voltmeter with a scale of 1,000 microvolts providing the necessary high speed analogue-to-digital conversion. A unit of this type was delivered recently to one of Britain's most important marine establishments, the Admiralty Underwater Weapons Establishment.

The same company also recently introduced the 6400 Microscan, a four-tier multi-function system with an input capability of 100 channels, programmed range changing controlled by a pin board and dual output capability. In addition to the measurement of signals from analogue voltage signals — for example, thermo-couples and resistance thermometers — the 6400 can be fitted with a constant voltage power supply for strain gauge bridges, or an automatic off-limit detection and warning system and a six-decade digital lock for real time print-outs as well as other optional equipment.

BRITISH ROYAL NAVY SURVEY SHIP JOINS INTERNATIONAL EXHIBITION

A survey ship of the British Royal Navy, HMS Hydra, has sailed from Gibraltar to take part in an international Atlantic Trade Wind experiment as part of the Global Atmospheric Research Programme, arranged by the World Meteorological Organisation. She will join vessels from Federal Germany and the United States, which are also taking part in the expedition. The purpose of the experiment is to carry out meteorological investigations over the sea — the interaction between sea and atmosphere — that will be of benefit to future long-range weather forecasting, and oceanographic research. HMS Hydra will to a 30-foot balloon, with sets of sophisticated equipment fitted to its cable, at different heights up to 2,000 feet. These instruments will radio back to the ship information on variations in wind speed, wind inclination, temperature and humidity. Radio sonde balloons will be released to measure temperature and humidity of the atmosphere; other observations will include measurements of seawater temperature, salinity and density.

TRANSMITTING BUOYS

As an alternative to gathering oceanographic and meteorological data by making measurements from a ship, a number of companies have developed ocean buoys which can be moored at a variety of depths and automatically transmit data to shore or shipborne stations. One type, shown on the stand of E.M.I. Electronics, can be moored at depths down to 19,680 feet (6,000m), and provision can be made for it to accommodate sub-surface and surface electronic packages and sensors.

The standard buoys have a sub-surface float that can support instrumentation to a maximum weight of about 110 pounds (50 kg), and a surface float that can hold up to 22 pounds (10 kg). The surface and sub-surface floats are launched separately and there is an automatic mooring device. More than 150 buoys employing similar automatic mooring principles have been successfully launched.

SOPHISTICATED DATA-PROCESSOR

A sophisticated data-processing system for small research vessels was also displayed. Called the Elliott Hydroplot System, it will be fitted to the British fisheries research vessel EXPLORER and will increase considerably the amount of data that small vessels (up to 200 feet — 61m) will be able to collect and process at sea.

The system was designed originally for ocean surveys and research, and has been expanded, initially for research purposes on board the EXPLORER, but with a

general application to fishing vessels. It uses an Elliott MCS. 920C computer and its on-line computing techniques will be used to gather and process data from about 60 sources.

Facilities include connection of any electronic navigational aid to the system; signals from echo-sounders are monitored and analysed; and the behaviour of the trawl is monitored by acoustic measuring and telemetry systems. Other logging functions include strain gauge accelerometers, trawl warp vibration, warp angle measurements, and so forth. Audible warning of loss of optimum engine room conditions is given, and corrective actions indicated.

One of the problems associated with presenting data from an echo-sounder to a computer is that in many cases information about the seabed is recorded in analogue form — that is, as a direct trace of the contours of the bottom. This has to be converted to digital form for analysis by a data-logger. In an attempt to speed up this process, Kelvin Hughes has introduced an automatic digital output unit which can be used in conjunction with its MS. 36 hydrographic echo-sounder. This sounder consists of recorder, power/transmitter unit, and transducer. The standard model operates at 32 kHz and is provided with either inboard or outboard transducers.

The automatic digital output unit provides a depth readout, either at a fixed rate determined by internal circuitry or on demand from an outside source.

CORRECTION

In John Marriott's article on page 71 (column 3, eight lines from bottom) in the February/March/April, 1969 edition of "The Navy", 'The Royal Navy's New Tactical Teacher', the whole playing area is described as covering 2,048 square miles. This should of course, read 'an area 2,048 miles square'.

AUSTRALIAN SEA CADET CORPS & R.A.N.R. SCHOOL CADETS NEWS

NEW SOUTH WALES DIVISION

Report on training and activities undertaken by the Australian Sea Cadet Corps and the R.A.N.R. School Cadets for the quarter ending 31 March, 1969.

Continuous training periods of 7 and 10 days duration were conducted in January.

H.M.A. Naval Establishment	Date	Course
H.M.A.S. CRESWELL	5-12 January	
H.M.A.S. NIRIMBA	5-12 January	
H.M.A.S. ALBATROSS	5-15 January	Physical Training Instructors Badge Air Badge
H.M.A.S. WATSON	5-15 January	Gunnery Badge

Invaluable sea training for 5 days was also given to 45 Cadets who travelled from Sydney to Adelaide in H.M.A.S. "SYDNEY". These personnel returned to N.S.W. by coach.

Weekend training took place in the following ships and establishments:—

H.M.A.S. STALWART — Feb. 21-23.

H.M.A.S. WATSON — Feb. 21-23.

H.M.A.S. PENGUIN — Feb. 21-23.

H.M.A.S. STALWART — Feb. 28-Mar. 2.

H.M.A.S. QUEENBOROUGH — Feb. 28-Mar. 2.

H.M.A.S. PARRAMATTA — Feb. 28-Mar. 2.

H.M.A.S. MORESBY — Mar. 7-9.

H.M.A.S. ALBATROSS — Mar. 7-9.

H.M.A.S. STALWART — Mar. 21-23.

H.M.A.S. MORESBY — Mar. 21-23.

H.M.A.S. QUEENBOROUGH— Mar. 28-30.

H.M.A.S. MELBOURNE — Mar. 28-30.

H.M.A.S. PARRAMATTA — Mar. 28-30.

The Annual Swimming Carnival was held in H.M.A.S. PENGUIN on Saturday, 22 February. The overall aggregate point score winner was Scots College R.A.N.R. School Cadet Unit followed closely by T.S. TOBRUK (Newcastle Unit). In equal third place were T.S. HAWKESBURY (Gosford Unit) and T.S. PARRAMATTA (Parramatta Unit). This year the decision was made that the trophies and medals for the three annual competitive meetings (Swimming, Athletics and Sailing) would be presented at a special ceremony to be held at the end of the year.

The first of the 1969 Annual Inspections by the Representative of the Flag Officer-in-Charge, East Australia Area took place on Saturday, 1 March when Commander K. Graham, M.B.E., R.A.N. inspected the Hunter's Hill Unit, T.S. WARREGO.

T.S. PARRAMATTA was inspected at 1430 on Saturday, 22 March.

It is pleasing to be able to report that the Cadet Force in New South Wales has been declared a Hot Weather Area for all Units.

This long awaited decision will do much to lift the morale of the Cadets when training in ships and establishments is undertaken during the time summer routine is in force. Cadets will now be able to appear in proper dress of the day which is much more conducive to achieving a sense of belonging.

A Guard of 30 Cadets paraded with their Army and Air Force counterparts in a ceremony held in the Domain on Sunday, 25 January, 1969 to celebrate Australia Day. The R.A.N. Massed Bands were on parade.

The Senior Officer of the Naval Reserve Cadet Force N.S.W. was invited by the Commanding Officer and Officers of the N.S.W. Squadron Air Training Corps to attend a "Dining-In" at the Officers' Mess, R.A.A.F. Bankstown. The occasion was taken to present them with a suitable R.A.N. plaque.

L. MACKAY-CRUISE,
Commander R.A.N.R.
Senior Officer.

JOIN THE AUSTRALIAN SEA CADET CORPS

If you are between the ages of 13 and 18 years

The Australian Sea Cadet Corps is a voluntary organisation administered by the Commonwealth Naval Board and The Navy League of Australia.

The aim of the Australian Sea Cadet Corps is to provide for the spiritual, social and educational welfare of boys and to develop in them character, a sense of patriotism, self-reliance, citizenship and discipline.

Uniforms are supplied free of charge.

Cadets are not required to undergo any medical examination and are fully insured against accident while on duty.

Parades are held on Saturday afternoons and certain Units hold an additional parade one night a week.

The interesting syllabus of training covers a wide sphere and includes seamanship, handling of boats under sail and power, navigation, physical training, rifle shooting, signalling, splicing of wire and ropes, general sporting activities and other varied subjects.

Instructional camps are arranged for Sea Cadets in Naval Establishments, and they are also given opportunities, whenever possible, to undertake training at sea in ships of the Royal Australian Navy.

Cadets, if considering a sea career, are given every assistance to join the Royal Australian Navy, the Mercantile Marine or the Royal Australian Naval Reserve, but there is no compulsion to join these Services.

For further information please contact the Divisional Senior Officer in your State, using the Form provided below.

Senior Officers, Australian Sea Cadet Corps

NEW SOUTH WALES: Staff Office Cadets, H.M.A.S. Watson, Watsons Bay, N.S.W. 2030.

QUEENSLAND: C/- Box 376E, G.P.O., Brisbane, 4001.

SOUTH AUSTRALIA: C/- Box 1529M, G.P.O., Adelaide, 5001.

TASMANIA: C/-

VICTORIA: C/- Room 8, 8th Floor, 528 Collins St., Melbourne, 3000.

WESTERN AUSTRALIA: C/- 182 Coode St., Como, 6152.

AUSTRALIAN CAPITAL TERRITORY: Industry House, National Circuit, Barton, 2600.

NORTHERN TERRITORY: Box 444, P.O., Darwin, 5794.

TO: The Senior Officer,
Australian Sea Cadet Corps

I am interested in joining the Australian Sea Cadet Corps and would be pleased to receive further information.

NAME.....

STREET..... SUBURB.....

STATE OR TERRITORY..... POST CODE.....

PHONE No..... AGE.....

(Please print clearly)

Please address your envelope to the Senior Officer in your State or Territory—see list of addresses above

THE NAVY

H.M.A.S. ARUNTA

Last of the Australian Tribals

By C. Sattler and B. Morrison.

Photographs supplied by the authors

On the 15 November, 1939, the keel of the first Australian improved "Tribal" class destroyer was laid down at Cockatoo Docks and Engineering Co. Ltd., Sydney. She was launched on the 30 October, 1940 by Lady Gowrie. Having been commissioned on 30 March, 1942, under the command of Commander J. C. Morrow, D.S.O., R.A.N., ARUNTA proceeded on a period of working up trials, which consisted of anti-submarine patrols and escorting coastal convoys.

The 29 August saw her first victory against the enemy, when she detected and sunk by depth charges, the Japanese submarine RO 33 ten miles South East of Port Moresby. Whilst operating in the New Guinea area, she rescued the survivors of the S.S. ANSHUN, which was sunk at Milne Bay by Japanese cruisers on the night of 6/7 September, 1942.

In January, 1943, ARUNTA took part in the evacuation of guerilla troops from Timor, becoming a unit of Task Force 74 on the 4 May. This Force consisted of the Australian cruisers AUSTRALIA (Flag), SHROPSHIRE, destroyers WARRAMUNGA, ARUNTA and U.S.S. RALPH TALBOT and HELM. As a unit of this Force, she supported the American landings at Kiriwina and Woodlark Islands during June-July, 1943. In company with the three other destroyers of the Force, ARUNTA bombarded Japanese ammunition dumps near the mouth of the Anwek River (New Britain) TF 74 next supported the landings at Arwe in December and the second landing at Cape Gloucester on 26 December, 1943. Temporarily attached to TF 76 (U.S. Amphibious Group), ARUNTA and WARRAMUNGA took part in the landing of the U.S. 32 Division at Saidor, New Guinea. She captured her only prisoner of war in this area, when the pilot of an enemy aircraft was rescued after he had been shot down by American fighter planes.

In March, 1944, as a unit of TF 76, she took part in the landings at the Admiralty Islands. Rejoining TF 74, she supported the Hollandia invasion and the capture of Wakde Island in mid-May, expending over 300 rounds of 4.7 inch ammunition in this latter bombardment. Whilst acting as a guard ship for the Biak landings, ARUNTA with other units of TF 74 and TF 75 (cruiser group), contacted four Japanese destroyers on the night of 7 June, 1944. A high speed but unsuccessful chase developed (ARUNTA exceeding 30 knots), which was abandoned when the leading allied destroyers were 30 miles South East of Mapia Island.

ARUNTA also participated in the following operations in this area:—

2-7-44 — Took part in the bombardment of Noemfoor Island, Dutch New Guinea 545 rounds 4.7 inch fired.

7-44 — Bombardment of coastal guns east of Aitape, New Guinea.

30-7-44 — Support of landings at Cape Sansapor as a unit of TF 78.

After a refit in Sydney, she rejoined TF 74 and took part in the last major landing in the New Guinea campaign, the seizure of Morotai Island 15 September, 1944. ARUNTA sailed from Hollandia on 13 October as a unit of TF 77.3 (close cover group) under

Rear-Admiral Berkey U.S.N. for the landings at Leyete Gulf, participating in the pre-landing bombardment, she took part in the final surface engagement of World War II in the Surigao Strait.

Next came the landings at Lingayen in January, 1945. The entire allied attack force consisting of over 850 ships. ARUNTA, being attached to TF 77.2 approaching Lingayen on 5 January, was attacked by a KAMIKAZE plane which narrowly missed hitting the port side. Two ratings died of wounds as a result of this attack. At the end of February, she returned to Sydney.

After a six week refit, her next job was in supporting the landing of the Australian 6th Division at Wewak on 10/11 May. Joining TF 74.3, ARUNTA participated in the landing of Australian troops at Brunei Bay, Borneo. In July, she sailed from Tawi Tawi in company with TG 74.1 (SHROPSHIRE, HOBART, destroyers ARUNTA, U.S.S. METCALF and HART, for preliminary shelling of Balikpapen, in preparation for the landing of Australian troops on 1 July. The task group expending 38.052 shells ranging in size from 8 inch to 3 inch, ARUNTA's share being 601 4.7 inch shells. Returning to Sydney on 11 July for a refit at Cockatoo Dockyard where she was at the time of the Japanese surrender.

On completing the refit, she sailed for Darwin on 18 October, to escort the repatriation ship ESPERANCE BAY to Timor and then to Java. In November, she proceeded to Japan to join the occupation force stationed there, returning to Australia in March for urgent repairs.

On 11 June, 1946, she sailed for a cruise to the Philippines, returning to Australia, where most of the time was spent operating around the Sydney area, until the 3 December, when she sailed with the SHROPSHIRE for a four month deployment in Japan. Relieved by H.M.A.S. QUIBERON, ARUNTA arrived in Sydney on 21 April, 1947, leaving Sydney again on 10 November for another tour of duty in Japan. In June 1948, she proceeded on a cruise of the Western Pacific Islands and after a period in home waters, ARUNTA paid off on 21 January, 1949 for a conversion to an anti-submarine destroyer.

Recommissioning on 11 November, 1952, the next year was spent working up around the Australian coast, then in January, 1954, ARUNTA sailed for a seven month tour of duty in the Far East operating as one of the allied units of the Korean Patrol groups based in Japan. Returning to Sydney in October for a refit, once again she sailed in mid-May for her second deployment in the Far East, returning to Sydney on 19 December, 1955. Most of the time was spent around Australian waters until 14 June, 1956, when ARUNTA arrived in Sydney for the last time flying her paying off pendant. She was handed over to dockyard hands on 21 December, 1956 for preparation to be placed in reserve having steamed 357,273 miles since her commissioning in 1942.

For eleven years since she remained in the Reserve Fleet at Sydney, many people hoping she would be preserved as a Naval Museum, but unfortunately, it was announced that this valiant ship had been sold to the China Steel

Corporation of Taipei, Formosa, on 1 November, 1968.

The tow to the breakers yard at Kaohsuing was started at 10.50 a.m. on 12 February, 1969 by the Japanese tug "Toko Maru". ARUNTA leaving Sydney for the last time at 1.20 p.m.

At sunrise on 13 February, 1969, ARUNTA was observed to be listing to starboard. The tug reversed course for the coast but at 1.15 p.m., the tow was cut as ARUNTA was lying on her starboard side, capsized, eventually sinking by the bow at 4.40 p.m. in position 33.42 South, 152.23 East.

A fitting end to a fine ship.

Sister Ships — WARRAMUNGA, BATAAN (ex KURNAI).

STATISTICS AS COMPLETED

Displacement — 1,970 tons (standard).

Dimensions—335½ ft. (p.p.), 377½ ft. (o.a.), 36½ ft. Beam, 9 ft. Draught.

Machinery — 2-Shaft Parsons Geared Turbines, S.H.P. 44,000 = 34 knots (sea speed 36.5 Knots (designed) Boilers 3 Admiralty 3 Drum Type.

Armament — 6-4.7 in. (3 x 2), 2-4 in. A.A. (1 x 2), 4-2 pdr. A.A. (1 x 4), 6-20 MM A.A. (6 x 1), 4-21 in. (1 x 4) T.T.

Complement — 190.

NOTE: In 1945 Y Turret 4.7 in. removed, 2 pdr. replaced in 1950 by 2-40 M.M. A.A. (2 x 1).

Armament after Conversion to Anti-Submarine Destroyer — 4-4.7 in. (2 x 2), 2-4 in. A.A. (1 x 2), 6-40 MM A.A. (6 x 1), 4-21 in. (1 x 4) T.T., 1 squid triple barrel anti-submarine mortar.

Displacement — 2,012 (standard), 2,700 (full load).

Complement — 293.

Australian Navy Judge Advocate Observes U.S. Military Justice

His Honor Judge Trevor G. Ropke, Queen's Council, Judge Advocate General for the Naval Forces of the Commonwealth of Australia, visited military installations in the United States under the sponsorship of the Judge Advocate General of the U.S. Navy, Rear Admiral Joseph B. McDevitt.

The purpose of Judge Rapke's visit was to study U.S. military justice and correctional systems and to discuss certain aspects of International law, administrative discharges, and criminal investigations.

His visit included tours of naval activities in San Francisco, Los Angeles, San Diego, Great Lakes, Boston, Newport, New York, Washington and Norfolk. He was an Army guest at Fort Riley, Kansas, and at the Judge Advocate General's School, Charlottesville, Virginia.

He toured Air Force facilities at Richards-Gebour Air Force Base, Missouri, and Marine Corps facilities at the Marine Corps Development and Educational Command, Quantico, Virginia. As part of his research into military disciplinary and correctional programmes, he probed the U.S. Disciplinary Barracks at Fort Leavenworth, Kansas, and the Naval Disciplinary Command, Portsmouth, New Hampshire.

In 1965 Judge Rapke was made an Honorary Professor of Law at the Naval Justice School, Newport, R.I., and was at the same time admitted to practice at the U.S. Court of Military Appeals.

During his visit to the West Coast, Judge Rapke presented mementos of the late Prime Minister of Australia, Harold E. Holt, to the wardroom of the U.S.S. HAROLD HOLT (DE 1074), named in honour of the former Prime Minister.

Judge Rapke's visit has also featured such diversions as a night cruise in a Chicago police car, attendance at the St. Patrick's Anzac Day Parade in Boston, and a tour of New York City by helicopter.

Judge Rapke departed the U.S. on 24 April for the United Kingdom where he is continuing his comparison of military justice and correctional systems.

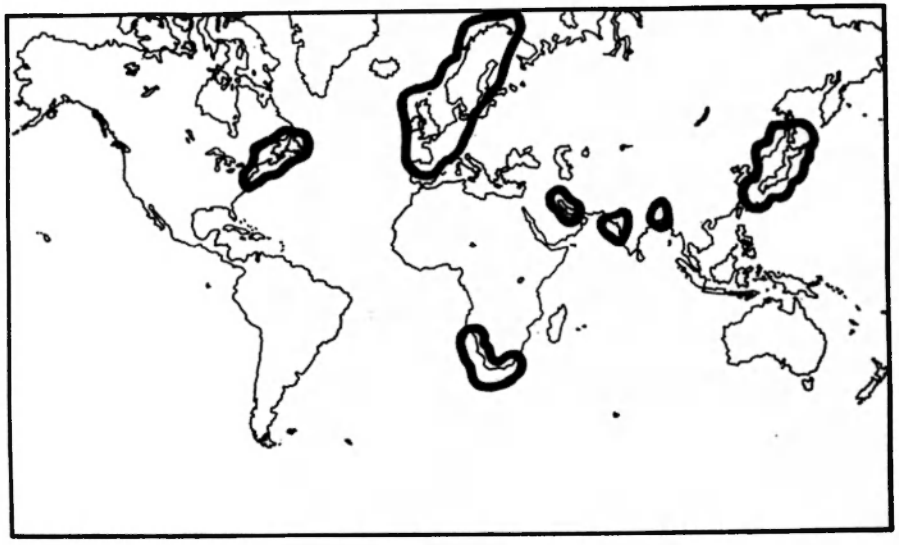
Judge Trevor G. Rapke, Queen's Council, Judge Advocate General for the Naval Forces of the Commonwealth of Australia (centre) discusses the Military Justice Act of 1968 with Rear Admiral Joseph B. McDevitt, Judge Advocate General for the U.S. Navy (left), and Rear Admiral Donald D. Chapman, Deputy Judge Advocate General.

GUIDING LIGHT FOR MARINERS AND AVIATORS

World-wide Navigational System

Lieut. Commander G. L. COLES

More than 13,000 ships of many nations, ranging from aircraft carriers and giant supertankers to trawlers and hydrographic survey vessels, today have the facility of high-precision automated navigation through a unique British system of continuous position-fixing and recording. The Decca Navigator system, which is effective over wide areas from Japan to the Baltic Sea and from the Persian Gulf to North America's Gulf of St. Lawrence, also assists some 3,000 aircraft. Used by 14 navies of the world, the system was first employed to enable minesweepers to clear precise paths across the English Channel for the Allied Invasion of Europe in 1944.



DECCA NAVIGATOR WORLD COVERAGE

The ability to establish and record tracks makes the system useful for trawlers working over shoals of fish or near reefs and seabed obstructions that might foul nets, and also for hydrographic survey vessels. It also provides accurate navigation control in routing schemes currently operating, or visualised, that fall within the transmission range of the Decca chains of radio stations. The use of modern radio navigational aids for this purpose is a recommendation of the International Maritime Consultative Organisation, resulting from an inquiry into the implications of the loss of the oil tanker TORREY CANYON off the south coast of England.

Some 34 Decca chains of radio transmission stations cover more than 6,500,000 square miles (16,800,000 km2) of land and sea in the Northern Hemisphere. The system will soon be introduced in the Southern Hemisphere, with the building of five chains around the South African coast.

BASIS OF SYSTEM

The Decca chain is a radio navigation system based on hyperbolic geometry, and operated in

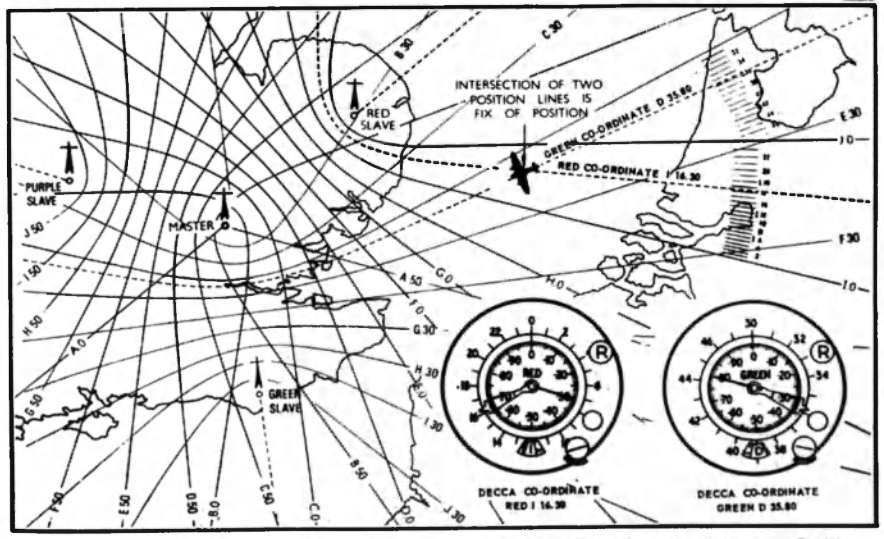
conjunction with groups of shore-based transmitters working in the 70 to 130 kilocycles frequency band. It is entirely different from radio direction-finding, there being no directional "beam"; a network or grid of intersecting position lines is established through the synchronised Decca transmissions.

Basically, the system comprises three elements: the chain of transmitting stations, the receiver and Decometer combination in a ship or aircraft, and the specially over-printed charts or maps on which the information from the Decometers is plotted to provide a position-fix.

A chain consists of three pairs of transmitters, a common central master and three outlying slave stations, 50 to 100 miles (80 to 160 km) from the master, which are designated red, green and purple. In the ship are three Decometer indicator dials similarly designated as colours. Through the medium of the receiver, these indicators are actuated by the continuous unmodulated radio waves, with slave signals phase-locked to the master.

The Decca Navigator Mark-6 display head and associated controller provides a pilot with a continuous indication of his position.

Each Decometer displays a numerical reading, the value of which at any given moment depends upon the position of the ship relative to the ground stations. The special charts are covered with a grid of red, green and purple lines numbered to correspond to the



Decca Navigator hyperbolic system, illustrating an aircraft at the intersection of the red and green co-ordinates.

Decometer readings. The space between the grid-lines is called a lane, and the Decometer counts these lanes as the ship or aircraft passes across the grid.

To take a fix, the officer of the watch will take the readings from only two of the colour Decometers, that is those corresponding to the two patterns giving the best angle of cut on the chart and with these establish the point on the chart at which the two indicated position lines intersect, providing a precise position of the ship.

This operation is extremely simple, even for a person with no navigational training; it can be understood within minutes, it is claimed, with a high degree of proficiency in one or two hours. The receiver, measuring less than four cubic feet (0,11m3), operates unattended, no tuning or other adjustments being required. Switching on and turning of the selector switch to the number of the transmitter chain are the only operations necessary for receiver use. Fixes can be obtained in a matter of seconds, and their accuracy is said to be unimpaired by violent movement of the ship or state of weather.

CONTINUAL IMPROVEMENTS

Decca has continually improved and increased the facilities of the Navigator since it was first established. The introduction of lane identification transmissions in 1948, an important characteristic of the system for cross-checking and setting up, marked the expansion of the firm's equipment on an international basis.

This multipulse system entails the transmissions of additional composite signals from the ground stations. It facilitates a new technique that provides improved position-line geometry from the patterns of adjacent chains. A position line of one chain is crossed with that of another to give a good angle of cut.

AUTOMATIC PLOTTER

Decca has carried automation even further into the mariner's world with the Marine Automatic Plotter, which provides an accurate and continuous record of a ship's position as registered by the Navigator. Actuation of the Decometers is translated into a pen and paper movement, along both horizontal and vertical axes, to show the ship's track at any given moment. This is drawn on a compact display unit on which an area of chart measuring approximately 10 inches by 10 inches (25 cm by 25 cm) is visible at all times, sections of chart moving progressively and automatically into position as the ship advances.

The facility enables ships to follow any desired course without the need for manual plotting, and is intended primarily for operations that demand accurate holding of pre-determined tracks or the recording of tracks that can be analysed later. As a result, it has particular applications, such as fishing, the navigation of ferries in congested and hazardous traffic routes, hydrographic surveying, dredging, undersea oil exploration, cable laying, sea search and certain naval operations.

A new track plotter — type 1877 — is to be introduced soon, which will widen its potential application, particularly in merchant vessels for general navigation. It will not only accept Decca Navigator information, but other systems such as Loran when outside Decca coverage. It will also be possible to feed in dead-reckoning factors, such as heading of the ship and log distance readings.

Minidec manpack receiver — an application of the Decca Navigator principle in military air/ground co-operation.

INCREASING FISHING PRODUCTIVITY

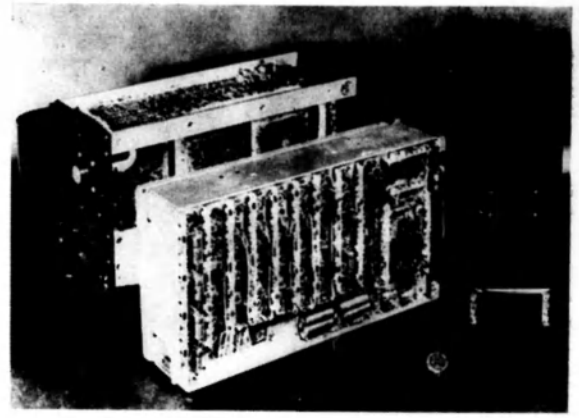
The Decca Navigator is installed in more than 6,000 fishing vessels. A Norwegian Government survey of the effectiveness of such installations showed that productivity of a trawler or seiner can be increased by more than 20 per cent.

In the past, acceptance trials of new vessels have been limited by problems associated with measured distances, with visibility of shore markers and other factors a governing consideration. Now, with Navigator and plotter installed, it is stated that trials can be conducted independently of such restrictions to an accuracy of about one-tenth of 1 per cent, and a complete record of the trials, including turning circles, acceleration and crash-stop information is recorded. This is particularly useful for modern vessels such as the huge new tankers that are steadily approaching the 500,000 deadweight tons mark.

At the other end of the scale, Navigator and plotter can be of great use in the laying of buoys at precise points.

SITING OF CHAINS

With 18 chains operating in Britain and continental Europe, 2,500,000 square miles (6,475,000 km2) are covered by the system in north-west Europe alone. In North America, five chains provide navigational coverage of the Canadian eastern seaboard and the New York area.



Sectioned display of Decca Navigator airborne receiver and computer, illustrating the compactness of the units.

The waters of the Persian Gulf are completely covered by two chains that provide pin-point navigation leading the world's tankers to the Middle East oil terminals. The approaches to the major Indian ports of Bombay and Calcutta are serviced by two chains, while in Japan the sea surrounding Hokkaido is fully covered. A further Decca chain, in Kyushu, is being constructed and there are plans to cover the remaining Japanese waters.

EVEN GREATER ACCURACY

While the Navigator system has brought a high degree of precision to position-fixing at sea and in the air, an even higher degree of accuracy has been achieved by a derivative of the system called Hi-Fix. This can be operated as a mobile chain of transmitters and has proven to provide the necessary accuracy over a shorter range required in such operations as hydrographic survey to create the charts of seas and waterways.

Along the master-slave base line of the system, a position fix can be repeated by this system to within one yard (metre), to a range of approximately 100 miles (160 km). This degree of accuracy is not only

essential for hydrography, but also for such tasks as the positioning of oil rigs that probe the seabed for petroleum and natural gas, and for port maintenance and other civil engineering projects.

Hi-Fix has been used extensively on such operations as the big international search for oil and gas beneath the North Sea, and also for the geophysical survey under the Straits of Dover to establish the feasibility and route for the projected Channel Tunnel between England and France.

AIRCRAFT APPLICATIONS

As an aid to aircraft, the Decca chain information and its use must be much faster because of the high speeds involved. Pictorial display of a special track plotter or flight log is therefore employed. The pictorial display on a moving map, mounted on a roller, provides a pilot with clear and instantaneous information of his track and position, even at the highest speeds of today. This, of course, has both commercial airline and military uses.

This system has been developed further by the introduction of a computer. The flight log pictorial display can be used in conjunction with a digital computer and coupled to an automatic pilot to give automated flight control in addition to position and track recording.

The introduction of the computer has brought into service another facility stemming from the Navigator. This is the Data Link, basically an aid to air traffic control. When an A.T.C. officer interrogates an aircraft about its position, height, heading and similar information, the answers are reproduced instantaneously on a display in the A.T.C. centre, at an airport or in an aircraft carrier's operations room.

The Navigator aircraft system is of particular use to helicopters as, being a low-frequency system, it operates down to ground level and is said to be unaffected by hills and buildings. These factors also make the Navigator system a unique aid in two further fields: air-sea rescue operations, and co-operation between ground and air in military operations. As both aircraft and ships in a sea rescue operation can carry the special Navigator charts, they can easily exchange information about the position of a vessel in distress and needing assistance.

MILITARY AID

For military operations, Decca has evolved a battery-operated receiver called the Minidec that can be carried in a pack on a soldier's back. Main difficulty of arranging air support for infantry has been the inability of ground troops to locate their exact position in featureless or badly mapped areas. Now, the self-contained Minidec receiver, weighing only 15 pounds (7 kg) can give a position fix on standard Decca co-ordinates. This has simply to be relayed to a supporting aircraft that carries the same gridded map and can plot the precise position of the troops, on its moving map display, in relation to the aircraft's own position.

FOR TRANSATLANTIC FLIGHTS

Another development of the Navigator system is being used for transatlantic air traffic. The Decca system, operating in the 70 kilocycles band, uses two transmitters in England, two in Canada, and another in Iceland. Its primary aim is to permit close lateral separation standards for aircraft over the North Atlantic, where increasing traffic demands more ground control capacity.

Use of this long-range system can, it is claimed, reduce lateral separation distance between aircraft safely down to 60 nautical miles (110 km), compared with the 120 nautical miles (220 km) at present in use.

No other system today offers the simplicity of operation, flexibility and accuracy that the Decca Navigator system provides. It is not surprising, therefore, that an increasing number of Decca chains are being planned by authorities in many parts of the world.

— THE GUN —

A DEVELOPMENTAL RESUME

First of a Series: by GALATEA

The Editor Invites Readers to Comment on this Article

Ever since Man discovered that, unlike other carnivores, he must rely on artificial aids to both hunt for his food and to counter his enemies; he has been fascinated by the power he evolved of being able to strike and kill, if necessary, from a distance.

The simple thrown rock was his first method of achieving this objective, followed in later times by the sling, the thrown spear and the first crude bows and arrows. This last was brought to a state of perfection by the English longbowmen in the 11th and 12th Centuries and was used to devastating effect in numerous major battles of the period. Massed, high-arc plunging fire was the tactic employed and when used "en barrage" in a similar manner to the massed hub-to-hub artillery of World War I, produced appalling casualties amongst packed lightly armoured troops and cavalry. Such tactics were often the deciding factor in the frontal encounters which were the order of the day. King Harold II was killed in this manner at the Battle of Hastings in 1066 by a Norman arrow through the eye.

THE BATTLE OF HASTINGS

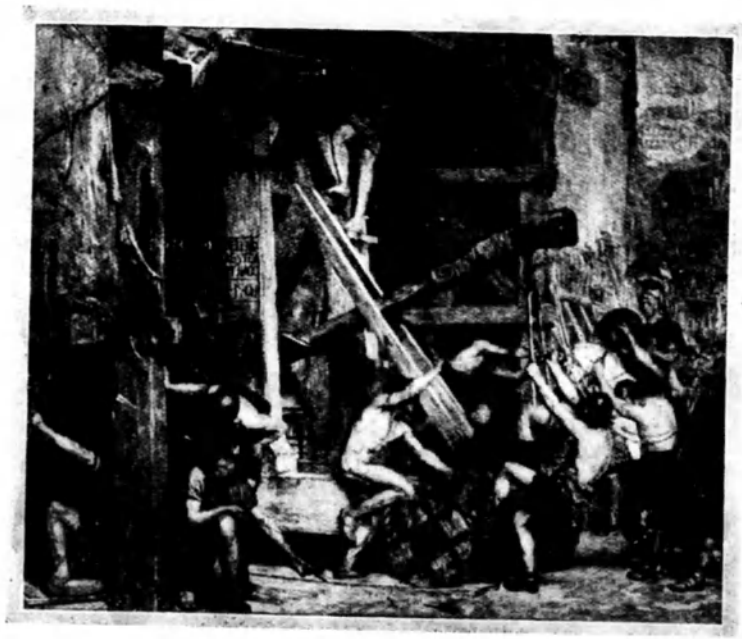
The scene at the height of the battle that brought about the last conquest of England. The picture is after an engraving from a well-known painting, and the death of Harold is shown. The Norman duke (afterwards William the Conqueror) commanded his archers to shoot high in the air, and it was one of these missiles, falling "like a bolt from heaven," that cost the English king his life.

Roman Onager in action

Mechanically operated missile-directing devices were in use long before the birth of Christ, and certain types of these weapons were the only form of "artillery" known until the 14th Century. The ancient Romans in particular made notable use of, what were for the first time, rather sophisticated engines of war including huge catapults powered by a large skein of rope tensioned by pulling back on the arm of the catapult. That which was to be projected was placed in a large cup on the outer extremity of the arm, and then released.

A fair measure of distance could be achieved with this device, but being a large cumbersome machine, it was far more likely to be used in a static posture than in actual battle. Siege operations were its metier and many bizzare objects were hurled into the beleaguered towns and cities, including vessels of burning pitch, rocks, and even putrefying corpses; the latter for the purpose of spreading disease amongst the defenders.

14th century archers



THE CATAPULT

The above illustration shows that ingenious weapon of warfare the Roman catapult, being used to batter down the walls of Carthage. This appliance threw enormous darts, stones or arrows, the missiles being sent hurtling through the air when a heavy bow was released.

Naval operations of the time were assisted by smaller versions of the catapult, commensurate with the size of vessel, and one of the very first guided weapons also made its appearance. This was an exceptionally large cross-bow, usually mounted to fire forward, and which directed very large fletched arrows at enemy ships. Rags, sheepskin or wadding were wrapped around a proportion of the shaft's length, then soaked in pitch or oil and set alight prior to releasing. The primary object was to set the ship afire and was therefore not intended to be an anti-personnel weapon, although, no doubt, other uses for it were found.

One of the first examples of chemical warfare raised its head in this era in the form of "Greek Fire". The exact origins and ingredients of this compound are obscure, however its use was well established even prior to the time of the Roman Empire. As far as can be ascertained, the occasions of its use were not plentiful, even so, it found employment both at sea and on land. An educated guess names at least two of the ingredients as being boiling pitch and sulphur; the whole being heated under pressure — presumably with a type of bellows — and then let pass out through narrow tubes which could be directed by the operators at the foe: all very similar to the modern flamethrower, except that the means of igniting this dangerous concoction are not known with certainty.

Greek Hoplite about 500 B.C.

The human race is indebted to China for the invention of such momentous things as paper, the original printing process by way of woodblocks, and the compass, however one of the few things of which we can be fairly certain about the origin of Gunpowder (black powder) is that the Chinese did not discover it.

Cheldren warriors 2000 B.C.

We shall never be certain as to exactly who discovered gunpowder, unless new documents come to light. However, the British historian Partington (1960) concludes that as far as China was concerned gunpowder was known in the latter part of the Mongal Yuan dynasty (A.D. 1260-1368), when it was already known in the West. The Franciscan friar, Roger Bacon, writing approximately A.D. 1260, was the first man to actually record the composition of gunpowder, inasmuch as is known at the present time. But it is interesting to note that, awareness of the existence of gunpowder notwithstanding, the Chinese still had to purchase stone-throwing catapults from Persia as late as 1273 during the siege of Hsiang-Yang Fu. It is true that the Chinese had Roman candles, fire arrows, incendiary grenades and a primitive form of rocket, but it seems they were unaware of the explosive properties of gunpowder until 1365, when one of the first notations was made concerning "Cannon".

Almost from the beginning of the use of explosives in warfare the gun and the rocket have coexisted. However, historically speaking, one of the main differences between the two weapons is not the obvious one of variance in type, but that which lies in the agonisingly, protracted development period of the rocket. Almost 700 years were to elapse between the first recorded use of rockets in war (A.D. 1232) and the early years of the 20th century. All through that period the rocket rarely escaped from the classic "firework on a stick" formula, whereas developmental work on the gun proceeded apace, combining both intricacy and craftsmanship, especially in the case of small-arms. Since it was — and still is — the predominant weapon, let us examine the ancestral development of the gun.

Like gunpowder, the origin of the first gun is clouded by myths, legends, half-truths and only a little fact. The first real evidence of their existence comes to light in 1326 with the first written reference to cannon, contained in a decree issued by the Council of Florence. The first-known illustration of a gun was found in Walter de Milemete's English manuscript of the same year and depicts a bulbous wine-jar shaped gun with a flared bell-mouth resting on a kind of trestle. It is depicted as firing a large arrow with a bronze head and fins. Since there is no wadding or similar substance wrapped around the shaft to aid compression of the charge, power and range must have been very low, together with atrocious accuracy.

Two Saxons and a mounted Norman knight

One of the first uses of cannon in warfare appears to be the occasion when the French used "canons et bombards" to fire arrows at the English at Quenoi in 1340 and, almost as if to return the dubious compliment, historians tend to agree that Edward III of England used cannon with spherical iron shot against the French at the Battle of Crecy in 1346.


Archer drawing crossbow

So, here at last we have the principles upon which artillery and naval ordinance were to remain based until the second half of the 19th Century. Iron, brass or bronze cannon, firing metallic spherical shot by means of the sole propellant and explosive known until a century or so ago, i.e. black powder. But there were some surprising variations. Stone round-shot was often used, for the reason that, being lighter in weight than metal shot of the same calibre, greater range was possible for the same amount of propellant and, conversely, by using a lesser charge of powder in any given calibre (using stone shot) one could still obtain the same range as gunners using metal shot and a larger charge.

A less obvious but equally valuable reason for the use of stone round-shot was that an invading army need only carry a minimum of "ready use" metal round-shot in its baggage train; the remainder being formed on the spot by masons travelling with the army.

In those days, when major wars were usually conducted in a very chivalrous and formal manner, the opposing sides usually had ample notice of both time and location for the impending clash, and so the masons had plenty of opportunity to choose and use the local stone for the making of shot. However, since it was impossible to make stone shot as spherically perfect as its metal counterpart, cannon attrition was very high due to wear and explosive jamming.

Grapeshot appeared at this time, but when this anti-personnel shot was in short supply the gunners were in the habit of ramming almost any available debris down the barrel, with the result that, once again, this uneven fodder caught upon scoring within the barrel, and upon firing packed itself into a solid mass and jammed, thereby destroying the gun through explosion, in the process often killing or at least wounding the entire gun-crew. The lessons herein still had not been learned three centuries later, as 18th century blunder-busses occasionally blew up in the hands of coach drivers for the same reason.

But the most far-reaching development of the period was in the actual construction of guns. Even though large bells were being perfectly cast at this time, gun-casting was in its infancy. So, the first cannons were made up of longitudinal iron bars arranged in a circle like barrel staves, partially welded, and then molten lead was poured into the remaining spaces for sealing purposes. The whole was held together with many iron hoops driven over the resultant tube and closed at one end with a heavy plug which, in turn, was wedged in position.

Contrary to popular opinion, breech-loading cannons appeared early in the 15th Century. They were generally small, light pieces with a calibre seldom exceeding four inches. The best example of this sub-type of gun is the breech-loading petarara made in the manner described in the previous paragraph. The complete breech was detachable and a number of them could be pre-loaded with powder-and-ball and placed near each gun. When required for action, the gunner only had to place a loaded breech in the trough, which was precisely cut at the rear of the gun and held in position against the breech-mouth whilst a wedge was driven into place, thereby securely fastening the breech-block to the barrel proper. A red-hot wire was then thrust onto a primed touch-hole in the breech block and the gun thus fired in the classic manner. They were in use both on land and at sea, in the latter case being mounted initially in a hollowed-out balk of timber so that the gun lay in it, as in the lower half of a mould. The whole weapon lay flush on the deck, recoil being halted by a wooden stop fastened to the deck. Later, as the familiar wheeled-carriage naval guns appeared, weapons similar to the petarara were placed on swivel mounts made of iron and positioned near or on ships' bulwarks as anti-boarding weapons. A similar installation was fitted to the walls of castles and forts for obvious reasons.

Guns of this period were unwieldy rather than heavy. However, we cannot progress further without mentioning a few huge cannon — enormous even by today's standards — which the gunmakers of Europe produced in the mid and later 15th Century. The famous bombard "Mons Meg" was made in the previously described manner in Flanders from iron bars and hoops. Still on its huge wooden carriage with four iron-rimmed and studded spoked wheels, this famous piece is at rest in Edinburgh Castle. Its impressive statistics include a weight of five tons, a length of over 13 feet, a calibre of 19½ inches and an ability to heave a 1,125 pound iron shot to a range of 1,400 yards. A 549 pound stone shot could be fired to about 2,800 yards. Mohammed II had several huge guns cast around 1450 for the siege of Constantinople. But eleven years later his bronze masterpiece was cast in the form of the "Dardanelles Gun" now residing in the Tower of London. This great weapon is 17 feet long, 18½ tons in weight, with a calibre of 26 inches, and could fire an 800 pound stone shot to a distance of approximately 1.25 miles — a remarkable achievement. For easier handling for transport, the great breech could be unscrewed (an engineering feat in itself considering the bulk and weight of the gun), although it was most as-


Cannon at the battle of Crécy

suredly *not* a breech-loader. For sheer size, however, it would be difficult to surpass "Mad Margaret". This "whopper", still in the Belgian city of Ghent, is over 18 feet in length, weighs only 15 tons, but possesses a calibre of 33 inches! Its shot-weight is unknown; however, a conservative estimate places the weight of an appropriately sized stone shot at approximately 1,600 pounds, with an unknown range.

Interesting though these mammoth guns undoubtedly are, their type was hardly practical for general use, and armies the world over gradually standardised on very much smaller calibres; three, six and twelve pound spherical shot-firing cannon being commonly used along with the mortar in its various sizes. The latter utilised either solid shot or explosive "bombs" with hand-lit fuses (*not* shells) fired from a stubby barrel in a high, parabolic arc, rising over walls or hills to land on top of its target. Normal field guns fired their shot in a comparatively flat trajectory, making their use problematical in hilly or mountainous country. An almost ideal compromise between the field gun and the mortar appeared early in the 18th Century in the form of the Howitzer which was, in effect, a longer-barrelled mortar fitted to a carriage like that of a field gun, thereby making it more mobile than the mortar. The armies could now fire heavy-calibre shot from a mobile weapon.

To digress for a moment, it is interesting to recall an early attempt to provide front-line troops with an extremely mobile light artillery piece. This was the "Leather Gun" invented by Robert Scott (an Englishman), and used by that superb strategist and tactician King Gustavus Adolphus of Sweden. The guns were basically a central copper tube bound with either wire or iron hoops, thence with hemp rope and, finally, a thick outer casing of leather was shrunk on. These guns fired a shot of approximately 1½-2 pounds and weighed only 50 pounds! Gustavus used them at the Battles of Breitenfeld (1631) and Lutzen (1632), in the last of which he was killed.

During the Spanish siege of Gibraltar (1779-1783) it was discovered that the 5.5" mortar bombs could be fired from 24-pounder cannon which had a calibre of 5.8". By shortening the fuses the bombs could be made to explode at long range and in mid-air over the heads of the Spanish besiegers, thereby achieving with cannon that which was hitherto impossible to do with mortars, for obvious reasons. As this was at best a makeshift device, Lieutenant Henry Shrapnel of the Royal Artillery designed a new type of shot in 1784. He called it "spherical case" shot and it comprised a hollow, round, thin-walled shot, filled with bullets and with the smallest possible bursting

Arquebusier and helper

charge which was only intended to break open the casing, together with a standard fuse having an accurate predetermined length. A protracted decision to accept the shot was not forthcoming from the Ordnance Board until nineteen years later in 1803.

Naval ordinance has always had its own special problems, including the magnified one of keeping large quantities of black powder free from dampness in an unlikely and hostile environment, together with its very carriage in a close-confined and inflammable barracks, which of course precisely describes the wooden-walled fighting vessels of old. Also inherent with this form of combat were lack of manoeuvring room on and between decks for the guns and men, coupled with the long, flat and unimpeded ranges at which "slugging" matches could, but in fact rarely were, fought. Add to these factors the picture of what could happen when heavy guns broke loose in a storm and hurtled through the living spaces, and the frightful injuries inflicted by huge splinters of wood flung up by cannon-fire. Fighting and manhandling heavy guns at sea in confined spaces was no sinecure. New developments at sea were in weaponry, not tactics, and, whilst all were important, one in particular introduced a new type of vessel — the "Bomb Ketch", first constructed by the French around 1740 to carry to sea a weapon very much needed for reducing fortified ports, etc., but one which was completely lacking up to now in the European navies, i.e. the mortar. The unique problems connected with the possibility of the mortar's high-flying shot fouling the masts and rigging were solved by the French simply by stepping the vessel's two masts well aft, thereby enabling the two mortars usually fitted in the vessels to be sited amidships, forrard of the masts, thereby permitting a reasonably clear arc of fire. The British built similar vessels, a good example of which was provided with two 13-inch brass weapons.

Artillery on land was usually loaded with loose powder placed in the muzzle of the gun with a ladle. Wadding was placed atop the powder and the whole tamped down. The shot followed and was rammed home. Some powder was carefully poured down the touch-hole and the piece was then ready to fire. A slow-match held at the end of a linstock was then applied to the touch-hole, thereby firing the gun. This procedure was not very acceptable to the Navy and gradually, although it took many years, the Senior Service evolved a system of loading and firing its guns which suited perfectly its own requirements.

Loose powder, in a wooden ship at the height of battle, presented a considerable fire and explosion hazard, so the exact quantity of powder required to charge a particular size of gun was made up in a paper cartridge. Apart from the obvious advantages of this method the knowledge that the same quantity of propellant was being placed in the gun each time it was charged helped the gunner considerably when aiming his weapon. If the shot charge also

did not vary between rounds, then it only remained for *him* to have the actual ability to lay it accurately. However, not all the paper in the cartridge burned when the gun fired, thereby building up a wad at the breech which not only reduced the internal capacity of the gun, but also blocked the touch-hole. So, cloth was adopted as the container, and this burnt completely, leaving only a fine ash. It only remained for the French to take the next obvious step of combining cartridge, wadding and ball into a single unit in 1853, thereby setting the pattern for the completely self-contained round of ammunition of the future.

Priming the sea-going cannon was still a matter of loose powder in the touch-hole ignited with a linstock until an Admiralty Order of 21st October, 1755, took the momentous step of authorising the fitting of a specifically designed flint-lock adjacent to the touch-hole or ("vent") on the Navy's guns. A long lanyard was attached to the releasing trigger and to fire the cannon, the gun captain (the lock having been primed) simply gave the lanyard a sharp jerk from behind the breech, having made certain that he was clear of the cannon's recoil track. The next and final step towards convenience and safety was taken when loose powder in the vent was done away with and a slightly smaller quantity placed in a tin tube, which itself was replaced by more easily obtained and less costly quills.

As mentioned earlier, the Navy relied on what was essentially a long range, comparatively (for its time) flat shooting, high velocity cannon for main armament, whereas in fact most ship-to-ship duels were fought at extremely close range. So close, in fact, that the ships' sides were often touching. At this distance, when the opposing-sides' cannon were facing each other, almost literally muzzle to muzzle, a cannon-shot pierced a clean hole through the opponent vessel's side which was comparatively easy to plug.

A discovery was made, that when the muzzle velocity of a cannon's shot was reduced to the point where, at close range, the power was just sufficient to ensure penetration of the opposing vessel, a bigger, jagged hole resulted which flung up many splinters. In those days more casualties resulted from flying splinters than round-shot, the exception being when "cannister" or grapeshot was employed. After much thought the Carron Company (shipowners and ironfounders) produced in 1778 the weapon which was to become known as the Carronade or, more colloquially, the "Smasher". It was a very short-barrelled small gun with a very large bore which fired a large shot (or, if needed, grape) with a small amount of powder over much shorter distances. Considering the size of shot and the damage it could cause it was a very light, handy weapon. Even the largest carronade firing 68-pound shot weighed only 36 cwt. and was 4'11" long. Compare this with the largest usual cannon — a 32 pounder — which weighed up to 3 tons. Because of its light weight fewer men were needed to handle it and it could be mounted high in the ship on a new type of sliding carriage: not forgetting one of its main advantages in that it permitted small ships — both Naval and merchant — to carry a "punch" normally associated with the biggest warships.

The stage was almost set for what was to be the rapid transition from tradition to the modern ballistics era. The Royal Navy had first experimented with elongated shot in 1776, with the simple intention of firing a heavier projectile without any increase in the cannon's bore, since it was found that when firing two shots simultaneously from the same weapon each ball diverged considerably at longer ranges. The original oblong shot were cylinders rounded at each end; although the increase in recoil was considerable, the innovation was justified; longer range was achieved. The wheel had almost turned a full circle. Lieutenant Croly of the British Army proposed the use of a breech-loading

17th century soldier with flintlock musket

rifled cannon with lead-coated shot in 1821, and in 1826 Lieutenant Colonel Miller of the Rifle Brigade invented the cylindrical pointed shell incorporating a percussion fuse, although it had to wait until the Battle of Sinope (1853) and the Crimean War (1854-5) before it was first used with devastating effect.

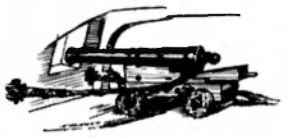
Man's natural conservatism being what it is, it's hardly surprising that such "advanced" ideas as breech-loading were not in general use until almost 70 years after Lieutenant Croly's original idea was proposed. Thanks to the Scottish clergyman John Forsythe, an invention patented by him in 1807 was to revolutionise the whole world of gunnery from the smallest pistol to the largest siege gun. That invention was the Percussion Cap.

Forsythe's original intention was to speed up the lock time on his favourite fowling piece, as he was an ardent pheasant hunter. There was a considerable time-lag between the fall of the cock and the actual discharge of the weapon. This annoyed him considerably, because alert birds could spot the initial flash in the pan as the trigger was squeezed and could thence manoeuvre to escape the main charge. After considerable experimentation he succeeded in getting a very small amount of fulminate of mercury into a small "cap" of varnished paper which was inserted into a hollow on the striking face of a newly-designed cock (or hammer). Upon pulling the trigger the hammer was released to crush the cap against a small tubular nipple, thereby exploding the fulminate which sent

a jet of flame directly through the nipple into the gun's breech, thus exploding the main charge instantly. He had, in one stroke, invented the direct ancestor of every gun fired by percussion, built since that time, although it is typical of bureaucracy that the British Army had to wait a further 35 years before getting its first percussion musket.

Progress was such that the period 1850-1900 brought to light such men as the French artillery officer Colonel Paixhans, Joseph Whitworth, William (later Lord) Armstrong, Alfred Krupp and lastly Hiram Maxim, whose completely automatic machine gun (patented in 1883) was to revolutionise battle tactics on land. Paixhans reasoned that the cause of France's comparative weakness at sea was the result of Britain's large Fleet and her almost limitless supply of trained seamen. France lacked both of these and so her only chance of challenging Britain's superiority lay in producing weapons which would render obsolete the Royal Navy's sailing fleet. His plans for building a "steamship" navy did not quite materialise, but by 1837 he had succeeded in designing and testing a new type of "smoothbore", which at first glance resembled a carronade. The great difference was that the weapon, large bore (8½") notwithstanding, was designed to fire explosive shells. It weighed no more than a 32-pounder cannon, but fired a shell (the same diameter as an 80-pound solid shot) weighing only 62½ pounds. The surprise came from the fact that the gun had a very flat trajectory in spite of its short barrel and large shell. It was adopted by the French Navy which, at that time, began to standardise the calibres of all its guns.

As for the French Army, Colonel Treuille de Beaulieu devised a muzzle-loading cannon in 1842 which was designed to fire an elongated "studded" shot in a large-groove, rifled barrel. After the Crimean War, Napoleon III, recognising the great cost of complete re-equipment, realised the advantages of Beaulieu's system and ordered that his bronze field guns



be similarly modified. The Battles of Magenta and Solferino (1859) proved the soundness of the modification, as they were a complete success.

So far we have concerned ourselves with weapon development in Europe and Britain. But let us not forget the New World, where we find a 17-year-old Midshipman named John A. Dahlgren entering the United States Navy on 1 February, 1826. After reaching the rank of Lieutenant he was ordered to undertake Ordnance duties at a Washington Navy Yard in January, 1847, where his hitherto latent mathematical genius helped him to develop his "Boat Howitzer"; a light, all-brass weapon, easily recognised by its parallel-sided smooth short barrel.

Designed as a boat gun, it was equally at home aboard ship or (when used with a small field carriage) as a light field-piece for use ashore with landing parties. The U.S. Navy adopted two versions of this smoothbore weapon. The 12-pounder had a 4.6" bore, weighed 760 pounds, a range of 1,085 yards and was only 55" long! The 24-pounder was 58" long, weighed 1,300 pounds, had a bore of 5.8", together with a range of 1,270 yards. Both weapons were particularly easy to handle and, when used correctly, were capable of tremendous destruction. Dahlgren even wrote a manual concerning their use which, along with other carefully written volumes on Ordnance and its uses, was to add to his ultimate lustre.

Little or no developmental work had been carried out on naval ordnance since the War of 1812 and, for various reasons, Dahlgren had long been dissatisfied with the levels of ballistic science pertaining at the time. Whilst on duty at the Experimental Battery at Washington Navy Yard he escaped without injury when a 32-pounder cannon shattered under test. Dahlgren was in close proximity to the gun at the time of the explosion, and this unnerving experience confirmed his long-held belief in the need for a complete re-design of the weapons upon which the Navy depended for its very existence.

In early 1859 he submitted designs for an entirely new cannon to the Navy's Chief of Ordnance. The prototypes were so successful that Dahlgren guns were to remain the principal large-calibre naval weapons long after the termination of the Civil War; a conflict dominated at sea by the Dahlgren guns of the Federal Navy.

Dahlgren had realised that, when a gun fired, the gas pressure gradually decreased as the shell travelled towards the muzzle and so, after careful calculation, was able to design a scientifically sound, gracefully proportioned rifled muzzle-leader, in which the thickness of the walls matched the gradual curve of internal pressure. This design feature gave the weapon a thicker breech, smoothly tapering to a smaller diameter at the muzzle, with the result that the finished product resembled a long-necked French wine bottle and, in fact, they were affectionately known by their crews as "soda bottles". The factory cast each gun thicker than it was to be in its final shape, after which it was "turned" down to the desired size and bore. The latest refinement was added when the gun's cascabel (the large "knob" at the extreme rear of the gun) was threaded for a vertically-positioned screwed rod which, when turned, caused the gun to depress or elevate.

This powerful series of guns proved to be very accurate and were manufactured in several calibres, including 9, 11 and 15-inch. For comparative purposes think of the statistics of the 15-inch guns installed aboard H.M.S. *Repulse* in World War One, and then read the following figures for Dahlgren's 15" gun — Weight, 42,000 pounds; Length, 130 inches; Weight of Shell, 330 pounds; Black Powder Charge, 35 pounds; Range, 1,700 yards. Surprising, isn't it?

Dahlgren's case for better gun design was proven in the epic Civil War duel between the *Merrimac* and the *Monitor*. The *Merrimac* had 10 guns, including six 9-inch smoothbores. The *Monitor* fought her to a draw using only two 11-inch Dahlgren guns in a revolving turret.

Meanwhile, in Britain, Messrs. Armstrong and Whitworth, working separately, had made considerable progress towards developing what would become a modern, efficient, breech-loading, rifled artillery piece. Britain was not alone in not accepting what was offering on the breech-loading market of the day. Successful obturation (gas sealing) was hard to achieve, and once again natural conservatism favoured the reliable, proven muzzle-loader. Admittedly, Armstrong in 1855 discovered and developed a new, lighter system of gun building, known as the "built-up" principle, based on building a gun, layer-by-layer, around a central rifled tube, but old habits die hard. He also developed a gas-tight screw-threaded light artillery piece for Ordnance Board trials in 1855-6, but so entrenched was the faith in muzzle loading that Italy ordered several huge 100 ton 17.72 inch guns from Armstrong's Elswick factory at a time when the largest muzzle-loading (i.e. M.L.) gun made at Woolwich Arsenal was a 68 ton, 13.5 inch calibre weapon.

The crunch came in 1881, when Britain finally decided to accept the breech-loading (B.L.) gun. Two serious accidents on board ship were among the main reasons for the change. The first, on board H.M.S. *Thunderer* in 1879, occurred when a 12 inch, 38 ton M.L. blew up after being double-loaded. The second accident occurred aboard the Italian warship *Duilio* when one of the 17.72 inch giants blew up for the same reason.

To utilise to the utmost extent the slow-burning properties of black powder meant that the Navy's muzzle-loading guns' barrels were getting progressively longer. Indeed, the ridiculous stage was reached when H.M.S. *Inflexible's* four main big guns had to be loaded *outside* the turrets from special protected shelters! This situation was gradually relieved with the invention of the smokeless and faster burning modern powders such as "Cordite" and "Ballistite", both of which were developed in 1888 by, respectively, Sir Frederick Abel and the Swedish engineer Alfred Nobel. The latter gentleman was also responsible (at an earlier date) for the invention of "Dynamite". The properties and characteristics of Cordite and Ballistite were admirably suited to the newly developed and shorter barrelled breech-loading guns, of which Armstrong and the factory bearing his name were to become leading exponents. As time progressed Cordite went on to become the main big-gun and small-arms propellant for Britain, whilst Italy chose Ballistite and the United States, Germany, Japan, Rumania, Spain and numerous other countries both large and small chose Nitrocellulose. This last mentioned explosive was invented by the French chemist Vieille in 1884.

Let us now retrace our steps to point out that the Champion of the Breech-Loading Cause on the European continent was Alfred Krupp, whose huge munitions complex at Essen was, by 1870, one of the largest extant. His faith in steel was unshakeable and both he and his scientists put enormous energy into producing cast-steel of a quality suitable for gun-making. It was as early as 1867 that a beautifully made 50-ton breech-loading Howitzer firing 1,000 pound explosive shell was included in the Paris Exhibition. It took 16 months to make and comprised a forged steel inner rifled tube with three layers of steel coil over the chamber and two layers around the barrel. The gun was subsequently presented as a gift to the King of Prussia.

With the invention of the elongated explosive shell, rifled barrels, practical gas-sealed breech-loading, and finally smokeless propellant, it was really only a matter of detail and tactical refinement before the various countries concerned arrived at the guns, both land-based and naval, with which they were to slug out both World Wars I and II.

In my opinion it was Germany who brought the science of Gunnery to its highest pinnacle of technical achievement. That country's recognition of the capabilities of the machine-gun led its leaders to develop new tactics based almost entirely on its use. These tactics led, in World War I, to the virtual elimination of horse cavalry for assault purposes, and to the utter decimation of the flower of the British, and in particular the French, infantry, especially in the early period of the War. In naval gun construction superior manufacturing techniques and methods enabled the Germans to endow their latest battleships with 12-inch rifles weighing only 48 tons each, yet their performance in battle equalled (if not bettered) British 13.5-inch rifles which weighed 76 tons. The German naval gun-barrels were also stiffer, resulting in less vibration when fired, which in turn enhanced accuracy. In this last mentioned quality the Germans were almost without peer; at Jutland they often straddled their opposite numbers with the opening salvoes.

Very worthy of mention here are three extraordinary guns. The first (and truly the most remarkable) of these is the "Paris Gun", of which several examples were made. In an effort to "bombard without detection" Krupps were commissioned to manufacture a series of guns which scientists estimated would have a range of approximately 60 miles. They were to be made from 15-inch naval

Handling bomb with tongs

Light Parrott rifled cannon

guns fitted with an inner liner tube to bring the calibre down to 8.26 inches. The relatively small 228 pound shell was designed to leave the enormously long braced barrel at a muzzle velocity of 5,260 feet per second, at a barrel angle of 45 degrees. Using the atmospheric vacuum present at the altitude of 24 miles, the shells began to fall on Paris at 7.20 a.m. on 23 March, 1918. They were fired from a forest near Laon, a full 67 miles from Paris. Possibly only four were made. However, one gun blew up prematurely, killing its entire crew, but not before the remaining three joined in the action. Because of the extreme precision needed to operate these guns only 367 shells were landed (albeit with excellent accuracy) on or near Paris. However, they were a spectacular scientific achievement.

The Germans were experts in the construction of railway guns, and their 28 cm K5 (E)-Kanone, Model 5, became the standard super-heavy railway gun and was, perhaps, the first example of its kind in the world. Each gun had its own special train, with air-conditioned ammunition wagons, anti-aircraft guns for its defence, living quarters and messes for its crew and flat-cars for the gun-units' own motor transport. Twenty-five units of this type were produced in all.

Lastly, the biggest guns the world has ever known came into being when the Krupp arsenal designed and manufactured the two examples of the gigantic 80 cm Super Kanone (E) I.40.6. Named *Gustav* and *Dora* respectively, each gun needed 4-6 weeks for construction and dismantling, and a 4,120-man detachment commanded by a General to maintain, protect and operate each weapon. Included in this figure was a 250-man loading and firing team. Each 25 ft. long shell weighed 10,500 pounds, with a range of 51,040 yards (29 miles). The rate of fire was, at best, 2 rounds per hour. Each gun, with its 80-wheel double-bogie railroad track carriage, weighed 1,350 tons! This was the Germans' last big effort. *Gustav* was used on only one occasion, at the siege of Sebastopol, when approximately 40 shells in all were fired. One shot destroyed a heavily protected Soviet ammunition dump 100 feet underground. There is no record of *Dora* having ever been used in action.

To close this dissertation I would like to make clear certain points. As far as is practicable, within the scope of the subject under discussion, I have attempted to stay with the mainstream of weapon development, leaving the tactics concerning their use as far as possible by the wayside. Also, I apologise if I have not included other inventions and developments which readers may feel are pertinent. Included in this category are all small-arms, from pistols and rifles to medium machine-guns.

These will be covered, along with the developmental history of guided missiles, in later articles within this series.

BATTLE OF MOBILE BAY

By R. G. MILLAR

Slowly, with the rising sun, the ships of Rear Admiral David Farragut's East Gulf Blockading Squadron moved towards the defences of Mobile Bay, in an attempt to close the last major Confederate controlled port in the Gulf of Mexico.

As early as the 16th of February, 1864, ships of the blockade had shifted to the attack, softening up the bay's outer defences, and on the 2nd of August preparations were got underway on the wooden ships for the coming battle. Splinter nets were hung on the starboard sides, chains and hammocks were placed around the vital parts of the ships, all spars above the top masts were removed and on the U.S.S. "Richmond" even the top masts and top sails yards were struck.

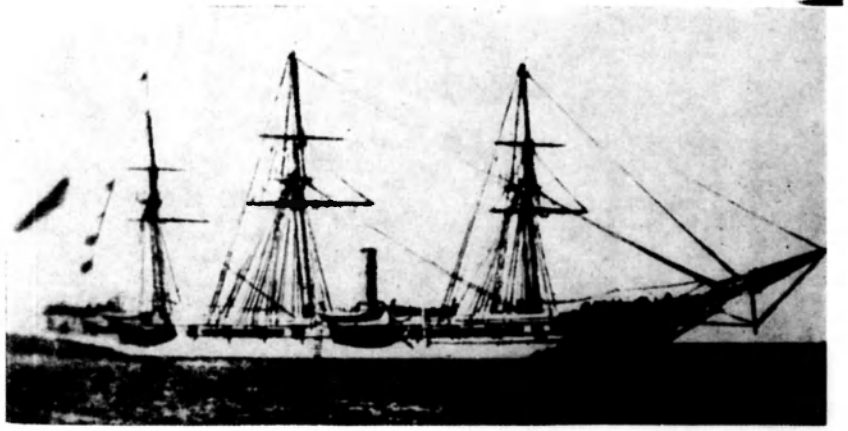
By the 5th everything was in readiness and at 4.30 a.m. the ships began to take up their battle stations in the following manner. Farragut intended to run under the powerful guns of Fort Morgan, which could bring 43 rifles and smooth bores of between 10 inch and 32 pounder calibre to bear on the squadron as it passed. So as to blunt the fire of the fort's guns he placed his monitors, of which he now had four (the single turret vessels "Tecumseh" and "Manhattan" and the twin turret eight draft vessels "Winnebago" and "Chickusaw") to starboard of the wooden ships in a single line, with "Tecumseh" in the lead. The screw sloops of war with a gunboat lashed to their port side, 14 altogether, took up positions to port of the monitors so as to be spared the major part of Confederate fire.

Then once past the fort his ships would then engage the Confederate Squadron operating inside the bay. This squadron under the command of Rear Admiral Franklin Buchanan (Merrimac — Monitor engagement 9th March, 1862) consisted of a casement ironclad, the "Tennessee" and three paddlewheel gunboats "Gaines", "Morgan" and "Selma", all of which were unarmoured.

At 5.40 the fleet in stately line moved in to the attack, while hoarse shouts of command mingled with rattling gun tackles and beating drums to disturb the stillness of the morning.

At 7.06 the first Confederate shots whistled out and as each ship came in range the firing became general. In the engine rooms of the monitors the stokers worked in temperatures of 150F., seeing nothing of the battle until they were moved up to the turrets for a breathing spell. The frequent blows on the turrets and the blinding smoke of their 15 inch gun being discharged quickly told them that neither their comrades or the enemy were idle.

As the monitor "Tecumseh" moved past the fort, she navigated



U.S.S. HARTFORD, Steam Sloop — Farragut's Flagship.

towards the "Tennessee" which now moved towards the Federal fleet to engage.

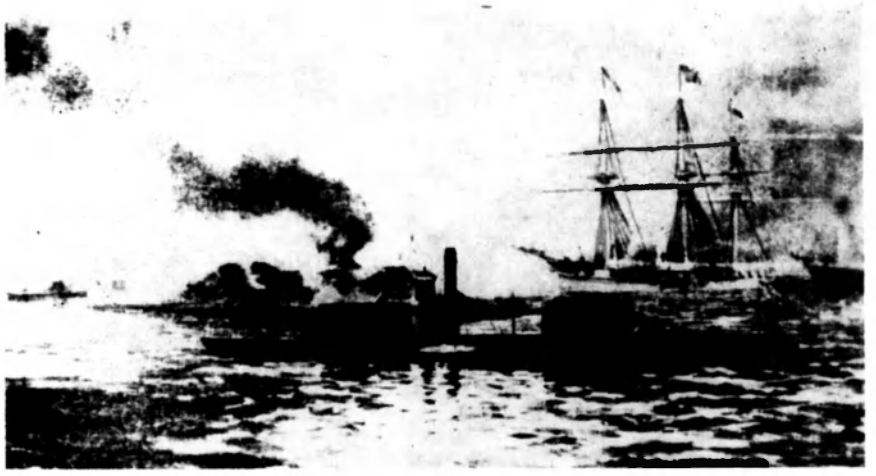
From the second monitor the "Manhattan" men observed a tiny white wave of froth curl around the "Tecumseh's" bow as she reeled a little to starboard, then plunged to the bottom bow first, with her propellers still revolving in the air. On the "Hartford" to port of the monitors the crew sprung to the starboard rail and gave three ringing cheers in defiance of the enemy and in honor of the dying as the sloop passed through the wake of the sinking monitor.

In the sloop of war "Brooklyn" directly to port of the sinking Tecumseh there was a frothing of foam around her stern as she began backing to clear a row of suspicious looking buoys directly under her bow. Farragut who was lashed to the rigging of his flagship the "Hartford", to get a better view of the battle quickly realising the line was likely to be thrown into confusion directly under the guns of the fort yelled out "Damn the torpedoes, full speed ahead," and with this his flagship moved out from behind the torpedoes, which were heard bumping against the hull. The rest of the force followed.

The "Tennessee" now bore down on the flagship intending to ram, but this threat was avoided although the Confederate broadsides were not. The "Tennessee" then passed on down the line attempting to engage each ship in succession and in the course of this manoeuvre she was ineffectually rammed by the sloop of war "Monongahela."

By this time the slow moving monitors had moved up from the fort and began to open fire so the "Tennessee" moved to under the guns of the fort for protection.

As for the small Confederated gunboats, well they had not seen much of the action. The C.S.S. "Selma" was chased across the bay and forced to surrender by the U.S.S. double ender gunboat "Metacomet", which had cast off from



THE SURRENDER OF THE "TENNESSEE".

the port side of the "Hartford" shortly after she engaged the "Tennessee".

The "Gaines" suffered a steering casualty early in the battle and was forced to retire and be run aground after she had been subjected to a concentrated fire from the passing "Hartford" and "Richmond". The "Morgan" engaged the "Metacomet," trying to assist the "Selma" but she faced the possibility of being cut off and captured so she retired under the guns of Fort Morgan and later escaped across the bay to Mobile.

The Union force now anchored briefly for breakfast and to take care of the wounded, and as the men looked across the bay, which now had become overcast they could see the sun outside the bay silhouetting the dark shape of the "Tennessee" under the guns of Fort Morgan, while up the bay the C.S.S. "Selma" could be seen hotly engaged with the "Metacomet".

But hardly had the fleet stopped than the order was given prepare for action, and as men hastened to their stations the dark shape of the "Tennessee" could be seen moving from under the guns of the fort.

Farragut realised the destruction of his flagship was the intent of the ram, so he ordered his squadron to attack with gun and bow. For an hour the battle raged. The four times the "Tennessee" was rammed seemed to effect her little, but a shot from "Manhattan's" 15 inch gun managed to remove two feet of wood and five inches of iron, but it failed to cause any casualties.

Broadside after broadside poured out at ranges of less than 10 feet, but the Confederates' fighting ability was not diminished until a lucky shot damaged the exposed steering chains which due to Confederate inexplicable negligence lay exposed aft. For 20 minutes the "Tennessee" drifted with the current hounded by the unceasing fire of the Union monitors and wooden ships, but by 10 o'clock Commander J. D. Johnston, C.S.N., on behalf of the wounded Rear Admiral Franklin Buchanan, C.S.N., emerged from the ironclad under a white flag uttering the words "For god's sake don't fire. I surrender. I surrender." From behind the bulwarks and engine rooms of the Union ships black faced sailors appeared to cheer as the twin turreted monitor "Chickasaw" slowly towed the disabled ram towards the "Hartford" as a trophy of victory, a victory which would keep its full harvest in the following days.

That very afternoon the "Chickasaw" moved up to the rear of Fort Powell and reduced the fort via the unprotected side, and by the 22nd of August Fort Morgan, the last Confederate bastion at Mobile Bay had surrendered thus putting the finishing touch to the battle of the 5th, which had now deprived the army of the south of its last port in the Gulf of Mexico through which supplies and arms could be shipped from Europe.

SIR BARNES WALLIS:

Man of Ideas

By TONY OSMAN

Sir Barnes Wallis is working on the design for a fleet of containerised, cargo-carrying submarines, which will travel North from Great Britain and turn left under the polar ice cap to reach the Pacific Ocean and Japan.

It does not sound particularly practicable, but that can be said of most of his ideas.

Indeed it was said of most of them, but they all worked in practice. He is a scientifically-minded engineer with a flair for finding completely original solutions to problems.

Sir Barnes Neville Wallis, to give him his full name, is a courteous, lively, grey-haired man, whom one would place in his middle fifties. In fact he is 81, and fifty years ago he had already started designing the airships that were to occupy him until 1930. But he started his career in an unusual way.

After leaving school, he trained as a marine engineer at J. S. White and Company's shipyard at Cowes, where he met Hartley Pratt, the airship designer, who had recently left the company that had built Britain's first airship.

This was the Mayfly.

Pratt was sure that it was structurally unsound.

The name turned out to be unconsciously comic for the airship broke up as it was leaving the hangar, and when, in 1913, the company, Vickers, was asked by the Government to build another one it clearly considered that someone who could recognise a bad design could probably produce a good one.

Hartley Pratt was invited to design what eventually became R9 and he asked Barnes Wallis to come to Vickers with him.

CHEQUERED CAREER

The R9 had the chequered career that seems usual in the airship industry. It was started in 1913, but was cancelled in 1915, when there were ideas that the Great War would soon be over. Barnes Wallis and Hartley Pratt enlisted in the Artist's Rifles.

Then it became clear that the war would not end quickly and they were recalled to finish their job.

The R9 was not really an original design, but Barnes Wallis's next one, the R80, was.

He had realised that the classical cigar shape of the Zeppelin was an ineffective one he decided that his ship was to be streamlined and thus more economical on fuel.

He started work in 1917, but the war ended before the airship was finished and government backing for what was essentially a military project was withdrawn. It was time, he thought, to get some academic qualifications.

RAPID PROGRESS

This took six months. London University demanded an Intermediate Examination, which usually took students a year: it took Barnes Wallis three weeks.

He then had what is normally a two-year course ahead of him for a degree in engineering.

This he finished in five months. Next he considered that he should polish up his knowledge of languages, so he taught in Switzerland.

Finally, coming to the conclusion that there was no future in airship designing, he went back to his old company, Vickers, as a salesman.

This was the only unsuccessful time in his career — he has been quoted as saying that his entire sales were worth only £29 — but at that moment there was a revival of interest in the airship.

A scheme for a fleet of trans-oceanic passenger airships was proposed by Commander Burnly, and the first two, R100 and R101, were started at the same time as rivals.

Each had to be able to carry 100 passengers at 70 m.p.h. to India, and Barnes Wallis's design, the R100, made a successful trial flight to Canada and back.

Unfortunately the R101 crashed on her maiden flight and the plans for an airstrip fleet were abandoned. This story, incidentally, has been admirably told by the novelist Nevil Shute, who was working with Wallis at the time as a mathematician, in his autobiography **Slide Rule**.

NEW TECHNIQUE

So Barnes Wallis turned to aircraft design and went to what was then Vickers Aviation Ltd. at Weybridge.

There he worked out how to build large aircraft by using a technique he had invented.

His geodetic construction method uses a lattice of thin girders which remains strong even if some of the girders are damaged, and Barnes Wallis and Rex Pierson, the chief designer at Vickers, used the method to build the **Wellesley**.

This aircraft was to establish the world's long-distance record in 1938, when two of them each flew 7,159 miles. This success led to the designing, by the same team, of the **Wellington**, an enormously successful bomber used in World War II.

BOMB DESIGNER

From aeroplanes Barnes Wallis went on to tackle the design of bombs. He was successful at this and two enormous empty bombs

stand on either side of the window of his present office. (He is now Chief of Aeronautical Research and Development at the British Aircraft Corporation's factory at Weybridge.)

The large bombs resulted from his argument that bombing in the late 1930s was inefficient because a small bomb could not inflict severe damage; using lots of small bombs, he pointed out, meant only that there was widespread minor damage.

He suggested that one large bomb would be much more effective than the same weight in small bombs, but the idea was not taken up at the time, probably because bomb-aiming was not accurate enough.

"DAMBUSTERS"

His next innovation, the bouncing bomb, was used. Dams were important war-time targets, but they were small targets, as seen from the air, and secondly because hitting the top of a dam did not markedly affect its ability to retain water.

So he devised the quite extraordinary idea of making a spherical bomb that could be given backspin as it left the aircraft. It would then skim along the water behind the dam until it reached the solid structure, which would be breached by the explosion. The bomb was successful in the raid, which has since become the subject of a film — The Dambusters — but it was not used in later raids.

His big bombs, on the other hand, were.

By now, bomb-aiming had improved and so had the technique of building bomb-proof shelters for bombarding rockets.

These launching sites were now impregnable to ordinary bombs.

Barnes Wallis's ten-ton bombs were so effective that the idea of launching from fixed sites was abandoned and a system of launching from moveable platforms was developed by the Germans.

SUPERSONIC PLANES

After the end of World War II, in 1945, Barnes Wallis returned to aircraft design and attacked the problem of making an aircraft that would fly at supersonic speeds.

The difficulty is that supersonic flight demands swept-back wings, so that the air does not build up in front of them in an impenetrable wall.

Unfortunately, heavily swept-back wings do not provide sufficient lift for taking off and landing at low speeds.

NOVEL APPROACH

The Anglo-French Concorde solves the problem by using a narrow delta wing, which provides lift at slow speeds if it is relatively steeply inclined.

Barnes Wallis used a completely novel approach for his design the Swallow, which had moveable wings.

The aircraft took off with its wings in the normal position for subsonic flying and then swung them backwards for supersonic flight, so that the aircraft looked much like a paper dart in shape.

His wings differed from conventional ones in another way.

Normal aircraft wings are fitted with slots and flaps to give lift at slow speeds, airbrakes to slow the aircraft, trimming tabs to adjust the balance of the aircraft in flight and ailerons to control roll.

The tailplane has elevators to point the aircraft upwards or downwards.

This collection of projections into the slipstream adds drag and lowers efficiency and, in any case, the idea of using separate control surfaces, one for each function, is untidy.

Concorde does away with most of them, the wing itself provides braking and low-speed lift, but the aircraft still needs elevons, combined elevators and ailerons, fitted to the trailing edge of the wings.

Barnes Wallis's Swallow did away even with these.

The scientific adviser to the Ministry of Aircraft Production thought that Barnes Wallis's swing-wing design had possibilities and he was given a contract to develop the idea.

He made a successful working model and spent nine years on experiments that provided the data for a scale design. Unfortunately the Swallow was cancelled, but it was taken up by the U.S.A.

NEW SEA ROUTES

Barnes Wallis's latest idea was put forward at the 1965 meeting of the British Association.

The nuclear submarine Nautilus had successfully travelled under the polar ice cap, and Barnes Wallis recognised that this feat opened up completely new sea routes.

Japan could be reached by way of the Bering Strait and the whole journey would take a fortnight off the time taken by a ship going round on the conventional sea route.

What made the idea particularly attractive to Barnes Wallis was the fact that sea transport is much cheaper than land transport.

This meant that it was cheaper to carry raw materials to a factory, and finished goods away, by sea than by land; this in turn meant that countries with extensive natural resources did not necessarily have insuperable advantages over small islands.

His plan was that the submarines should be large and should be containerised, that is, they should carry their cargoes in standardised packages that could be mechanically handled in the docks.

There are two problems.

One is that submarines are not fast under water, but Sir Barnes (he was knighted on June 8, 1968) is sure he can solve the problem and he is also sure that he can solve the problem of propulsion. Nautilus was nuclear-powered, but nuclear-powered submarines are not economic for commercial use.

Any conventional fuel has to be burned and exhaust must be discharged.

This makes the submarine conspicuous and also means that the lost mass has to be taken in as ballast.

When I saw him, Sir Barnes made it clear that he re-thought the problem and could solve it in a radically new way.

If he says so, he certainly can.

One of his colleagues told me that he was always a bit disturbed when Sir Barnes came to a design discussion, as he was always likely to produce a novel idea that everyone else wished he had thought of.

The details of his containerised submarine fleet are bound to include a lot of ideas like that.

"The Civilian Arm of the Navy"

The principal objective of the Navy League of Australia is to stress the vital importance of Sea Power to the Commonwealth of Nations and the important role played by the Royal Australian Navy.

The League, in conjunction with the Commonwealth Naval Board, administers the Australian Sea Cadet Corps, by providing finance and technical sea training for boys who intend to serve in the Naval or Merchant Services, also to those sea-minded boys, who do not intend to follow a sea career, but who given this knowledge will form a valuable reserve for the Naval Service.

We invite you to swell our ranks and so keep up to date with Maritime Affairs to help to build an ever-increasing weight of informed public opinion. The Navy League will then become widely known and exercise an important influence in the life of the Australian Nation.

The League consists of Fellows and Associates. All British subjects who support the objectives of the League are eligible for membership. Members receive copies of the League's magazine "The Navy".

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A BRIEF HISTORY OF THE PAKISTAN NAVY

Captain Rifat M. Shaikh, P.N.

Two decades ago, Pakistan inherited a small, inadequately equipped Navy. Our young Navy's inheritance comprised a meagre, ill-assorted share of ships, Naval equipment and personnel. Training institutions, which fell to her lot, were very few and still in their infancy, while docking, repair, logistic and maintenance facilities were non-existant. To crown all these deficiencies was the acute shortage of officers in the Service; there were only four Muslim officers who had 8 years of service and all the 50 Muslim officers of the service had joined the Royal Indian Navy during the Second World War.

Though time has travelled a comparative short span of 20 years, the Pakistan Navy has come a long way. Today, the Navy comprises a modern, self-sufficient fleet, compatible with the resources and defence requirements of the country, and a closely knit shore organisation, containing adequate docking and repair facilities, and training institutions imparting highly specialised and skilled professional knowledge to the Naval Personnel.

A cursory glance at the peculiar geographical position of Pakistan makes it amply clear that the Navy is destined to play a major and vital role in the development, integration and progress of the country. Pakistan has two distinctive features, judged from the point of view of Naval strategy. The two wings are separated by 3,000 miles of sea and a large measure of Pakistan's prosperity is inevitably bound up with the seaborne trade, flowing through different regions. These outstanding factors actually influenced the role of the Navy. Some of the important functions this Navy is designed to perform are as follows:—

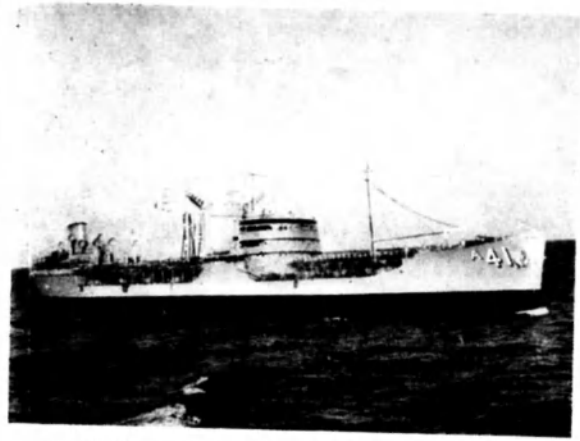
(a) Maritime Defence of the Country.
(b) To maintain East-West link over the ocean.
(c) To assist the Army in the riverine defence of East Pakistan.

The development and expansion of the Pakistan Navy has, therefore, been effected with an eye on its role in times of national emergency. The development plans envisaged a steady, balanced expansion of the fleet, training of officers and ratings, particularly of the more technical branches; establishment of well-stocked supply and shore base, and construction of a modern dockyard, which could cater to the docking and repair requirements of the fleet.

During the first three years of its development plans were made for the expansion and integrated development of the Navy. During this period steps were taken to set up small organisations of logistic supplies, and the building of a Naval Dockyard, complete with all the requirements. This phase saw the conversion of P.N.S. HIMALAYA, the Gunnery School into the Combined Training Establishment. The training for all categories of seamen, specialising in Gunnery, Torpedo and Anti-Submarine, Navigation, Radar, Signal and Communications Branch personnel; Supply and Secretariat and Electrical Branch personnel, were started as early as December, 1947. Other measures adopted were the setting up of the Mechanical Training Establishment, P.N.S. KARSAZ, in the BOR's Rest Camp at Manora and the training of officers in HIMALAYA. A Cadet Training School was also started where cadets were trained for a period of one year as pre-cadets before sending them to the United Kingdom for their five years' training as subordinate officers with the Royal Navy.

By the end of the first phase of the development period the Navy

One of Pakistan's eight Coastal Minesweepers of the MSC Type — P.N.S. Mubarak



The Oiler "Dacca" transferred on loan to Pakistan under Mdap in 1963

was able to overcome some of its initial handicaps. The manning and training position started looking satisfactory. The bulk of the ships that we had at that time were made operational. It was during this period that a multi-purpose plan for the future size and shape of the Pakistan Navy was formulated. The object of the plan was to modernise and expand the Fleet in order to be able to perform various roles; and to provide fully developed Naval Bases, shore facilities and installations at Karachi and Chittagong for achieving self-sufficiency in repair, maintenance, logistic support, and all training and administrative requirements of the Fleet.

After the consolidation of the Service, which always precedes the expansion of the Fleet, other measures were taken to augment the defensive and offensive potentialities of the Navy. At the time of Independence the Pakistan Navy had only a few frigates.

NAVAL HEADQUARTERS

The Command is exercised by the Commander-in-Chief through Naval Headquarters. He is assisted by Chief of Staff and four Principal Staff Officers, i.e. Deputy Chief of Naval Staff (Operations), Deputy Chief of Naval Staff (Personnel), Deputy Chief of Naval Staff (Technical) and Deputy Chief of Naval Staff (Supply Services).

SHORE ORGANISATION

The Command function ashore is principally exercised through two local authorities, viz., the Commodore-in-Charge, Karachi, and the Naval Officer-in-Charge, Chittagong, who are also the Area Naval Commanders.

NAVAL OFFICER-IN-CHARGE, CHITTAGONG

The Naval Officer-in-Charge, Chittagong, is the C.-in-C.'s representative in East Pakistan. He exercises operational control over the ships and craft placed under him. He is also responsible for the administration of Naval Base in Chittagong and the Extended Defence Organisation in Khulna.

AFLOAT ORGANISATION (COMPAK)

The Commodore Commanding P.N. Flotilla is responsible to the C.-in-C., Pakistani Navy, for the operational readiness and training of ships placed under his command, which is divided into three main groups, viz., the Destroyer Squadron, the Frigate Squadron and the Minesweeping Squadron. Each Squadron Commander is responsible to COMPAK for the fighting efficiency of his ships.

BASES AND BUILDING FACILITIES

Karachi and Chittagong are the two main bases for Pakistan Navy. Repair and refit facilities exist at P.N. Dockyard, Karachi, for ships up to Destroyer type.

P.N.S. Ghazi, a submarine of the "Trench" Class. It has been reported that Pakistan has ordered three submarines of the French "Daphne" Class

The Battle Of The Coral Sea May 4-8, 1942

THE STORY OF THE CORAL SEA BATTLE AND ITS SIGNIFICANCE IN AUSTRALIAN HISTORY

In 1942 Australia's fate was being decided by the battle of the Coral Sea, the turning-point of the Pacific war. But for American aid we should have been defeated.

The full significance of the joint American-Australian Naval and Air victory in the Coral Sea Battle was not generally realised until its historical and geographical importance became evident in the march of events towards the downfall of Japan. Even today, its proximity to the Australian coastline, and the possibilities involved had the Japanese plans succeeded, are not appreciated by many.

The Coral Sea Battle was the first serious check to the amazingly rapid series of Japanese successes, which had advanced Japanese power well south of the Equator. The margin between victory and defeat was extremely small. Reliable authorities have stated that had the Japanese been successful, our position in New Guinea would have proved untenable and the whole of the north-east Australian coastline would have been open to invasion.

The Coral Sea Battle is now rightly recognised as a landmark in the history of Australia. It marks the nearest approach of hostile forces in strength to the coast-line of Australia and our deliverance from threatened invasion.

The significance of the Coral Sea Battle in relation to the safety of Australia is clearly seen by a glance at the map accompanying this article.

The Japanese plan and the following extracts are taken from the full documented U.S. Naval History of World War II. by Samuel E. Morison.

Basic Japanese War Plan

Following Japanese successes in 1941, three new conquests were planned:

1. Tulagi and Port Moresby, in order to secure air mastery of the Coral Sea;
2. Midway Atoll and the Western Aleutians, in order to bring the United States Pacific Fleet to a decisive engagement.
3. New Caledonia, Fiji and Samoa, in order to cut lines of communication between the United States and Australasia.

All three moves were in the Japanese Basic War Plan, as stated in Japanese Combined Fleet Operation Order No. 1, promulgated Nov. 1, 1941. "The Areas which are to be rapidly occupied or destroyed, as soon as the war situation permits" were (1) Areas of Eastern New Guinea, New Britain, Fiji and Samoa; (2) Aleutian and Midway Areas; (3) Areas of the Andaman Islands; (4) Important points in the Australian Area. The whole of the "Op Order" is from the Nachi Documents (recovered from cruiser Nachi in 1945), translation by Capt. E. T. Layton from the original.

Japan's overall plan for the Coral Sea Operation was: "With the co-operation of the South Seas Army Detachment and the Navy, we will occupy Port Moresby and important positions on Tulagi. We will establish air bases and strengthen our air operations in the Australian area."

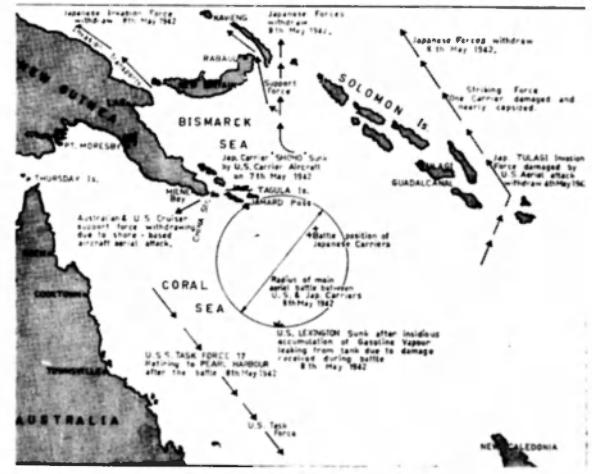
The Japanese Task Force for the Coral Sea invasion comprised:—

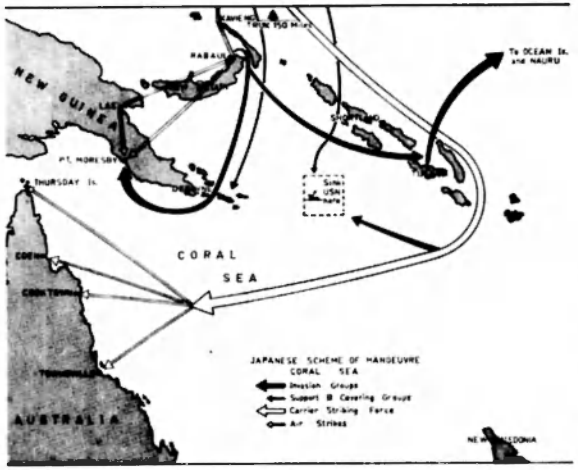
The Port Moresby Invasion Group of eleven transports carrying both Army troops and a Naval Landing Force, screened by a destroyer squadron;

A smaller Tulagi Invasion Group;

A Support Group of one seaplane carrier and 5 other ships;

Below: THE END OF THE BATTLE -- May 8, 1942.





Above: THE JAPANESE PLAN (based on captured Japanese documents).

A Covering Group consisting of light carrier SHOHO, four heavy cruisers and one destroyer;

The Striking Force of two big carriers SHOKAKU and ZUIKAKU, two heavy cruisers and six destroyers — a total of 62 ships.

The Allied Task Force, which included AUSTRALIA and HOBART, consisted of two heavy carriers — LEXINGTON and YORKTOWN — 8 cruisers, 13 destroyers and 3 other ships — a total of 26. It was under the command of Admiral Frank Fetcheler.

Tulagi was to be occupied first, on May 3; then the Support and Covering Groups and Striking Forces would cover the Port Moresby Invasion Group, which would leave Rabaul on the 4th and land a sizeable army at Port Moresby on the 7th. (A timetable that was never carried out!)

The Japanese expected the United States Navy and the Army Air Force to try to stop them. But once the Allied Task Force entered the Coral Sea, Admiral Inouye expected to destroy it by a pincer movement, while the Invasion Group nipped through Jamard Pass into Port Moresby. Then the carriers would proceed to smash up Allied planes and ships at the four Queensland bases, as they had done so successfully at Darwin.

Admiral Chester Nimitz and General Douglas MacArthur properly regarded this Japanese thrust as a major threat. Port Moresby was not simply a place to be denied to the enemy; it was essential for General MacArthur's strategic plans. He intended to develop this outpost as a major air base to block enemy penetration of Australia and as a starting point for his return journey to the Philippines.

Into the Coral Sea

At about 0800, on May 3, the Tulagi Invasion Group made an unopposed landing on the beaches which United States Marines were to win back three months later. The Port Moresby Invasion Group was still anchored at Rabaul, scheduled to leave at 1800 next day.

On May 4, planes from YORKTOWN made three separate attacks on shipping in Tulagi harbour, damaging one destroyer and sinking a few smaller ships.

By May 5 the Port Moresby Invasion and Support Groups were steaming merrily along a southerly course aiming at the Jamard Passage through the Louisiade Archipelago. The Japanese Striking Force was beating down along the outer coast of the Solomons. By dawn on May 6 the enemy carriers were well into the Coral Sea. By the afternoon of the 6th, Intelligence confirmed that the Port Moresby Invasion Group would turn the corner of New Guinea through Jamard Passage, and that they would come through next day for the 8th, if not stopped. At 1930, on May 6, Admiral Fetcheler resumed course to the northwestward to be within striking distance of the Port Moresby Invasion Group by daylight on May 7.

The main action of the Battle of the Coral Sea should have been fought on May 6 and would have been if either Admiral had been aware of the other's presence.

By midnight on May 6 the Port Moresby-bound transports were closing Misima Island, almost ready to slip through Jamard Passage. The Covering Group was protecting the left flank of the Port Moresby invaders, SHOHO furnishing the combat air patrol until sundown.

This was the day, May 6, that marked the low point of the war for American arms; General Wainwright was forced to surrender his forces in the Philippines. But on the very next day there opened a new and brighter chapter in the Pacific war. The time had come for the Allies to take their first step forward. The transition from Corregidor to Coral Sea is startling, dramatic and of vast importance.

Actions of May 7 — Loss of U.S. Ships "Neosho" and "Sims"

The Japanese Striking Force reversed course to the northward on the evening of May 6 and maintained it until two hours after midnight, when it turned again and headed south.

SIMS was patrolling about a mile ahead of NEOSHO shortly after 0900, when 15 high-level bombers dropped, missed and disappeared. At 1038 another group of ten made a horizontal bombing attack on SIMS, which avoided nine bombs dropped simultaneously. After noon her number came up when 36 dive-bombers arrived. The planes came in from astern in three waves. Three 500-pound bombs hit the destroyer, two exploded in her engine-room, and within a few minutes she buckled amidships and sank stern first.

In the meantime, 20 dive-bombers concentrated on NEOSHO. Within a few minutes they scored 7 direct hits and 8 near-misses, one by a suicider who exploded against No. 4 gun station; gasoline burst from the plane's tanks and flowed blazing along the deck. Captain Phillips ordered all hands to "make preparations to abandon ship and stand by". She drifted for four days and was finally scuttled on May 11.

SIMS and NEOSHO did not die in vain. If they had not drawn off this strike, Japanese planes might have found and attacked Fetcheler on the 7th, when the American planes were working over SHOHO.

Crace's Chase

Admiral Fetcheler, at 0625 on May 7, ordered Admiral Crace's Support Group to attack the Port Moresby Invaders, which reconnaissance planes reported heading for Jamard Passage.

At 1358, Crace's group, consisting of AUSTRALIA, CHICAGO and HOBART, was attacked by eleven single-engine land-based planes. All ships opened fire and drove them off. Immediately after, radar picked up twelve "Sallys" (land-based Navy bombers) 75 miles away. Crace ordered radical manoeuvres and every ship opened fire as the planes came in low. Eight aerial torpedoes were dropped, but all missed and five of the bombers were shot down. Immediately after the surviving torpedo planes had retired, 19 high-flying "Sallys" dropped their steel eggs from an altitude of 15,000 to 20,000 feet. The ships dodged the bombs as they had the torpedoes, and the planes flew away.

By midnight Admiral Crace had reached a position about 120 miles south of the New Guinea bird's tail. He continued on course part of the night and then, having heard that the Port Moresby invaders had turned back, headed south.

As the Japanese attack was of the same type and strength as the one that sank H.M.S. PRINCE OF WALES and REPULSE on December 8, 1941, the escape of Crace's Support Group without a single hit is a tribute to its training, and to the high tactical competence of its commander. The Japanese thought they had bettered the score of December 8. They claimed having sunk CHICAGO and AUSTRALIA, and having torpedoed another battleship.

Sinking of "Shoho"

While the planes of the Japanese Striking Force were slaughtering NEOSHO and SIMS, the Port Moresby Invaders still were moving toward Jamard Passage. However, Japanese aircraft had now discovered the United States carriers. The Port Moresby Invasion Group was consequently ordered to turn away instead of entering Jamard Passage. Thus 0900 on May 7 marked the nearest that this or any other Japanese naval force got to Port Moresby.

SHOHO, having been located, was immediately attacked. Ten SBDs attacked at 1110, LEXINGTON'S torpedo squadron followed seven minutes later, and YORKTOWN'S air group piled in at 1125. Ninety-three planes against one light carrier! No ship could have survived such a concentration. After receiving two 1,000-pound bomb hits, she burst into flames and went dead in the water. More hits followed, and "by 1130 the entire vessel was damaged by bombs, torpedoes and self-exploded enemy planes, records the SHOHO war diary. Abandon ship was ordered at 1131, and the carrier sank within five minutes.

CARRIER BATTLE OF MAY 8

"Yorktown" and "Lexington" v. "Shokaku" and "Zuikaku"

The decisive action was fought out in a carrier battle on the morning of May 8. The number of planes operational on both sides was almost the same: 121 Japanese and 122 American.

At 0838 Admiral Fetcheler ordered both U.S. carriers to launch air strikes. The YORKTOWN group of 39 planes took off at 0915, and an hour and a quarter later the attack on SHOKAKU commenced. Only two bomb hits were scored, one well forward, which damaged the flight deck, and the other well aft, which destroyed the repair compartment. LEXINGTON dive-bombers added one more hit.

SHOKAKU lost 108 men killed and 40 wounded; but was not holed below the waterline, and at 1300 she high-tailed it for home. She almost capsized on the way, and arrived in bad shape; but she got there. Admiral Takagi had no qualms about releasing SHOKAKU, for by this time he believed that both United States carriers were well settled on the bottom of the Coral Sea.

By the time the American planes began returning to their carriers, both YORKTOWN and LEXINGTON had been hit. Ninety planes from SHOKAKU and ZUIKAKU were beating up the American carriers a few minutes after YORKTOWN'S attack on the Japanese carriers ended and before LEXINGTON'S had commenced. In this strange crisscross air battle, superior success attended the Japanese, whose strike group was larger and better balanced and more accurately directed to its target than that of the Americans.

At 1118 the Japanese approached from the north-eastward, downwind and down-sun. Torpedo-bombers came in on both bows of LEXINGTON to launch their "fish" from an altitude of 50 to 200 feet. One hit on her port side forward was quickly followed by a second on the same side opposite the bridge. One small bomb exploded in an ammunition box on the port side of her main deck, another scored on the smokestack structure. Near-misses ruptured plates and raised huge plumes of water. It was all over in nineteen minutes.

Six minutes later YORKTOWN was attacked. For the next three minutes she dodged steel eggs, then received her one and only hit. An 800-pound bomb struck the flight deck and penetrated to the fourth deck. Sixty-six men were killed or seriously injured, mostly by burns. Owing to skilful handling YORKTOWN escaped with damage that did not impair flight operations.

The big carrier battle was over by 1140 on May 8. But at 1247 a devastating internal explosion shook LEXINGTON from stem to stern. More eruptions followed, each more violent than the last. At 1707 abandonment was ordered and destroyer PHELPS administered the coup de grace with torpedoes. At about 2000 the battered amazon, with one final detonation, slipped into a 2,400-fathom deep.

Invasion Thwarted

But the enemy had retired: his main objective, the invasion of Port Moresby, had been thwarted. Before the end of May 8, Inouye formally postponed the Port Moresby invasion until July 3! (But Midway settled that). One may well ask what prevented the Invasion Group from reversing course again and steaming through Jamard Passage to its original destination instead of returning to Rabaul. The Army Air Force may take a bow for that. Inovye did not dare to risk his transports in a second try, because of the intense activity of the Allied Air Force along the southern shores of Papua, and the want of air protection now that SHOHO was sunk and the Striking Force had retired.

The Battle of the Coral Sea will be ever memorable as the first purely carrier-against-carrier naval battle in which all losses were inflicted by air action and no ship on either side sighted a surface enemy. It was a tactical victory for the Japanese, but a strategic victory for the United States. The enemy inflicted relatively greater losses than he sustained; SHOHO and the few small ships sunk at Tulagi were a cheap price to pay for NEOSHO, SIMS and LEXINGTON.

On the other hand, the main purpose of the Japanese operation, the capture of Port Moresby, was thwarted. The Louisiades proved to be a barrier beyond which no warship flying the banner of the Rising Sun could ever pass. Tulagi, one of the two secondary objectives of the enemy, had been won and it cost us dear to root him out of it. But in the other scale one must place the temporary elimination of SHOKAKU and ZUIKAKU. The former was so damaged that she could not rejoin the fleet for two months, and the latter, owing to plane losses, was out of the war until about June 12. If these two fine carriers with veteran pilots had been able to participate in the Battle of Midway, they might well have supplied the necessary margin for victory.

Call Coral Sea what you will, it was an indispensable preliminary to the great victory of Midway. The morale value of the battle to all Allied nations, coming as it did immediately after the surrender of Corregidor, was immeasurable. It was a story of cool efficiency, relentless action, determination and superb heroism.

Less than a month later, on June 4, Japan lost four of her best carriers at the Battle of Midway — which was the turning point of the Pacific war. Coral Sea was the end of the beginning — Midway was the beginning of the end.

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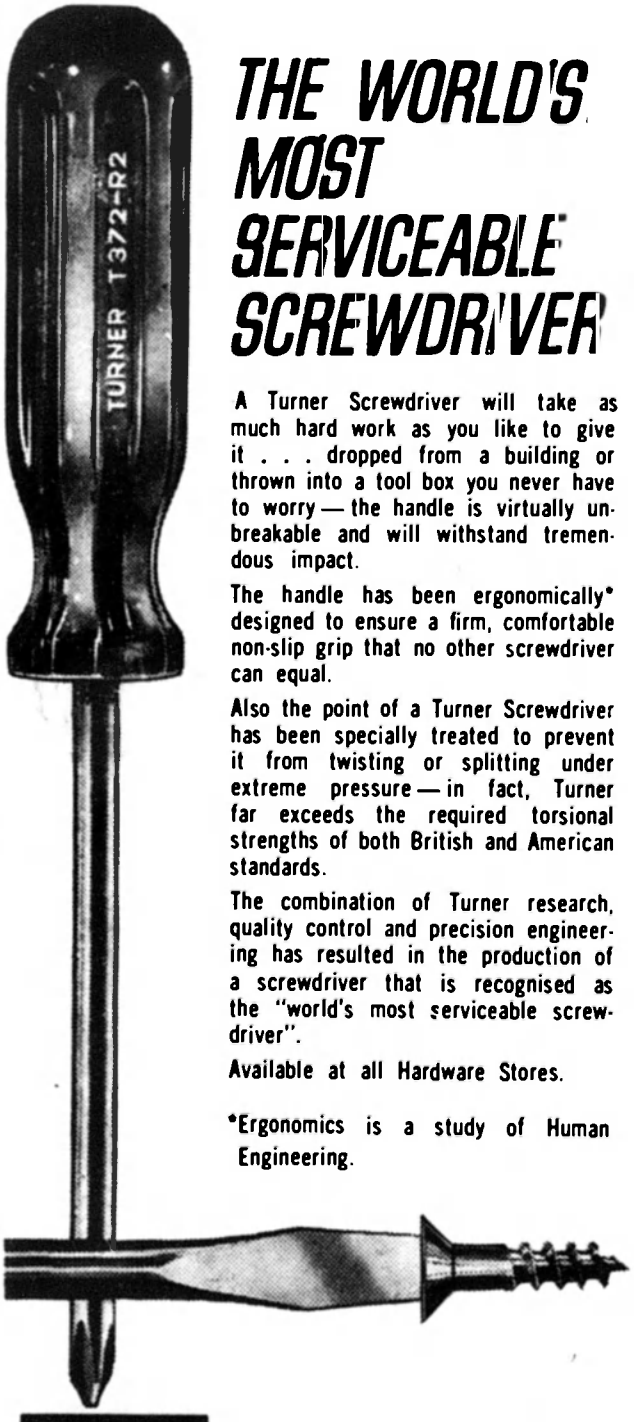
Turner



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