NAVAL ENGINEERING REVIEW

THE JOURNAL OF THE ROYAL NAVAL ENGINEERS BENEVOLENT SOCIETY
FOUNDED IN 1872

WINTER 1971 No. 184

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Articles and correspondence submitted for publication, also communication relating to advertising, etc., should be addressed to:—

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FRONT COVER ILLUSTRATION

Shorts' Seacat close-range ship-to-air missile system—seen here being fired from the R.A.N. frigate *Torrens*—has been adopted by 15 navies and is the world's most widely used shipborne missile. A lightweight Seacat launcher now enables small naval craft such as fast patrol boats to mount an effective missile defence against air or surface attack.

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General Secretary's Notes and Comments

One of the regular features of the *Naval Engineering Review* when I first began to read it as a new entrant 45 years ago was the inclusion of the winning essays written by members competing for the Marrack Memorial Prizes. One of our older members, who was a prizewinner on at least three occasions, recently wrote to me enclosing for my collection, some old copies of the *Review* containing his essays. This brought the competition back to my mind.

By a strange coincidence, at about the same time, Mrs Adsell, aged 84, the daughter of Captain Marrack whom the the Marrack Memorial Fund commemorates, visited *HMS FISGARD*. She is a BSc. (Hons) of London University and was in this country on a visit from America with her son and daughter. She enquired whether the Marrack Memorial Fund still existed and was assured that it did. The Fund now provides prizes for Workmanship among Artificer Apprentices in *HMS Fisgard*, the essay competition having fallen out of favour many years ago, when it was discontinued for lack of entries.

Browsing through some of the old copies of our journal brought home to me how much more *character* it had in those days. It may have lacked the polished professionalism which it undoubtedly has today, thanks to our present editor, but what is missing in my opinion is the participation of its readers, which was so much a part of the *Review* in the first thirty years of its existence. Not just the prizewinning essays on engineering subjects, but also letters to the editor and articles by members on unusual repair jobs, experiences with new types of machinery, small items passing on "useful tips", or hand tools or devices discovered or made by themselves. Articles such as those telling of the measures adopted by the writers whereby they had succeeded in reducing the feed water or fuel consumptions to microscopic proportions! All good stuff, in a variety of styles, but redolent with the atmosphere of the engine room or workshop.

Can we not get back *some* of this today? I cannot believe that our members have nothing of interest which they could share with their fellows. If security is involved, items could first be submitted by the writers to their Engineer Officer. In any case, I would undertake to see that nothing is published without first having been submitted to the Ministry of Defence for clearance. Who knows what time and trouble you may save someone by recounting your own experience? This is true of all Specialisations, not just the Marine Engineering branch. Simple line sketches or suitable photographs can sometimes be used for illustration, if necessary. Not only useful, but also amusing anecdotes would not come amiss, providing they have some bearing on your work.

Notwithstanding the foregoing, there is ample evidence that the style and content of the present-day *Review* is greatly apreciated. That is not to say that there is not occasional gentle criticism that there is not sufficient coverage of this or that subject. The difficulty about such subjects as are generally mentioned in these criticisms is that anything about them which would be of interest to our readers is almost certainly not available for publication because it is Secret, or at least Restricted. If, however, you read something in another source which you find interesting, it is likely that others might also find it interesting. Pass it on to the editor for his consideration. Though he reads widely in search of suitable material from sources both at home and abroad, he may have missed what you have seen. It is probably not generally appreciated that as well as "reviewing" other people's work in these pages, he also frequently contributes his own work. It is almost certain that if the source of an article is not acknowledged in the title line or by a footnote, it is his own contribution. Some of his articles are later reproduced in other journals at home and overseas.

Readers will gather from the foregoing that what I am doing is appealing to them to make this journal more their own by contributing something to it. It does not require great literary talent. It is what you have to say which matters, not so much how you say it. Although both the editor and myself do our best to keep in touch with the "new" navy, every year inevitably takes us a little further from the modern scene. Whilst it cannot yet be said that we belong to the previous generation, every year that passes sees fewer ships afloat which were in commission when we were serving. The past ten years have seen greater changes in the Royal Navy than in any similar period in its history, including the change from sail to steam or from coal to oil, both of which were much more gradual changes. This is true of service conditions as well as of technology. Your views and opinions would therefore be greatly appreciated, even if not for publication.

The R.N.E.B.S. is approaching its centenary year (1972). It is doubtful whether any of its founders in 1872 would have dared to predict that it would survive 100 years, to 1972. Indeed, there were many who 50 years ago were saying that the Society was a "dead duck". It has weathered much severe criticism in the past, not the least, I am sorry to say, from official sources. Happily this is not the case today. That it has survived and flourished is a tribute to the wisdom and tenacity of its early fathers, but chiefly, in my opinion, because it was founded upon and still maintains, simple and sincere Objects—the ultimate good of the Service as a whole and the Branch in particular.

1972 will also be important to the R.N.B.T., which celebrates the Jubilee of its foundation in 1922. Not least among the founders were members of our Society, which has continued to furnish it with officers who have played an important part in its progress. The list of Chairmen of Local Committees of the R.N.B.T. and members of its Central Committee during the past 49 years contains many names of members of our Society, among which I am proud to be included. Though I shall not be around to see it, I venture to suggest that it is more than likely that my successor in 50 years' time (should this Society survive to see the Centenary of the R.N.B.T.) will also be able to lay claim to such a distinction. Like our Society, the R.N.B.T. has had to weather a lot of ill-founded criticism in its time (though fortunately not from official sources). Being equally well founded on unimpeachable principles, it has also survived and will undoubtedly continue to do so while there is still a living relative of a member or ex-member of the Royal Navy. Our Society cannot, I am afraid, claim such a firm charter. But we have a 50 years' start and will give them a run for their money!

Launch of HMS Ariadne

The twenty-sixth and last Leander Class Frigate

HMS Ariadne, twenty-sixth and last of the Royal Navy Leander Class Frigates, was launched at the Glasgow shipyard of Yarrow (Shipbuilders) Ltd, on Friday September 10. The ship was named by Lady O'Brien, wife of Admiral Sir William O'Brien, KCB, DSC, Commander-in-Chief, Western Fleet, and the service was conducted by the Reverend A H Lawson, Minister of Kilbowie Parish Church, Clydebank.

HMS Ariadne has a standard displacement of about 2,900 tons, an overall length of 372 feet and a beam of 43 feet. She will be powered by steam turbine machinery supplied by J S White Ltd, with the gearing supplied by David Brown Ltd.

Her armament will comprise 4.5 inch guns in a twin mounting directed by a fully automatic radar controlled fire control and gun direction system, a Seacat ship-to-air launcher and director, and an anti-submarine mortar. She will also carry a helicopter for anti-submarine use.

As in other ships of the class, her living accommodation will be of a high standard, with bunk sleeping, separate dining halls and cafeteria messing. Electric galleys will be installed and the ship will be air-conditioned throughout the operational spaces and mess decks.

HMS Leander was the first of her class; she was built by Harland and Wolff Ltd, Belfast, in June 1961.

The philosophy of gas turbine propulsion for major naval vessels

by G. C. Connor*

In a comparatively short paper such as this, it is quite impossible to adequately cover the whole field of gas turbine propulsion for warships, both large and small, military hovercraft and hydrofoils. The author has therefore decided to confine his attention to the propulsion of large warships, but before doing so, it is worthwhile to review the technological advancement of aero-type gas turbines.

The development of the gas turbine engine as an aircraft power plant has been so rapid, it is difficult to appreciate that only thirty years ago very few people had heard of this method of aircraft propulsion. During this period the thrust of jet engines has increased some thirtyfold; compression ratios have increased from around 4 to 1, to 25 to 1 for present day Turbo-fan engines, and the specific fuel consumption of 1.0 lb of fuel per hour/per lb of thrust has decreased to 0.36 lb of fuel per hour/per lb of thrust at sea level.

The aero gas turbine was initially developed to meet military requirements and following this it was successfully adapted to meet the needs of civil transport aircraft.

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These extensive efforts have resulted in today's high technological standards. Comparable efforts have not been undertaken in connection with any other propulsion engineering. As a result, the lightweight aero turbine, with the minimum of change, has been fully competitive in both Marine and Industrial engineering. Furthermore, its launching costs were relatively small in these fields as the major development costs had already been covered in its aero role.

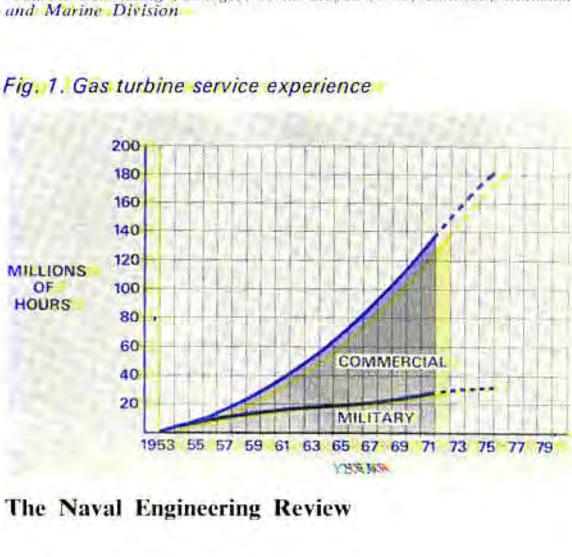
Fig 1 shows the build up of running hours accumulated by the author's company in the aero field until mid 1971 and clearly depicts the experience, background and "know how" available to these engines when used in the marine field.

Fig 2 shows a very generalised plot of specific power requirements for a complete range of vessels of all types from 70 knot hovercraft, to 100,000 ton deadweight tankers. On examination of the specific power requirements it can be seen there is a 'striking' variation from the region of 100 SHP/ton for the fastest and smallest vessels, to about 0.2 SHP/ton for the large moderate speed vessels.

The specific power figures are presented for speeds of 15 knots, 30 knots and 45 knots and whilst the two lower curves refer to displacement vessels, the 45 knots refer very generally to non-displacement vessels and spot points are shown for hydrofoils and hovercraft.

For the latter category, low engine weight is

Fig. 1. Gas turbine service experience



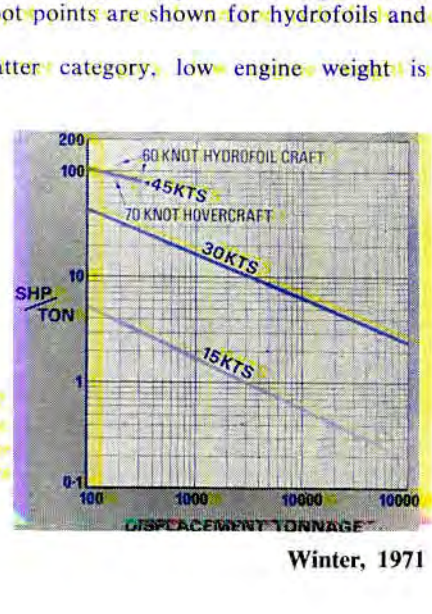


Fig. 2. Specific power requirements

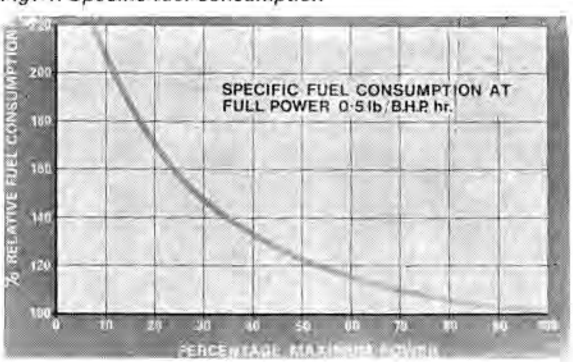
Fig. 3. HMS 'Brave Borderer'

essential and here the marinised aero engine is practically unchallenged. It was natural therefore that this type of engine first found its application in small high speed vessels. To achieve the performance required, the ship designer was forced into taking the risk, in the late 1950s of using converted aero engines and the earliest example of this type was HMS Brave Borderer (Fig 3), fitted with three Proteus engines which began its very successful career in the Royal Navy in 1958.

Today, eleven of the world's navies use improved versions of this same engine in fast patrol boats, motor gun boats, military hydrofoils and hovercraft. The operation of the engines in these vessels has not been free of problems but it has led continuously to a better understanding of the effects of environmental conditions, to modifications to the engines to meet these problems and an ever growing confidence by naval authorities in the suitability and reliability of such engines in the Naval role.

It was largely this experience which has led the major navies of the world to support the development of other and much larger engines, again based on successful aero engines, to provide propulsion for larger naval vessels at their top speed. It is apparent from Fig 2 that these vessels with displacement of

Fig. 4. Specific fuel consumption



up to 8,000 tons, require very high specific powers at speeds of 30 knots and above and real advantages are gained in the disposable load and space in such ships by the use of lightweight gas turbines.

In the last eight years the marinised aero gas turbine has totally eclipsed all other prime movers in providing full power for warships in the displacement range from 700 to 7,000 tons, with speeds up to 40 knots. The propulsion plants include simple cycle gas turbines, combined diesel and gas turbine or alternatively combined diesel or gas turbine. The characteristics of the type of gas turbine considered in this paper are such that the cruising role cannot be undertaken by throttling the main gas turbine due to the unacceptable increase in specific fuel consumption which occurs under these conditions. Fig 4 which depicts the variations of specific fuel consumption with percentage power for a typical simple cycle gas turbine illustrates this point clearly. Separate cruising engines are a necessity and the rival merits of gas turbines and other engines must be considered for the role by the ship designer.

Therefore, as previously shown, lightweight gas turbines were installed in small fast craft because they were virtually the only prime mover which could be fitted in the space available to achieve the desired high speeds. In large warships, different circumstances dictate the reasons for the use of gas turbines and we shall now examine why this type of unit has superseded steam turbines and diesel engines.

The adaptation of gas turbine propulsion provides the following well known advantages:

(1) Reduced volume, space and weight.
(2) Rapid response to power demands—starting from cold to full power within two minutes etc.
(3) Minimum development costs.
(4) Low vibration levels.
(5) Low lubricating oil consumption.
(6) Ease of automation.
(7) Self contained power units—with minimum linking of vulnerable power sources.
(8) Economy of manpower—in the Royal Navy's new frigates, 50,000 BHP of gas turbine is being fitted in place of the 30,000 SHP steam plant fitted in Leanders. The Engine Room complement for this larger frigate is reduced from two officers and forty-seven men to one officer and twenty-eight men.

Other not so obvious advantages are:

(9) Increased ship availability—major maintenance is carried out by replacing the main machinery units by units which have been overhauled under controlled factory conditions (repair by replacement). A complete

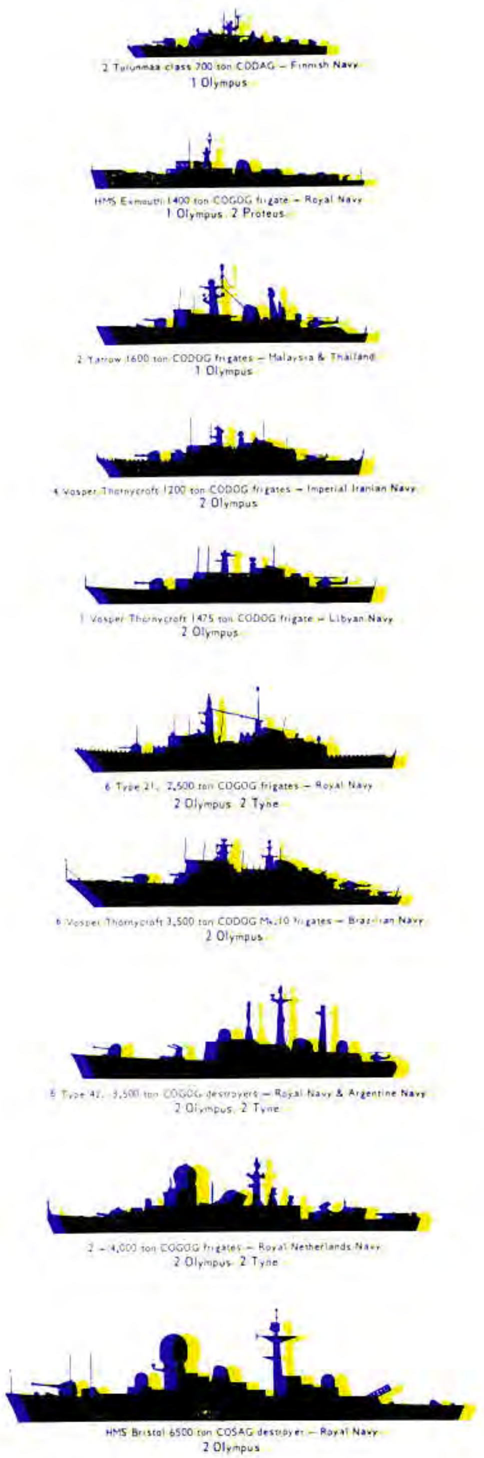


Fig. 5. The Rolls-Royce fleet

gas generator change can take place in 15 hours.

(10) Reduced staff-training—due to standardisation on simple cycle gas turbines.

(11) Improved habitability and working conditions—engine simplicity and elimination of interdependence of equipment gives improved standard in habitability and also cleanliness in machinery spaces, for example no boiler cleaning etc.

(12) Fewer hull penetrations—elimination of salt water inlets.

(13) Ability to up-grade machinery systems during ship's life—increase in ship's effectiveness through uprating of installed gas turbines and modular replacement with more advanced engines.

(14) Good resistance to damage and to nuclear, biological and chemical warfare.

(15) Reduced spare part inventories to support all ships having common machinery ie Type 42 and 21 warships.

(16) Improved flexibility—although unexpected failure of gas turbines will occur, effects will be reduced since two engines are normally fitted per shaft and full performance can be restored by replacing the damaged unit.

(17) Reduced shipbuilding time.

The disadvantages associated with gas turbines are namely:

Transmission complexities—existing gas turbines are non-reversible and consequently require either reversing gearboxes or CP propellers.

Large intake and exhaust ducting—these ducts are much larger than those required for other propulsion systems.

To summarise this section, gas turbines have been chosen for major warships because they have effectively reduced repair costs, personnel costs, improved world wide machinery logistic support and reduced "down" time to repair ships, thus giving improved overall ship effectivenesss. The gas turbine powered ship is a new concept which generates new capabilities. In the past it has been found that the changing of the propulsion system resulted in changing the whole ship system, support system, and the utilisation of such ships. It is assumed the gas turbine ship will do likewise.

Current installations

Let us now examine some of the new gas turbine powered ships of the seventies at present under construction (Fig 5).

Type 42 guided missile destroyer (Fig 6)

The Type 42 Destroyer (displacement 3,670 tons)

Fig. 6. Type 42 destroyer

has been designed by the Ship Department of the British MOD (N) to meet specific Royal Navy Staff requirements. This class of ship has been designed to operate on a world wide basis with a minimum of dockyard support between refits. The time between refits is planned to be four years.

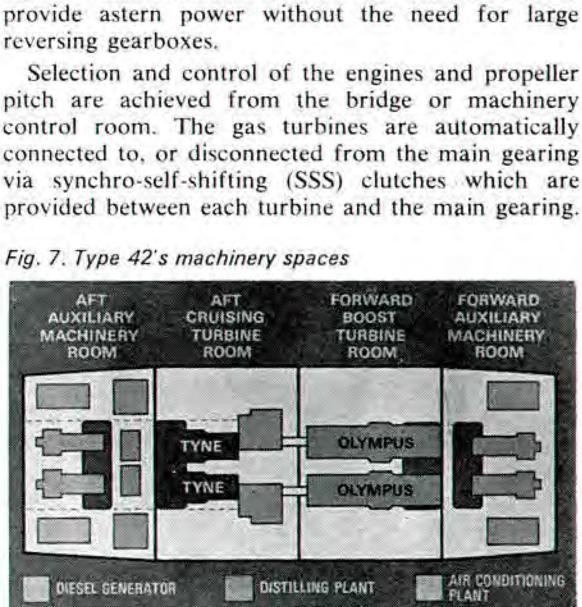
The Type 42 has two propeller shafts, each of which is powered by one Rolls-Royce Olympus TM 3B gas turbine engine (28,000 BHP) for boost or full power conditions and one Rolls-Royce Tyne RM 1A gas turbine (4,250 BHP) for cruise conditions.

Each set of main engines has been designed to operate as a COGOG installation, only one gas turbine provides power to the propeller at any one time.

Controllable pitch propellers are fitted to allow for the most efficient use of the gas turbines and to provide astern power without the need for large reversing gearboxes.

Selection and control of the engines and propeller pitch are achieved from the bridge or machinery control room. The gas turbines are automatically connected to, or disconnected from the main gearing via synchro-self-shifting (SSS) clutches which are provided between each turbine and the main gearing.

Fig. 7. Type 42's machinery spaces



The design of the air intakes and exhaust uptakes has been important, consideration having been given to the elimination of spray in the air intake and the establishment of an acceptable noise level from the propulsion machinery as a whole.

There are four main machinery spaces as shown in Fig 7, two engine rooms sited in the centre with an auxiliary machinery room at either end. The Olympus gas turbines are in the forward engine room. The layout of the machinery has been designed to withstand action damage. This can be seen in the positioning of the Olympus and Tyne gas turbines in separate compartments. In addition to the normal shock mountings, the Olympus gas turbines are provided with a constant position mounting system which combines a high degree of noise and vibration isolation with efficient positional control.

This vessel was the first to be designed around the Olympus/Tyne Main Propulsion Machinery Package (Fig 8).

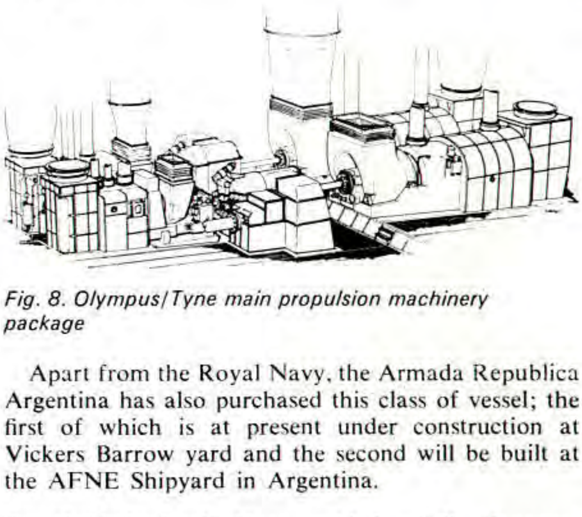


Fig. 8. Olympus/Tyne main propulsion machinery package

Apart from the Royal Navy, the Armada Republica Argentina has also purchased this class of vessel; the first of which is at present under construction at Vickers Barrow yard and the second will be built at the AFNE Shipyard in Argentina.

Royal Netherlands Navy guided missile destroyer (Fig 9)

The Royal Netherlands Navy have placed an order on the "De Schelde" Shipyard in Holland to build two 4,300 ton displacement COGOG Guided Missile Destroyers.

These ships will be similar to the Royal Navy Type 42 Destroyers and use Olympus/Tyne Main Propulsion Machinery Packages.

Royal Australian Navy gas turbine destroyers

The Royal Australian Navy is planning to order up to six Fleet Destroyers (DDL's). It is understood in the absence of any suitable existing or projected Royal Navy or United States Navy Ships, the RAN has prepared its own designs.

Fig. 9. Artist's impression of Royal Netherlands Navy guided missile destroyer

It is also understood the propulsion plant will comprise COGOG machinery and that uprated versions of the Olympus and Tyne Machinery Package have been chosen for design purposes.

Brazilian Navy general purpose frigates (Fig 10)

The Brazilian Navy have placed a contract on Vosper Thornycroft Limited for the supply of four Mk 10 3,000 ton Frigates with a further two ships to be built in Brazil. They will be powered by a combination of gas turbines and diesel machinery. One Olympus TM 3B and two 4,000 HP diesel engines will be used on each of the two propeller shafts.

Type 21 frigates

In 1968 the British MOD(N) placed a contract with the Vosper Thornycroft Group for the design of a frigate to be prepared in the fullest collaboration with Yarrow (Shipbuilders) Limited.

The staff requirements called for a ship of about 2,500 tons displacement. The COGOG propulsion plant is identical to that installed in the Type 42 destroyers with the exception of the control system. The design of the propulsion plant in both these vessels has been vindicated by the results of trials carried out on the experimental frigate HMS Exmouth (Fig 12) and the extensive shore testing which has been carried out and is still continuing at Rolls-Royce Ansty works.

Fig. 10. Vosper Thornycroft Mk. 10 frigate

Fig. 12. HMS 'Exmouth'

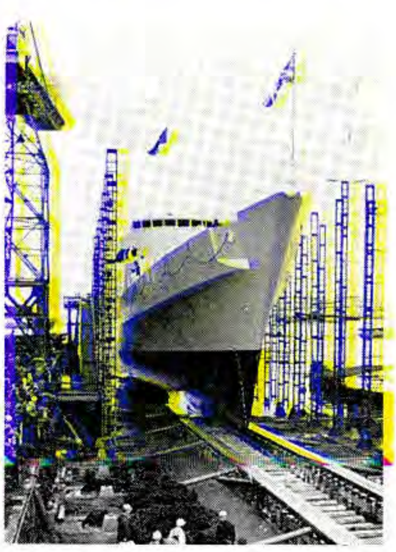
The continuance of these trials will be to assure that the full potential reliability of the engine is realised as quickly as possible. Further support trials will be undertaken with the intention of achieving increased overhaul lives and investigating such problems as may arise at sea.

Fig 13 shows the projected build up of running hours and the number of Olympus engines at sea until the end of 1976.

Other gas turbine warships

A number of gas turbine powered ships are in operation or on the drawing board and have been specifically designed as Private Venture or Commercial warships by shipyards, to cater for newly

Fig. 11. Launch of HMS 'Amazon', first of Type 21 frigates



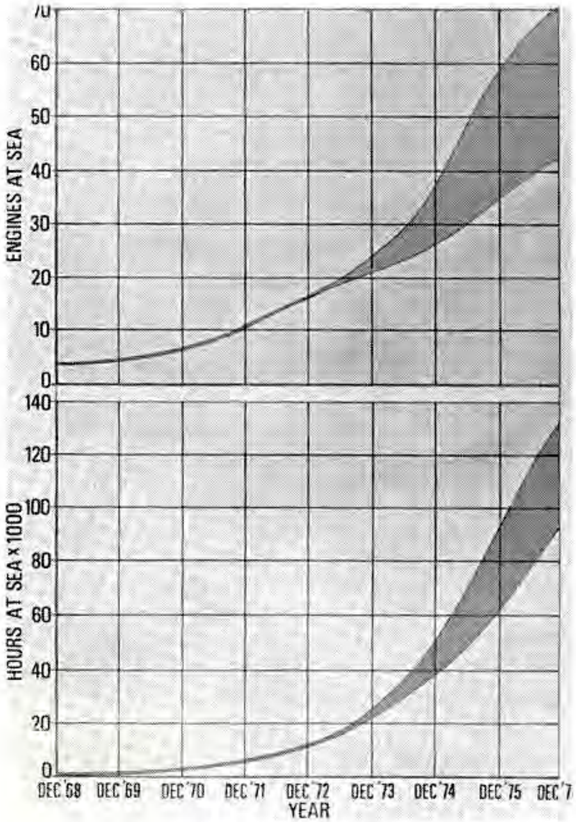


Fig. 13. Marine Olympus build up of sea experience

emerging navies or navies contemplating new construction to fulfil tactical and strategic roles which falls in the gap between patrol boats/corvettes and the larger sophisticated frigates.

The builders of these ships state that the cost of the ship is about 60% that of a conventionally powered frigate, gives a higher ratio of armament to displacement tonnage and is approximately half the displacement. Only installed gas turbine boost engines allow these claims to be made.

Such ships include the Vosper Thornycroft Mk V and Mk VII frigates which have been built for the Imperial Iranian Navy and the Libyan Navy respectively. The Yarrow frigate for the Malaysian and Thai Navies, the Vickers medium frigate and the Vosper Thornycroft Mk VIII corvette and the Finnish Navy Corvette. All these ships are powered by Olympus engines.

Other countries who have adpoted gas turbine propulsion for major warships are the USSR, USA, Canada, Germany and Denmark.

Fig. 14. Primary requirements for future gas turbines for naval ship propulsion

LOW FUEL CONSUMPTION =
HIGH CYCLE EFFICIENCY

LOW WEIGHT AND SIZE OF TOTAL INSTALLATION =
LOW SPECIFIC AIR CONSUMPTION
CONSTRUCTIONAL SIMPLICITY

LOW OPERATING COSTS =
LONG LIFE
HIGH RELIABILITY
LOW OVERHAUL COSTS
EASY MAINTENANCE
= CONSTRUCTIONAL SIMPLICITY MINIMUM NUMBER OF PARTS

Future developments

Primary requirements for future gas turbines for naval propulsion are given in Fig 14. As previously stated, the aircraft industry is highly competitive and vast sums of money are continually invested to push aircraft engine technology forward to new frontiers. These frontiers are advancing at a staggering pace.

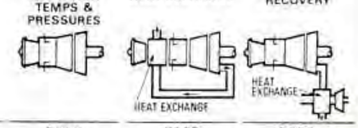
The shipbuilding industry on the other hand could be considered as a poor relative. Only modest investments are required to enable the "spin off" from the aircraft engine industry to be used in the marine industry once the known ship requirements are found to be compatible with aircraft requirements. In other words to develop techniques and understanding of how to adapt aircraft power plant to the marine environments.

The adaptation of advanced aircraft engines which are now going into service in the latest aircraft is being pursued actively. These engines are comparable in size and power with current marine designs but achieve specific fuel consumptions roughly 25% less. Such engines are the Rolls-Royce RB211 and the Rolls-Royce/SNECMA M45H.

The M45 marine derivative could produce approximately 9,000 BHP and envisaged applications range from fast patrol craft to large warships.

Finally Fig 15 outlines alternative high efficiency gas turbine cycles.

Fig. 15. Alternative high efficiency gas turbine cycles



	SIMPLE CYCLE WITH HIGH TEMPS & PRESSURES	HEAT EXCHANGE	WASTE HEAT RECOVERY
CYCLE EFFICIENCY	GOOD LIMITED ONLY BY BLADE METAL TEMPERATURES	GOOD HEAT EXCHANGER OF MOST BENEFIT TO LOW PRESSURE RATIO CYCLE	GOOD LIMITED BY SIZE OF HEAT EXCHANGER
SPECIFIC AIR CONSUMPTION	VERY GOOD	FAIR	GOOD
CONSTRUCTIONAL SIMPLICITY	VERY GOOD	POOR	VERY POOR
SPACE REQUIREMENT	VERY GOOD	POOR	VERY POOR

Royal Navy's new Type 1006 radar

Considerable interest already shown by NATO, Commonwealth and foreign navies

The Type 1006 Naval radar which was developed by Kelvin Hughes will be the Royal Navy's standard navigational radar in the seventies

The Type 1006 radar, developed by Kelvin Hughes in co-operation with the Admiralty Surface Weapons Establishment as the Royal Navy's standard navigational radar for the seventies, has completed all development and test stages and will shortly be going into service in the Fleet. Of non-thermionic design, it will serve to replace three navigational radars currently in service on warships, submarines, and support vessels.

Three facets of the new radar result in an all-round improvement of service and maintenance techniques. Non-thermionic construction with the exception of the magnetron and cathode ray tube, leads to higher component reliability; a comprehensive transmitter monitoring system gives advance warning of failures in the system; and modular construction permits rapid replacement of parts.

The 12 in. display unit has been designed specifically with high definition presentation as one of the main objectives. The continuously adjustable range marker—linked to a neon digital output—covers all ranges from 0 to 64 miles and is accurate to ± 50 yards. The electronic bearing cursor, operable in both true and relative modes, is accurate to $\pm \frac{1}{2}^{\circ}$. System flexibility is evidenced by the provision of up to four video outputs from the transmitter.

The P.P.I. will accept heading line, radar video, and three channels of auxiliary video information. This facility will be especially useful in conjunction with helicopter trans-ponders and is a vital link in helicopter anti-submarine warfare. Information from the range and bearing markets can be remotely displayed or fed to ancillary equipment such as plotting tables. Surface vessels will also be equipped to operate the Type 1006 in conjunction with the Navy's Computer Assisted Action Information System (C.A.A.I.S.).

Technical information of the Type 1006 radar

The equipment is non-thermionic with the exception of the magnetron.

The solid state modulator, which may be externally synchronised, provides three pulse lengths at two

Power output		25kw		
Pulse length (microseconds)	0.08	0.25	0.75	Switched with range except when pulse length switch overrides.
P.R.F. (p.p.s.)	1600	1600	800	
I.F. Bandwidth (MHz)	25	10	5	
I.F. Centre (MHz)	60	60	60	
Overall Noise Factor	9dB	9dB	9dB	
Number of video linear outputs		4		
Number of logarithmic video outputs		1		
Number of sync outputs		4		
Number of pre pulse outputs		1		

The solid-state transmitter/receiver for the Type 1006 radar

repetition frequencies to drive the magnetron which is coupled directly to the R.F. head. The advanced broadband design of the R.F. head ensures the best obtainable minimum range under adverse waveguide conditions.

The Gunn diode local oscillator is controlled by an A.F.C. with tuning indication, and the I.F. generated is fed to a combined linear/logarithmic receiving system. The linear video is used for navigation radar displays and the logarithmic video is used for weapon system data extraction systems. The receiver bandwidth is automatically optimised for the transmitter pulse length in use.

The transmitter-receiver is provided with monitoring facilities which measure magnetron current, power output, receiver noise factor, mixer-crystal currents and locally produced voltages. A waveguide switch and dummy load is provided to allow the transmitter-receiver to be run under radar silence conditions.

When controlled by a master synchronisation pulse generator the radar may be synchronised over the range 700-1000 p.p.s. and 1400-2000 p.p.s.

Display Unit

The equipment is non-thermionic with the exception of the cathode ray tube.

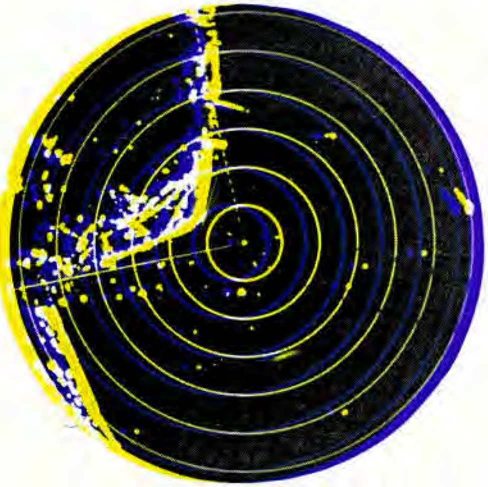
The display unit uses a rotating scanning coil system to provide range scales from $\frac{1}{4}$ to 64 data miles. Fixed coils provide off-centring facilities up to 75% of a radius from either an external true motion unit or from internal sources.

The rotation of the scanning coils is controlled by a 400Hz synchro-servo system. Display presentation is normally North stabilised.

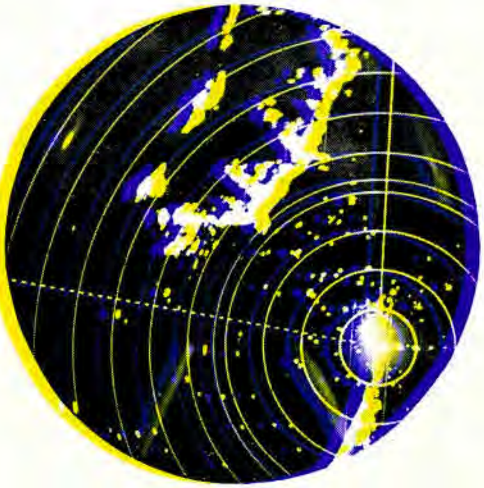
An adjustable electronic range marker is provided whose range is displayed on neon numeric indicators. The range marker is continuously variable to cover all range scales from 0 to 64 data miles. The range may also be measured directly in yards from 0 to 100,000 yards, when the accuracy of measurement is ±25 yards.

A mechanical parallel line cursor and an electronic bearing marker is provided. The position of

A view of the approaches to Portsmouth harbour on the PPI of a Type 1006 radar



Off-centring of the PPI allows the maximum of information to be displayed



Kelvin Hughes and A.S.W.E. development engineers like the two pictured here co-operated closely throughout the project

the bearing marker is displayed on neon numeric indicators with an accuracy of $\pm\frac{1}{2}°$. Readings may be taken of both true and relative bearing.

The information from the range and bearing markers is available in Binary Coded Decimal form for remote display or feeding to ancillary equipment.

The display will accept heading line, radar video and three channels of auxiliary video information.

The range switch will normally control the transmitter pulse length. An overriding Pulse Length Selection control may be used to override the range switch pulse length selection to give medium or long transmitter pulse lengths.

The following front panel controls are provided:

- Mains On/Off and C.R.T. Brilliance
- Range Switch (including Range Ring Selection)
- Range Ring On/Off
- Range Marker Control with Coarse/Fine switch
- Range Marker Miles/Off/Yards switch
- Bearing Marker Control
- Bearing Marker True/Off/Relative switch
- Video Gain
- Swept Gain
- Differentiation
- Pulse Length Selection
- Auxiliary Video Mixing Switches
- Off-Centring controls
- Bearing Scale and Panel Illumination controls
- Readout brightness control

The following internal pre-set controls are also provided.

- Video Gain (maximum level)
- Focus
- Range Ring Brilliance
- Range Marker Brilliance
- Bearing Marker Brilliance
- Panel Illumination Brilliance

An anti-parallax reflection plotter is available.

The following scales are provided:

Range Scale (Data miles)	Off-centring (% of radius)	Cal. Ring Intervals (Data miles)
$\frac{1}{2}$	75%	0.1
$\frac{3}{4}$	75%	$\frac{1}{4}$
$1\frac{1}{2}$	75%	$\frac{1}{4}$
3	75%	$\frac{1}{2}$
6	75%	1
12	75%	2
24	75%	4
48	0	8
64	0	8

A prototype model of the Type 1006 radar undergoing sea-trials aboard HMS 'Grenville'

Primary power supply

The unit will accept 440V 60Hz 3-phase or 115V 60Hz 3-phase or 220 D.C. as the primary supply. The inverter is capable of supplying the power requirements of a system comprising one transmitter-receiver and two display units. The unit may be synchronised to an external source or may free run at 800Hz.

Aerial control and system master on/off switches are provided. Removable keys are provided to lock the switches in the off position.

Surface Aerial and Drive Unit

A turning mechanism is provided to rotate the slotted waveguide aerial array at 24 rev/min in wind speeds up to 90 knots. To meet special requirements the aerial outfit may be inverted and mounted on the underside of a mast spur.

Two alternative arrays are provided of 2.4 and 3.1 metres length. With a 2.4 metre array the overall gain is 31dB, horizontal beamwidth at 3dB is 1°, vertical beamwidth 18°. With a 3.1 metre array the overall

Unit Dimensions	Height	Width	Depth	Weight
Transmitter-Receiver	840mm	470mm	240mm	44kg
Display	565mm	470mm	633mm	90kg
Primary Power Supply	420mm	470mm	280mm	34kg
Aerial 2.4m	650mm	2400mm }	turning	81kg
Aerial 3.1m	650mm	3100mm }	circle	76kg

gain is 34dB, hortizontal beamwdith is 0.75°, vertical beamwidth 18°.

For both arrays the side lobe levels within ±10° of the main beam are better than 28dB belom maximum power in the main lobe and better than 35dB below main lobe power outside ±10°.

Aerial bearing data is provided by coarse/fine synchro transmission. Bearing rate data is provided by a tachometer. The array is rotated by a 3-phase 60Hz motor to minimise magnetic interference.

Launch of HMS Swiftsure

Seventh nuclear fleet submarine for Royal Navy

The Royal Navy's seventh Fleet Submarine, HMS Swiftsure, was launched from the Barrow Shipbuilding Works of Vickers Ltd on Tuesday, September 7. The naming ceremony was performed by Lady Pollock, wife of Admiral Sir Michael Pollock, GCB, MVO, DSC, the Chief of Naval Staff and First Sea Lord. Whilst the service was conducted by the Reverend E Notman, vicar of St John's Church, Barrow-in-Furness.

HMS Swiftsure is of all British construction. She has a length of 272 feet and a beam of 32 feet 3 inches. Her primary role is that of a submarine hunter-killer. For this purpose she will have the latest underwater detection equipment and weapons. She will be fitted with an inertial navigation system and a means of measuring her depth below ice.

Her main propulsion machinery is of all British design. It is an improved version of the VALIANT class propulsion unit based on design experience from the United States and in building the Dounreay submarine prototype. Refuelling of the reactor will be necessary only at very long intervals. Fitted with the latest air conditioning and purification equipment, the submarine will be able to undertake patrols of long endurance at high underwater speeds without need of air from the surface. The nuclear reactor is being built by Rolls-Royce and Associates Ltd. in conjunction with Vickers Ltd, Foster Wheeler John Brown Boilers Ltd and Babcock and Wilcox Ltd. Manufacture of the steam turbine has been undertaken by English Electric Ltd.

Her complement of 12 officers and 80 ratings will be accommodated to a high standard and in view of the long underwater patrols which she will carry out, particular attention has been given to habitability. This includes improved water distilling plant providing unlimited fresh water—even for shower baths and for the fully equipped laundry. Separate messes for senior and junior ratings are provided on either side of the large modern galley where meals will be served on the cafeteria system. Particular attention has been paid to the recreational facilities. These will include cinema equipment, an extensive library of books and tape recordings, all of which will help to offset the monotony of long underwater voyages.

The great moment

Gears for combined machinery

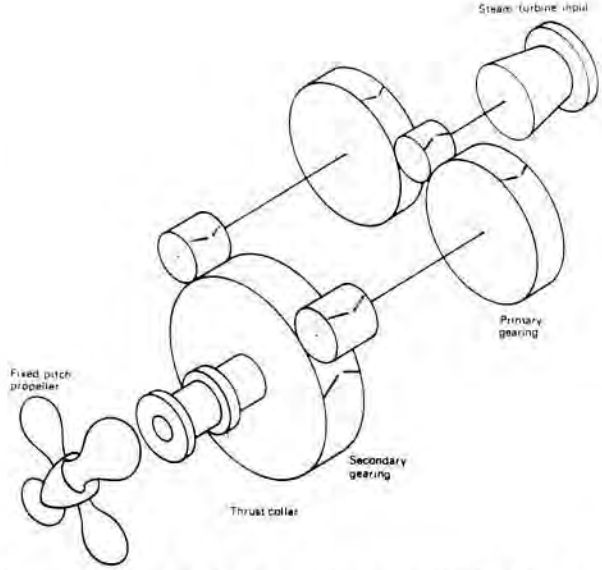
David Brown transmissions for steam turbine, CODOG and CODOG-powered frigates and destroyers

Most of the major naval vessels at present on order for European and South American powers will employ some form of combined propelling machinery in which areo-derived gas turbines are used alternatively with lightweight diesel engines or other aero turbines of lower power. This abstract* from a paper traces the development of the gear system for naval vessels from the last of the steam frigates to the present COGOG destroyers.

For a number of years the work horse of the fleet has been the *Leander*-class frigate, performing such widely differing duties as anti-submarine patrols and fishery protection. These are, like their predecessors, the *Whitby*-class, twin-screw steam turbine-driven ships. The main propulsion sets consist of single-cylinder turbines with conventional dual tandem articulated double reduction (locked-train) gears. The input pinion meshes with two primary wheels, each connected to a secondary pinion. Both secondary pinions are in mesh with the same wheel. Articulation is provided by the quill shafts between the primary wheels and the secondary pinions. Each quill shaft rigidly coupled to its gear at one end and flexibly couped, axially, to its gear at the other end by means of a fine-tooth gear coupling. Load sharing is achieved by torquing-up the system.

The primary and secondary pinions are made from BS En 36 steel forgings with carburized hardened and profile-ground teeth. Profile and helix modifications are carried out to provide tip and end relief in addition to appropriate helix correction. Primary and main wheels are of bolted construction with the rims made from En 30b heat-treated forgings. The shafts are all carried in sleeve bearings arranged for easy removal without it being necessary to remove the shafts from the case. A tilting pad thrust bearing is fitted at the after end of the main shaft.

Developments in naval machinery gear transmission presented by Mr. J. Hepper of David Brown Gear Industries Ltd to the Half-Yearly Technical Meeting of the British Gear Manufacturers Association



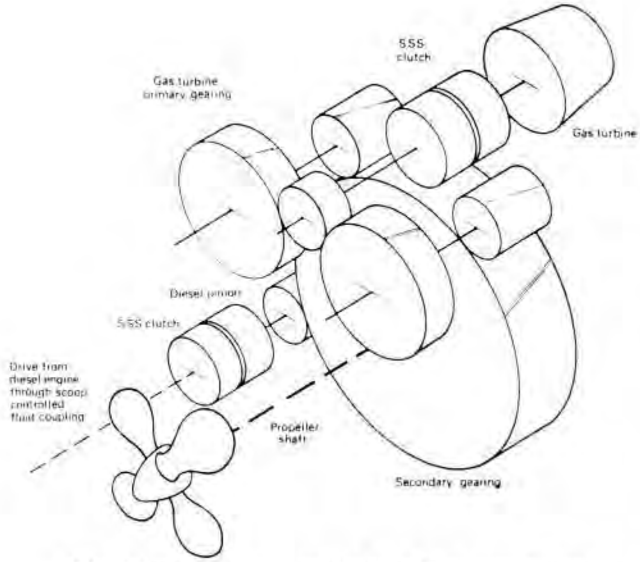
Conventional locked-train double-reduction double-helical drive line as used in steam turbine-driven 'Leander'-class frigates

HMS 'Exmouth'

As a consequence of experience with the Tribal and *County*-class ships fitted with COSAG machinery the Navy Board in 1965 took the decision to go ahead with the development of an all-gas turbine ship. It was decided to convert a *Blackwood*-class frigate, HMS *Exmouth*, as a fully-operational unit of the fleet and not just a trial unit.

The problem presented by the uni-directional power turbine was overcome by the use of a controllable-pitch propeller but the high fuel consumption of a gas turbine plant at low powers called for a rather more complex solution. A COGOG or COmbined Gas Or Gas turbine system was chosen in which two Rolls-Royce Marine Proteus engines could be used either singly or together as cruise and low power engines or, alternatively, a Rolls-Royce Marine Olympus turbine for high power. SSS Synchro Self Shifting clutches are fitted in the input shaft lines from the Proteus and Olympus gas turbines and enable the change from one engine to the other to be effected automatically without loss of power.

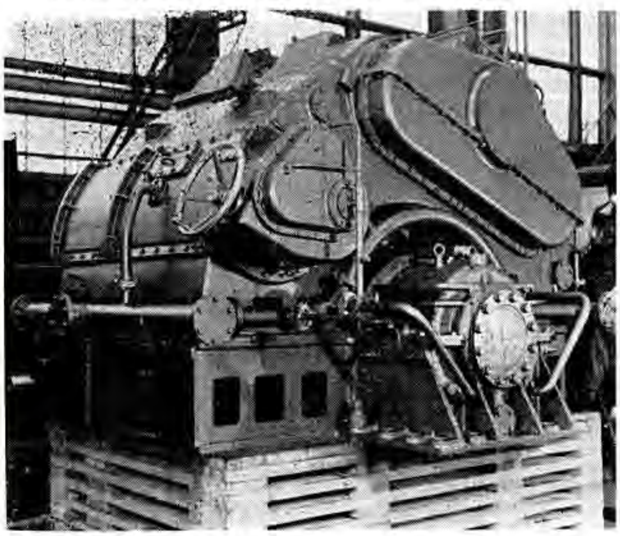
In the interests of standardisation it was decided that where possible major gearbox components should be as already fitted in *Leander*-class frigates, both to enable existing spare rotating parts to be fitted, if necessary, and to shorten the time for production. The gear was in fact designed, built, delivered and installed within 12 months.



CODOG gear arrangement for Mark 5 destroyer with one Marine Olympus input (locked-train double reduction), alternatively one Paxman 16-cylinder engine input (single reduction), in each case through an SSS clutch. Single helical trains are used throughout

The Marine Olympus main drive is taken through a dual tandem articulated locked-train and two additional pinions engage it with the main wheel for the Proteus drives. The Proteus turbines, incidentally, are arranged aft of the gearcase. The turbines drive their respective pinions through diaphragm couplings; in the case of the Proteus a torsion shaft passes through the drive pinion and clutch and a diaphragm coupling is at the remote end. This provides a short

Exterior of Mark 5 destroyer gearcase seen from gas turbine input end (blanked aperture at top right)



machinery length while still permitting relative movement of the Proteus engine when subject to underwater shock. A pneumatically-operated transmission brake is fitted to one of the secondary pinions. This has a single chromium-plated copper disc and two caliper units each with two pairs of pads. It will bring the transmission and the free power turbine to rest in under 15 seconds from idling speed with propeller thrust at zero and no way on the ship.

CODOG gears

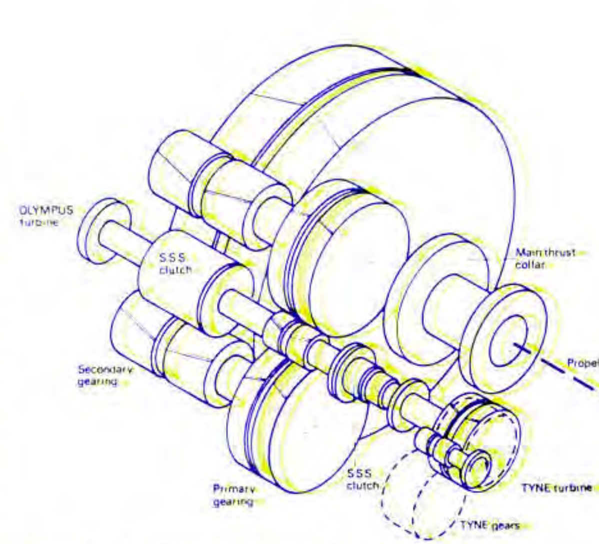
The installation fitted in the Vosper Thornycroft Mark 5 fast destroyers for the Imperial Italian and Libyan Navies consist of one Marine Olympus gas turbine or one 16-cylinder Paxman Ventura diesel engine arranged in CODOG. In these small, high-speed vessels space is at a premium and the positions at which the gas turbine and diesel engines can be located relative to the main shaft to some extent dictates the gear size and layout. In this case a conventional dual tandem articulated locked-train arrangement has been adopted for the main turbine but due to the position of the machinery the primary gears have been rolled inboard around the secondary wheel. The diesel drive pinion is on the outboard side driving into the main wheel. In order to keep the overall size of the power block as small as possible the primary gears are located aft of the secondaries and after careful choice of primary gear centres it has been found possible to locate the SSS clutch in the gas turbine drive over the secondary wheel. For the diesel drive, which enters aft of the gearcase, the SSS clutch is positioned in the line of the primary gears placing all the machinery within the limits of the primary and secondary gear face widths.

Single helical gears are used with tilting pad thrust bearings to take the gear thrust. The primary wheel/secondary pinion connection is by a quill shaft rigidly coupled at each end, and with the gear loads opposed. An unbalance of load keeps the line towards the aft end in order to provide stability under running conditions. The primary pinions and wheels are gas carburize-hardened and then ground on Maag machines, the pinions being provided with profile modification. The secondary pinions are also gas carburized, profile ground with the main wheel rim nitrided. The main wheel has a forged steel rim welded to a cast steel centre, the whole then bolted to the main shaft. The wheel proportions are such that profile grinding of the teeth could be carried out if necessary but due to careful control exercised during machining and the stress-relieving operations carried out grinding was not needed, tooth accuracies, roundness, etc, of the rim still being within allowable limits after nitriding.

Type 42 destroyer and Type 21 frigate

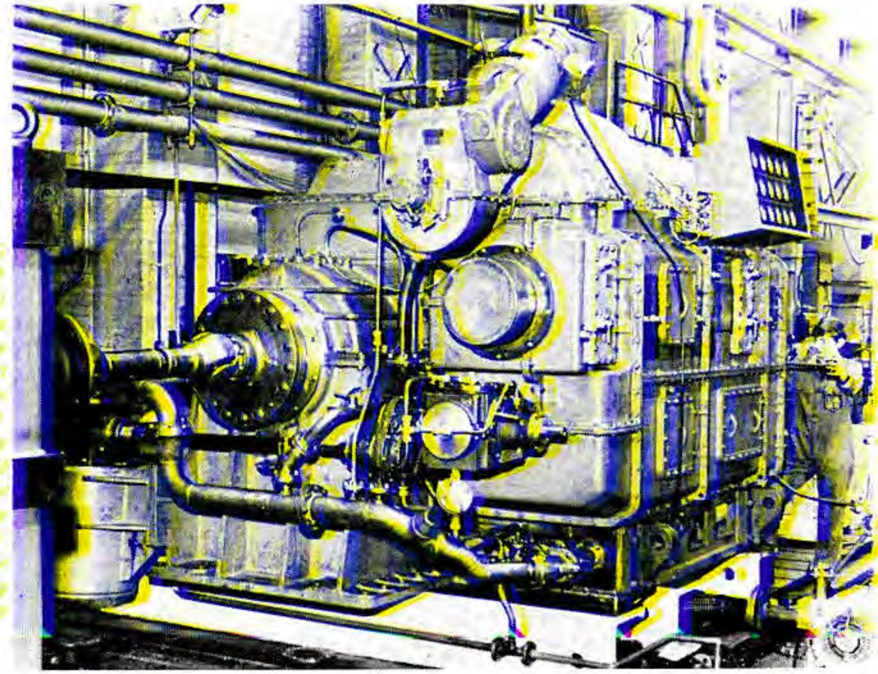
In late 1968 the Royal Navy ordered the first of a new class of guided-missile destroyer designated the Type 42 and later in 1969 the first of a class of general purpose frigate designated the Type 21. These two classes are somewhat unique in that although they are of different sizes and designed to perform different duties they have what is virtually a common propulsion system. Feasibility studies carried out by MOD(N) showed that the required performance of these ships could be met using a twin-screw arrangement with one Olympus engine per shaft with a smaller engine for cruise conditions on a COGOG basis. The engine selected for the cruise condition was the marinised version of the Rolls-Royce Tyne. Careful consideration was given to the question of reversing with the alternatives of reversing gearboxes with fixed-pitch propellers or, as decided, unidirectional transmissions with controllable-pitch propellers.

Major problems were presented by the widely different speeds of the two prime movers and by the positions in which they were preferably to be located in the ship. Rather than have a single complex gearbox it was decided to use a main gearbox and a separate primary gearbox (as part of the Tyne engine module) in order to reduce the Tyne speed to one suitable for acceptance by the main unit. With this arrangement, as long as the ratio of powers between Olympus and Tyne engines remains the same, the Tyne module will be unchanged regardless of the propeller speed required.



Type 42 destroyer and Type 21 frigate COGOG gear arrangement with co-axial inputs from Olympus TM3 and Tyne RM1A turbines to same primary pinion through SSS clutches. Double-helical trains are used throughout. The Tyne primary gears are in a separate casing and the port hand set has an idler to correct the rotation

In order to meet the conditions imposed by the shaft positions the main unit primary gears have been "rolled" inboard around the main wheel. In this case having matched the input speeds by the



David Brown COGOG gearbox for the Type 21 frigates (Amazon-class) and Type 42 destroyers (Sheffield-class) of the Royal and other navies. It is a port hand gear, seen from the inboard after end. The co-axial inputs from the Rolls-Royce Olympus and Tyne gas turbines are near the fitter's head and at the blanked flange respectively. Note the cross-over pto for the shaft-driven lubricating oil pump gear ratio included in the separate primary unit, both inputs are led into the same primary pinion, the main Olympus drive at the forward end and the cruising Tyne drives at the aft end. With SSS clutches at each end of the primary pinions all the gearing in the main unit will rotate under load when in either main or cruise drive.

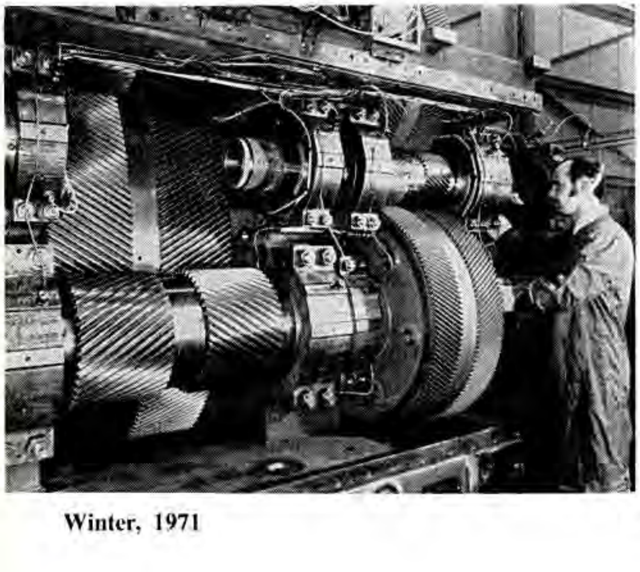
The Tyne engine drives into the primary gearbox through a torque tube and Metastream diaphragm couplings are also used between the primary unit and the main unit to accommodate the misalignment possible between the flexibly-mounted engine module and the rigidly-mounted main gearbox.

The power turbine of the Olympus engine can be arranged to give either direction or rotation but this is not the case with the Tyne. Therefore, in order to provide the correct rotation for port and starboard main shafts an idler gear has been placed in the primary gearbox train for the port set. The positions of the shafts are not changed and externally the primary units are identical.

These double helical gears are made from solid En36A forgings, carburise-hardened and with the teeth profile ground to a standard better than BS. 1807 A1. Tip, root and end reliefs are applied to the pinion in the starboard set and to the idler in the port set. With a pitch line speed of approximately 23,000ft/min which is in excess of normal naval practice, considerable thought was given to the design of the gear case to minimise oil churning and windage losses.

The main gear drive is the conventional dual tandem articulated locked-train arrangement with the primary gears placed aft of the secondaries. The SSS clutch between the Olympus engine and the gear is located alongside the secondary wheel. The gears are double helical with the pinions made from solid forgings in En36A steel and with the teeth carburise-hardened and profile ground. The primary wheel rims are En40b forgings nitride hardened. Careful attention was paid to the design of the wheel rim so that grinding of the teeth is not necessary. The wheels are of welded construction with the rim welded to sideplates and the sideplates welded to flanges formed on the shaft. The main wheel in which the teeth are hobbed is of bolted construction with the En30b through-hardend rim bolted to sideplates which are bolted to the shaft. Tip, root and end relief is applied to the pinions. With the proportions of pinions employed it is not necessary to introduce helix correction.

Primary and secondary shaft lines of Type 42 starboard gear. The SSS clutches have yet to be lifted in the spaces at each end of the primary pinion



All the shafts are carried in medium wall thickness whitemetal lined bearings which are fitted in separate steel sleeves and made in halves. The bearings are arranegd for easy removal and all journal bearings can be removed and replaced without disturbing the main bear case. Propeller thrust and gear location is taken on a conventional tilting pad thrust bearing which is located aft under the primary gears. This arrangement has enabled the gearbox length to be kept to a minimum. Ahead and astern thrust meters are fitted.

As with the *Exmouth* installation controllable-pitch propeller control and sea water pumps are driven from intermediate shaft ends and a shaft brake is fitted at the forward end of the unit. Due to the proximity of the brake to the input coupling torque tube the disc diameter is limited, therefore the same diameter chrome-plated copper disc as was fitted in HMS *Exmouth* is used, but in this case with three pairs of calipers. A shaft turning gear is fitted at the aft end of the intermediate shaft designed to turn the gearing and shaft for inspection purposes.

The gear case is of welded steel construction with the main portion of box section for rigidity. All the plates are designed to be as far as possible clear of critical resonances in the running range. The case structure has been analysed using finite element techniques to determine stress levels and deflections. Support in the vessel is through three areas located around the main thrust block and at two forward corners in the line of the main wheel. Covers which do not carry load are made in light alloy to facilitate handling during maintenance.

An interesting feature of the Tyne unit is the arrangement of the low speed coupling connection to the main unit. The length of torque tube necessary to accommodate the relative movement between the Tyne and the main units under shock conditions, while keeping the machinery length as

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Ferranti helicopter autostabilizer

A lightweight, simple, versatile equipment that can be used in any or all control axes—yaw, pitch or roll—to provide any helicopter with a "hands off" operational capability . . . even in hovering

The helicopter, with its ability to hover and to take-off or land vertically, appears to hold the promise of a perfect airborne vehicle. The casual observer might think that such a machine, because it takes off and lands at zero speed and cruises relatively slowly, would be easier to fly than a conventional fixed-wing aeroplane, which takes off and lands at anything between 100 and 200 knots (115 and 230 mph). Having the ability to fly at zero forward speed has its advantages, of course, but the pilot's task of controlling is in some ways more demanding with the helicopter than with a fixed-wing aeroplane.

The main reasons for this apparent paradox are fourfold: (i) the helicopter has an extra flying control (the collective-pitch lever); (ii) there is interaction between controls, ie altering one control affects the others; (iii) the effect of changes in airspeed is far more pronounced; and (iv) and by no means least, the helicopter is inherently unstable.

The last reason means that a short-term displacement, resulting from a gust of wind, tends to increase rather than subside. For example, a displacement in pitch will cause a helicopter, if unchecked, to continue to pitch at an increasing rate in the same direction. This effect is present in all planes of motion (roll, pitch and yaw) but varies in magnitude in each depending on the air speed, becoming worse at very low speeds. Consequently, the pilot is continually making corrective control movements to stabilise the aircraft, which is of course very tiring. Moreover, very rapid pilot response is necessary to keep the helicopter stable and although in clear weather conditions an accomplished helicopter pilot is able to cope with these flying characteristics without undue difficulty, in bad weather conditions and when instrument flying, his task becomes extremely difficult —even picking up a dropped map from the cockpit floor can be a hazardous operation.

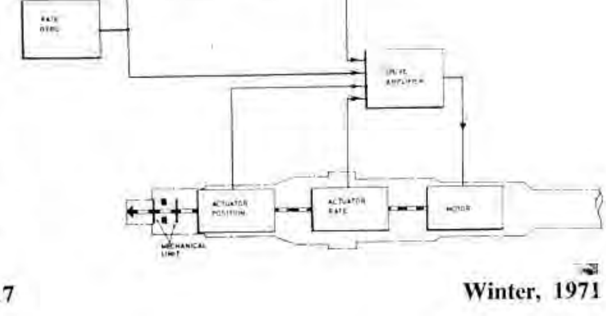
Clearly there is a need for some form of automatic device to relieve the pilot of some of the work involved and to make the helicopter a more stable and safer vehicle.

The Gyro Amplifier and Servo Actuator Units comprising one axis of the Ferranti FAS.2 Helicopter Autostabilizer

The Ferranti FAS2 Autostabilizer produced by the Company's Instrumentation Division was developed to meet this need. The autostabilizer senses the deviation of the helicopter from the desired flight attitude and automatically operates the controls to correct the flight path.

In each axis the autostabilizer uses a rate gyro as a sensor. The output of the sensor is processed by a small computer and used to control a servo actuator connected in the helicopter's control run. The actuator works in addition to the normal pilot's control movements, thus, while the autostabilizer acts on its own to keep the aircraft stable, the pilot puts in additional movements when he wishes to alter the attitude of the helicopter. With the autostabilizer fitted one to two minutes of stable flight can be achieved 'hands-off' and a considerable re-

General arrangement drawing of the Ferranti FAS.2 Helicopter Autostabilizer



duction in the pilot's workload results, particularly in turbulent conditions and during instrument flying.

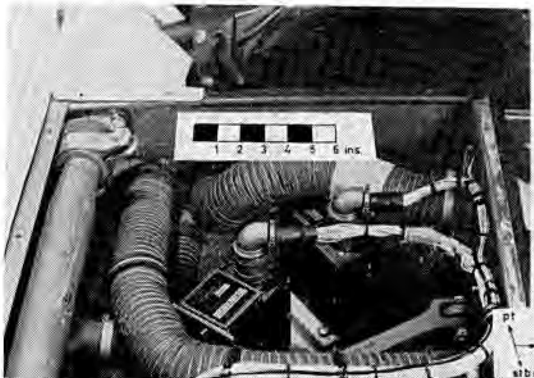
The equipment is light, self-contained and is easily installed and maintained. Furthermore, it can be fitted to any helicopter, large or small, to increase the operational and instrument flight capabilities.

The autostabiliser has already been fitted in a number of helicopters both in this country and abroad. Air Registration Board approval in Full Passenger Transport Category has been granted to the installation in the AB206 Jet Ranger and the Westland Wessex 60. The capability and reliability of the autostabilizer has been proved both during executive transport and in everyday workhorse activity servicing the North Sea drilling rigs.

Technical description

The Ferranti FAS2 Helicopter Autostabilizer consists of a Gyro Amplifier and a Servo Actuator for each axis. The Gyro Amplifier contains computing and drive amplifiers together with a rate gyro, which senses the rate of motion of the aircraft and whose output is split into two signals. The first of these is fed directly to the drive amplifier which controls the servo actuator. The other signal from the rate gyro is integrated to provide a signal proportional to the angular deviation of the aircraft from its datum. This integrated signal is subjected to "wash-out" (with a 12 second time constant) and limitation to ensure that desired changes to aircraft attitudes can be made without opposition from the stabiliser and that rate damping is available in the presence of a maximum integrated signal. These signals derived from the rate gyro, together with actuator position, and actuator rate signals, are summed and fed to the drive amplifier. This controls the motor and results in an actuator ram extension or retraction proportional to the rate and amount of aircraft movement.

Two of the three Gyro Amplifiers are fitted in the restricted space under one of the pilots' seats



The small diameter of the Servo Actuators enables two (one shown here) to be fitted in the already well filled control tunnel in the centre of the cabin

The Servo Actuator replaces one of the aircraft control rods and thus provides control movements in addition to those of the pilot. The actuator consists of a motor generator with gearbox driving a nut on a leadscrew, which has a position pick-off to provide feedback to the drive amplifier. The maximum stroke of the actuator is limited by a mechanical stop to approximately 10% of the total pilot control. The small size of the units enables installation in cramped situations and results in a negligible weight penalty. A three axis system has a total installed weight in the order of 9 to 11 kg (20 to 25 lb) and is driven from standard 28 V d.c. and 115 V a.c. aircraft supplies.

The simplicity of the system and proven design of the components ensure a high reliability with the added advantage that in the event of a fault, diagnosis and rectification is by unit change and within the competence of an 'X' licensed aircraft engineer.

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short as possible, has been passed through the low speed shaft, allowing the two units to be close coupled.

Prototype units have been built and tested at full load and speed at the works before being despatched to Rolls Royce to be used during engine development and testing.

In accordance with usual practice all the main and Tyne units will undergo a comprehensive flushing and cleaning process before a light load running at full speed, inspected and sealed before leaving the works, the seals should not be broken until the units are installed in the vessel and the ship's lubrication system has been flushed and cleaned to the same degree.

Gas turbine overspeed control

HSD fail-safe instruments for Rolls-Royce marine and industrial gas turbines

Every operator of prime movers is keenly aware of the dangers of overspeed, and provision for positive control of the evil is commonly made. However, as is often pointed out in this journal, the control itself may become unreliable owing to not being tested in practice as a maintenance routine. On the other hand unwanted operation can be expensive or even risk provoking.

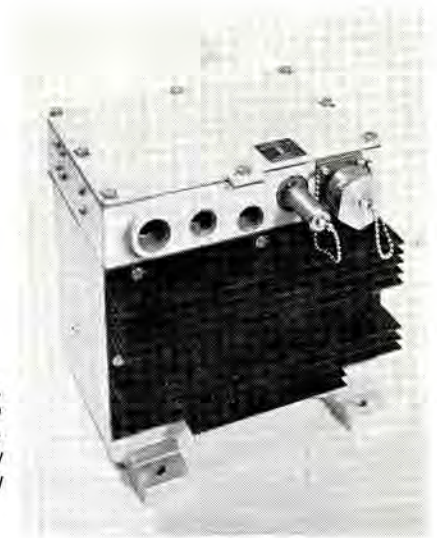


Fig. 1. The HSD gas turbine overspeed control

Essential features

In the case of overspeed of gas turbines used for marine duties or industrial service a run-away can endanger the lives of those working in the vicinity, cause very expensive damage to the power unit and its driven equipment, also interfering with the continuity of whatever task is in hand at the time. Two very important aspects of functioning of the device chosen for overspeed prevention are the ability to fail safe in all circumstances and the ability to be tested for working condition, even with a "dead" engine.

These and other requirements have been the bases for the design of a fast response, pulse-type dual-channel overspeed protection system for gas turbines, primarily for the range of Rolls-Royce gas turbines employed for marine and industrial services. The system is capable of application to gas turbines of other makes. It has been designed and is made by Hawker Siddeley Dynamics Engineering Ltd, Manor Road, Hatfield, Hertfordshire (Fig 1).

Redundancy techniques ensure that failure of any one component cannot cause inability of the system to trip should an overspeed occur. Use of two channels means that if excessive speed is sensed by either of two separate electromagnetic probes working with ferrous toothed wheels the engine is stopped by a fuel shut-off cock.

"Lowest-wins" dual-channel input power capability in conjunction with an engine driven tacho-generator facilitates correct functioning independent of the normal site power. A combined signal/power tacho-generator has been developed by HSDE to provide a three-phase signal to a speed indicator and 50 VA power to operate the trip machanism. Drive is from an accessory pad of the engine or from a compressor casing, turbine casing or primary gearbox. The shaft bearings are lubricated from the engine by oil mist (Fig 2).

If one channel is defective it is indicated as a fault without impairing ability to operate on the remaining channel. A logical circuit gives warning if either of the two outputs of the parallel duplicated thyristor switches should fail, and de-energises a relay when either of the lanes is switched to energise the shut-off cock solenoid. Warning also is given in the event of loss of either speed signal, failure of the higher frequency switches or loss of power supply.

An inbuilt test facility provisions a signal from a

Fig. 2. The HSD engine-driven tacho-generator

function test oscillator, set to a value somewhat higher than the service figures, to be injected into each lane of the system to check satisfactory operation.

Principles of operation

A pulse-type bistable higher frequency switch compares shaft speed as a frequency derived from an inductive speed probe with a frequency datum in each channel. If the shaft speed exceeds the predetermined value both higher frequency switches give outputs to operate a stage of the parallel duplicated thyristor switches. When either stage is operated energy is injected into an engine fuel system solenoid to shut off the fuel and stop the engine. A simultaneous warning is given of the working of the trip for monitoring purposes.

An integral part of the overspeed control unit is the provision for adjustment of the selected speed limit; this permits application of the standard device to a variety of gas turbines. Control accuracy is within $\pm 1\%$ over the full temperature range.

As the higher frequency switches require two cycles of frequency difference for trip working, the danger of false action due to electrical noise pick-up is minimised.

Environmental conditions

The trip device operates over an ambient temperature range of $+55^\circ C$ to $-20^\circ C$. The tacho-generator has the under operation range of $+125^\circ C$ to $-20^\circ C$. The rugged construction allows engine frame mounting and will absorb marine shock and vibration conditions.

The design is intended to operate over a wide range of voltage supplies and load requirements by internal link connections and external components.

Construction

The components of the system are carried by five banks of glass fibre double-sided printed circuit boards, firmly located on pillars; electrical connections are via screwed terminals. The neat aluminium alloy casting is sealed and waterproofed, being safeguarded against the ingress of the usual contaminants and sea water. A double safeguard feature prevents inadvertent operation of the test facility. The unit occupies some 3,081 cm^3 (180 in^3) of space.

Shorts introduce naval application for army missile

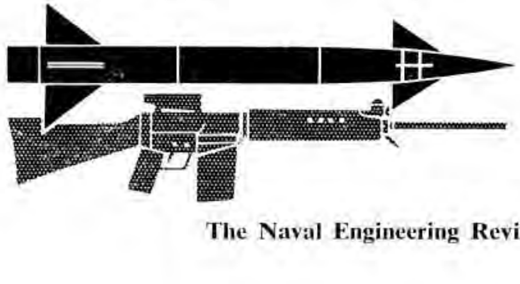
Shorts' Blowpipe anti-aircraft missile system—now under advanced development for the British Army—has been adapted for naval use with a new two-round launcher

Blowpipe is a supersonic guided missile system which is so compact, light and simple that it can be carried and operated by one man. It is designed for defence against low-level air attack, and has a secondary capability against land and sea surface targets.

The absence of launch recoil makes it possible to design, for naval use, ultra-light multi-missile launchers which can be quickly installed on frigates, coastal minesweepers, patrol boats and hovercraft without structural stiffening. Shorts' also have a design study for a power-operated 10-missile launcher which when used with an optically stabilised sight or suitable fire control director could maintain Blowpipe's effectiveness in conditions of rapid or erratic ship motion or low visibility. It has no firing reaction forces and with a weight of less than 340kg can be mounted on any surface vessel.

The extreme portability and versatility of Blowpipe give the system a wide range of naval applications. It is particularly suitable for use by marines in assault operations, enabling them to carry their own defence system onto the beaches with the first assault wave; and can be used as a "carry on board" weapon system to be fired from the shoulder by an aimer.

Blowpipe, weighing less than 40lb, is comparable in size to an automatic rifle



New HF SSB radio equipment for R.N.

The Ministry of Defence has placed a contract with the Communications Division of Redifon Ltd (a member company of the Rediffusion organisation) for the supply of 42 HF SSB transmitter systems and 82 general-purpose receivers for warships of the Royal Navy. Each transmitter system will be used with one of the receivers to constitute a complete 100W radio station for R/T and W/T communication over the 1.5 MHz to 30 MHz range. The order covers a major stage in the replacement of naval equipments (type 618/619 transmitters and CAT receiver outfits), currently in service in warships of all classes, by SSB installations employing frequency synthesis. The Redifon receivers additionally provide continuous VFO tuning for band search, an important feature in naval applications, while the all-solid-state broadband linear amplifiers used in the transmitter systems obviates amplifier tuning and loading adjustments.

The transmitter systems and the receiver both incorporate standard units of Redifon's new HF range, developed as a private venture and already being marketed commercially.

The entire equipment is designed to the relevant clauses of defence specification DEF.133 and complies with the latest ITU recommendations concerning the use of SSB in the maritime mobile service. The receiver is the R.550, which provides unbroken frequency coverage from 100 kHz to 30 MHz in 100 Hz increments by frequency synthesis. It also incorporates VFO tuning, which is an important facility for searching congested calling bands and which permits operators to "rock" the tuning when reading signals through spasmodic interference. At the same time, the full frequency synthesis tuning ensures rapid and precise setting to stations of known frequency.

The basic naval receiver assembly is designated Outfit CJP (1). In some installations an adaptor panel will be fitted to allow operation via the naval aerial distribution system, which may be used to feed a number of receivers from one aerial. In this form the designation is Outfit CJP (2).

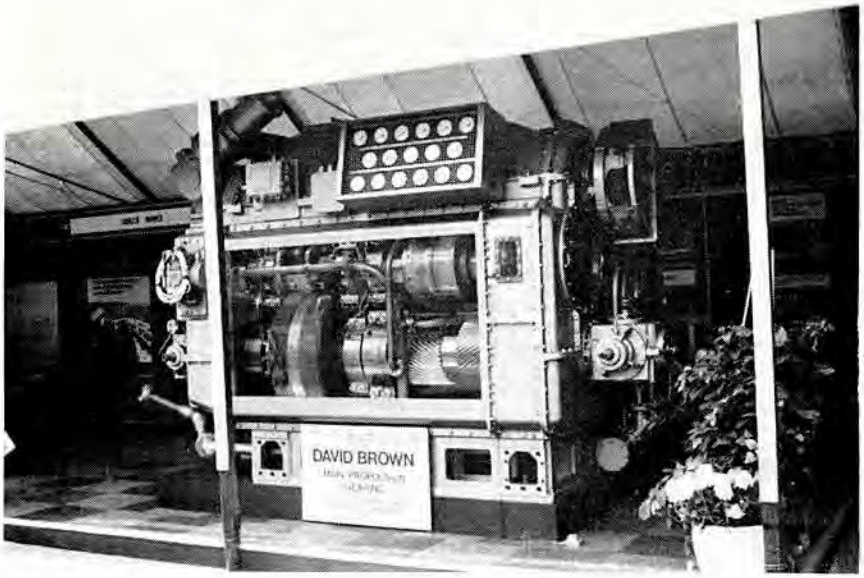
Of three separate assemblies which make up the transmitter system, only one need be sited under the immediate control of the operator. The assemblies are the driver, comprising a GK.203 frequency synthesiser drive unit which develops the low-level signal at frequency of radiation and in the required transmission mode: the linear amplifier comprising a GA.481 all-solid-state 100W broadband amplifier and its power unit; and a remotely-controlled A.T.U. for use with open-wire aerials or with whips such as the naval AWH 24-foot and AWN 30-foot aerials. The control panel for the A.T.U. is housed in the GK.203 cabinet. The naval designation for the complete transmitter system is Outfit 643.

To select transmission on any given frequency, in increments of 100 Hz, it is necessary only to set the digits on the GK.203's six in-line frequency synthesiser dials and adjust the A.T.U. Correct adjustment is indicated by maximum reading on a single meter on the remote-control panel. The rest of the system is broadband and the linear amplifier can therefore be conveniently located remotely from the operator without resort to auto-tune servos. This fact, together with the complete elimination of valves, represents an advance in reliability in those shipboard installations where speed of operation is required at the same time as maximum frequency flexibility.

Although the GK.203 incorporates its own frequency reference source, it can be locked to a ship's main frequency standard. Modes of transmission include CW, MCW, DSB, and SSB with full, pilot or fully suppressed carrier. USB and LSB are manually selectable. As well as being manually keyed for morse, the unit accepts an audio frequency input for RATT operation. A full range of Redifon terminal units for this purpose has been supplied to the Royal Navy over several years, and the company can supply a complete warship RATT system (Outfit RWB).

For warship installations requiring a transmitter power of more than 100W, the GA.481 linear amplifier can be replaced by all-solid-state broadband units with output powers of 400W or 1kW. These amplifiers, which were recently introduced by Redifon, use similar techniques to those employed in the 100W unit and cover the 1.5 to 30 MHz frequency range.

The new receiver outfit CJP(1) as supplied to the RN



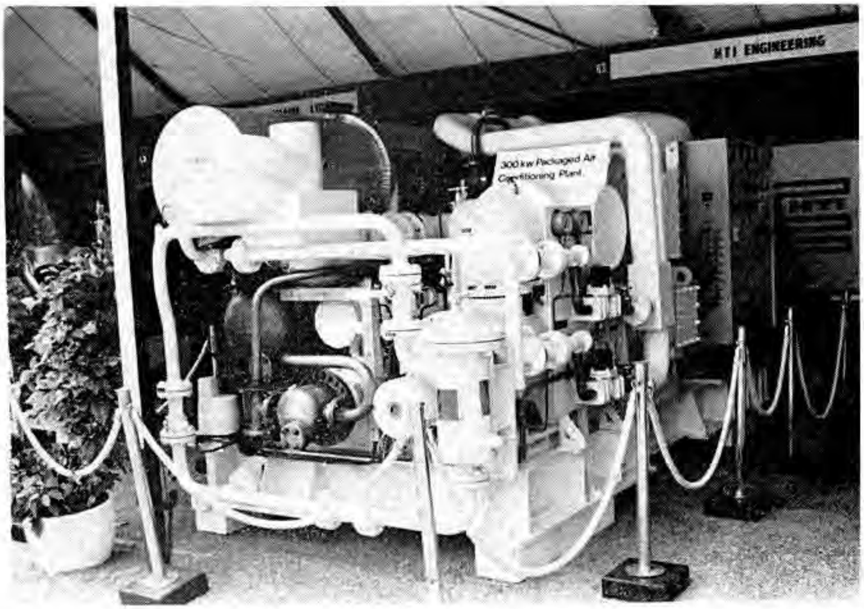
David Brown COGOG reduction gearbox offers alternative drive with on-load change of mode through SSS clutches from Rolls-Royce Marine Olympus or Marine Tyne gas turbines. Both turbines drive into the upper shaft, which carries the primary pinion. There are thus no unloaded gears in either mode

ROYAL NAVY EQUIPMENT EXHIBITION AT GREENWICH

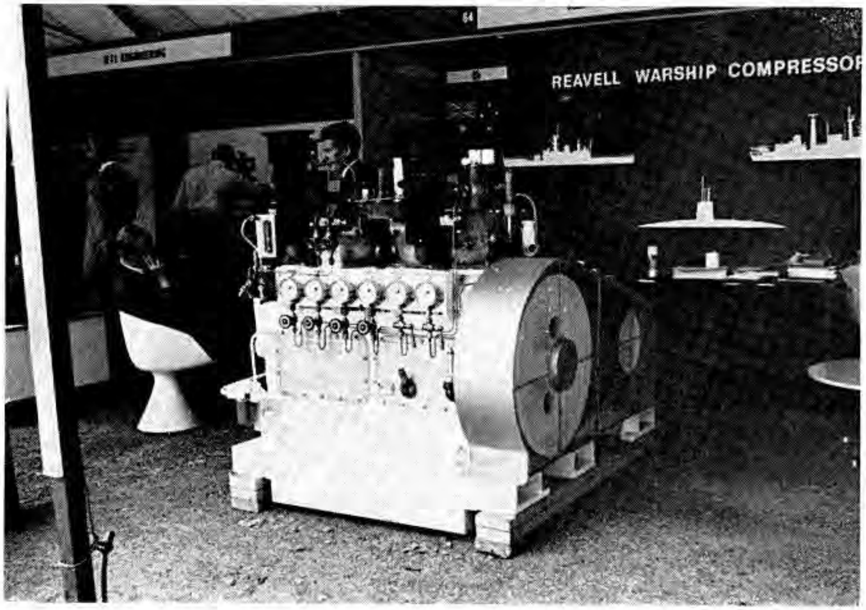
Stone Manganese Marine five-bladed propeller for a 'Leander'-class frigate. The 'cropped' blades of this highly efficient design contrast interestingly with merchant vessel practice. SMM will supply their Mark XX cpp's for the frigate and destroyer programmes of the Royal Navy

Rolls-Royce Marine Olympus gas turbine package, ordered as the boost engine of the Royal Navy's Type 42 destroyers and Type 21 frigates, for vessels of the Royal Netherlands and Argentine Navies and nominated by the Royal Australian Navy

One of the largest exhibitions sponsored by the Sales Branch of the Ministry of Defence (Navy) was held in the grounds of the Royal Naval College, Greenwich, last September. It was supported by a large number of companies manufacturing the equipment which keeps the Royal Navy in the forefront of modern technology, including advanced electronics, surveillance and weapons guidance field. Other equipment included night vision sights contrast with new types of lighting, underwater fuel cells and primary batteries with alternators, gas turbines with diesel engines, fork lift trucks, compressors, refrigeration units and boilers together with guided weapons, radar, air navigation systems, peri-

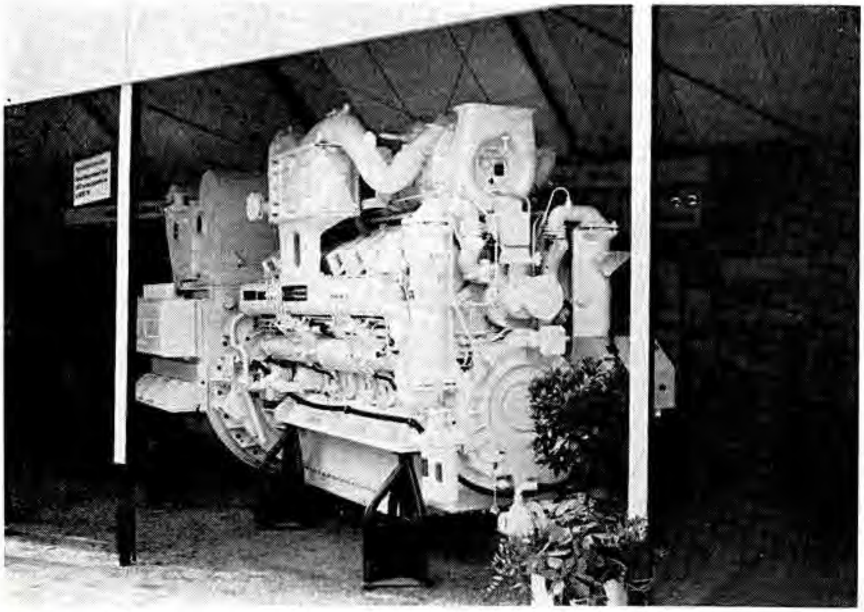


One of the 300kW HTI packaged air-conditioning units, four of which will be installed in the Type 42 destroyers. Basis of this compact unit is a Howden screw-type rotary compressor driven by a 140hp closed circuit water-cooled electric motor. The package incorporated the condensers and fresh water chiller and cnly needs connecting to the ship's chilled water and electrical systems



Reavell R80/4000 high pressure (280kg/cm²) air compressor will be installed in the Type 42 destroyers. It has no out-of-balance forces to give rise to vibration or an under water noise 'signature'

scopes and hovercraft models. The exhibition coincided with an important Services meeting in London which was attended by senior naval officers and controllers of material from many overseas navies which gave the British equipment a splendid opportunity of direct contact with the specifiers and users of their products. In the few years that the Sales Branch has been in existence to promote the export of British hardware and knowhow, it has had some notable success least of all this latest exhibition which was a credit to all concerned. On this and preceding pages we illustrate six of the heaviest mechanical items exhibited under an open canopy alongside the main avenue.



Standard 1MW diesel-alternator set for the Royal Navy is powered by a 16-cylinder Ruston Paxman Ventura engine. Four of these sets are to be fitted in each of the Type 21 and Type 42 ships. The 450V 60Hz alternator is an English Electric-AEI machine

New shipborne search and target tracking radar

Fully automatic tracking facility for small warships

A new automatic search and target tracking radar for small warships is under development by Marconi Radar Systems, a GEC-Marconi Electronics company. This advanced radar, the Type ST801, has been planned for ships down to fast patrol boat size, and is designed to enhance their tactical advantage without materially increasing their manning, space or weight problems.

The radar will automatically track selected airborne or surface targets, and provide fast and accurate position data for directing guns or missiles. It will operate in the 3-centimetre frequency band, with extensive protection against radar jamming measures incorporated in the basic design. Signal clutter due to sea reflection has been minimised to enable the radar to track effectively down to very low angles of elevation and the target line-of-sight is fully stabilised against ship's motion, even in heavy seas.

The complete weapon direction system would normally include a fully automatic missile gathering and guidance television system. The television camera, directed by the radar, is centred on the target at all times. This is primarily intended to guide the missile automatically on to the target, but can also be used to identify targets and confirm the end of the engagement. The overall system, which consists of a director with a 1 metre diameter antenna and television camera above decks, with the transmitter/receiver and control consoles below, weighs only just over a ton and is fully ruggedised for operation in the maritime environment.

Radar Tracking

The ST801 radar tracks by using a four-horn monopulse feed on the aerial in conjunction with a fine pencil beam. After target selection and acquisition, which may be achieved by the ST801 in a search phase, the aerial in the autotrack phase is automatically driven to keep the target echo equalised in the four quadrant horns. This is known as a 'static-split' horn arrangement, and will keep the aerial trained straight at the target at all times. The tracking system is designed for minimum lag in following the target, and the narrow, 2.4° pencil beam ensures highly accurate definition of the target's position.

Add-on Television System

The range and bearing of the target can be fed as information to direct guns or missiles against surface targets. In engagements against airborne missiles and aircraft, automatic gathering before guidance of the defensive missile is necessary, and for this a television system is normally fitted in association with the radar. This combination creates a completely automatic, fast reacting missile system which will carry out all phases of a target engagement, from search and acquisition through to destruction. The television camera is mounted on the radar director, and is also trained on the target. When the missile is launched, the television system automatically 'gathers' it from whatever attitude it has assumed, and commands it on a line-of-sight path to the target at the centre of the radar-driven camera sightline.

Transmitter and Signal Processing

The transmitter incorporates a tuneable magnetron operating in the 3-centimetre frequency band, with a short pulse for maximum range resolution and tracking accuracy. The receiver, with monopulse signal processing, is provided with anti-jamming facilities. Sea reflection clutter, normally a major drawback to low level radar search and tracking has been minimised by employing a digital MTI (Moving Target Indication) system which can discriminate between moving echoes and echoes which are basically static.

Dunlop Seafarer inflatable liferafts for R.N.

The Ministry of Defence has placed a joint services order with Dunlop for 110 ten-man Seafarer type inflatable liferafts. They will be used by the services not only in the U.K. but throughout the world. The R.A.F. Marine Craft Fleet will be the first to be provided with these liferafts, which will be supplied in "large pack containers", enabling the R.A.F. to include their own special ancillary pack. The standard Seafarer ordered complies with the rigid specifications in the appropriate sections of the Department of Trade and Industry regulations (Marine). Seafarer inflatable liferafts are produced by Dunlop's G.R.G. Division in eight sizes from four to twenty-five man rated capacities.

Vosper Thornycroft fast patrol hovercraft

The Vosper Thornycroft fast patrol hovercraft, though smaller in size and less expensive than many patrol boats, has a full speed of 46 knots and an armament of formidable power and accuracy. The main anti-ship weapons are four Exocet guided missiles with a range of some 20 kilometres and a kill-power equivalent to that of a 15in. shell. The forward gun is a twin-barrelled 35mm Oerlikon, designed primarily for rapid and accurate fire against aircraft and guided missiles but also extremely effective when directed against light craft. Both are controlled by Contraves fire control equipment as fitted in a number of the latest frigates.

The lift fans and propellers are driven by a single gas turbine engine fitted each side of the craft.

Principal Particulars:		
Length o.a.	93ft 6in	(28.05m)
Breadth (hard structure)	43ft 6in	(13.25m)
Draught hovering	3ft 6in	(1.07m)
Draught floating	10ft 0in	(3.05m)
Basic weight	66 tons	

A particular feature of the hovercraft in the fast patrol boat role is its stability in rough weather and the ability to maintain a high speed in rough seas. Like the VT1, the patrol hovercraft is driven by water propellers carried on skegs or keels below the main raft and spaced laterally some 20ft (6.1m) apart. In rough weather, at speeds of 40-50 knots, water propellers require only about half the installed horsepower of air propellers, while the transmission system is of standard marine type and is less costly. Other advantages of water propellers are that they are less noisy than air propellers and do not interfere with the arcs of fire of the guns. The high speed of the craft, coupled with its shallow draught of 3ft 6in (1.07m) when on a cushion, makes it virtually immune to attack from torpedoes. The skegs carrying the propellers also carry water rudders, therefore the craft is held firmly in the water and as was demonstrated during trials can be simply and accurately manoeuvred in strong cross winds. The hovercraft can be beached for maintenance or repair on any hard sloping surface. This is normally best effected on a concrete hard but the craft can also be secured alongside a jetty.

Both propulsion and lift are obtained from a single Avco Lycoming TF35 gas turbine fitted each side of the craft and auxiliary machinery includes two 100kW gas turbine powered alternators. With 20 tons of fuel the craft has an endurance of 14 hours at 43 knots, or 600 miles.

Radar and radio equipment includes a Decca TM626 navigational radar, electronic counter measures equipment and a full outfit of craft-to-air, craft-to-ship and craft-to-shore communications.

Air-conditioned accommodation furnished to the most modern standards is provided for a captain, three officers and seven ratings.

An artist's impression of Vosper Thornycroft's 46-knot fast patrol hovercraft firing one of its four Exocet guided missiles. The forward gun is a twin-barrelled 35mm Oerlikon

The SCOT system

Highly reliable system for operation with the British military Skynet

The first production order for the new SCOT mini-dish space communications terminals has been placed with Marconi Space and Defence Systems, a GEC-Marconi Electronics company, by the Ministry of Defence. This order for eight terminals, worth well over a million pounds, follows a development contract placed with the Company last year.

The production terminals will be fitted to all classes of HM ships down to frigate size to provide highly reliable communication through the British military Skynet system. Delivery will be completed by early 1974.

A prototype SCOT terminal is now nearing completion at the Company's headquarters at Stanmore, Middlesex, and is to be fitted in HMS Grenville, a Royal Navy frigate, in the autumn of this year, for comprehensive ship trials.

The company sees considerable export potential in this new SCOT system which will be sufficiently advanced for practical demonstrations in the very near future.

The electronics equipment for each complete space terminal is contained in a transportable cabin, designed to be mounted on the deck of the ship. The two 3.5 foot diameter dish aerial units, each equipped with a gyro-stabilising unit, are mounted on the superstructure on either side of the ships, to provide an unobstructed view of the satellite from at least one dish, at all times. All operational controls and test facilities are provided on a simple operational control console in the ship's main communications office.

Complete SCOT systems can be transferred between ships, as necessary, without any difficulty. Installation of all of the SCOT systems will be carried out by Naval Dockyards.

The SCOT system

The SCOT system is designed to provide effective communications through a satellite link, using a self-contained and highly reliable system which is small enough to be mounted on a frigate, and which will provide effective and extremely mobile, inter-continental communications.

The system uses a pair of 1.1 metre (3.5 foot) diameter dish aerials, constructed from glass fibre reinforced plastic, with a metal coated reflecting surface. It uses a double reflector system which provides an illumination efficiency about 10% higher than any other arrangement. The two aerials can be mounted on either side of the ships in such a way that at least one dish will be able to see a satellite in any part of the sky, at all times. Each dish is fully steerable, and is mounted on a three-axis mounting designed to cater for the worst possible ship's motion in heavy seas, and to ensure that full steerability will be maintained at all attitudes. Each dish aerial will be protected by a double skinned radome.

Stabilisation of each of the two aerial units is provided by a gyro-stabilised platform on the aerial mounting. The only other active units on the aerial are the motors and resolvers which control the movement of the aerial systems.

Electronic equipment has otherwise been almost entirely eliminated from the aerial unit, and concentrated in an engineering cabin mounted at deck level, where complete protection can be provided for all of the communications equipment. This also simplifies maintenance in service. The aerials are connected directly with the first stages of amplification in this cabin, by a length of low-loss waveguide.

The engineering cabin mounted on the deck is completely self-contained, and houses the solid-state receiver, which uses an uncooled parametric amplifier as a first stage. The transmitter is also fully solid-state, with the exception of a klystron output stage and travelling wave tube drive. Power supplies for the complete SCOT system are provided within this cabin, which requires only an input from the standard, unstabilised ship's power supply.

An air-conditioning system is built into the equipment, to provide full environmental protection for all of the equipment. This cabin is a fully stressed, lightweight aluminium structure, designed to survive in the most arduous circumstances, without any additional protection.

Full control facilities are provided within the equipment cabin, although the system is designed to be controlled entirely from an operational control console in the ship's main communications office, and there is no need for the equipment cabin to be manned in normal circumstances. An operator can acquire a satellite and control all of the communications facilities from this remote position. The status of all units can also be monitored here.

The original concept of the SCOT system was formulated in the Admiralty Surface Weapons Establishment at Portsdown, where an experimental model was constructed and brought into operation to prove the feasibility of the concept, before the development programme was awarded to Marconi Space and Defence Systems.

Turbine blades from blanks

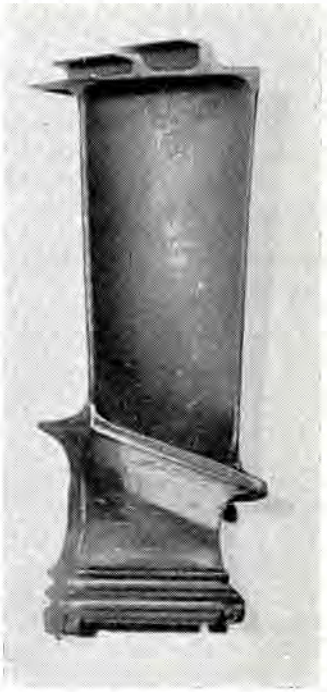
In the quarter of a century during which commercial gas turbines for industrial, marine and land transport have been available the manufacture of blading has been a key matter. At the outset it was somewhat of a toolroom job, and accordingly expensive. Progress of this form of prime mover called for much larger volumes of production and finished cost per blade at a much more acceptable level. The material used has to withstand operational conditions which necessitate onerous processing tasks. Today much more is known about efficiency in executing these tasks, in no small measure due to the know-how built up by Henry Wiggin and Co Ltd, of Hereford. That concern has served not only the non-aircraft gas turbine industry but the larger one of military and commercial aircraft, the former right back in the "infancy" days of the 1940s.

Where very high temperatures are involved cast blades are favoured because hot working of the alloy materials is not practical. Such cast items have a somewhat lower fatigue strength and greater brittleness than are desired, although with correctly applied knowledge these characteristics can be kept to a minimum. Better structural integrity is offered by the use of wrought blades, machined from either (a) blanks forged to close tolerances from extruded and machined bar; or (b) from extruded, cold rolled and heat-treated blanks. Which of the two practices is adopted is determined by the ultimate shape of the blade and the amount of metal which has to be machined to waste, or scrap.

Specialised precision grinding plant has been installed by the Wiggin concern, and this means that the customer has only to machine and polish a block or blank to attain his blade objective. Highly important is the fact that fundamental soundness of the piece of material is ensured by the supplier before final processing. Precision blanks go straight on to the production line, using the standard ground faces as datum faces. Machine shop times, costs and clerical labour are all reduced by this practice.

Fig. 1. Some of the various extruded blade blanks made by Henry Wiggin in Nimonic alloys for gas turbine manufacturers

Fig. 2. A Nimonic 105 turbine blade, machined from a Wiggin blank, after seven thousand hours in a Rolls-Royce Dart gas turbine



Blanks are offered in heat-resisting and creep-resisting Nimonic alloys 80A, 90, 105, 108, 115 and 118. These materials are cast as ingots, which are extruded to rectangular bar form in either a 3,500-ton or 5,000-ton press. Cold rolling introduces a carefully controlled amount of cold working; the reduction in section is calculated and closely regulated to give the best grain size after final heat treatment. Next straightening is applied, if necessary and then solution heat-treated, following by ageing treatments; no extra heating is necessary at the blade manufacturer's works.

Inspection, cutting to blank length, etching and precision grinding follow, according to individual customer's requirements.

This practice of the supply of blanks (Fig 1) has existed for some 20 years, and has covered such well-known turbine makers' names as Rolls-Royce (Fig 2) and Ruston (Fig 3). In the Ruston case Wiggin blanks used in over 500 turbines (500 to 5,000bhp rating per machine) have shown the results in practice quoted in the concluding paragraph, fuels having been natural and oilfield gases, unwashed sludge gas, product-off gases and liquid supplies ranging from crudes to diesel fuels. No Ruston blade failures have occurred and blade inspections are precautionary only.

In 7,320,907 running hours the greatest number of hours by any single unit has been 115,000 and the longest non-stop run 15 months; no fewer than 55 turbines have exceeded 50,000 running hours apiece. Total-energy installations have accomplished over 1,500,000 hours.

Fig. 3. A power turbine rotor from a Ruston industrial gas turbine returned from Kuwait after 100,000 running hours; after metallurgical inspection of two blades it was returned to site for further work

CODAG machinery in the Italian Navy

A series of fast twin-screw escort vessels is now being commissioned in the Italian Navy. Each shaft is driven by two Franco-Tosi QTV320/12 four-stroke engines with a maximum rating of 4,200bhp at 730 rev/min and one Franco-Tosi-AEI G6 Mk 2 gas turbine of 7,500hp at 4,900 rev/min. The three-input single-output transmission has a double single-helical main wheel providing two reduction ratios for the diesel engines. The propellers are designed for the maximum combined output of 15,900shp (2 x 4,200 plus 7,500) and would absorb the maximum output of the two diesels alone at a speed of some 19 per cent lower than that corresponding to their full power condition. In order to enable the diesels to develop their full output they are coupled by a gear train providing a 1 : 1.24 lower reduction ratio.

The gas turbine, arranged forward of the gearcase, drives the forward helix of the main wheel through an articulated train with quill drive and SSS clutch. The diesels are arranged after of the gear and drive the propeller shaft through a single reduction train, using the after helix of the main wheel (higher ratio) for full power and the forward helix (lower ratio) when cruising independently of the gas turbine.

Change-over is effected by means of two Franco-Tosi-AG Weser Vulcan hydraulic couplings. The driving runners are coupled by a quillshaft which extends through the pinion shafts, while the driven runners are secured independently to their respective pinion shafts. The SSS clutch enables the gas turbine to be engaged without interrupting the transmission of power as follows: the diesel engines are run up and the cruising couplings are engaged to provide a single reduction drive through pinion and wheel. When boost is required the gas turbine is run up until the speed of the first reduction wheel coincides with that of the hitherto idling second reduction pinion. The SSS clutch then engages automatically. The load is then transferred from the diesels to the gas turbine, and the cruising couplings are disengaged. The speed of the diesels is then reduced until the driving and driven elements of full power couplings coincide. When these are engaged the diesel and gas turbine power is increased to the maximum.

Did you know that . . . ?

Immediately following the launch of the Royal Navy's Type 42 destroyer HMS *Sheffield* from the Barrow shipyard of Vickers Shipbuilding Group, the first section was laid of a similar vessel, to be named *Hercules*, for the Argentine Navy. In each case the machinery will consist of Rolls-Royce Olympus gas turbines for full power and Tyne gas turbines for cruising, coupled through SSS clutches and David Brown reduction gears to drive cp propellers.

The Royal Australian Navy is planning to order up to six fleet destroyers. It is understood that in the absence of any suitable existing or projected Royal Navy or United States Navy ships, the RAN has prepared its own designs and that a contract has been awarded to Y-ARD (Aust) Pty Ltd to undertake preliminary design studies. It is also understood that the machinery will comprise a COGOG propulsion system and that Rolls-Royce Olympus and Tyne gas turbines have been chosen for design purposes.

The first firm news of the Royal Navy's projected "through-deck" cruiser, a 19-20,000 displ 30-knot command and helicopter and V/STOL aircraft-carrier, was given in *Jane's Fighting Ships* for 1971/2, which published an official artist's impression. A twin-screw COGOG plant with one Rolls-Royce Olympus or RB211 gas turbine and one Tyne gas turbine for each shaft is being spoken of, but we have heard that a twin Olympus/RB211 COGAG arrangement is possible. This would be a similar arrangement to that used for the US Navy's DD 963-class destroyer.

The tremendous cost and concentrated risk attaching to large strike aircraft-carriers has led the US Navy to show great interest in much smaller vessels, able to handle the Harrier VTOL aircraft. Hawker Siddeley have orders from the US Navy for 114, of which 30 have been delivered.

The French-built submarine *Emily Hobhouse*—formally handed over to South Africa some weeks ago—recently arrived in Toulon for training exercises at the French Mediterranean naval base.

Principal particulars of the class are:

Length, o.a.	57.7m
Max. breadth on waterline	5.9m
Aft draught	4.6m
Forward draught	4.4m
Depth amidships	4.19m
Displacement (surface)	869 tons
Displacement (submerged)	1043 tons
Speed	13.5—15.5 knots

The boat is armed with twelve 550mm torpedo tubes and carries a crew complement of 46.

Projected 'through deck' cruiser for the Royal Navy—largest all gas turbine-powered naval ship

Did you know that . . . ?

Main propulsion is Diesel-electric, primary power for the boat's two 450 kW alternators being supplied by two SEMT-Pielstick Atlantique Diesels developing 800hp at 390 rev/min, while there is a 1400/3250kW storage battery.

The boat is one of three French-built *Daphne*-class submarines which will eventually form the nucleus of a South African submarine force.

Welcoming her into port were the South African crew of *Maria van Riebeck*—the first of the French-built submarines sold to South Africa.

Emily Hobhouse is scheduled to stay in Toulon for several months.

The third submarine destined for South Africa—*Johanna van der Merwe*—is still under construction at Nantes in North-west France.

The three French-built South African submarines are identical to the four already handed over to Portugal, and three sister craft have been built for Pakistan.

The 1,550 ton displacement destroyer escort *Ayase* was recently delivered to the Japan Defence Agency by the Tokyo Shipyard of IHI (Ishikawajima-Harima Heavy Industries Co Ltd). The dimensions are: 93.35m in length, 10.8m in breadth and 7.0m in depth. The main propulsion machinery consists of four Mitsubishi UEV30/40N-type 12-cylinder diesel engines with a total output of 16,000bhp for a speed of 25 knots. Armament includes two tripled torpedo tubes and an ASROC launcher.

The Ministry of Defence has ordered two Type 42 destroyers from Cammell Lairds and Co, Birkenhead and a third from Vickers Ltd, Barrow-in-Furness. The announcement concerning the last was made at the launching by Her Majesty the Queen, of HMS *Sheffield*, the first ship of the class at Vickers, Barrow, early last month. They will be powered by a combination of Rolls-Royce Tyne gas turbines for cruising and Olympus gas turbines for full power, and they will be armed with the 4.5 inch MK 8 gun, A/S torpedo tubes and the new Sea Dart surface-to-air/surface missile system. They will also carry the new twin-engined WG13 Lynx A/S helicopter.

Oil which drips on to insulated pipes carrying high temperature steam or exhaust is a potential fire hazard which must be familiar to most operators. Foster Sealfast, manufactured by Atlas Preservative Co Ltd under licence from Achem Products Inc U.S.A., is a solution to this problem and one which is currently used in several CEGS power stations. The insulation is treated with a sealing coat of Sealfast 30-36, followed by a layer

Multi-diesel engined destroyer-escort 'Ayase' of Foster glass cloth membrane No. 20, which is embedded into the sealer coat. The cloth membrane is then finished with a coat of Sealfast 30-36 of 0.3in wet film thickness (about 80ft^2 per gallon 1.6m^2/litre). Once treated, any oil falling on the pipe will run harmlessly around the insulation and drop off onto the floor. Where insulation is to be painted in colours to identify the fluid in the system, main steam, auxiliary steam, feed water, auxiliary exhaust, etc, Foster Vitect coating can be applied. An illustrated leaflet describing this system is available from the Thermal Insulation Protection Division of Atlas Preservative Co Ltd, Erith, Kent.

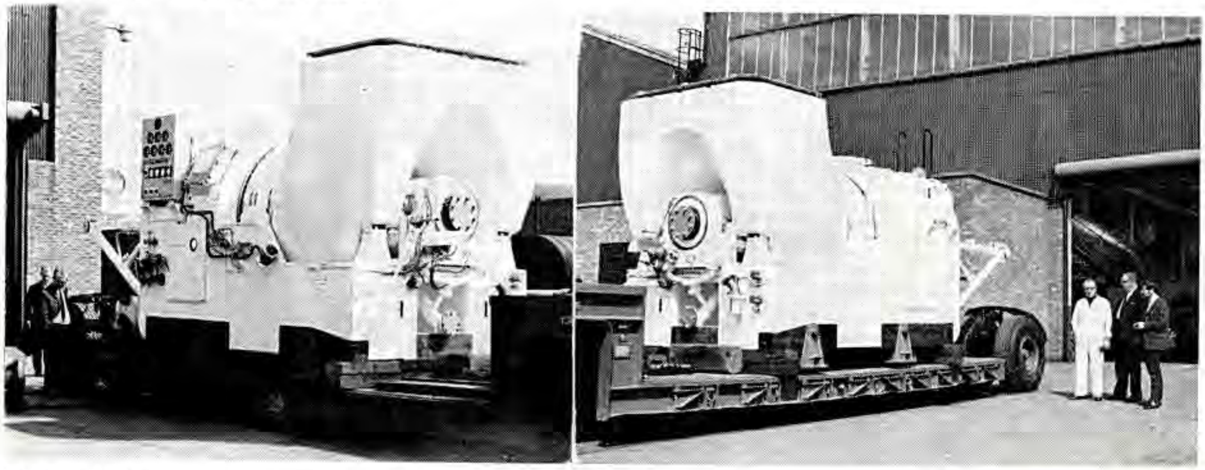
The Industrial and Marine Division of Rolls-Royce (1971) Ltd, has despatched the first of the latest model Marine Olympus engines to Woolston, Southampton, where it will be installed in HMS *Amazon*, lead ship of the Type 21 frigates. Each of the two SMM controllable-pitch propellers will be driven, through SSS clutches and a David Brown reduction gearbox by one 27,200hp Olympus engine for full power or a 4,100hp Tyne engine for cruising. The TM3B differs from the TM2A fitted in the Iranian destroyers of the *Saam* class and TM1A of HMS *Bristol* and HMS *Exmouth* in having a narrower parallel sided supporting base and a straight-through 90-degree exhaust bend. Cooling air directed to the H.P. turbine stator blades has had the result of raising the output of the gasifier, and the shaft horsepower from 24,000 to 27,200hp, an increase of 13 per cent. This improvement is associated with a substantial reduction in fuel consumption and a 20 per cent reduction in weight and envelope space. TM3B's have been ordered for vessels of the Argentine, Brazilian, Thai and Netherland navies.

Following the successful trials of a first set of equipment installed in a submarine during 1969, the Royal Swedish Navy has ordered at a cost of £63,000 a further set of torpedo tracking equipment from Marconi Space and Defence Systems Ltd.

The tracking equipment provides a record of the trajectory of a suitably equipped torpedo fired by, or against, a submarine. It is completely automatic in operation and produces weapon track data in real-time. It will track an approaching weapon from long range and automatically change over to a high-definition, high accuracy tracking mode as the weapon closes on the target in the final attack phase. Similar equipment has been supplied to the British Ministry of Defence and interest has been shown in many other countries.

Rotterdam Dockyard Co have launched the 1,800/2,300tdispl submarine *Tijgerhaai*, second of two built for the Royal Netherlands Navy. The first is named *Zwaardvis* and was launched in July last year. These submarines are of a new design for the Royal Netherlands Navy with a hull form practically identical to that of nuclear-powered submarines, but with a conventional diesel-electric power plant. Moreover they have one propeller as opposed to the two of the latest triple-hulled *Dolfijn* and *Potvis*

Despatch of the first TM3B Marine Olympus power turbine from the Rolls-Royce Ansty Works. This represents the right hand half of our little masthead sketch



Did you know that . . . ?

Class. A single large propeller is more efficient and makes less noise than two smaller and faster-running propellers. These will be hunter-killer submarines, able to maintain a submerged speed for long periods and to dive very deeply. Their "tear-drop" shape improves underwater manoeuvrability. A revolutionary type of torpedo-launching gear, the so-called "catapult" system, designed by Captain J. C. Vermeulen, Royal Netherlands Navy (retd), is simpler and makes it possible to launch different types of torpedo from any depth.

As a complement to the *Spruance*-class (DD963) 7,000tdispl COGAG destroyers of the U.S. Navy, a design for a new 4,000tdispl single-screw PF is being brought forward. These would be A/S and A/A patrol and escort vessels, machinery is certain to be gas turbine with likely choices of a 25,000/4,000shp COGOG or a 2 x 25,000shp COGAG plant.

The sketch below, taken from the paper presented by Gerald M. Boatwright of U.S. Naval Ship Systems Command and John Couch of Litton Ship Systems to the ASME Gas Turbine Conference at Houston, Texas in March, shows the arrangement finally chosen for the all-gas turbine machinery of the U.S. Navy's *Spruance* (DD963)-class destroyers.

Four General Electric LM2500 aero-derived "20,000hp class" gas turbines will drive two cp propellers. Since the propeller shafts are not parallel, a mechanical cross-over transmission between the two sets of machinery is not practicable. Instead a synchronous ac transmission designed to carry half the output of one gas turbine is to be provided, enabling both shafts to be powered by one turbine or three turbines and thereby achieving a flattish saw-tooth fuel rate curve. Overall machinery weight will be 926 tons, equivalent to 24.4lb (11.2kg)/hp at the maximum total output of 85,000shp.

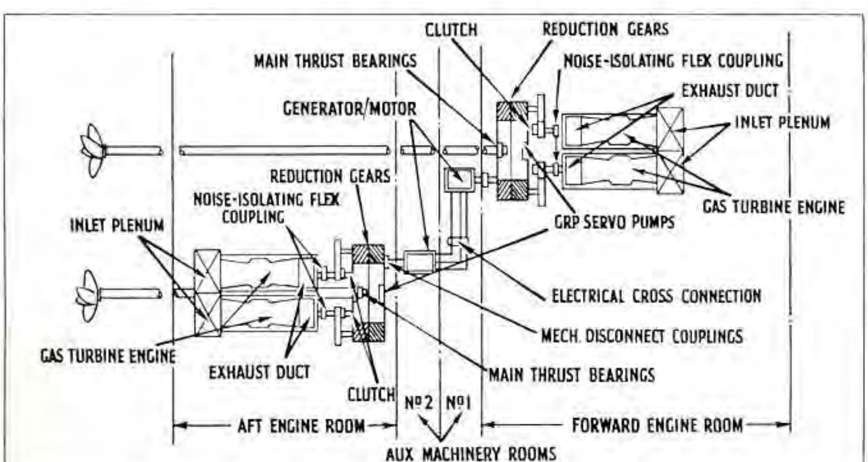
The U.S. Navy has awarded three contracts for the construction of a new class of fast-attack nuclear-powered submarines to be known as the SSN 688 class.

The first contract was for the construction of the lead ship SSN 688 and the second and third contracts cover 11 additional submarines of the same class. These 12 represent the first increment of a new U.S. submarine programme which, it is anticipated, will be augmented by additional ships of the same design in subsequent years.

The fixed price incentive contract for the lead ship SSN 688, is being awarded to Newport News Shipbuilding and Dry Dock Co, a subsidiary of Tenneco Corp, Newport News, Va, at a ceiling price of $83 million.

Two fixed-price incentive multi-year contracts, providing for the construction of 11 additional submarines are being awarded as follows: four submarines are being awarded to the Newport News firm at a ceiling price of $249,500,000, and seven submarines are being awarded to the Electric Boat Division of General Dynamics at a ceiling price of $428,074,000.

The contract for construction of seven high-speed nuclear-powered attack submarines will enable



Arrangement of the four General Electric LM 2500 gas turbines in the new US destroyers

Did you know that . . . ?

Electric Boat to retain its team of experienced and skilled production workers who have built more than one-third of the U.S. Navy's nuclear submarine fleet.

The SSN 688 class is the new U.S.N. multi-ship class of attack submarines since 1962 when the SS 637 Sturgeon-class submarines were authorized. A total of 37 Sturgeon class have been funded and Electric Boat has had contracts for 12, four of which are still under construction.

USS Pogy, the United States Navy's most advanced nuclear-powered submarine recently joined the fleet. This 292ft attack type submarine, designed to cruise the ocean depths in search of enemy subs, is the ninth nuclear-powered submarine completed by Ingalls giving the USN ninety-one nuclear submarines, including fifty attack types and forty-one Polaris missile-firing subs.

Pogy, a Sturgeon Class submarine is fitted with Subroc, a combination torpedo-missile which can target in on an enemy submarine many miles away. With a hundred man crew she is capable of submerged speeds in excess of 20 knots.

Pogy's complexity of electronic and scientific equipment includes an atmosphere control system which will enable the submarine to remain submerged for long periods of time, and the most sophisticated sonar and other underwater detection systems.

Saturday's commissioning is the Pogy's official entry into the Navy Fleet. She will be assigned to the submarine force, US Pacific Fleet.

USS 'Pogy', the US Navy's most advanced nuclear submarine, undergoing full power trials

Under the command of Commander George Stott, Washington, DC, Pogy is the second submarine to bear her name, taken from a small fish found in the Gulf of Mexico.

Ingalls has been building nuclear submarines since 1959, and recently completed an extensive modernisation programme to equip the facility for the overhaul of submarines.

Litton Industries, headquartered in Beverly Hills, Calif, is a major multinational corporation specialising in products, systems and services for business, defence, marine, industrial and professional markets.

The Hayase, a 2,000-ton displacement mine sweeper tender for Japan's Defense Agency, was launched last June by the Tokyo Shipyard of IHI (Ishikawajima-Harima Heavy Industries Co Ltd). She is the first of her kind to be built for the Defense Agency and is 99m long, 14.5m wide, 8.4m depth and 4.2m draught. Main propulsion machinery consists of four units of Kawaju-Man V6V 22/30 ATL type diesel engines, with a total output of 6,400shp developing a speed of 18 knots. Complement is 180 persons.

Among the weapons provided for the vessel are a 3-inch rapid firing gun, two 20mm machine guns and two 3-barrel torpedo tubes. It also has a training mine laying system, mine sweeping equipment, etc.

Delivery is scheduled for the end of November this year.

In the early 1960s there appeared to be reasonable prospects of DC power becoming available, either from fuel cells or by direct conversion of nuclear heat thermo-electrically. Such power, if available, could not be utilised at that time in a practical ship propulsion system without resorting to gearing since low speed high power electrical machines, suitable for direct coupling to a propeller shaft, were so heavy and bulky, and by using gears little advantage over conventional systems would be achieved.

Superconducting materials were beginning to show promise at that time and with the potentially high fields likely to accrue from their use, without an iron circuit, seemed to offer a substantial reduction in both weight and size of a low speed motor directly coupled to a propeller shaft

In September 1963, therefore, after discussions with Messrs International Research and Development Co Ltd, a contract was placed by MOD(N) with the firm to examine the possibility of using superconducting materials for the field winding of a low speed engine. The study was to include review of

Did you know that . . . ?

the practical problems of refrigeration, heat leakage paths, including the shaft, magnetic shielding etc.

This study was completed in September 1964 and it was clear from the report that the most promising machine would be of the homopolar type, ie a Faraday disc but some problems still required solution. The homopolar machine has a simple coil system, which is essential if it has to operate at about 4°K, and has an additional advantage in that there is no inductive coupling between the field winding and the rotor conductors, hence no torque reaction appears on the superconducting field coil. A major difficulty with this type of machine is in the current transfer to the rotor since, in its simplest form, there are effectively only two armature conductors and the working voltage is very low and correspondingly high currents are involved. This is why the homopolar machine invented by Faraday has not been exploited in the past. To solve this problem, liquid metal was proposed as a means of current transfer in the initial study, but further investigation showed the rubbing contacts using modern brush materials were practicable.

Although the avaliable superconducting materials at that time were poor compared with those available today, it was decided to go ahead and build a model machine to prove the theories developed in the feasibility study and to demonstrate that such a machine was practicable.

Marconi Radar Systems, a GEC-Marconi Electronics company, are supplying from their Leicester establishment a £350,000 Sea Dart radar simulator for the new £5 million shore trainer complex recently ordered from Ferranti Ltd, for the Navy's School of Tactics, Navigation and Action Information Organisation, HMS Dryad. The equipment will take its place in the part of the trainer simulating the operations room and weapon control systems of the new Type 42 destroyers, which are to carry the Sea Dart (GWS 30) surface-to-air guided missile system. Marconi supply the target tracking and illuminating radar for GWS 30 and it is the operation of this radar which will be simulated at Dryad.

The simulator will be used to train command and operations room teams of the future fleet, and it will provide a completely realistic sea 'exercise' at only a fraction of the cost of actual sea-training. Tests for the operators will be programmable through a central Ferranti computer complex and special Marconi electronic back-up equipment, and Dryad instructors will be able to assess their students' performance during and after an exercise. A much greater flexibility in the nature of exercises will be possible than under real sea conditions.

Simulators of this type will be available to any user of the GWS 30 system.

A range of heat shrink products that replaces taping and other methods of protecting electrical connections is available from AMP of Great Britain Ltd. This range of products, known as Ampsulation, is easy to apply and provides special advantages when working in the field or in confined spaces.

This thermoset plastic is available as tubing or as closed end caps and is slid over the connection where it is reduced to the required shape by the application of heat from such sources as an electric heat gun or gas torch. The shrink ratio is such that wide variation in the diameters found in a connection can be overcome and once shrunk to the required size and shape it remains permanently in this form.

Rated for continuous operation in the temperature range −65°C to 130°C, these heat shrunk products provide high dielectric properties, resistance to mechanical abrasion and chemical action.

Complete waterproofing can be obtained with the use of thick wall tubing which has a factory applied sealant which, under the application of heat, conforms to the most irregular shapes and fills voids to produce complete water sealing unaffected by conditions of vibration to which the joint may be subjected.

Ampsulation tubing being reduced to size by heat from a butane gas torch

Did you know that . . . ?

Stanley Works has announced the introduction of a saw with a blade capable of cutting a wide variety of materials such as wood, copper, zinc, lead, aluminium, asbestos, plastic laminate and mild steel and which therefore has many uses both in shipyards and on board ship.

The blade has an anti-friction coating which makes sawing smoother and less of an effort. A large screw cap gives quick action to enable the blade to be set at any of seven positions. Shaped at the end for easy starting in small holes, the blade is also holed for hanging.

The glass-filled nylon handle is very light yet exceptionally strong and is designed to give a comfortable grip.

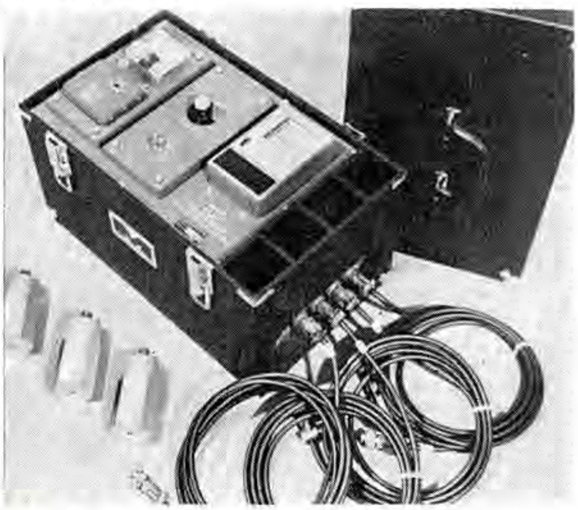
The all-purpose saw goes under the reference No. 15-715 and spare blades are available when eventually required.

Stanley Works (G.B.) Ltd, Woodside, Sheffield, S3 9PD, Yorkshire, England.

Stanley multi-purpose saw

The Series 1250 Portable Multichannel Vibration Monitor-Recorder manufactured in the USA by Ird Mechanalysis Inc is now available in the UK through Mechanalysis International. This unit provides protection against serious machinery damage during critical periods such as start-up and other speed or load changes. It is ideally suited for field service and installation checkout of new equipment. A convenient jack permits a Mechanalysis Vibration Analyser to be connected for vibration analysis and in-place balancing.

Vibration monitor recorder for protection against machinery damage



When a machine's vibration exceeds the pre-set warning level, a monitor light is illuminated and the annunciator is triggered. Warning and shutdown alarm signals are available at barrier terminal strip to activate a remote alarm system.

The Recorder provides a permanent record of developing mechanical defects which may occur during periods while the monitor is unattended. Each pickup point is easily identified on the standard 1in/hr (25mm/hr) chart paper.

The Monitor-Recorder system consists of a standard Mechanalysis Vibration Monitor, Scanner, Recorder and Vibration Pickups housed in a rugged carrying case.

Mechanalysis International, Crown House, London Road, Morden, Surrey, Egland.

Following a year of development, Atcon Inc has introduced a glass fibre non-skid grating which is suitable for numerous marine applications. Known as the Brute Grating, the product is non-corrosive, non-erosive, non-conductive and being light in weight is easily installed.

Platforms are available in three thicknesses of $1\frac{1}{8}$in, $1\frac{3}{8}$in and $1\frac{5}{8}$in (28mm, 35mm and 41mm) in widths up to 8ft (2.4m) and lengths up to 40ft (12.2m), the free area being 54 per cent. Typical uses for the gratings are for catwalks on tankers, steps on decks, wheelhouse entries and for gratings at electrical control panels.

In addition to the standard Brute Grating, a self-extinguishing version is available.

Atcon Inc 62-64 North Front Street, Philadelphia, PA 19106, USA.

Printed by F. A. Clements (Chatham) Ltd, 399 High Street, Chatham, Kent.

ROYAL NAVAL ENGINEERS'
Benevolent Society

GENERAL SECRETARY'S REPORT

OCTOBER, 1971

Dear Sir and Fellow Member,

Since the introduction of the Pensions Increase Scheme, 1971, I have received a number of letters from members asking for clarification or explanation of their new pension. Newspaper announcements at the time the increases were introduced by Parliament led some people to expect greater increases than they eventually received. Whilst I am always happy to give whatever help and advice I can on this or any other problem, it is difficult in the case of pensions. The amount of pension due to anyone is influenced by a number of factors. The only useful advice I can therefore give is that they should write to the Director General of Defence Accounts, Ministry of Defence, Warminster Road, Bath, BA1 5AA, asking for an explanation of how their new pension has been computed. If there has in fact been an error in calculating it, this should bring it to light. If there has been no error the pensioner has the satisfaction of knowing that he has the correct pension and how it has been calculated. Some people seem to have gained the impression from reading the newspapers that existing pensioners would, by various increases, have their pensions brought up to the level of that paid to someone of the same seniority retiring today. That is not so. It may be of interest to know, for example, that the pension payable to a Chief Artificer today, on completion of 22 years' reckonable service is £9.02 per week. He also receives a Terminal Grant of £1,407.12. No older pensioner Chief Artificer who has only 22 years' reckonable service has, so far as I know, had his pension made up even to within a pound of that level.

CENTENARY DINNER

This has now been arranged for Saturday, 3rd June 1972, in the Carisbrooke Hall at the Victory Club, Seymour Street, near Marble Arch, London. Tickets for the Dinner will cost £2, exclusive of wine. The menu chosen, subject to confirmation, is:

Chilled Melon Maraschino
Goujon de Sole and Tartare Sauce
Whole Roast Poussin and Game Chips, New Potatoes, Green Peas
Ice Cream Gateaux
Roll and Butter, Cheese and Biscuits
Coffee

The separate Bar, attached to the Hall, will be available from 5.30 to 11.30 p.m. The Victory Club has kindly agreed to make bedroom accommodation available to a limited number of those attending the Dinner at a cost of £1.25 per night which will cover the cost of the bedroom and Temporary Membership Fee. This does not include Breakfast, which is paid for when taken. Those desirous of taking advantage of this offer are advised to let me know as early as possible, as it will be a case of "first come first served".

Coaches will be arranged, if the numbers warrant it, from Chatham, Portsmouth and Plymouth, and these coaches will not leave for the return journey before midnight. It may be possible for members living on the routes to London from these three Ports, to be picked up by arrangement, provided that it does not entail any deviation from the route. It will not be possible to guarantee such pick-ups until nearer the date of the Dinner (say, within one month or thereabouts) when the final numbers so travelling will be known.

Dress is informal. Dinner jacket or lounge suit, though we would be glad to see serving members wearing uniform.

It would be appreciated, in order to reduce correspondence, if members could send payment for the Dinner when applying for their ticket. This will be refundable in the event of a member having to cancel through unforeseen circumstances. All applications for tickets and correspondence regarding the Dinner should be addressed to me, at 26 Locarno Avenue, Gillingham, Kent.

Serving members who are at present overseas, but have reason to believe that they will be home in time for the Dinner, should apply for tickets now in the normal way, but are requested to let me know as soon as possible if their returu to the U.K. is delayed or if they are not likely to be able to attend the Dinner after all, for any other reason.

MISSING MEMBERS

The Secretary of the Devonport Branch has asked me to help him trace a number of members who cannot be found at the last address known to him, and whose correspondence has been "returned to sender". The Drafting Authority is not now willing to forward such mail, as it has done in the past. Would any member, therefore, who knows the whereabouts of any of the following, please notify the Devonport Branch Secretary, 113 North Hill, Plymouth, PL4 8JY.

A.A. D. Ackerman L/065839
M.E.A.(P.) J. P. Anderson 092088
M.E.A.(P.) D. H. Ashling P/M943787
A.A. D. M. Bairstow L/071789
E.A.(AIR) A. T. Barney L/092102
M.E.A.(P) J. W. Baxter M969909
A.A. R. M. Birnie L/060186
M.E.A.(P) R. W. Birt M956793
M.E.A.(P) M. Bolton 082341
M.E.A.(H) R. D. Bothwell 082343
C.M.E.A.(P) P. Bradley M857503
C.E.A. B.C. Burgess 065882
M·E.A.(P) J. E. Burnett 855690
E.A. S. R. Butchers 052747
M.E.A.(P) T. W. J. Chrisp P/057522
M.E.A.(P) P. S. Clegg 075578
A.A. G. M. Clifford L/0823379
A.A. J. H. Coote L/056074
M.E.A.(P) J. P. Crawford 069481
E.A. R. H. Crawford 063569
A.A. B. Davies L/076888
M.E.A.(P) M. P. O. Davis 082407
C.E.A. D. W. Dewhirst 085030
R.E.A. S. W. Dunlop 079555
M.E.A.(P) A. J. Edmonds 0824414
M.E.A.(P) R. D. Flockhart 071670

M.E.A.(P) N. C. Garnham 092152
C.E.A. F. C. George 085053
C.E.A. D. M. Greaves 098616
E.A.(AIR) T. R. Graham L/095128
E.A. P. Griffiths 092059
E.A.(AIR) R. P. Haves L/079570
C.E.A. A. R. Hawke 069532
E.A. M. J. Hennegan 076613
C.E.A. B. Jenkins 071820
A.A. D. L. Johns L/063214
E.A. J. F. Houlding 076622
E.A.M.L. John 087233
M.E.A.(P) R. J. Killingley 052603
M.E.A.(P) P. T. Lancey 087247
E.A. K. A. Lansley 085098
M.E.A.(P) K. C. Laurie 092181
R.E.A. D. A. Lawley 076648
M.E.A.(P) C. C. Leggett P/079443
M.E.A.(P) M. S. Lester 069570
M.E.A.(P) C. H. Lincoln M956596
C.E.A. J. A. Lester 076651
M.E.A.(P) J. D. Llewellyn P/M956336
M.E.A.(P) J. C. MacSween M969567
M.E.A.(P) J. D. R. Maggs 069575
C.E.A. J. Mitchell 084867
A.A. R. H. Mould L/087268
M.E.A.(P) S. K. Mulley 092067
M.E.A.(H) R. P. Murphy 098697
M.E.A.(P) P. Needham 065813
E.A. D. M. Parsons 091992
E.A. R. Perry 092068
M.E.A.(H) R. L. Penny 091810
M.E.A.(P) R. Pratt 055205
E.A. B. Price 098705
C,E.A. A. G. Ralph 069614
C.E.A. N. J. Rushton 077180
R.E.A. M. P. Scriven 084916
M.E.A.(P) C. D. Sharp 069633
E.A. B. T. Shugrue P/091355
M.E.A.(P) J. H. Silva P/088670
A.A. G. B. Sleight L/062510
M.E.A.(P) M. Skinner M888063
E.A. W. Vickers 079509
E.A. D. Webster 092032
C.E.A. J. L. Wetton 076776
M.E.A.(P) B. M. Wise 805976
M.E.A.(P) F. E. Wrigley 063270

The Junior Branch Secretary is also experiencing difficulty in sending out his post as he has lost trace of the members of S62, S63, S64, S691, S692 from HMS *Collingwood*. Classes S62 and S63 may have returned to HMS *Collingwood* by now, but are not replying to his letters. If you have any member of these classes serving with you at present it would be appreciated if Mr. Morey could be informed. (Address as above for Devonport Branch Secretary).

It is imperative that members remember to inform their Branch Secretary of every change of address or status. Post which has been "returned to sender" cannot now be sent again via the drafting office. If you hear any member complaining that he has not received his Review and Report, tell him to write to his Branch Secretary giving his present address. Better still, do us a favour and write and tell us on his behalf. He probably has an aversion to writing!

JUNIOR BRANCH

It is hoped, if a sufficient number of Apprentices wish to attend the Centenary Dinner, to arrange for special coaches from *Fisgard*, *Daedalus* and *Collingwood* (combined) and *Caledonia*. The Captains of these Establishments have been asked to arrange for special leave, if necessary, for this event.

The Chatham Memorial Trophy Fund has recently presented a silver cup to be known as the Inter-Ship Apprentices' Sailing Trophy. The first competition was held on 23rd September and the cup was won for the first time by HMS *Collingwood*.

The Society has also instituted an annual prize of £3 for the Apprentice at

HMS *Daedalus* with the best ONC result, which has been won this year by R.E.A. Apprentice Baldwin.

BRANCH MEETINGS

Portsmouth Branch, Second Friday in each month at 7.30 p.m. at the R.N.E.B.S. Club, 46 Clarence Parade, Southsea. 10th Dec., 14th Jan., 11th Feb., 10th March. **Devonport Branch, Second Saturday in each month** at 6.30 p.m. at 113 North Hill, Plymouth. 11th Dec., 8th Jan., 12th Feb., 11th March.

The Branch Secretaries regret to announce the death of the following members since my last Report:

Portsmouth Branch: Lt.(E) E. H. H. Rampling, R.N. (Retd.); Lt.(E) T. Allen, R.N.; R. E. Wellburn, C.M.E.A.(P), Messrs. W. Williams and G. Gaiger, both C.E.R.A.s (Retd.). Lt. (Eng.). G. E. Foote, R. N.

Devonport Branch: J. E. W. Kibbey, M.E.A.(P), Mr. C. J. H. Honey, C.E.R.A.(Retd.), D. M. Stobbart, E.A. App.

The following received the Invaliding Benefit:

J. Hogan, A.A. (Portsmouth) and S. L. Bond, M.E.A.(P.) (Devonport).

DEVONPORT BRANCH—SPECIAL NOTICE

(1) Members allotting £0.25 per month. As there will now be no surplus to bank for you, it is advised that you either transfer your balance at the Trustees Savings Bank, Fore Street, Devonport, to another account, or close it by withdrawing the money. To do this, write to The Manager, quoting your bank account number. If in doubt about the number write to your Branch Secretary, Mr. W. J. Robins at 113 North Hill.

Any balance still held to your account on the Secretary's ledger and not banked will be held to your credit. The amount, if any, is shown below. If you wish to have this refunded you should apply to the Branch Secretary. If the sum is small you are advised to leave it on credit as it will prevent you from falling into arrear if you later decide to change your allotment to a Banker's Order. There is usually a break in time between the two.

(2) Members allotting more than £0.25 per month. Your surpluses will continue to be banked as heretofore.

Yours sincerely,
R. H. CRICK,
General Secretary.

Your account to the end of last Quarter (30th September, 1971) is:

5 0 P BANKED

..........................in arrear ....in advance

Any subsequent contribution is not accounted for with this statement.

Printed by F. A. Clements (Chatham) Ltd. 399 High Street, Chatham