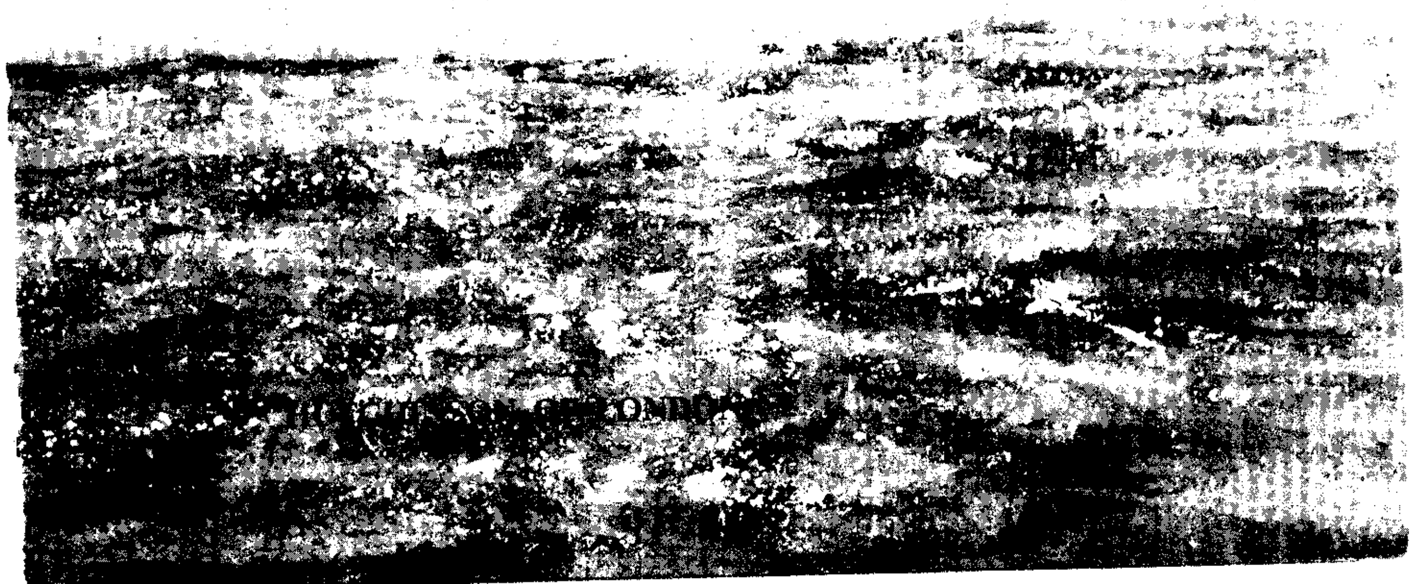
# A Quest for Speed at Sea

CHRISTOPHER DAWSON

Illustrated by Laurence Bagley



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To Commander Peter Du Cane, to whose technical brilliance and inspiring leadership the modern Vosper owes so much.



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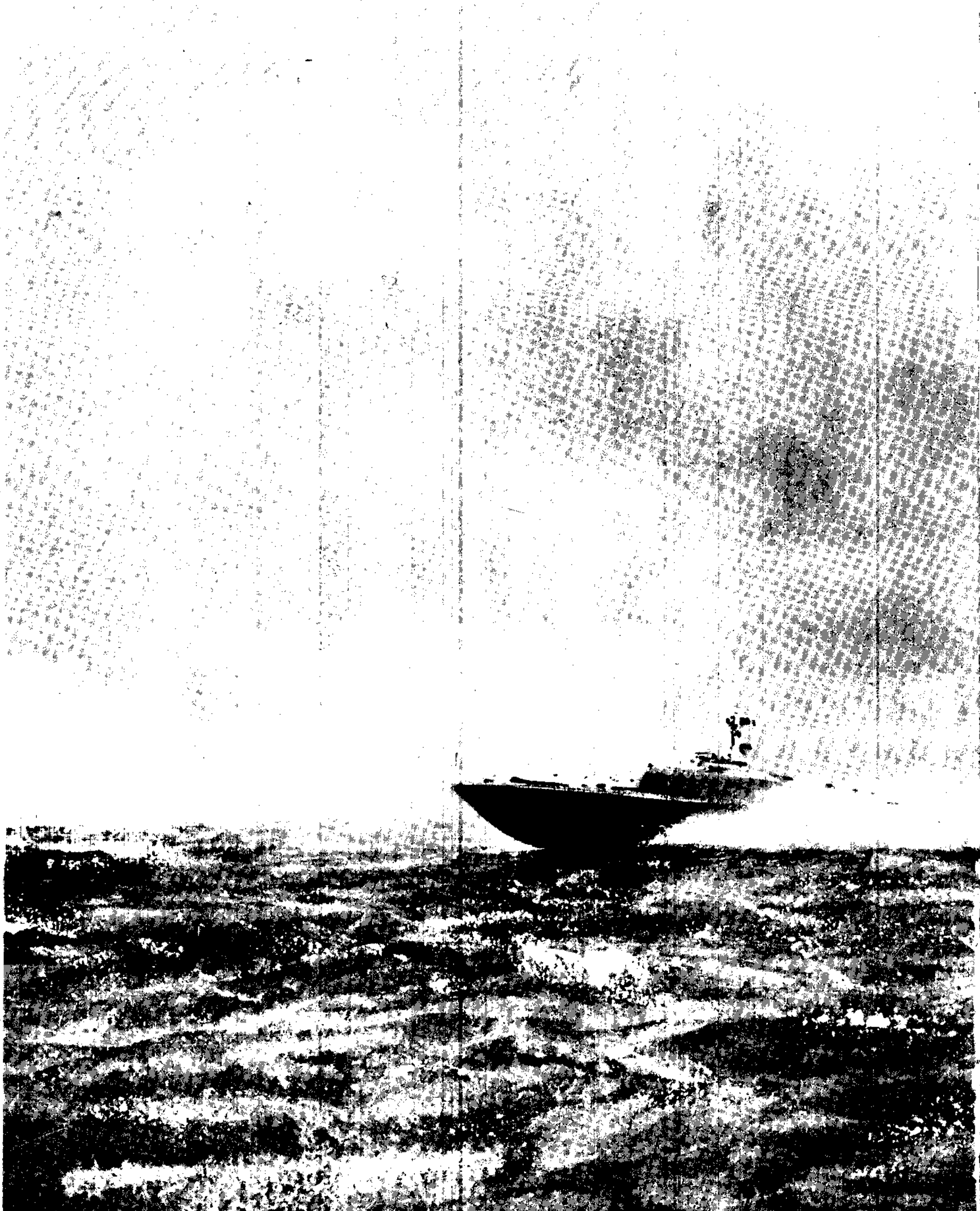


# Contents

# Acknowledgements

I AM OF course deeply indebted to many people and written sources consulted in the course of writing this book. At Vosper in particular I have had invaluable advice, information, guidance and help from Commander Peter Du Cane, and his secretary, Miss Jean Carpenter; Mr. John Rix on matters of policy and prospects; and Mr. Peter Usher, the Technical Director, on the latest developments in design and construction. I have also drawn heavily on the time and expert knowledge of the heads of technical departments, and many of their staff. I would like in particular to mention Mr. A. L. Dorey, Technical Manager (Design Department); Mr. D. J. N. Cole, Technical Manager, Shipbuilding Division, Portsmouth; Mr. R. D. Hunt, Manager, Hovercraft; Mr. L. E. Pierce, Mr. S. M. Adamson and Mr. R. F. Crook, Chief Ship, Engineering and Electrical Designers respectively; Mr. K. Suhrbier, Senior Hydrodynamicist; and Mr. G. Kingslake, Chief Structural Engineer.

# Foreword

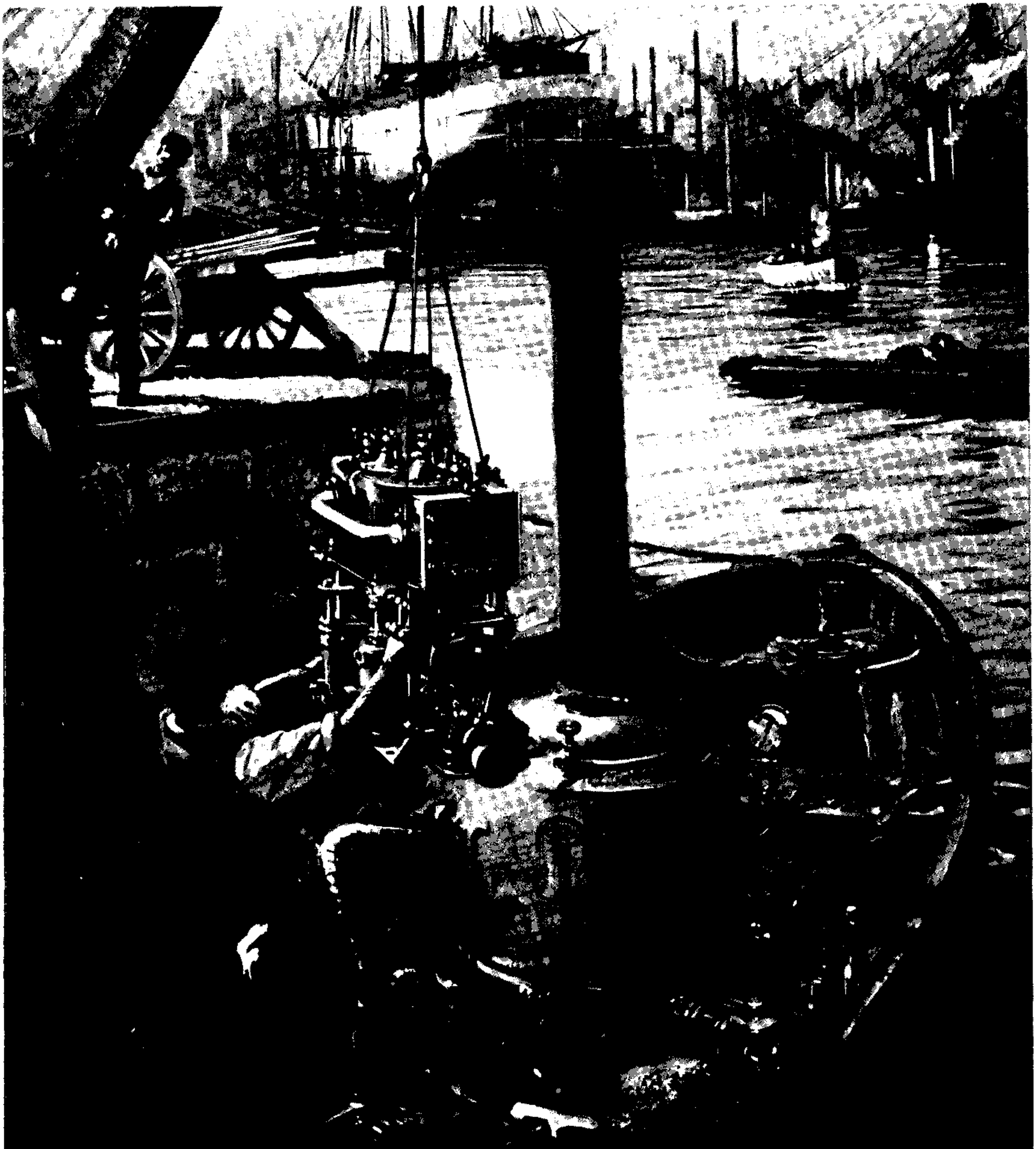
By Sir David Brown,
Chairman, Vosper Limited

In these times of rapid change it is not very common for companies to remain as close to their origins, both in their fields of activity and in simple geography, as Vosper. The Company began 100 years ago in Old Portsmouth as engineers and shipbuilders. One of their yards today is on the same spot, and their headquarters and the greater part of their facilities are still within a few miles; they are perhaps now more precisely described as shipbuilders and engineers.

The continuity of the firm's interest in small ships, concentrating in its second half-century on high speed vessels, mainly as warships, was one factor in its sustained technical success in its chosen field. This makes a story which we felt should be told, our centenary providing a good opportunity.

This book is not purely a history of Vosper as a company, but also in part a layman's view of the technical developments which have led to advances in achieving high speeds at sea, although it naturally looks at the scene from the Vosper point of view. In dealing with the last five years it covers the activities of the now integrated concern of Vosper Thornycroft Limited, but before the merger concentrates on those of the original Vosper. Thornycroft were slightly earlier in the field, and their centenary was marked by the book *100 Years of Specialized Shipbuilding and Engineering* by K. C. Barnaby, published by Hutchinson in 1964. It is pleasing to see that the united firm is still following through the pioneering work of the founders of each of the two original companies.

Vosper Thornycroft is now looking forward to a period of steady achievement after the very rapid growth of the last few years. Our aim in sponsoring this book is to mark our centenary by publishing something which is both attractive and informative for the general reader, and gives some indication of the basis on which our present and future development rests.



**Engines and boilers for launches were the first Vosper products, and the firm installed them at their Old Portsmouth Yard.**

# I

# Foundations

Progress towards higher speeds on the water has, since the earliest days of mechanical marine propulsion, depended on the development of engines. The limits to what can be achieved are set by the power output of the available machinery, particularly in relation to its size and weight. Not only must the engine for a high-speed craft be powerful, yet light and compact, but it must also be reliable enough for continuous service at a high proportion of its maximum rated output. The designer of fast craft has to make use of the power units which are available to him and design a hull which will extract the utmost speed from them. He must also know how to instal the machinery so that its power is converted to forward thrust with the minimum of losses, and without impairing its reliability.

Perhaps it is significant, in view of the later development of the firm of Vosper, that the company began as engineers. Herbert Edward Vosper himself was an engineer with a very considerable talent for innovation. The first recorded instance of this is his patent, dated 1870 (No. 2657/1870) when he was 19 or 20, for a direct-acting steam engine—in fact the device was a lost-motion linkage to the slide valve. He also designed a simplified boiler feed pump, using a rotating piston to distribute the steam, which Vosper & Co. continued to manufacture into the mid-1920s.

H. E. Vosper must, at an early age, have allied business ability and resources to his technical knowledge and inventiveness, for in 1871, when he was 21, he had begun setting up the workshops on the Camber, the small commercial dock on the east side of the entrance to Portsmouth Harbour, which were to form the base for the work of Vosper & Co. until just before the Second World War.

In the early years work was largely refitting and repairing coasting vessels, but Vosper quickly built up his own range of steam reciprocating engines, compound (i.e., two cylinders) and triple-expansion. These were fitted in craft of many kinds, yachts, tugs, tenders, and launches for the War Office and

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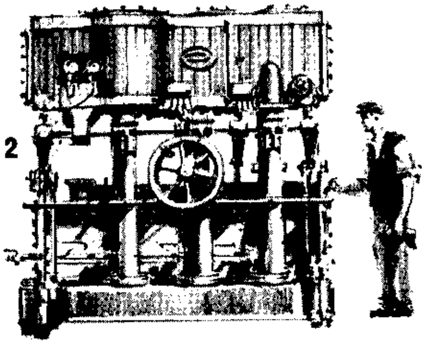

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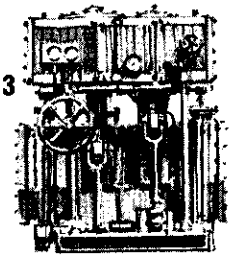

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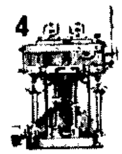

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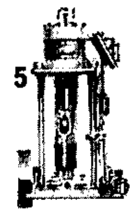

1. **Compound surface-condensing steam engine and boiler for a launch. A pipe outboard along the boat's bottom acted as the condenser (ca. 1900).**
2. **Triple-expansion engine for the steam tug *Isabel*. Cylinder bores were 12 in, 19 in, and 31 in, giving an output of about 200 horsepower. Stroke 21 in (1889).**
3. **A steam engine for the War Office vessel *General Dickson*.**
4. **Small compound launch engine, with cylinder bores of 2% in and 5 in, stroke 3½ in.**
5. **Single-cylinder launch engine, 10 in bore by 9 in stroke.**

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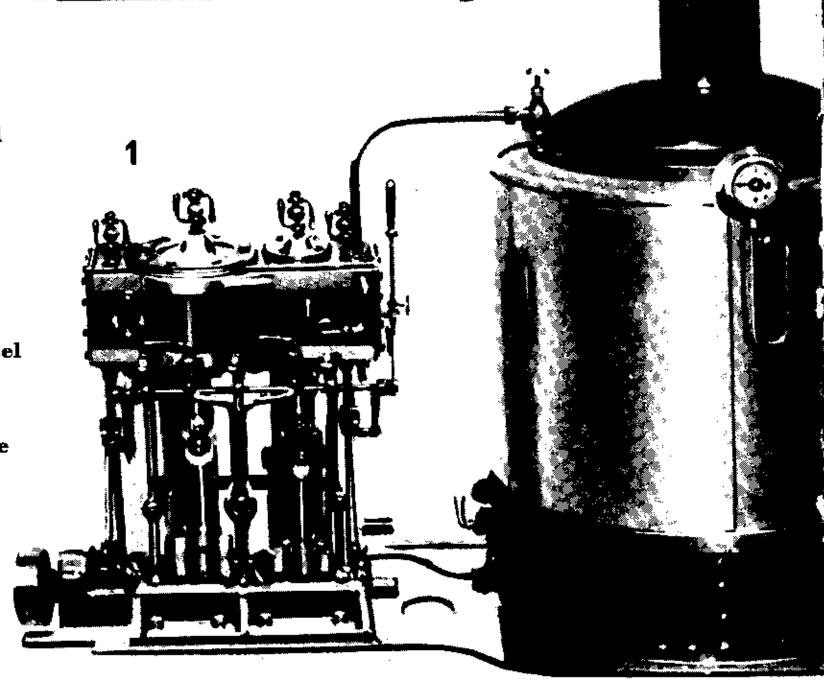

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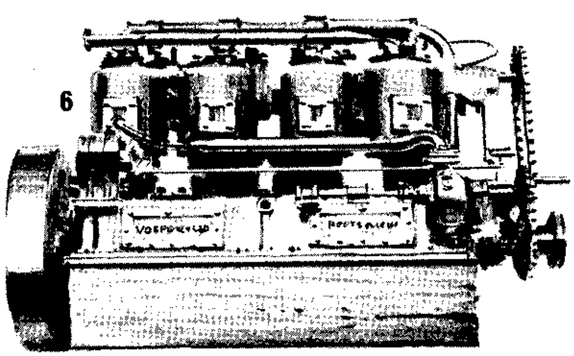

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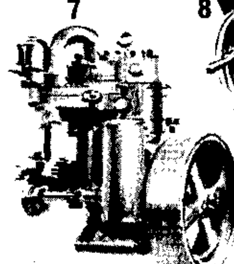

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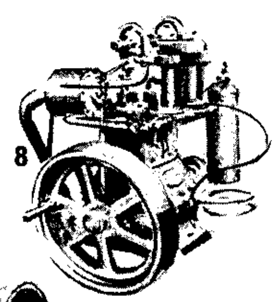


6. **Four-cylinder paraffin engine developing 35-40 b.h.p. at 700-750 rev/min. This engine weighed 15 cwt, without reverse gear (ca 1904).**

7. & 8. **Early single- and twin-cylinder oil engines. The single-cylinder one is quoted as giving 2 b.h.p. for a weight of about 300 lb (ca 1898).**

Admiralty. Many went abroad, particularly in South American river boats, and a number of these are probably still in use. Calls for spares for these early engines still occasionally come in.

In those days before specialization the works were remarkably self-contained, with ferrous and non-ferrous foundries, machine and fitting shops, forge and boiler shop. There were also woodworking shops for the refit work.

Vosper was a pioneer of the internal combustion engine, developing in parallel vaporizing paraffin engines and crude oil engines—semi-diesels. The latter were compression ignition engines but, as was normal at the time, did not when cold, compress the air charge enough to raise its temperature to a value which would cause the injected fuel to ignite. They therefore had an iron mass at the cylinder head which was pre-heated by a blowlamp; part of the mass projected into the cylinder to provide a local hot spot to help ignite the fuel. The Vosper oil engine also had fresh water injection for piston cooling, so that alongside the fuel injection pump was a water injection pump.

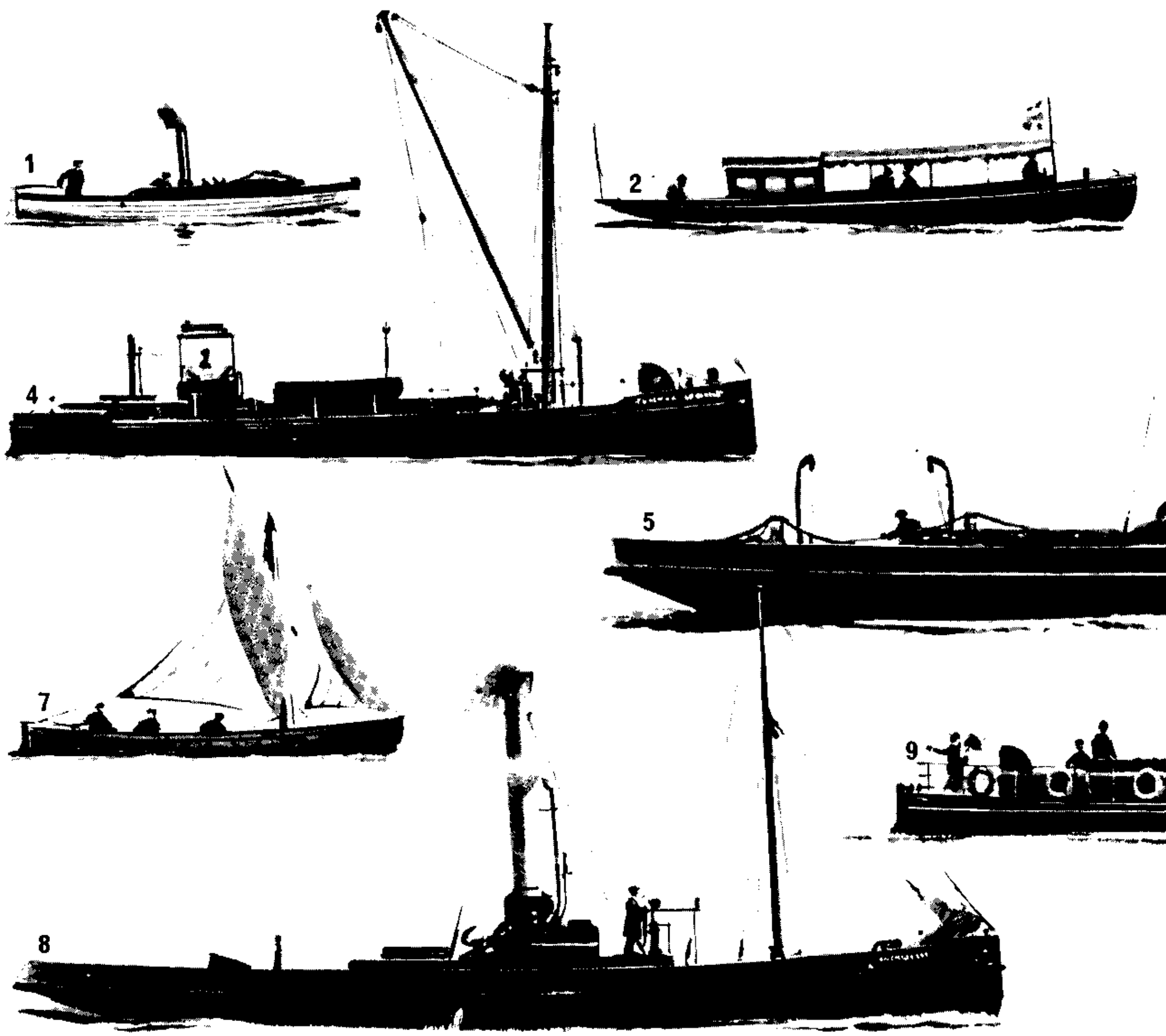
Both types of engine were manufactured in ranges of powers, the semi-diesels from 5 to 320 b.h.p., and the paraffin engines 7 to 100 b.h.p., until about 1916. They showed considerable originality in design and when Vosper sold his vaporizer patent rights to Thornycroft, this design was embodied in the range of Thornycroft paraffin engines which were widely used between the first and second World Wars.

Mechanical design in these early days resulted from discussion on the shop floor, aided by chalk sketches at most, and engines were built and run, modified and refined into successful products, with facilities which today would seem very primitive. However, in the process skills were developed which were to be an important foundation for later advances.

Although Vosper & Co. Ltd. (as they were then called) were still describing themselves as Engineers and Boiler Makers well into the 20th century, the building of small ships and launches began in the 1880s; the tug *Hercules*, for the Shoreham Harbour Trustees, being one of the first vessels built. The firm rapidly built up a business in the construction of craft from dinghies and lifeboats to yachts and tugs 70 to 80 ft long, mainly powered by their own steam and oil engines.

Looking through the list of craft built, and the surviving photographs of them, one sees at once that Vosper were not then builders of high-speed craft. Before the First World War ten knots would have been about their limit. A 25-ft speed boat illustrated in the 1908 catalogue probably barely reached this speed. Many of Vosper's boats, and small ships, like the tugs and barges, were solidly built, engined by his own heavy but reliable steam, paraffin and crude oil engines, and thoroughly workmanlike vessels, but they were not the fastest, even of their day. Even the lighter craft the firm also built showed no great pretensions to speed.

What did make Vosper & Co. an unusual company, particularly as it was quite a small organization, was its wide range of skills and capacities. Apart from designing, developing and building its own range of engines of three basic types, the firm built boilers, made pumps, and manufactured patent anchors. On the shipbuilding side they tackled steel hulls; both solid, workmanlike tugs and lightly plated launches for tropical waters, where the destructive ship-worm would have attacked wood; robust wooden barges on.

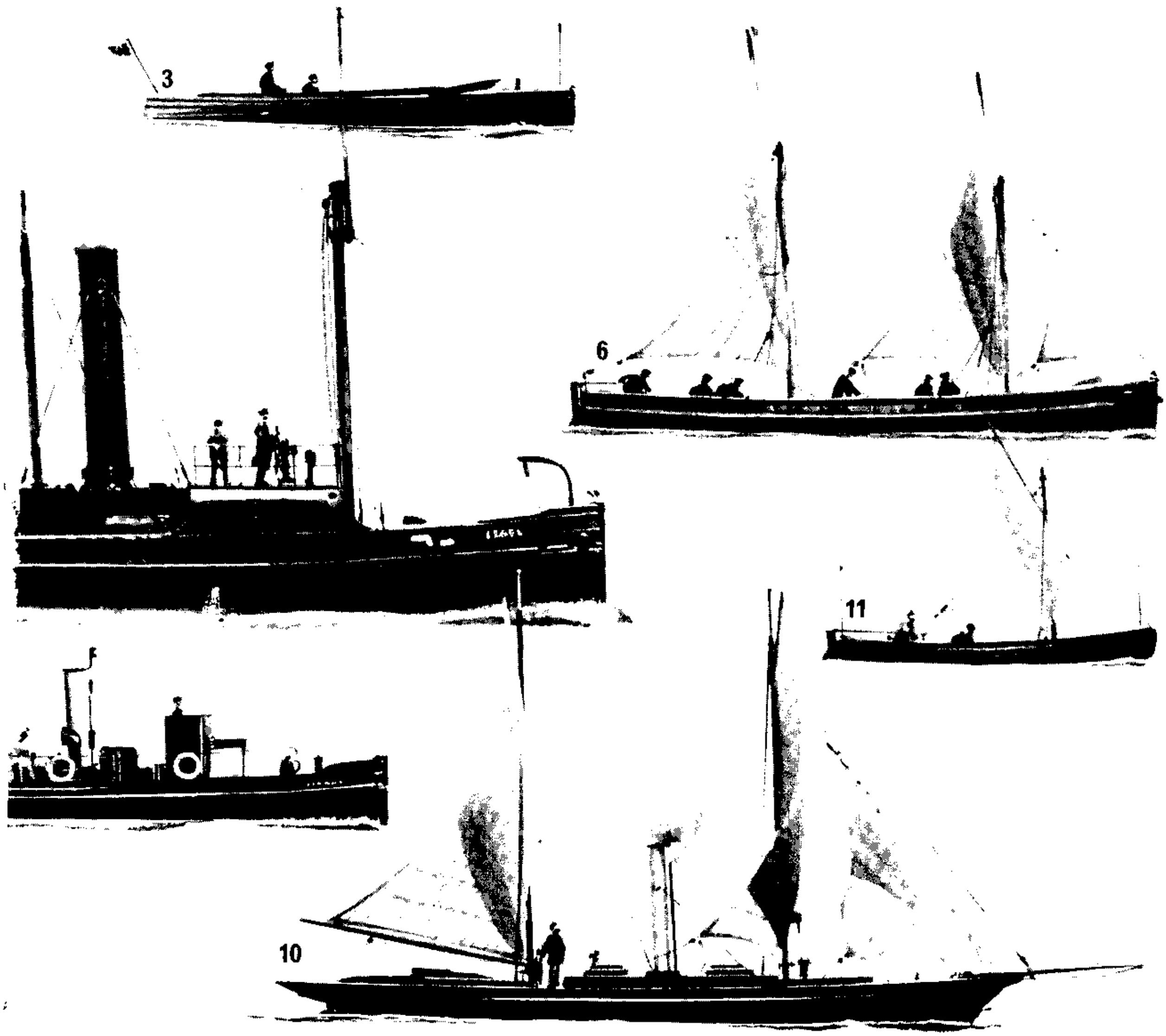



**1. 25 ft steam launch for the Admiralty.**
**2. *Sultana*, 40 ft, for Sultan of Zanzibar, with Vosper paraffin engine (ca 1905).**
**3. Motor launch *Kishti*, 33 ft (1920s).**
**4. Motor barge *Southsea Castle*, for Long's Brewery (1920s).**
**5. Tug *Isabel*, 87 ft 8 in (1889).**
**6. 45 ft Admiralty launch.**

grown oak frames, and light-timbered cedar launches. Many workboats for the Admiralty, ship's boats, whalers, dinghies and tenders were built, covering between them most forms of the shipwright's craft in wood or metal.

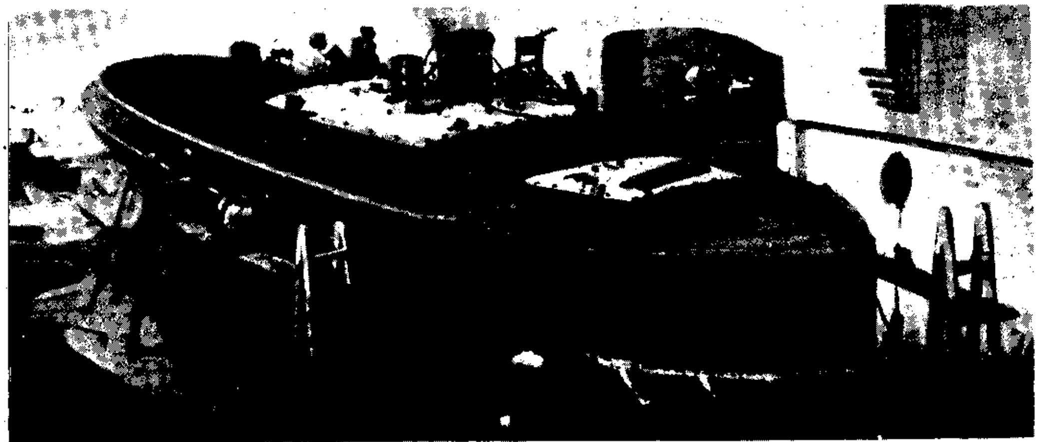
The combination of the skill in technical innovation which H. E. Vosper had from the beginning with the very comprehensive facilities for short-run engineering manufacture he set up, coupled with shipbuilding capacity, were the foundations on which the firm was built.

The First World War saw a rapid expansion in these activities, with the addition of shell manufacture. After the war the firm shared in the country's



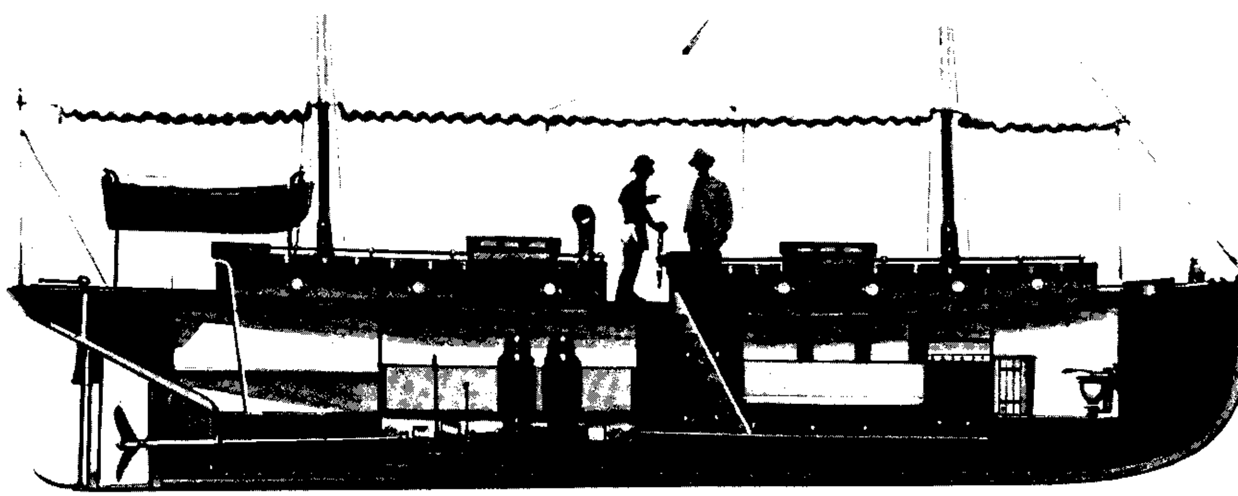

7. **28 ft double-skin lifeboat.**
8. ***Hercules*, 75 ft tug for Shoreham Harbour Trustees (1889).**
9. **Launch *Epping*, for Great Eastern Railway; 50 ft, 8½ knots (1920s).**

10. ***Hermion*, auxiliary steam yacht for Admiral Gordon.**
11. **One of two 24 ft gigs for Uganda Railways.**



**Steel tug *Pioneer*, for C. J. Palmer & Sons of London and Kingston (1923).**

**Wood boatbuilding shop with split-level arrangement (1920s).**



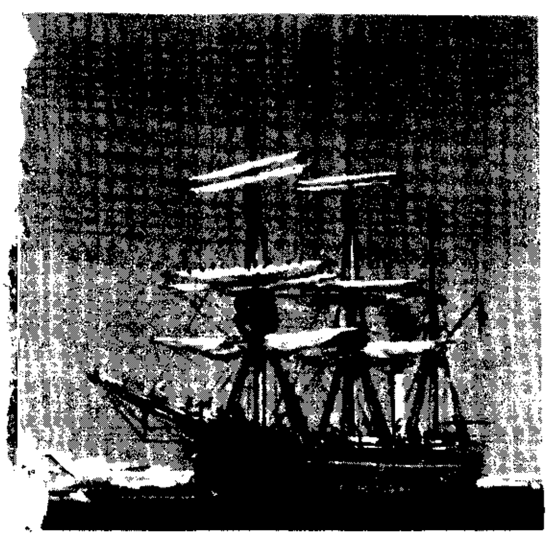
**London Missionary Society's yacht *Tamate*, 45 ft × 10 ft × 4 ft, with 55 h.p. crude oil engine giving 8·45 knots (ca 1908).**

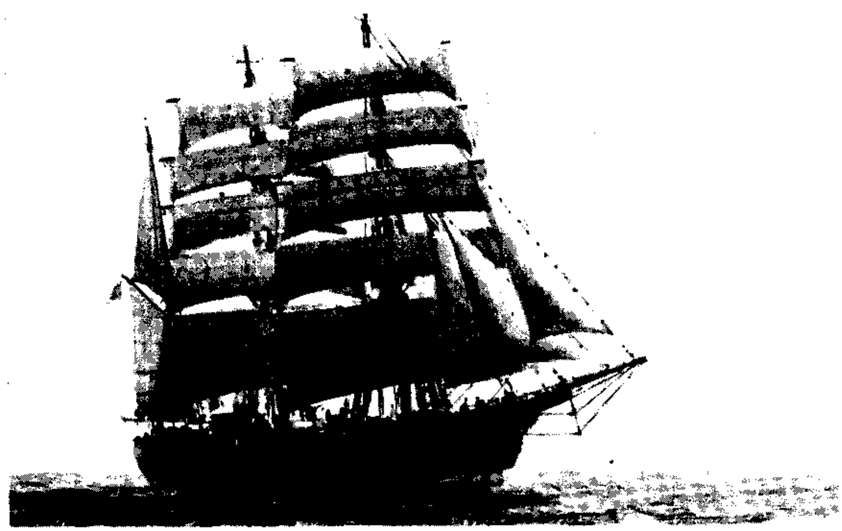
problems of retrenchment, reverting largely to refit work. One job was virtually to rebuild Captain Scott's *Discovery* for further Antarctic exploration. The company was kept intact, although at the end of the 1920s the total work force was only about sixty.

But the basic facilities were still there: the shipyard ways, which could accommodate vessels of perhaps 200 tons, with berths afloat for considerably larger ships; the boatbuilding shop for wooden craft, and the engineering facilities; the foundry where propellers and other non-ferrous castings were poured; the smithery with its furnaces and steam hammer, capable of forging engine crankshafts and connecting rods; the boiler shop which handled light plate work such as ships' ventilators as well as water tube and other boilers; the turnery or machine shop, with lathes, planers and shapers, driven by leather belting from overhead countershafts; and the engine fitting shop where engines were assembled and small craft could be brought in for their machinery to be installed. A large gas engine provided motive power for most of the machinery.

More vital still were the human skills of a nucleus of craftsmen in the wood and metalworking trades, and the ability to supervise with experience and flair in what would now be called development engineering.

*Discovery*, **a major refit job (1922).**



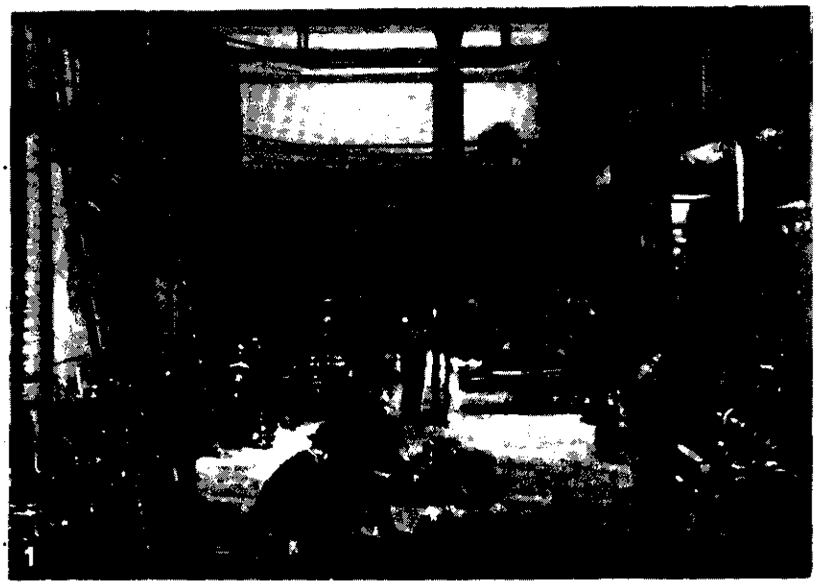


1. The turnery, or machine shop.

2. Engine fitting shop.

3. Boiler shop.

4. Smithery or forge.



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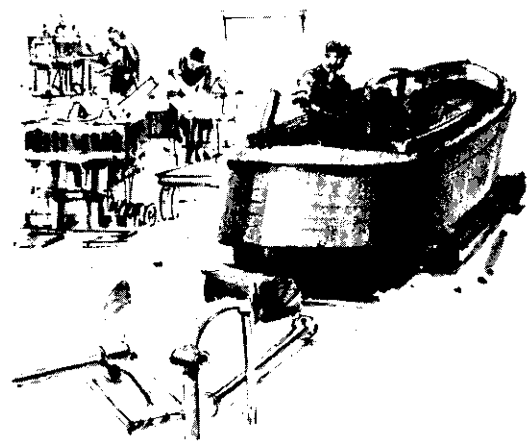

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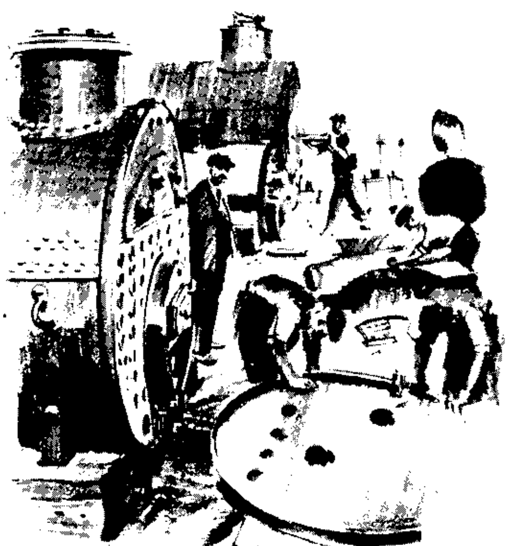

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# 2

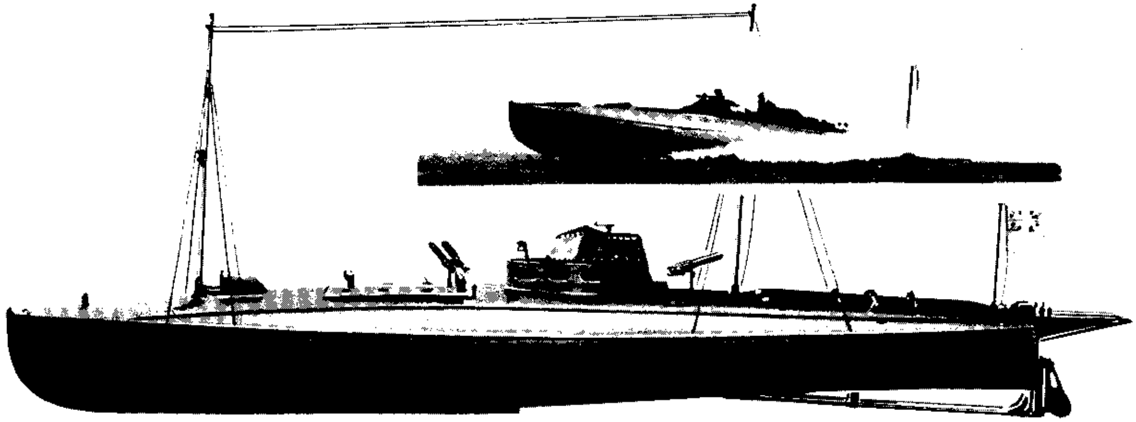
# The First Fast Craft

THE TWO essential elements for achieving higher speeds on the water, engines giving enough power for their weight and hulls which would plane, were first brought together in the opening years of the twentieth century. Already much had been done, notably by Sir John I. Thornycroft, in the case of reciprocating engines, and Sir Charles Parsons with the turbine, to develop steam plants of high power/weight ratio and fit them in easily driven hulls of narrow beam and rounded sections. For example, the torpedo boat HMS *Lightning*, designed and built by Thornycroft in 1876, waterline length 81 ft, achieved a speed of 18½ knots with a two-cylinder compound steam engine of 390 i.h.p. She was a pioneer in the field of naval torpedo-carrying small craft. Sir Charles Parsons' exploit, with *Turbinia* doing 35 knots, was at the fleet review of 1897.

The idea of planing craft, designed to lift (or in the terms of the Patent Office's definition "reduce their draught") is attributed to the Rev. C. M. Ramus, who was granted a patent in 1872. His design was for a stepped hydroplane of roughly flat bottom form. Sir John I. Thornycroft patented in 1877 another stepped hydroplane form, with injection of air under pressure at the step.

The forcing ground for development after the turn of the century was motor boat racing, the major annual events being held in Monaco. With the development of petrol engines and refinement of round-bilge forms, boats like *Ursula*, designed by S. E. Saunders, were by 1910 achieving speeds of over 35 knots. Hydroplanes began to make an impact on racing in 1908, and for a while were attaining much the same speeds as the then conventional round hulls, but with smaller powers and hence lower fuel consumption.

The type of hull which we know today as a hard-chine planing form began to emerge in 1908 or 1909. Among the more successful pioneers in the field were W. H. Fauber, who patented in 1909 a multi-step chine form, Thornycroft, who was developing what he called his "skimmers", notably the *Miranda* series, and S. E. Saunders, who was applying the Fauber ideas. Meanwhile, as an



*Top:* **HMS *Lightning* (later T.B. No. 1), the Royal Navy's first torpedo boat, was designed and built by Thornycroft in 1876.**

*Below:* **The CMBs of the first World War; both 40 ft and 55 ft types were of stepped hull form, and launched their torpedoes from the stern.**

aside, H. E. Vosper in 1904 won a gold medal at the reliability trials held in Southampton, with his paraffin-engined launch—speed was not his objective.

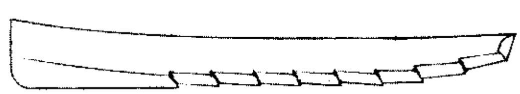
Naval authorities were seeking to apply the speeds attainable in petrol-engined craft for torpedo boats. A French boat with a central forward-firing torpedo reached 20 knots on trials in 1907, while a 110-ft torpedo boat by Yarrow, with four 180 h.p. Napier engines, reached 30 knots in 1908. The direct application of the benefits of planing hard-chine stepped hull forms as developed in racing came with the coastal motor boats (CMBs) which Thornycroft designed and built at the outset of the First World War. These stemmed from the successful racing hydroplane *Miranda IV*, built in 1910, which attained 35 knots. Two classes of torpedo-carrying CMBs were built, of 40 ft and 55 ft, and later some 70-footers as minelayers. Speeds were in the range 30–40 knots. A variety of engines were used, mainly of American origin, but some also specially developed by Thornycroft. These vessels proved the possibility of the type, that planing craft could be designed to carry a useful weapon load, and with a practical measure of sea-keeping ability.

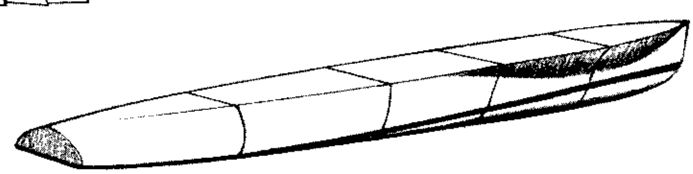
It was at the end of the decade of retrenchment which followed the 1914–18 war that development began to surge forward again. Rapid advances in aero-engines made it possible for the Thornycroft-designed and built *Miss England III* to gain the World Water Speed Record for Lord Wakefield in 1932 at 119.81 miles per hour (104 knots), with two Rolls-Royce engines developing about 4720 b.h.p. It was a time to look again at the practical application of what was being learnt in racing and record-breaking craft, and for design to catch up with the possibilities opened up by innovation and development.

This was the time when the firm of Vosper began to concentrate on fast craft. One of the leading designers of hydroplanes and related types, Fred Cooper, who had designed *Miss England II*, Sir Henry Segrave's record breaker of 1930 (with a speed of 110 miles per hour—95 knots) joined the company in 1930 and was responsible for a number of craft. Shortly afterwards, in 1931, Commander Peter Du Cane joined the firm, and in July of that year became its managing director. He established the policy of concentrating on these fast craft, and his enthusiasm for speed on the water was largely responsible for Vosper's development as a company over the years.

H. E. Vosper had continued to head the firm until he retired in 1919; he died in 1934. When Commander Du Cane joined it was a private company mainly owned by Fraser & White, Portsmouth coal merchants. Among his first projects was responsibility for liaison with Commander Glen Kidston, for whom Vosper were building the picket boat *Advance*. Commander Kidston

**The Fauber patent of 1909 showed a combination of the multi-step hydroplane form with a hard-chine.**



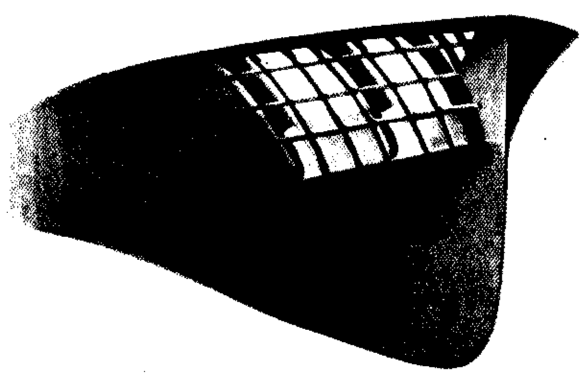


*Ursula* **was a fine example of the racing motor boats of the early 1900s, with a narrow round form, and flat run aft. With a length of 49 ft, beam 6 ft 6 in, she achieved 35 knots.**

was negotiating for the purchase of control of Vosper & Co when he was killed in a flying accident in 1931. In the event the controlling interest was bought, in 1932, by Commander Du Cane and the Earl of Hardwicke.

*Advance* was the first representative of the new generation of Vosper fast craft, and she was followed by a fast cruiser for Edward Wills, *Silver Star*, built in 1931–32. Two hydroplanes, stepped racing boats, were built for Horace E. Dodge, and shipped to the U.S.A. The second, *Delphine*, was completed in 1933. These craft were to Fred Cooper designs, but about this time he left the company and Commander Du Cane took charge of all aspects of the work, recognising that a reputation for first class workmanship and design were vital to the future of the company.

These boats, and a number of other comparable craft, built mainly for a variety of private owners as yachts and tenders, were powered by American engines. With their sights set on selling craft to the British services, Vosper sought to develop home-produced marine engines of suitable power/weight ratio for fast craft. They took the 65 b.h.p. V8 petrol engine manufactured by Ford at Dagenham, fitted a marine gearbox to it, and carried out the other necessary development work to convert it into a reliable marine unit. The resulting power unit went into production in about 1933, and continued until



*Right:* **Light wooden construction, with thin double-diagonal planking on light timbers, backed by stringers and more rigid frames, was typical of the system used for the early Vosper planing craft. This was the scheme used in a 55 ft 6 in express cruiser built in 1933.**

*Left: Delphine*, **shipped to America for Horace E. Dodge, was a typical racing hydroplane of her time, 26 feet long.**

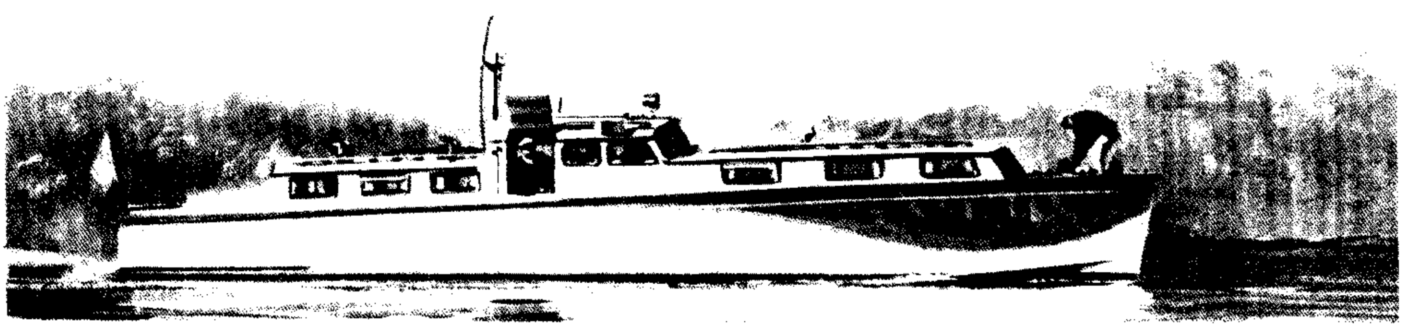
the end of the war in 1945. Many hundreds were built, and the unit was very successful. It was fitted in single, twin, triple and quadruple installations for a wide variety of craft. A smaller, four-cylinder, Ford engine developing about 40 b.h.p. was also adapted to marine use.

Another area of engineering development at this time was the vee-drive gearbox. Vee-drive boxes were used by Vosper as a means of installing the engines of small, fast launches right aft, in small machinery spaces. This arrangement also makes it easier to put all the fuel amidships, where the consumption of fuel will have least tendency to alter trim, which is critical in many high speed hull designs. Vee-drives were used in some wartime MTBs with engines of 1300 b.h.p. and form an essential part of recent combined gas turbine power plants. In a number of cases Vosper have designed and made their own vee-drive gearboxes.

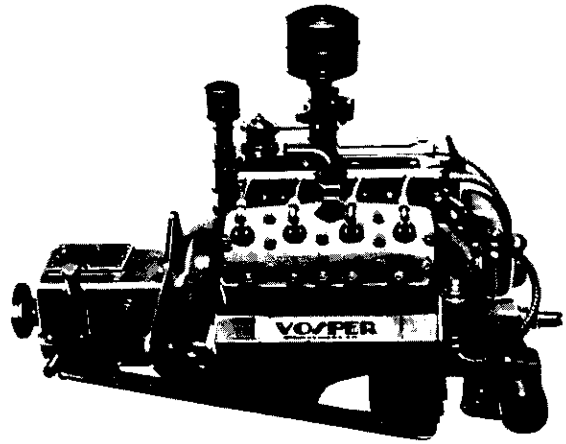
The line of development which the firm embarked upon after Commander Du Cane took charge, technically as well as administratively, was centred on sound, practical designs of hard-chine planing boats, almost entirely of unstepped hull form, and with close attention to the selection of the best available engines, followed by great care with their installation, to ensure reliability. It was a formula which the firm of Vosper was particularly well suited to apply.

*Right: Advance,* **the picket boat for Cdr. Kidston, fore-runner of many craft of this type built in the 1930s.**

*Below:* **One of the first Vosper pleasure craft with pretensions to speed was** *Silver Star.*



**The Vosper V8 marine petrol engine, based on the 65 b.h.p. Ford unit manufactured at Dagenham, powered hundreds of Vosper craft of the 1930 and 40s, and contributed much to their reputation for reliability, as well as having a high power/weight ratio for the time.**




At this same time came the change of emphasis from single orders, carried out as special designs to individual owners' requirements, towards the development of a range of standard Vosper basic designs, which could be adapted to various purposes. This began with the jolly boats. These were small planing boats, mainly with the four-cylinder Ford engine, which could either be open or have folding or removable rigid shelters for helmsman and passengers. Their prototype was a 16-ft boat which the company used themselves for trials, demonstrations and general odd jobs. Others of 13 ft, 15 ft and 18 ft were also built, but the original 16-footer was the most successful, becoming the basis for the familiar "skimming dishes" carried by so many of the Royal Navy's ships throughout the war. Speeds of up to 27 knots were reached by these boats, according to how heavily loaded they were. A light form of clinker construction was used in these craft. About 130 of the 16-footers were built in the 1930s, with about 30 of the other size.

Shortly after the jolly boats came a 25-ft design, with single Vosper Ford V8 engine, used both as a captain's boat and as general fleet workhorse in the Royal Navy. Nearly 100 of these were built between 1935 and 1939, and they were followed by 35-footers used as picket boats and barges, with twin V8 engines, also built in substantial numbers for the Admiralty in the period 1936–1944. The range extended to 45-ft picket boats, with four V8 engines, carried by battleships to replace steam boats.

Towards the end of the pre-war period Vosper designed and built a number of 40-ft seaplane tenders for the Air Ministry, followed by over seventy 45-ft refuelling barges for seaplanes, construction of which continued well into the war years.

Not all the construction was, of course, to standard designs, although the rapid build-up of a range of adaptable planing hulls made it possible to suit most needs by using, in only slightly modified form, something which was already familiar. In 1934 the firm's first *Swordfish* was built, and used by Commander Du Cane and the firm to try out various design developments. Powered by twin V8 engines, giving a speed of some 28 knots, this launch was designed to be able to operate in almost any weather, and represented a considerable step forward in extending the high speed type of craft's capacity to withstand heavy going. The second *Swordfish*, built in 1954, was similar, but with an improved hull form and a vee-drive machinery installation.

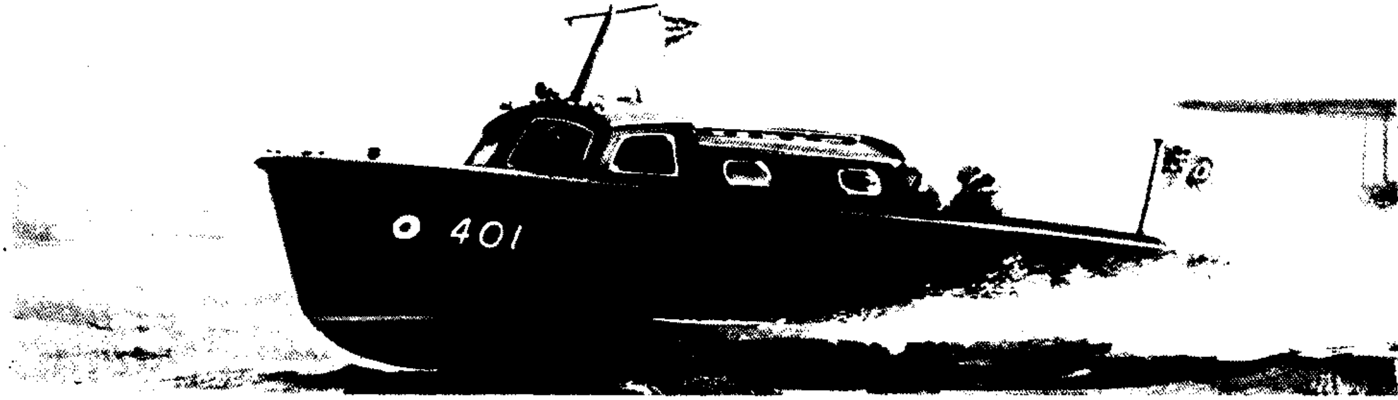
The recognition Vosper had achieved at the Admiralty in the few years of the middle 1930s led to their being commissioned to design and build a new 40-ft royal barge for the *Victoria & Albert*. This was completed in 1939, and had three V8 engines.

These changes in the character and scope of the company's activities called for an expansion of facilities. First the premises on the Camber were modernized, and later a second shipyard, Flathouse Yard, on the north side of Portsmouth Dockyard, was bought. Meanwhile, in 1936, the firm was incorporated as Vosper Limited, and became a public company, with a Stock Exchange quotation. Control remained with the directors.

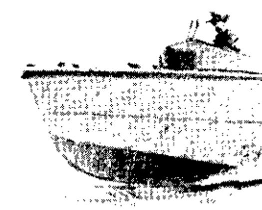
This period of rapid development had proved the suitability of the unstepped hard-chine planing form for a wide variety of practical duties, and that craft of this form could be designed to have good sea-keeping qualities, while achieving speeds of approaching 30 knots using reliable, standard, production engines.

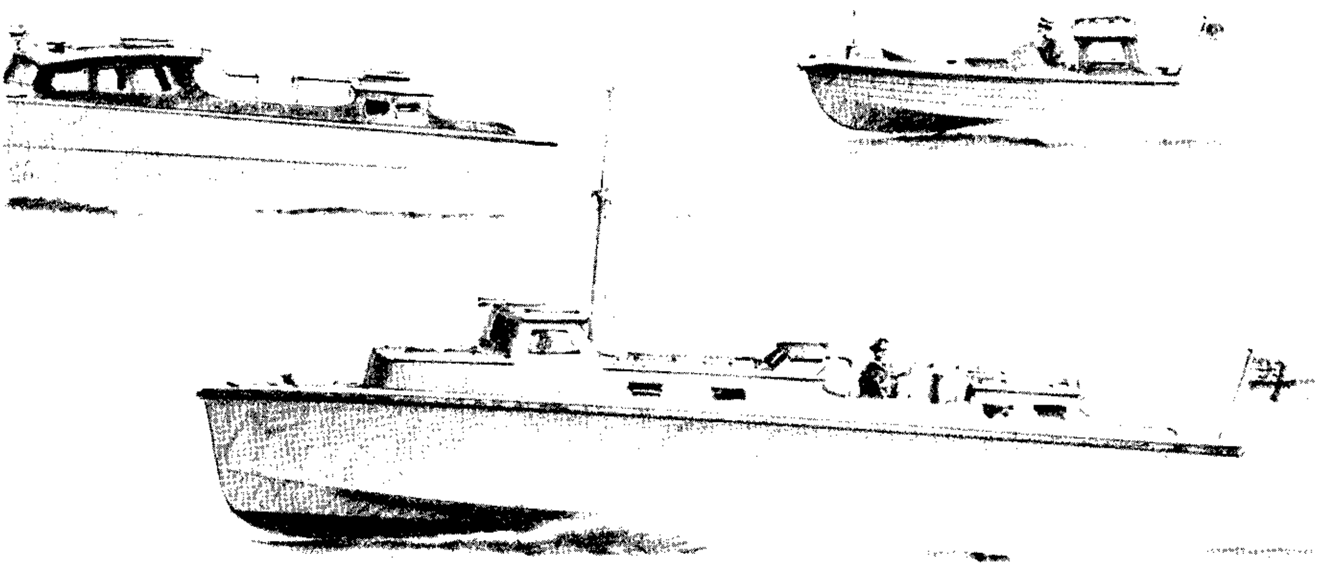
There remains to this day some controversy as to whether stepped or unstepped forms are the most suitable for this kind of duty, although the balance seems to be in favour of the unstepped type. The stepped form concentrates the planing forces on small areas of the hull's bottom, which causes high local stresses, and tends to result in a more violent motion in rough water. It is also more sensitive to trim changes, and causes more resistance at low speeds when the hull is not planing, a condition under which many practical craft often have to operate. In its favour, the stepped form can, when planing, have less resistance than the un-stepped hard-chine form. But the development of engines to higher power/weight ratio over the years, has provided designers with the means of overcoming any additional resistance the un-stepped form may have. Structurally, the discontinuity the step creates in the boat's bottom poses problems for designers. The bottom in unstepped forms is better able to make a contribution as the flange to the girder stiffening the hull.

In any event, it was the unstepped planing form which Vosper adopted, and which remained the basis for their progress for many years.




Among the first Vosper craft for the RAF were 40 ft seaplane tenders, capable of 24 knots. They were fitted for ambulance duties and rescue as well as for transport of passengers and crew. The low freeboard aft allowed the crew access under the wing of a flying boat. Complementary craft, although not of high speed, were steel refuelling boats carrying 2000 gallons of petrol and a petrol-driven pumping set to transfer the fuel to the aircraft. Over 70 of these were built.





**Jolly boats of 16 ft, (*above right*), which became known in the Royal Navy as skimming dishes or skimmers, were among the first Vosper fast craft for the Service. The range soon also included 25 ft, 35 ft (*above, left*), and 45 ft (*centre*) picketboats and barges. These were all built in quantity, and led in 1938 to a commission to design and build a new Royal barge for *Victoria and Albert* (*left*).**

# 3

# Fast Fighting Craft

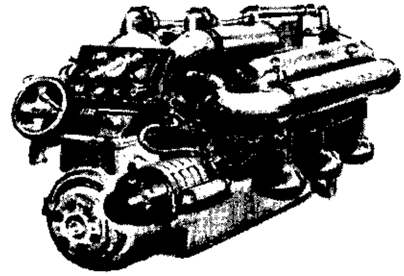
By 1938 technical advances in two areas were beginning at Vosper. The first, and ultimately the more important, led to the development of the new generation of torpedo boats, and laid the foundations for the company's later concentration on small, high-speed warships. The second was the design and construction of a record-breaking hydroplane for Sir Malcolm Campbell. Record-breaking and racing craft provide an opportunity for design teams to extend themselves with fewer practical constraints than apply in the case of more workmanlike vessels and Vosper's occasional involvement in such projects over the years has played a useful part in the general development of their fast craft.

The early story of torpedo boats has already been touched on: the naval requirement for fast, manoeuvrable boats capable of sinking or severely damaging large ships, by means of the torpedo, was one which recurred at intervals. Certainly the First World War CMBs (MTBs in fact, if not in name) proved their worth, and there was by the late 1930s beginning to be official recognition of a need for something comparable and more up-to-date, as the prospect of another major conflict began to loom ahead.

Until the recent development of suitable guided missiles, the torpedo was the only practical means of delivering from small craft an explosive charge capable of inflicting serious damage to a large ship, in a direct attack (that is, excluding the mine-laying role) and the motor torpedo boat was the natural choice for an offensive type of vessel based on developments in high-speed small craft.

To be effective the conventional torpedo has to be released in salvoes at close range, preferably from a position on the enemy's bow. Its use has encouraged the development of small vessels of the highest obtainable speed and manoeuvrability which can get in close, fire their torpedoes, and make their escape before the target ship can bring its defences to bear. Such were the motor torpedo boats (MTBs) of the Second World War, and the torpedo-carrying fast patrol boats developed since.

**A major contribution to the success of early MTB's was made by the Isotta Fraschini engine, originally of 1000 b.h.p., later supercharged to deliver 1500 b.h.p.**

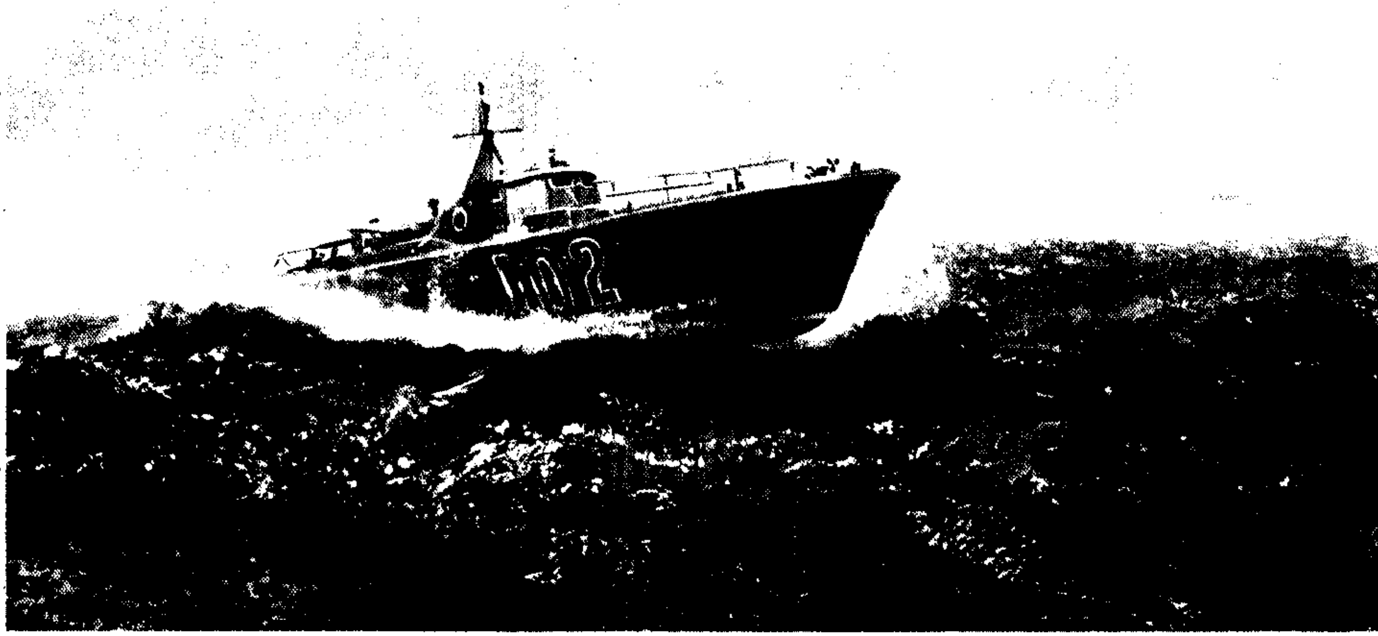


To have a reasonable chance of reaching their target, and of escape, MTBs need a speed substantially higher than that of conventional warships of their day, and a figure of over 40 knots, while carrying an effective weapon load, was set by Vosper as the aim when they entered this field.

As they had with their earlier and smaller vessels, Vosper took the initiative by designing and building (as a private venture at the company's own expense) a vessel to meet the requirements for a new type of MTB, as they saw them. Once again the first need was for suitable power units, and after careful study the choice was the Italian Isotta Fraschini engine, which at this time was a proven marine unit delivering 1000 b.h.p. It was later developed to produce, with supercharging, 1500 b.h.p. Vosper bought from the Italian firm an exclusive licence for the British agency and manufacture of this engine, and obtained a few of the engines for themselves. The entry of Italy into the war on the German side, however, prevented substantial numbers of the engines being used in later MTBs.

When the Italian engines became unobtainable, the only alternative of adequate power was the Packard of 1350 b.h.p., which had to be obtained from America, involving some delay. These too were later up-rated to 1500 b.h.p. British engine-building capacity in this category was applied almost exclusively to aero-engines during the war years. One British engine which was used, mainly by the British Power Boat Company, was a marine version of the Napier Lion aero-engine, but with a rating of 500 b.h.p. this was not considered adequate for the speeds needed to make MTB attacks effective. While waiting for the Packard engines, Vosper fitted Hall-Scott engines of 500 b.h.p. in some MTBs, with consequent loss in performance.

The Vosper prototype MTB, later to become MTB 102, had a hard-chine hull, without step, with an overall length of 68 ft. She was powered by three of the Isotta Fraschini 1000 b.h.p. engines and, before being armed, attained a speed of 48 knots on trials. Her construction was of double-diagonal mahogony planking on sawn frames, a scheme which was usual in this type of craft



**Trials in the English Channel in a Force 7 blow convinced the Admiralty that the Vosper hull form would give them the combination of speed and seaworthiness they needed for MTBs.**

until synthetic resin glues and marine plywood were perfected, and became available for marine use late in the war.

As originally designed, this Vosper MTB carried a 21-inch torpedo fired forward through an opening in the stemhead, and a second fired over the transom to travel forward under the vessel. She was also equipped with quadruple Bren gun mountings, although at one time twin Oerlikon mountings were fitted for evaluation. She attained 44 knots with full armament load.

Vosper had reached an understanding with the Admiralty that, if certain trial conditions were satisfactorily met, the craft would be bought for the Royal Navy. These trials included operation in the open English Channel in a wind of Force 7 on the Beaufort Scale under which conditions the boat duly proved her seaworthiness, and was bought by the Admiralty, then becoming MTB 102.

This was the beginning of a long period of close collaboration between Vosper and the Admiralty—now the Ministry of Defence (Navy)—on warship design; collaboration which has involved much interchange of information, some rivalry, and some differences of opinion, but which has been extremely fruitful over the years.

Further development was done on this design, following tank tests at the Admiralty Experiment Works, Haslar, and Vosper built a scaled-down manned version of the improved design, which was used for many years as a launch, for further evaluation of the hull form. This manned-model technique was one the company was to use again more than once.

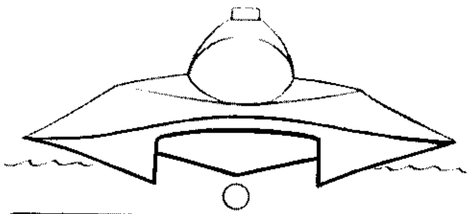
MTB 102 was herself modified, and fitted with two torpedo tubes on the side-decks. She thus became the first MTB to be fitted with two 21-inch torpedo tubes, both firing forwards over the bows, the arrangement which was to become the standard one in wartime craft, though certain later ones were armed with four 18-inch tubes. To make this possible her hull was slightly modified by the forming of scallops either side in the sheer, to provide the necessary clearance. The resulting operational craft was faster and carried a heavier armament load than any other MTB of her time.

Vosper were of course not the only company engaged on the development of craft of the MTB type in the 1930s. Perhaps their main rivals were the British Power Boat Company, under Hubert Scott Paine, who had worked in the aircraft industry, from which there was much to be learnt which was applicable to high-speed craft. Later, as demand for vessels for the flotillas of Light Coastal Forces grew, many of the country's best known ship, yacht and boat building concerns were drawn in, some developing their own designs, while others built to the plans of the Admiralty or other companies.

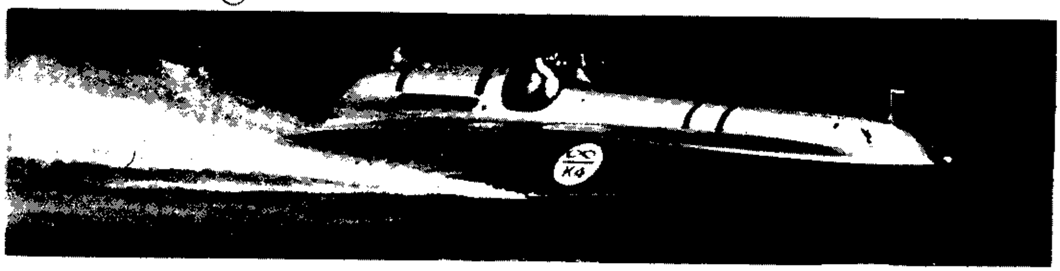
At much the same time as they were handling the 102 project, Vosper were designing *Bluebird II* for Sir Malcolm Campbell's 1939 attempt on the world water speed record. Her predecessor, *Bluebird*, had just gained the existing record at 130 miles per hour (113 knots) but at that speed, her owner said, was showing signs of instability. Her form was basically that of a conventional stepped hydroplane, but with special attention to reducing air resistance.

The Vosper design for *Bluebird II*, developed by Commander Du Cane with the help of model tests at the Haslar ship tank in collaboration with the superintendent, Dr. Gawn, followed to some extent the Apel system, which provides three planing surfaces in a tricycle plan, with two forward surfaces side by side, and a single central surface aft. *Bluebird II* took the record in August 1939 with a speed of 141.7 miles per hour (123 knots). This record-breaking digression took Vosper into a type of hull design which differed drastically from forms suitable for working and fighting craft which encounter rough water.

There was, however, still some controversy over the question of whether hulls for MTBs were better designed with a hard-chine form, like MTB 102, or with a step like the earlier CMBs and related hydroplanes. The Admiralty therefore ordered from Vosper such a stepped MTB, to be powered by two of the up-rated 1500 b.h.p. Isotta Fraschini engines in a vee-drive arrangement. She became MTB 103, and was delayed by the interrupted supply of Italian engines, eventually being fitted with the 1350 b.h.p. Packard engines from America. Her performance was not so good as to justify a departure from the



*Bluebird II*, **owing something to the ideas of Apel, had three planing surfaces: she took the world water speed record in 1939.**




designs, derived from that of MTB 102, which were being adopted for the bulk of the new Light Coastal Forces flotillas and she became a target-towing craft. The lack of the engines for which she was designed made it impossible to draw valid conclusions about the stepped hull form as such.

A number of craft were built at the Flathouse shipyard, but in 1938 these premises were bought compulsorily by the Admiralty, as a northwards extension of Portsmouth Dockyard. Vosper retained the use of some trials facilities there, while acquiring the site on the border of Portchester and Portsmouth, on the northern extremity of Portsmouth Harbour, which today houses the company's headquarters. The purchase price of Flathouse was not enough to make financially possible the new shipyard at Portchester and a "rights issue" was made early in 1939.

The new site was marsh land enclosed by a bund, which had been built during the Napoleonic wars by French prisoners of war. Vosper filled this area with chalk, and drove piles as foundations for a new boat-building shed and offices, together with an enclosed non-tidal fitting-out basin under cover. These upper reaches of Portsmouth Harbour are mudflats at low tide, and the access channel to the new yard was, and remains, usable at certain stages of the tide only. Later an extension gave a much larger non-tidal basin in the open, which is still an invaluable facility today. Portchester came into use in 1940, by which time air raids were beginning to cause damage to the Camber.

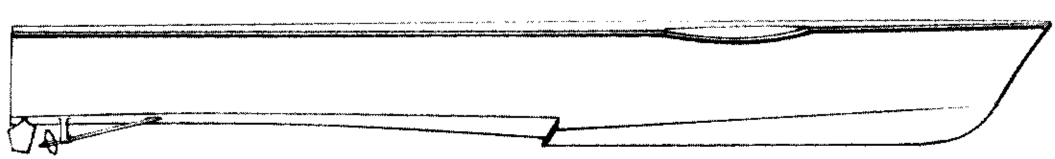
About 350 boats were built in various parts of the world to designs stemming directly from MTB 102 for the navies of a number of the allies, including Russia. Size did increase slightly, with the bulk of wartime MTBs having a length of 70 or 71 ft. Wartime construction was, however, largely to standard designs, for a number of practical reasons, including the convenience of being able to use standard cradles when the boats were slipped.

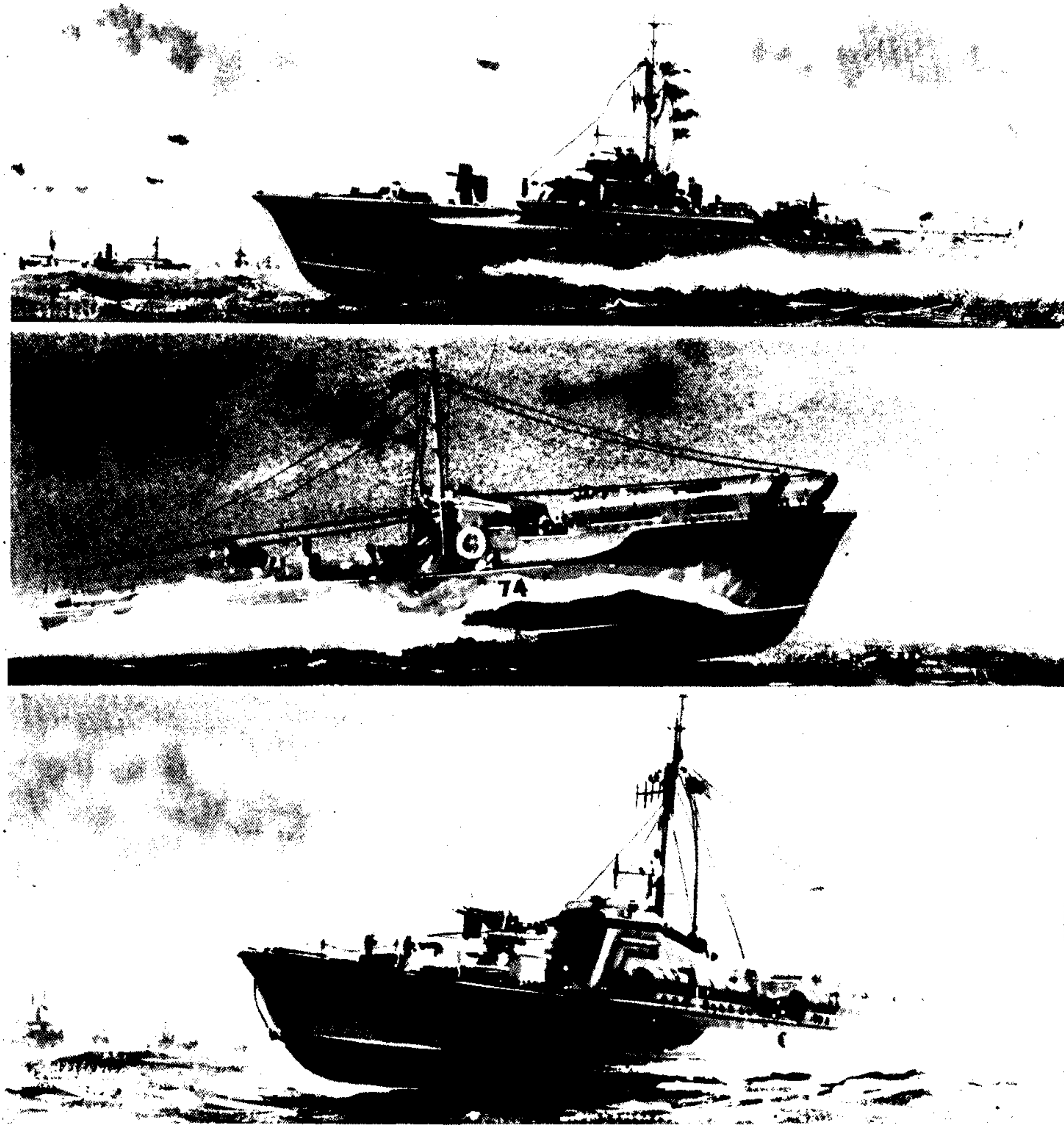
Immediately before the war, in 1938 and 1939, Vosper were building four 70-ft MTBs for Romania, two for Greece, and six 60-ft boats for Norway and Sweden. The large boats were taken over by the Admiralty at the outbreak of war, although they were replaced from later construction. The Admiralty themselves ordered in 1939 and 1940 some 75 Vosper 70 or 71-ft MTBs, of which a number were destroyed by bombing before completion. Many of these were subcontracted to other yards, some as replacements for those destroyed. The final orders for this class of boat were received in 1942, totalling 16 craft.

One of the 1940 programme boats achieved special distinction at the raid on St. Nazaire in 1942. Designated MTB 74, she was allocated to this duty from the outset, having special tubes fitted on the foredeck from which large explosive missiles could be launched. In the St. Nazaire raid these were successfully dropped into the mud outside the caisson retaining water in the main submarine basin, and some hours later detonated to destroy the caisson, draining the basin and making it useless for a considerable time. Pausing to pick up survivors from a sinking ML, MTB 74 was herself damaged and her captain and crew taken prisoner.

The production of large numbers of standard boats under war conditions called for a considerable organisation, and it was also necessary to disperse the building activity to minimize the losses likely in any single air raid. Much of this was achieved by subcontracting to other firms, but Vosper themselves, with the Admiralty, created a separate building yard at Wivenhoe in Essex, which was managed by Mr. John Rix, the present managing director of Vosper Thornycroft Limited, who had joined the Vosper design office before the war.

**A stepped hard-chine MTB, designated 103, was ordered for comparison with the unstepped types. The sheer scallops, later also built into 102, provided clearance for the torpedoes when these came to be fired from tubes on either side of the superstructure.**






*Top:* **Early wartime Vosper production MTBs of 70 or 71 feet carried two torpedo tubes and retained the scalloped sheerline. Light machine guns were fitted.**

*Centre:* **MTB 74 with her special foredeck launchers for the St. Nazaire raid, was basically of the Vosper 1940 programme type.**

*Bottom:* **From 1943 the Vosper MTBs were larger (73 ft) and carried four torpedo tubes and a heavier gun: they were beginning to combine the functions of MTB and MGB.**

Other Vosper establishments set up to meet wartime needs were Blackbrook Farm, near Fareham, which became the engineering centre with foundry, forge, machine and fitting shops; and Yachthaven, on Hayling Island, which built in large numbers steel 40-ft landing craft to Admiralty designs, and the 45-ft RAF refuelling launches, which were also of steel.

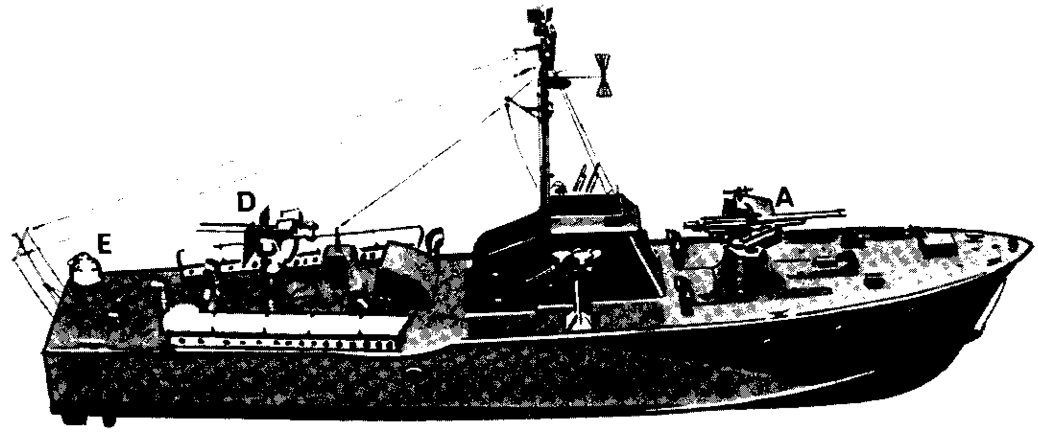
The 1943 and 1944 MTB programmes were for a modified design of Vosper MTB, with the length increased to 73 ft, and various improvements incorporated. The familiar scalloped sheerline disappeared with this class, of which about 28 were built. These craft, although improved in many ways, were becoming increasingly heavy and complex, with more elaborate and diverse armament, which resulted in a certain loss of performance.

So far as hull design went, MTB 102 and her derivatives were of fairly conventional hard-chine form, with the chine fairly low forward (a little above the load water line when at rest), and relatively little deadrise. She represented a very considerable advance in her day, and later planing warship hulls have not greatly increased in speed/length ratio. What has been done is to improve sea-kindliness, and to carry a more substantial fuel and armament load. Size has increased, and the corresponding increase in speed has called for major developments in propulsion.

The most important wartime fast craft, apart from the MTBs, were the air-sea rescue launches used by the RAF to recover airmen from the sea. This was a type with which the British Power Boat Company were mainly concerned, having a 68-ft design for high speed which was much used in the narrower parts of the English Channel and North Sea, particularly from Newhaven.

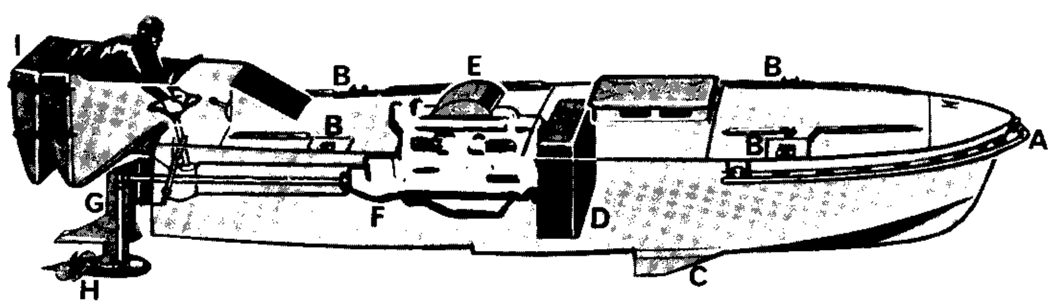
Vosper were in 1941 asked to develop a new type of air-sea rescue launch, with a little less emphasis on speed, but more on sea-keeping ability, to operate in the region of Lands End and from Milford Haven. This became the 73-ft RAF air-sea rescue launch of 1941–42, which was based on a scaled-down version of the Admiralty Fairmile D design. Fifteen were built. This was the beginning of a trend in design aimed at improved sea-keeping and sea-kindliness (needed because these launches were to be used, perhaps to carry badly injured men, in exposed waters and all weathers). The chine was higher at the bow and the forefoot fine in section with a large deadrise angle. The bows were flared to give a full deck line. This type of hull, which has led to the latest forms used in fast patrol boats, is often referred to as being a compromise hard-chine design. The success of these boats in meeting the requirements for sea-keeping made them an important step forward.

The machinery in the 73-ft HSLs consisted of twin 12-cylinder Thornycroft petrol main engines driving through special flexible couplings and reduction



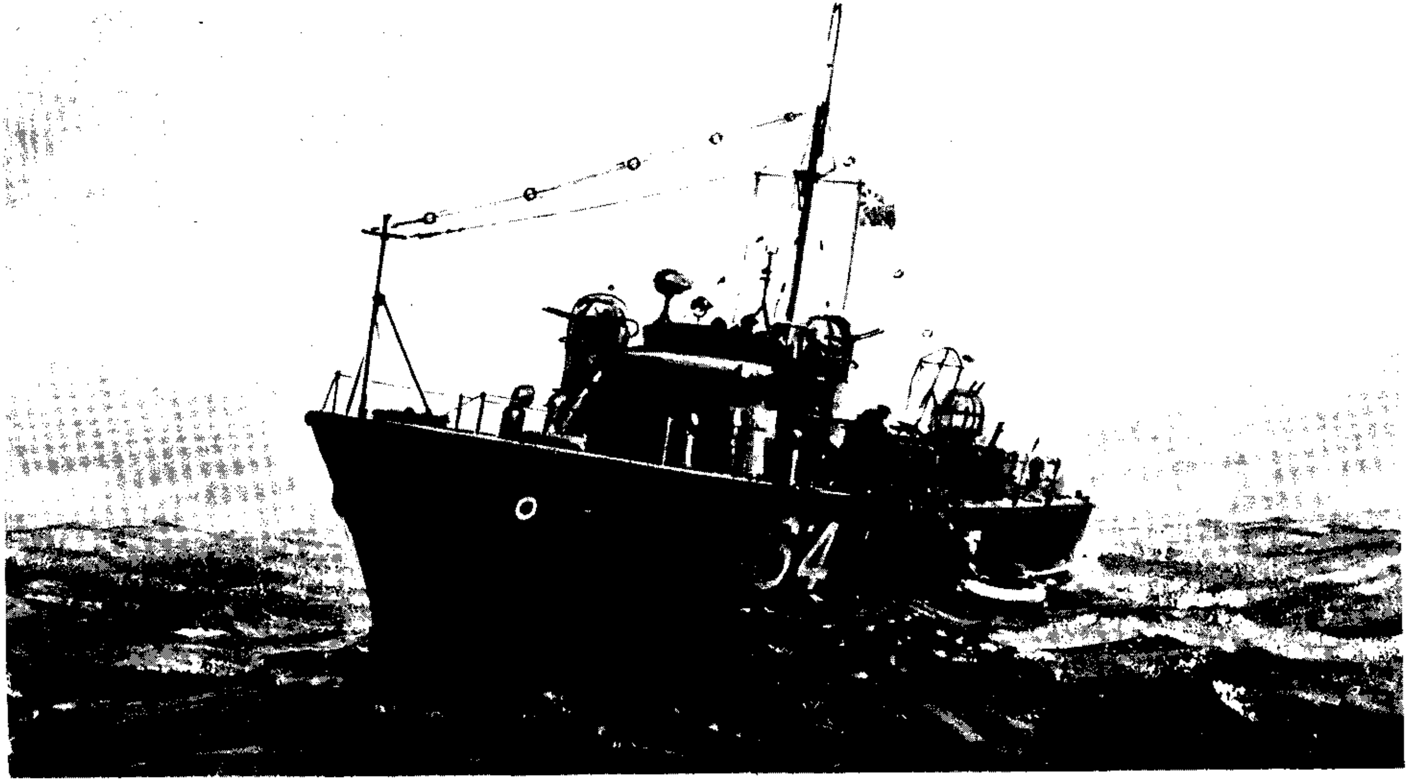

A typical late-wartime 73 ft MTB/MGB. Many of these carried a considerable weight of armament, rather to the detriment of speed.

A 6-pounder power operated gun
B Twin 0·303 Lewis guns, port and starboard
C Two 18 in torpedoes in tubes aft
D Twin 20 mm Oerlikon guns
E CSA Smoke generator




Boom patrol boats, or airborne attack boats, were expendable craft carrying a warhead forward, designed to destroy submarines in the Norwegian fjords.

A Bumper rail for detonation
B Sling points fore and aft for attachment to aircraft
C Plate fin
D 23 gal fuel tank
E Fairing over engine air intake
F Lagonda engine
G Inboard/outboard drive
H Coaxial contra-rotating propellers
I Life float and release gear to allow pilot to escape



**Air-sea rescue launches, of 73 ft, designed by Vosper for the open seas of the Western Approaches showed a change in hull form aimed at sea-kindliness, and gave valuable experience.**

gearing, with twin Vosper V8 engines coupled into the same gearboxes in a vee-drive arrangement for cruising. This installation was in some ways a fore-runner of the combined power plants used later with the advent of gas turbines.

One other, and relatively little known, type of fast craft was designed and built by Vosper during the war. This was the "boom patrol boat" or air-borne attack boat. This was conceived as a means of destroying enemy ships, and particularly submarines, which were lying deep in the fjords of Norway, beyond the reach of the Royal Navy and conventional bombers. These craft, with an explosive warhead in the bows, were to be dropped by parachute from an aircraft into a neighbouring fjord, with a commando pilot. He would steer the boat round to where the target lay, point it in the right direction, and make his escape by means of a special life-raft. For a reasonable chance of success, and escape for the pilot, the operation had to be carried out on a moonless night before snow had fallen. In the event the right conditions did not come before the war was over.

The boats themselves, however, were successful in trials, and seventeen were built in 1944 and 1945. They were 16 ft long, powered by Lagonda V12 engines, driving through a specially developed contra-rotating steerable out-drive installation, designed to eliminate the effect of propeller torque, so that the boats ran true when unmanned.

As the war progressed development in small, fast craft for warlike purposes continued on both sides. The German E-boat, designed and mainly built by Lurssen, was 114 ft long, of round form with a pronounced knuckle forward. Three 2500 b.h.p. diesel engines gave her a speed of 41 knots. This was comparable with that of the smaller British MTBs, with their often restricted choice of power unit, and led to the development of MGBs—motor gunboats—primarily to combat the E-boats, which could dispense with heavy torpedoes and tubes in the interests of speed. Small craft were also employed as motor minelayers (MMLs). The later, 1944, class of boats were combined MTB/MGBs, and were therefore somewhat overloaded, with reduced speed, and earlier boats were then also converted to the dual role, with loss of performance. In general it is fair to say that although the war years saw steady advance in the versatility of light coastal forces, the speeds they attained were not as great as those of the early war craft, designed with the more single-minded objective of torpedoing enemy shipping.

Although primarily associated with MTBs, Vosper did design and build an experimental MGB, No. 510, ordered by the Admiralty in 1943. The objective was to produce a faster version of the D-type Fairmile ML, which barely reached 30 knots. To this end a power plant consisting of four of the Packard engines, driving twin screws through fluid couplings, was devised. The boat reached 36.5 knots, and with further development on the propellers (which were beginning to be a limiting factor in high-speed craft) might have achieved more, but the war was ending and the Admiralty did not proceed with the type. MGB 510 did, however, prove to be a very good sea boat, again showing the worth of deeply veed forward sections when seaworthiness has to be combined with speed.

The end of the war found Vosper, in common with a number of other companies and the Admiralty, with a wealth of experience relating to all aspects of high-speed fighting craft—hull design, propulsion, construction, armament, electrical engineering—all contributing to the ability to reconcile the conflicting requirements for speed, load-carrying, seaworthiness, endurance, economy, and reliability. The problem became one of seeking outlets for this ability.

**Trials in MTB 1601 provided an opportunity to evaluate the improved hull design Vosper first developed in 1944. She was framed and planked in plywood, the planking being laid in sheets or in strips, according to the degree of curvature.**

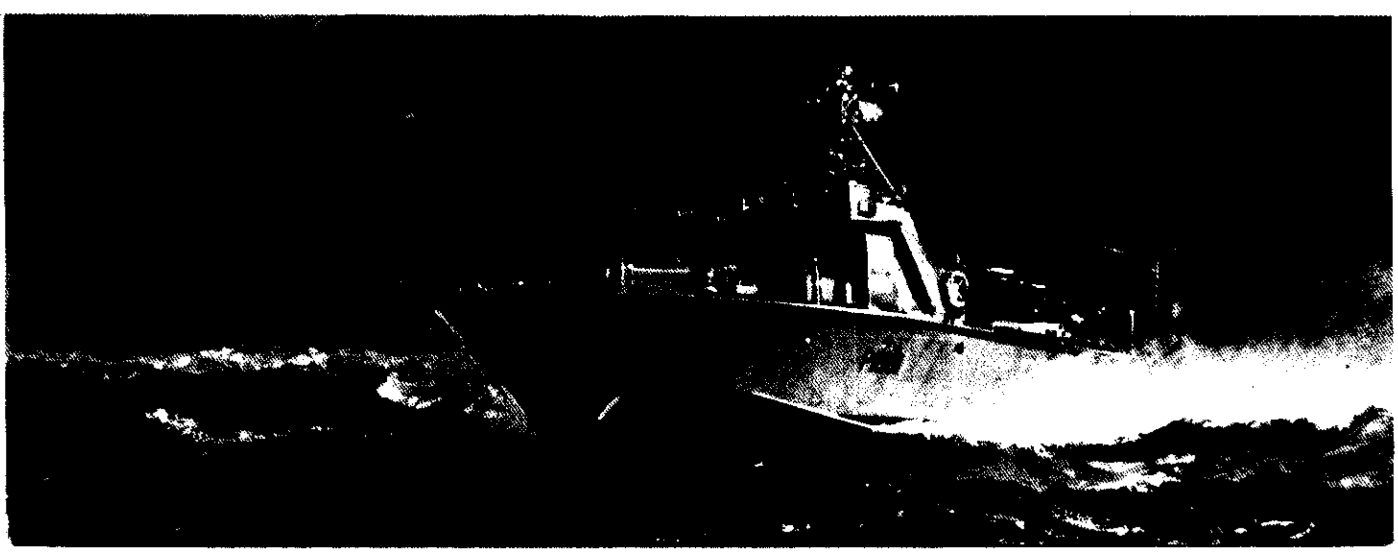
4

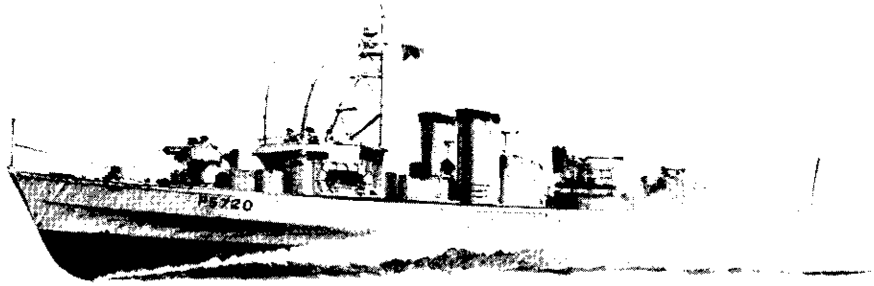
# Applying Wartime Lessons

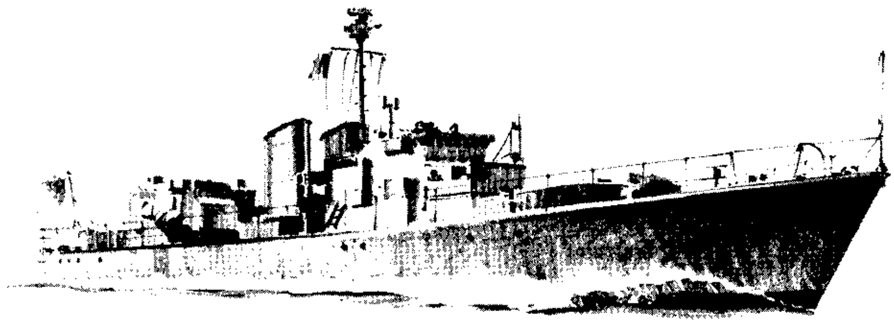
THE WAR'S END found those companies which had been designing and building fast craft for military uses, in common with many other industries, faced with a drastic reduction in the work there was for them to do—the classic swords-into-ploughshares situation. For Vosper in particular there was the knowledge that seagoing light craft could be designed and built to attain something approaching 50 knots. There was also the lesson that practical requirements for a diverse, adaptable, and inevitably fairly heavy load of weapons often overrode the need for outright maximum speed. Trials of two and three-bladed propellers of various diameters carried out in one of the Vosper-designed boats of the 1944 programme, MTB 524, showed these boats could reach speeds of over 48 knots when lightened. Less certain was what field of application there would now be for this knowledge.

It was also clear that fresh progress towards reconciling the conflicting needs for speed, sea-keeping ability, and weapon-carrying capacity would depend, once again, on developments in propulsion: both machinery and propellers. At the same time technical advances in materials, particularly glues, were opening up new structural possibilities.

The wartime experience with MTBs had convinced the Vosper design team







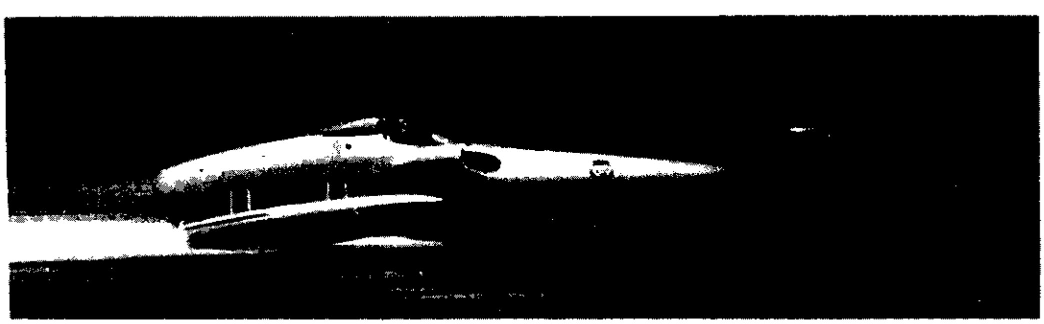
**HMS** *Grey Goose* **(***below***), re-engined with gas turbines, and** *HMS Bold Pathfinder* **(***above***), built and engined by Vosper, both had twin funnels for their gas turbine exhausts. These were the company's first gas turbine installations.**

that what had been virtually the standard hull form could be improved in a number of ways, most noticeably by modifying the bow so that the chine was higher, the forward sections more deeply veed, and the deck line fuller. Vosper had originally designed such a modified hull form in 1944, and it had been tank tested at AEW, Haslar, showing its possibilities. Vosper asked the Admiralty for permission to design and build a 73-ft MTB incorporating these ideas, and this was given. The result was MTB 1601, completed in 1948. Apart from the new hull form, she was built to make full use of the marine waterproof plywood which was now available, both for web frames and for planking. Originally designed with controllable-pitch propellers and no gear-boxes, she was later fitted with fixed propellers and reversing gearboxes and reached a speed of 43 knots. The new hull form was successful and became the basis for later Vosper designs, including the *Brave* class fast patrol boats.

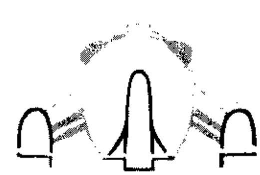
This was a period when lack of production orders for fast craft of appreciable size caused the firm to turn to a variety of other work, including motor yachts, a coaster, trawlers, and even fairground machinery and caravans. Continuity was maintained, however, by further Admiralty experimental work in the field of propulsion—in particular the application to marine use of the gas turbine engine developed at the end of the war for aircraft. The first such contract involved the installation by Vosper of a specially designed Rolls-Royce gas turbine (RM60) of considerable complexity in the former steam gunboat HMS *Grey Goose*, famous for its associations with the naturalist Peter Scott. She was also fitted with Rotol controllable-pitch propellers for astern power and manoeuvring. There followed the construction of the two Admiralty-designed *Bold* class vessels with twin Metro Vickers G2 gas turbines and Mercedes Benz diesels, taken from German E-boats, for cruising. This installation formed an early example of the CODOG (Combined Diesel or Gas-turbine) power plant which has since become a common arrangement. *Bold Pathfinder*, a round-bilge design, was built by Vosper and *Bold Pioneer*, a comparable hard-chine vessel with the same power units, by J. Samuel White. Twin experimental Deltic diesel engines were later fitted in *Bold Pathfinder* for cruising, in place of the Mercedes units. Although not particularly successful, these vessels taught the designers much about the installation problems of gas turbines in fast marine craft, particularly as regards keeping salt spray out and developing suitable propeller arrangements.

The gas-turbine installations for *Grey Goose* and the *Bolds* used the free turbine principle, in which the turbine which drives the ship's propeller is mechanically independent from the turbine used to turn the engine's compressor.

In 1949 Vosper began a three-year programme for John Cobb, to design and build a new record-breaking craft. This was to be powered by a jet aero-engine, and it was considered that, to be successful, a design speed of about 250 miles per hour (217 knots) was necessary. The configuration was suggested to John Cobb by Reid Railton, and took the form of a body supported on three planing surfaces, a single central one forward, and one either side aft. This was a reversal of the Apel arrangement, used in the pre-war *Bluebird II*.

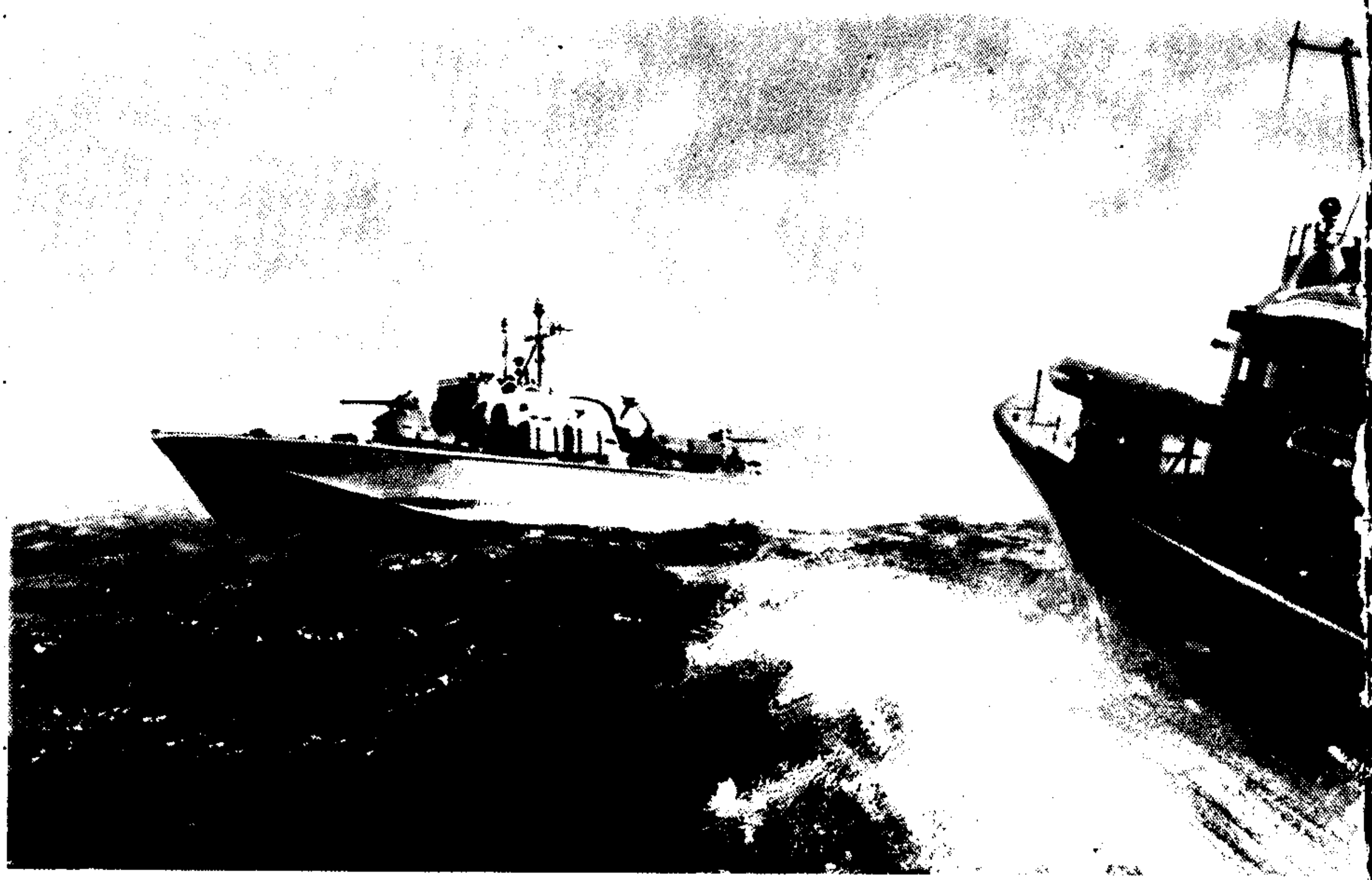


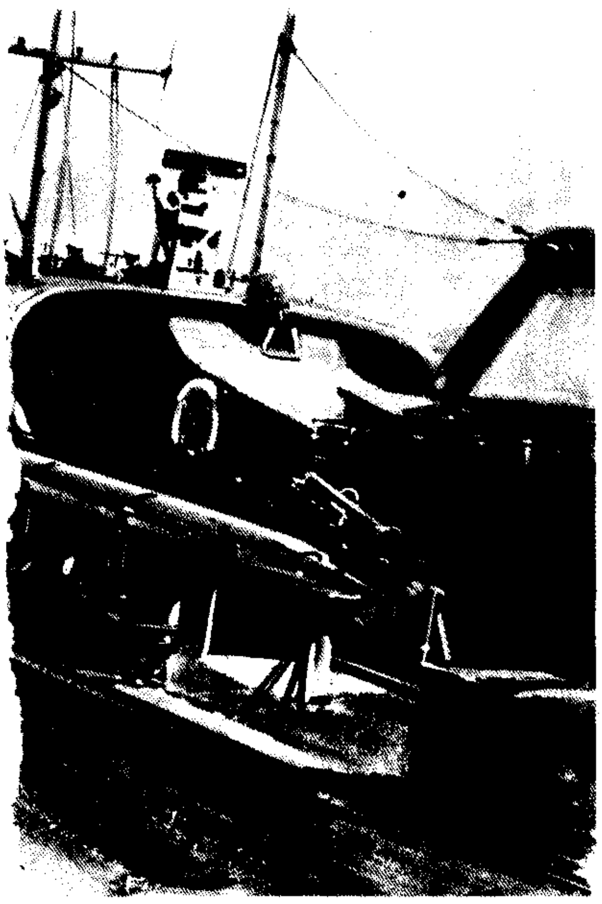
*Crusader* **planed on three ski-shaped surfaces in a tricycle arrangement.**



This particular project ended in disaster, but there are reasons for believing the basic design was sound and, perhaps with more time, could have reached its intended speed in safety. From the point of view of Vosper the project was of special interest because of the model testing techniques which had to be developed in the process of arriving at the best design compromise. These are discussed in more detail in Chapter 7.

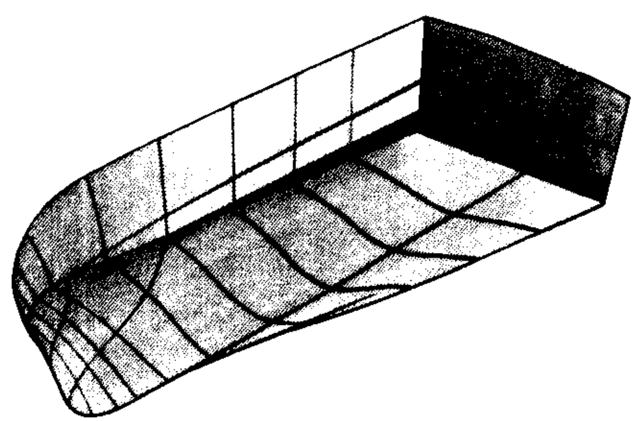
This period of 1948–1950 saw a number of craft built, including smaller launches for the Services and private owners, but the momentum of wartime success in more substantial craft was in danger of being lost because there was not the volume of business in production craft to sustain the firm financially, although a grant of £35,000 in recognition of wartime work, and particularly of the initiative with MTB 102 and the Isotta Fraschini licence, was some help. In the event the Korean crisis and war of 1951 led to an emergency programme for the construction of fast patrol boats (as MTBs were now called). These were





**Post-war 68 ft air-sea rescue launches for the RAF were built by Vosper using the same basic hull design as MTB 1601.**

**With *Brave Borderer* and *Brave Swordsman* the 1944 hull form showed what it could do. Among the convertible armament schemes for the Royal Navy's 50 knot fast patrol boats were those for the gunboat role, shown here with jettisonable fuel tanks on deck for long range, and as a torpedo boat carrying four torpedoes in side launchers. Others included minelayer and torpedo/gun boat arrangements.**



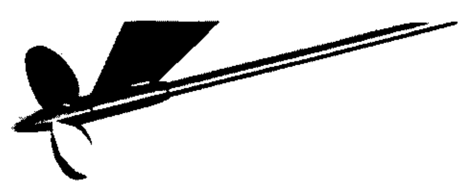
the *Gay* class of which Vosper built four to Admiralty designs, including the first of the class. This injection of work at a critical time can fairly be said to have saved the company.

The *Gay* class were powered by three of the Packard petrol engines, familiar from the wartime MTBs, and had a length of 73 ft. They were referred to as "short" boats, Type B, and were arranged to be convertible for use as MTBs, MGBs or minelayers. The Type A "short" boats were in fact the later *Dark* class, and the "long" FPBs were round-bilge craft of between 110 and 120 ft, with top speeds of about 31 knots.

Apart from the Korean war, there was in the 1950s some growth of new interest in high-speed craft for the Services, perhaps partly due to the fact that the stock of wartime craft was dwindling and becoming outdated. Vosper were approached by the Air Ministry to design and build a new air-sea rescue launch, to replace those formerly built by the British Power Boat Company, which had closed down following the ill-health of the owner, Hubert Scott-Paine. Their proposal for a 68-ft wooden boat based on the hull form of MTB 1601, was accepted, and sixteen craft built in all. The engines were marine conversions of the Rolls-Royce Griffon piston aero-engine, as required by the Ministry, and two of these gave the boats a speed of about 40 knots. One of the hulls was built experimentally with an aluminium alloy framework and bottom plating and glass-reinforced plastics topside panels bolted to the framework. This craft was also used for a number of measurements of stresses and accelerations under way.

In 1954 the first steps were taken to initiate a project which was to span six or seven years, and result in dramatic innovations in all the main technical areas applicable to small fast naval craft. It was also to be a culmination to the efforts and thinking of Vosper going back for nearly 20 years, and an important foundation for the years which were to follow. This project was the design and construction of the *Brave* class "medium" fast patrol boats for the Royal Navy. It was marked by a protracted period of discussion, development, negotiation, and compromise between Vosper and the Admiralty, as to the best way of achieving clearly-stated staff requirements. These were for the smallest and fastest boat, of hard-chine form, which would be able to carry a new gun being specially developed for Coastal Forces, the CFS 2. Speed was

**The faster turning propeller (*left*) may lose efficiency because of cavitation but it and its shaft and bracket are smaller and lighter. Its axis is also inclined at a smaller angle to the water flow.**



to be at least 44 knots, and 50 knots was the aim. The armament was to be adaptable to the roles of gunboat, torpedo boat, minelayer, raiding craft, or combined gunboat/torpedo boat. A number of other very specific operational requirements were also stated.

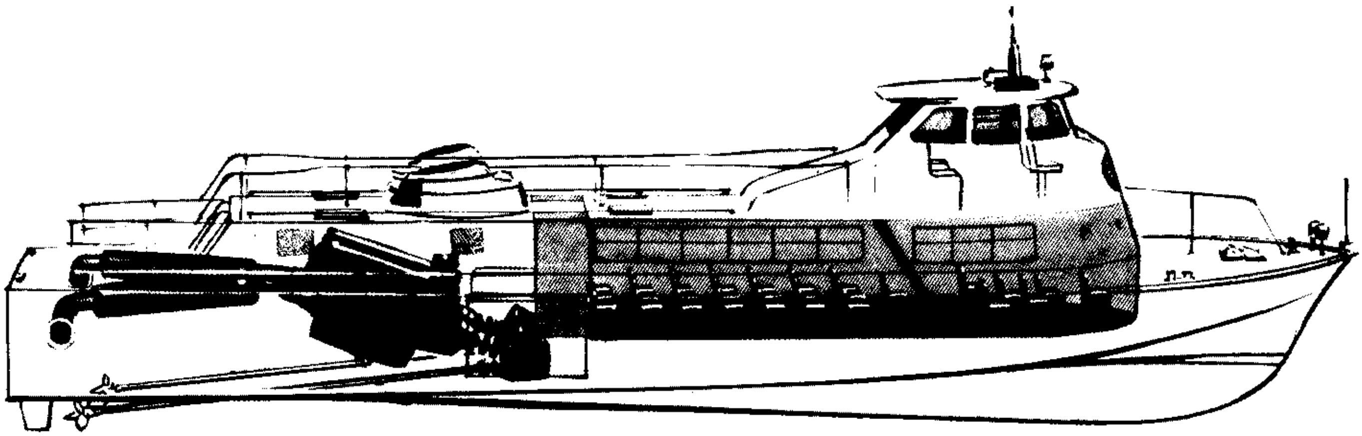
The basic design for the *Braves* was settled by way of a design study carried out by Vosper under Admiralty contract, with much interchange of information between the two parties, and substantial research and development efforts on both sides. As far as hull form was concerned, after tank testing a number of alternatives, the choice returned to that originally designed by Vosper in 1944, for MTB 1601, scaled up to a length of 96 ft.

The question of propulsive machinery was critical for the whole project. Among units considered were twin Metro Vickers G4 gas turbines, triple Napier Deltic diesel engines, and twin compound Deltics. Vosper's own choice, after careful study, was the Bristol Siddeley (now Rolls-Royce) Proteus gas turbine aero-engine. This choice was ultimately endorsed by the Admiralty.

The aero-engine makers had in less than twenty years brought the gas turbine, mainly in the form of the jet engine, to the point where it was virtually the only sensible choice of power unit for aircraft of appreciable size. It had become an engine of very high power/weight ratio, developed to excellent standards of reliability. The Proteus was not a jet but a ready-made free-power-turbine engine, having been a turbo-prop aero-engine driving an air propeller. The advantages of a free power turbine in a fast patrol boat are considerable. It enables the boat to accelerate or decelerate rapidly over the entire speed range and, as the relationship between horsepower and propeller revolutions is almost infinitely flexible, the propeller speed adjusts itself automatically to the boat's displacement. Thus there is no risk of damage to machinery if the boat is overloaded and conversely there is a useful gain in speed as fuel and ammunition are used up.

The machinery arrangement chosen for the new patrol boats was three of the Proteus engines, mounted aft, coupled to reverse reduction gearboxes in a vee-drive arrangement. These were complex gearboxes, by W. H. Allen, required to provide reverse and neutral gears for manoeuvring, the vee-drive change of shaft axis, and the necessary reduction ratio. The use of separate power units, diesels or electric motors, for manoeuvring was considered, but ultimately rejected because they would make the installation as a whole slightly heavier.

Apart from the power units themselves the main area where technical development was needed, if the new boats were to achieve the 50 knots, on which sights had been set, was that of propellers. Whereas the hydrodynamics of the hull as a whole did not involve radical departures from what was already



**A transport application for fast planing craft was found in the carriage of passengers to and from oil drilling installations on Lake Maracaibo. Twin Deltic diesel engines gave this boat a speed of about 37 knots.**

known, the efficient conversion into forward thrust of the power needed to overcome the hull's resistance at the speed envisaged posed severe problems—notably that of cavitation. This is discussed in more detail in Chapter 7, but in the case of the *Braves* there was a choice of two possible solutions. The first, originally favoured by the Admiralty, was to use large propellers turning relatively slowly. At Vosper, Commander Du Cane was convinced that this line of thinking was, at least in part, responsible for the disappointing performance, in terms of speed, of some earlier patrol boats, notably the *Bolds* and the *Dark* class. The reasoning was that, although the larger, slower propellers had the advantage in efficiency because they did not cavitate, the penalty in terms of the size and weight of the propellers themselves, their shafting and brackets, and of the additional water resistance these created, outweighed this advantage. To show this to be the case it was necessary to design smaller, faster-turning propellers which were of adequate efficiency in spite of the fact that cavitation would inevitably be involved.

It was to this end that, as is recorded in Chapter 7, Vosper installed their own cavitation tunnel and took on a full-time hydrodynamicist. With the collaboration of AEW, Haslar, this led to the Newton-Rader series of propellers which, in the event, made possible the performance achieved by the *Braves*, and their later derivatives, with speeds of up to 58 knots. The fully or super-cavitating propeller had won acceptance for this type of craft.

The structural scheme for the *Brave* class FPBs was that required by the Admiralty and a departure from Vosper's usual methods, in that the framework skeleton was of aluminium alloy, to which the double-diagonal mahogany skin was secured by stainless steel bolts, with plastic insulating bushes, to prevent electrolytic corrosion. These boats stood up very well to hard driving throughout the decade or so for which they were in commission.

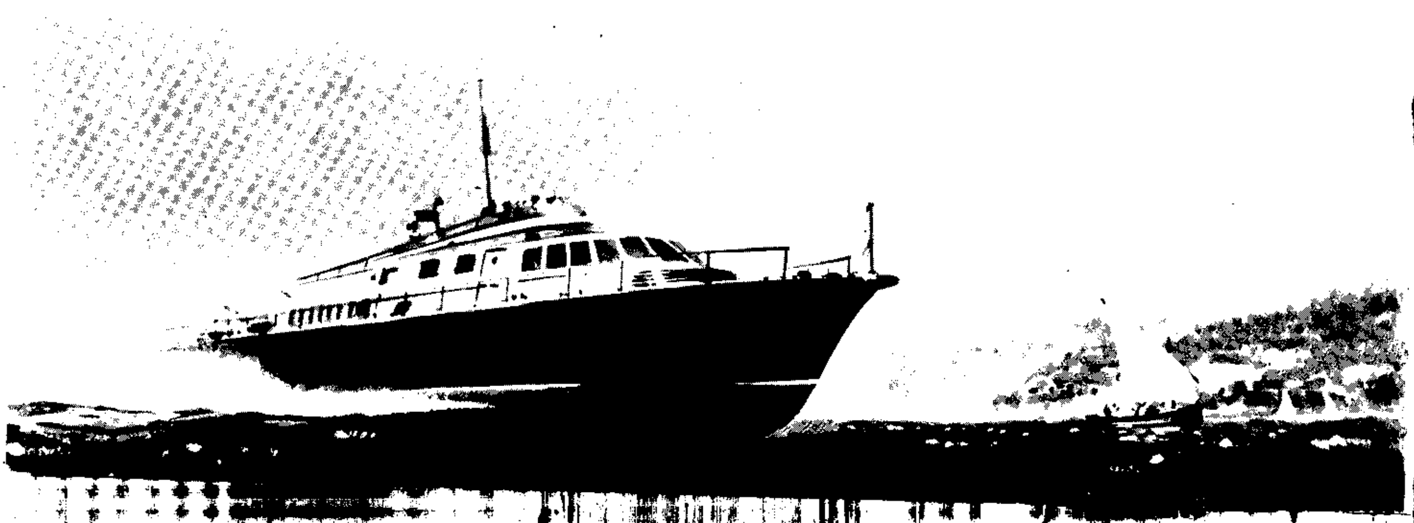
Another important change which came about with the *Braves* was in electrical supplies. The CFS 2 gun was to be power operated, and the growth in electrical demand from this and radar, communications and domestic equipment, imposed a new approach if an installation of reasonable weight was to be achieved. Wartime MTBs had conventional 24-V d.c. equipment with engine-driven generators which, although heavy in relation to output, did not pose a weight problem in the case of the modest demands of the simple systems then used. A 220/230-V lighting system was included for shore connexion. The early post-war FPBs had 220-V d.c. systems, in line with other Royal Navy ships of the time, with separate generating plants, usually driven by petrol engines, such as the old Vosper Ford V8 conversion.

The much greater electrical power needs of the *Braves* could be met either by using aircraft equipment or standard marine units, which were heavy. In the event, two 40-kW, 220-V d.c. generators were installed driven by Rover IS 60 gas turbines. One of the many design studies which formed part of the *Brave* project resulted in a scheme which used some aircraft equipment, suitably modified, and other items specially designed and made to be both light in weight and suitable for marine use. These included control and distribution panels and switchgear. Special lightweight junction boxes of fabricated construction were also made, to replace standard Admiralty cast fittings. For reasons of lightness, and so that they could be grouped together in the place where they were needed, the bridge instruments were stripped of their covers and mounted in a single watertight console, one of the first examples of what is now the common practice. This electrical development work, backed by in-house manufacture where necessary, was to make an important contribution in future craft by making possible light, reliable, and cost-effective installations.

The outcome of this long and thorough programme was that the Admiralty placed with Vosper a contract for the detail design and construction of two boats of the new class, *Brave Borderer* and *Brave Swordsman*. In the time which had elapsed since their conception, however, the CFS 2 gun, around which they were to some extent designed, had been dropped as an economy measure, and by the time the two boats were complete, in 1960, the Royal Navy's light coastal forces had been largely disbanded, so no more were built. The two prototypes were, however, very successful, meeting their specifications by exceeding 50 knots, while being very manoeuvrable, with good sea-keeping. They continued to run for more than a decade, and have only recently been replaced by the *Scimitar* class.

Although of great technical importance, the programme which led to the *Braves* was of course not the only activity of the late 1950s. Two individual craft were an 80-ft fast passenger launch and the motor yacht *Mercury*. The passenger launch was ordered in 1956 by Shell Tankers Ltd. as a tender to the Shell oil rigs on Lake Maracaibo, a large inland sea in Venezuela. She was of light steel construction, powered by two Deltic diesel engines of 1800 b.h.p. each, giving a speed of about 37 knots. Her hull form was similar to that which was to be used in the *Braves*, then still being designed, and the fact that this launch proved very sea-kindly in heavy weather was a valuable confirmation of the choice. *Mercury* was built for Stavros Niarchos, the Greek shipowner, as a yacht capable of 50 knots, and was similar in hull form and propulsion to the *Braves*, but with, of course, very different accommodation and arrangement.

During this period Vosper also built a number of craft for services at home and overseas, including inshore minesweepers, seaward defence boats, crash tenders, and four of the Admiralty-designed *Dark* class FPBs (with Deltic diesels); there were also two 12-knot firefloats, one 55 ft in length in all-welded steel and one 60 ft in length in riveted aluminium alloy, in each case the first Vosper boats to be built by these methods. They were fitted with telescopic masts and foam and water fire hydrants and were intended for use with seaplanes and the Princess flying boats. While providing essential work and revenue for the yards, these were different from the main stream of design progress which was the firm's prime interest. The company itself was still director-controlled, the Chairman for most of the post-war period until 1953 being H. S. Loebl, and from then until 1963 Owen R. Guard. In 1958 the controlling shares were bought by Minerals Separation Ltd., a company which had already bought a substantial holding on the market. Vosper thus became a subsidiary of another company for the first time. This was a recognition of the commercial potential of its technical achievements, and provided backing for the next phase of development.



# 5

# A Basis For Progress

THE FLOW of work for Vosper which resulted from the Korean emergency did not come to an abrupt stop with the cessation of hostilities, as it had after the Second World War, because the Government, as a matter of policy, did not cancel contracts already in hand. It was clear, however, that the firm could not count on surviving indefinitely, in its specialized field of fast military craft, on orders from the Royal Navy and other Services at home. At this time, when the Korean fighting was coming to an end, therefore, the company took the decisions which were to shape its future. Basically these amounted to the active seeking of orders abroad, for craft of the types which they understood best. To carry this out they had to set up a sales organization, and bring in modern management methods at the yards to ensure that contracts ran smoothly and showed a profit at the end of the day.

As far as the vessels themselves went, the new thinking led to two different areas of development. The first was the pursuit of high speed in gas-turbine powered fast patrol boats derived from the *Braves*, but which incorporated the company's own ideas. Secondly, the designers responded to a need which was detected by the sales team on their travels for a less sophisticated type of patrol boat.

As a first step Vosper designed and, in 1959, built their second private venture prototype FPB, *Ferocity*, with the help of development on a quarter-scale model. She was a little smaller than the *Braves*, being 88 feet long, and was powered by two Proteus gas turbines. Her hull form was very similar to that of the *Braves*, but incorporated more deeply veed sections forward to give an easier motion, at the expense of a small increase in resistance. The other main departures from the *Brave* design were the provision of diesel engines for cruising and manoeuvring, the use of glued wooden construction throughout and the arrangement of the superstructure to accommodate an enclosed bridge or wheelhouse. These were to be adopted in all the later Vosper craft of this type. *Ferocity* had a top speed of over 50 knots.



***Mercury*, a yacht to travel at 50 knots, was based on the designs for the Royal Navy's *Brave* class.**

The construction of *Ferocity* quickly bore fruit, the Federal German navy placing orders in 1960 for a similar, but slightly larger (92-ft) twin-turbine FPB (*Pfeil*) and a triple-screw 96-ft boat similar to the *Braves*, these becoming the first of a steady stream of craft for export. The larger boat, *Strahl*, reached a speed of 55½ knots on trials.

Following the German order, the Royal Danish Navy in 1962 ordered two all-wood 96-ft triple-Proteus boats with General Motors cruising diesels, with an arrangement for four more to be built in Denmark under licence. The basic FPB design developed to meet the Danish requirements was to remain current for several years, with boats being built to it for Malaysia, Brunei and Libya. The speeds attained by boats of this type, up to 58 knots, remain the highest warships have reached.

This family of Vosper 96-ft gas-turbine FPBs, like the *Braves*, mostly carried torpedoes (with the alternative of mines) and an armament of 40-mm and 20-mm guns, for anti-aircraft defence and use against other light craft. The torpedo was the main offensive weapon for use against large ships. The Danish boats have torpedo tubes—the others side launching chutes.

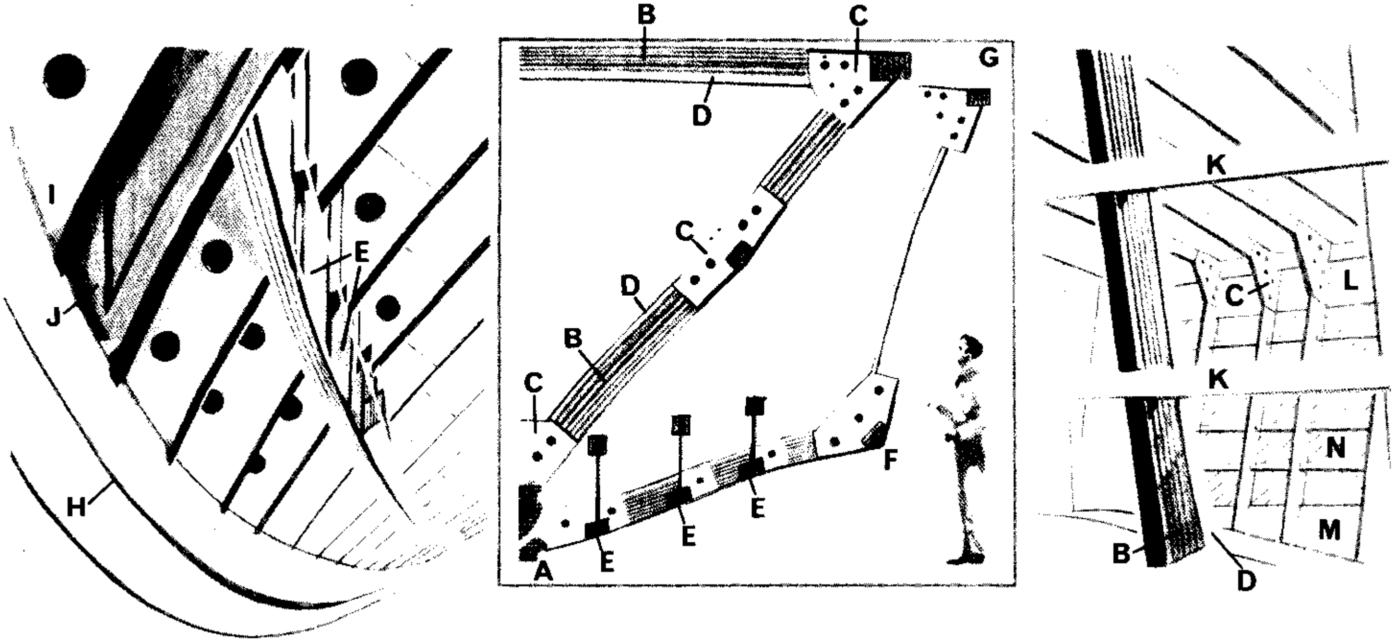
The virtually all-wood construction of these boats was chosen partly on grounds of cost, and because a homogenous structure, not using materials of widely differing stiffness characteristics, helps in avoiding local concentrations of stress.

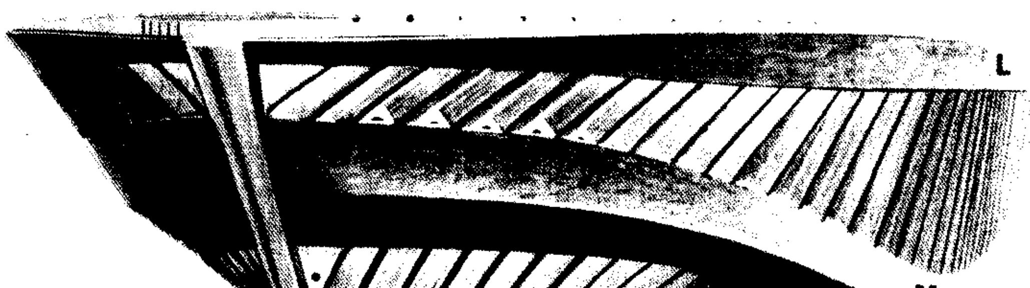
The Vosper wooden patrol boat hull, during construction and after completion, is a thing of considerable beauty, with sweeping curves and immense strength plain to see. The fairness of the finished hull, fully planked and sanded, is to a standard only achieved with considerable difficulty in metal.

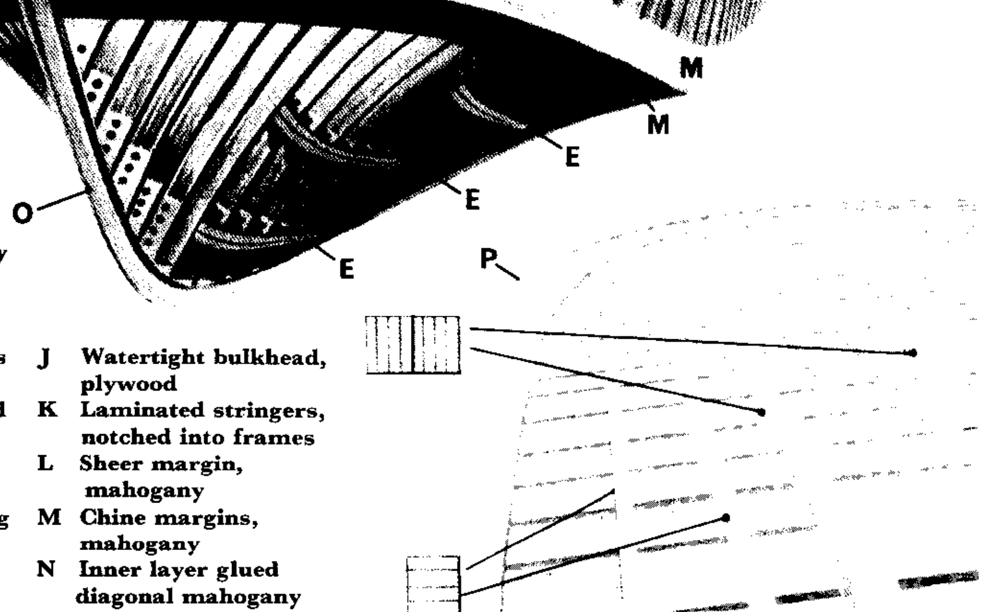
Aluminium alloy is used for superstructures in these patrol craft, as in others built of steel.

The CODOG machinery arrangement was used in all Danish and later 96-ft FPBs. The gas turbines are there to provide the highest speeds, while diesels of quite modest power are used for cruising and manoeuvring. In this way the turbines are only used at or near their full power, when they make their most efficient use of fuel. Both types of engine run on the same fuel.

With this CODOG arrangement, astern power, which is only needed for manoeuvring, need only be provided by the diesel engines. Fast planing craft stop themselves very quickly when power is cut, so that astern power for braking is not necessary. As the gas turbine is essentially an engine which can turn in one direction only, this means that a reverse gearbox capable of transmitting the full power output of the gas turbine is not needed, and a normal marine reverse-reduction gearbox can be fitted to the diesel cruising and manoeuvring engines only.




GLUED WOODEN CONSTRUCTION FOR A FAST PATROL BOAT HULL

- **A** **Keel, laminated rock elm**
- **B** **Frames and deck beams, laminated mahogany (more closely spaced in forebody where stresses are greatest)**
- **C** **Birch plywood brackets**
- **D** **Rock elm laminations in most highly stressed part of frame.**
- **E** **Bottom girders, plywood web with rock elm booms, also forming engine beds**
- **F** **Chine, laminated rock elm**
- **G** **Gunwale, laminated rock elm**
- **H** **Rabbet line**
- **I** **Bracket notched over keel**
- **J** **Watertight bulkhead, plywood**
- **K** **Laminated stringers, notched into frames**
- **L** **Sheer margin, mahogany**
- **M** **Chine margins, mahogany**
- **N** **Inner layer glued diagonal mahogany planking**
- **O** **Stem, laminated, integral with keel**
- **P** **Deck margin, mahogany**

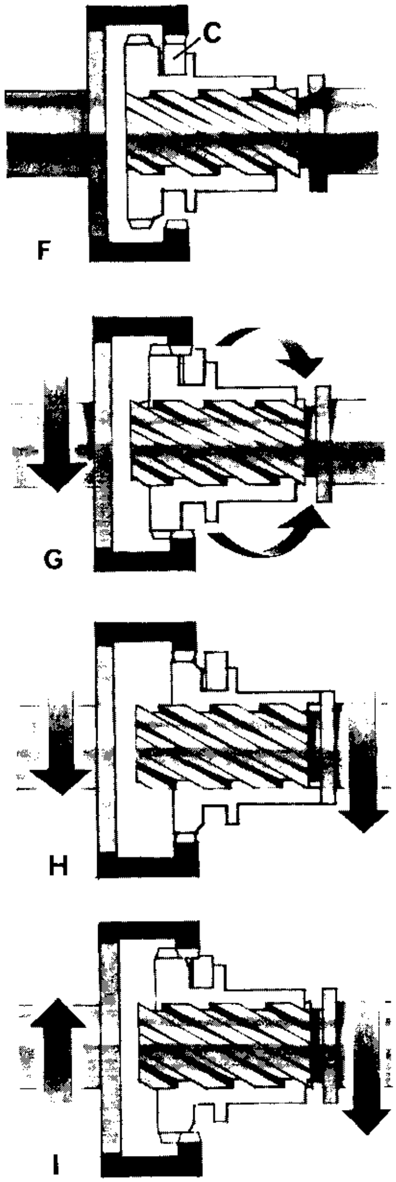
The turbines drive through vee-drive gearboxes, which incorporate a reduction ratio, and have provision for introducing an idler gear (that is an additional gearwheel which turns freely) to reverse direction of one of the shafts, giving handed shaft rotation from gas turbines which all turn the same way. The diesel engine with its reverse-reduction gearbox is mounted on the same axis as the propeller shaft, forward of the vee-drive gearbox, and drives the lower shaft in the vee-drive directly.

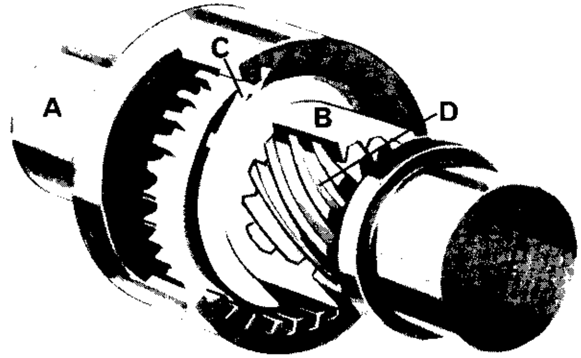
In a CODOG arrangement one must disconnect the power unit which is not in use from the propeller shaft so that it is not driven by the other engine, or by a trailing propeller. It is also important to transfer power smoothly from one engine to the other. This is accomplished by an ingenious mechanical device, the SSS (Synchro-Self-Shifting) clutch, which has the property of acting as a free-wheel to disengage the power unit which is not driving from the vee-drive box, and to clutch in the appropriate unit when, and only when, the engine and the shaft are rotating at the same speed. It is also necessary for the operator to select "drive" before the clutch will engage, and in the CODOG arrangement there are interlocks so that both SSS clutches cannot be selected to drive at the same time. In the Vosper fast patrol boat layout SSS clutches are fitted between each engine and the vee-drive box. On manoeuvring diesels a version is fitted in which the free-wheeling action can be locked out, so that it can drive in astern gear.

In all Vosper patrol boats, but particularly in the gas-turbine FPBs, weight limiting is carried to considerable lengths, with the result that of a total displacement of some 100 tons about 10 tons is available for armament load. The fact that these boats are designed for a period away from base of not more than about twenty-four hours makes it possible to save on equipment and accommodation.

From *Ferocity* onwards the electrical system adopted for Vosper craft was primarily an alternating current one. After careful study the choice for primary supplies was the 440-V 60-Hz 3-phase system, which had been used by the U.S. Navy for some time, and had now become standard in all NATO ships, including those of the Royal Navy. Although aircraft equipment working at 400 Hz would have resulted in some weight saving, this was offset by its greater cost and demands on maintenance. The gas turbine FPBs still use Rover gas turbines as prime movers for electrical supplies, but they are coupled to alternators. Electric motors and starters are chosen from standard industrial ranges, with minor modifications where necessary. This system proved reliable, reasonably light and not overcostly in *Ferocity*, and has formed the basis of electrical systems in later Vosper patrol craft.

The second main class of vessel which grew out of the decision to seek

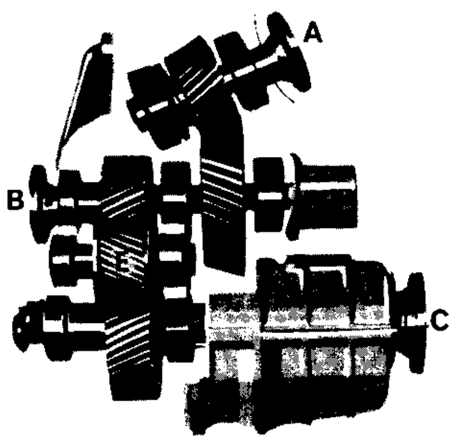



BASIC PRINCIPLE OF THE SSS CLUTCH

**A** Input shaft
**B** SSS unit
**C** Pawl, which when fully engaged with internal clutch teeth ensures internal and external teeth are accurately aligned
**D** Helically splined shaft
**E** Output shaft
**F** When clutch is disengaged; pawls give "free-wheel" action until input shaft starts turning, or its speed reaches that of output shaft which is already turning.
**G** Shafts in synchronism, pawls beginning to drive SSS unit along helical splines
**H** SSS unit has reached stop, clutch teeth fully engaged and driving
**I** Output over-running input, so torque reverses and SSS unit withdraws back along splines, disengaging clutch teeth

**Pawls are spring loaded, but arranged to withdraw under centrifugal action to prevent continuous ratcheting when output shaft is turning at high speed and input is turning slowly or is at rest. In practical marine units additional arrangements ensure that the pawls do not engage to drive the turbine when the propeller shaft is being driven in the astern sense by the manoeuvring engine, and locks and interlocks are provided to prevent harmful conditions from arising.**




VOSPER VEE-DRIVE GEARBOX FOR CODOG INSTALLATION

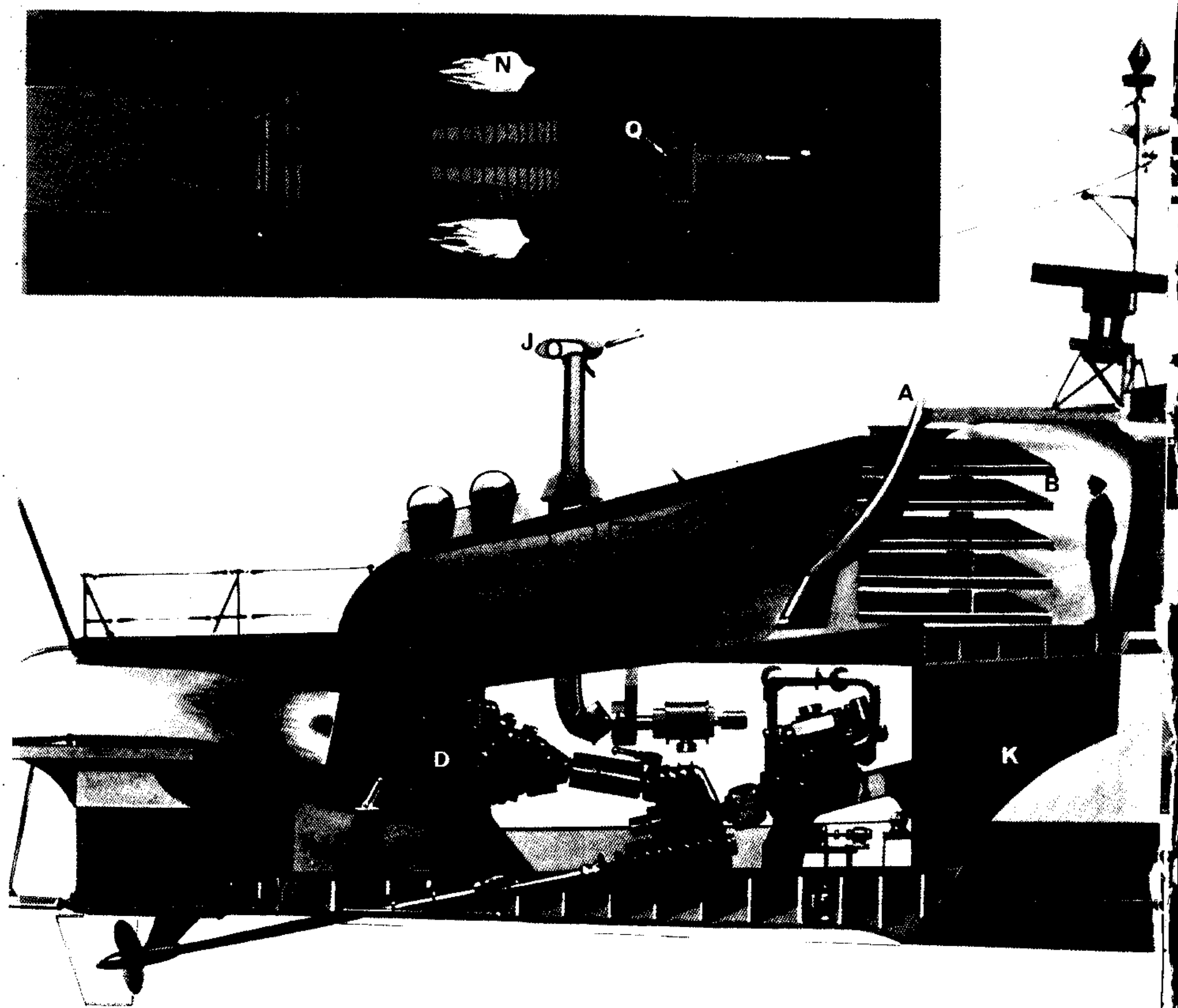
**A** Main input coupling, to gas turbine
**B** Auxiliary input coupling, to diesel
**C** Output coupling, to propeller shaft
**D** Thrust bearing housing
**E** Idler gear, fitted to reverse direction of rotation of one of the propellers

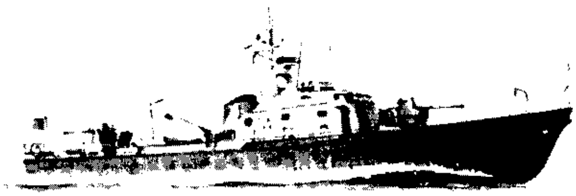
*Bottom:* **CODOG fast patrol boat propulsion scheme as used in *Ferocity* and later gas-turbine boats**

**A** Air intake shielded by cowl forming part of superstructure
**B** Air filters
**C** Air splitters (acoustically lined vanes to reduce noise)
**D** Proteus gas turbine
**E** SSS clutches
**F** Vee-drive gearbox
**G** Cruising and manoeuvring diesel engine with marine reverse/reduction gearbox
**H** Rover gas turbine alternator set
**I** Propulsion turbine exhaust through transom
**J** Exhausts from Rover alternator sets
**K** Fuel tanks

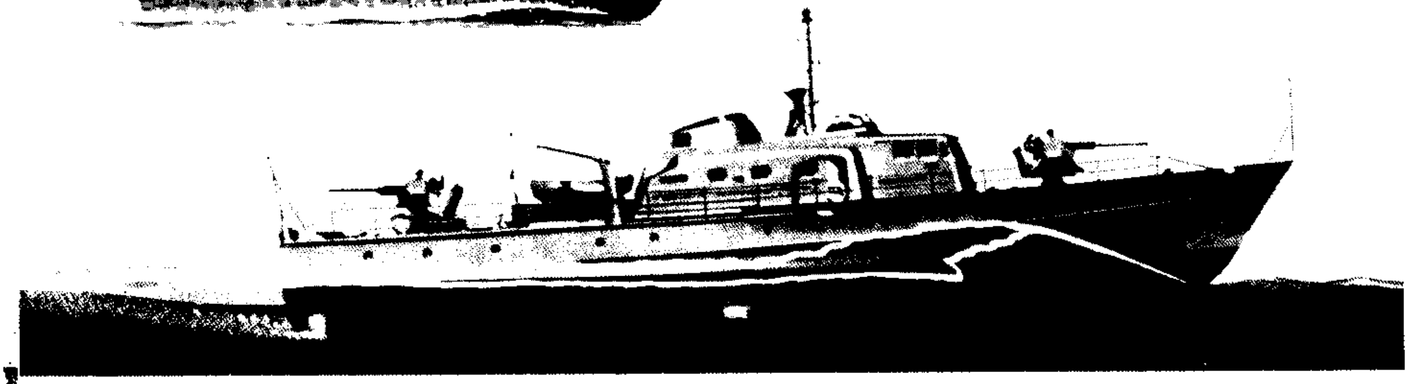
*Top:* LAYOUT OF THE PROTEUS GAS TURBINE

**L** Air intake to engine
**M** Compressor
**N** Combustion chambers
**O** Compressor turbine
**P** Free power turbine
**Q** Reduction gearing
**R** Output shaft
**S** Turbine exhaust





*Left:* **The first of the steel diesel-engined Vosper patrol boats designed specifically for export had a length of 103 ft, and attained speeds of up to 25 knots, according to the engines installed.**



**The slightly larger 110 ft steel patrol boats have reached over 32 knots. Their hulls represent a compromise between round and hard chine forms, with spray-deflecting knuckle forward, and hard turn of bilge aft. Vosper fin stabilizers have been fitted to all craft of this type as well as to many other vessels.**

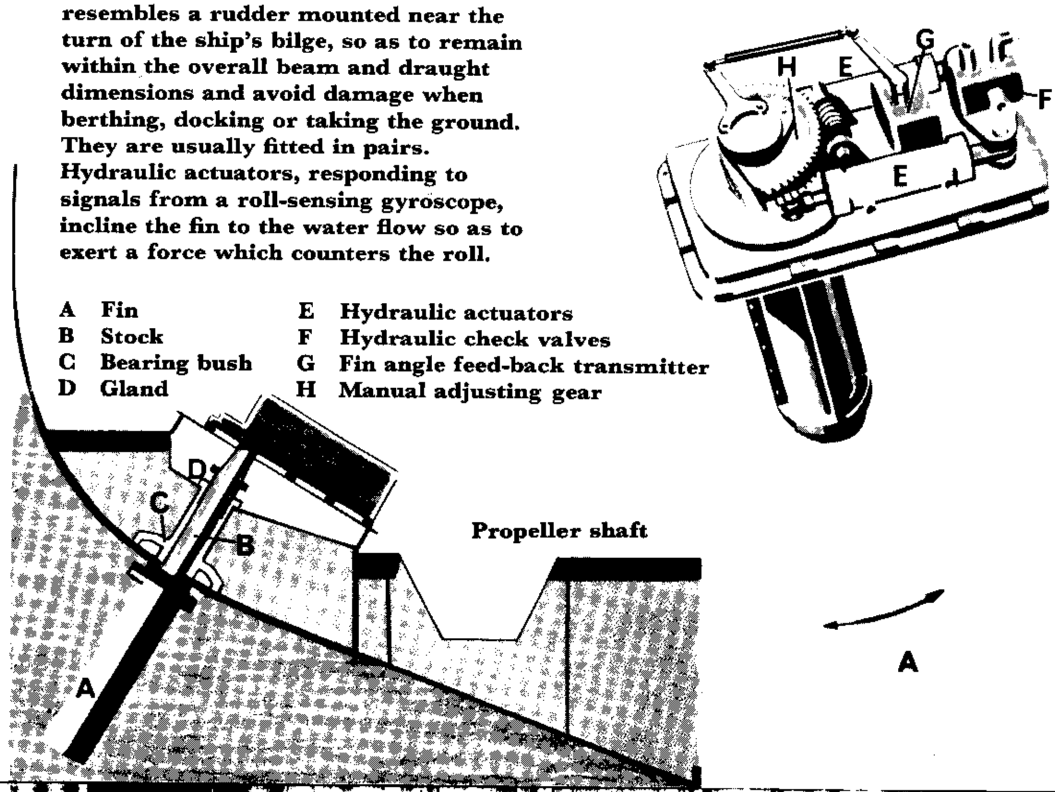
exports was perhaps less glamorous than the fastest gas-turbine FPB types, but involved a fresh line of thinking for Vosper. It also gave the designers an opportunity to apply the experience gained in a hard school to a type of craft for a different requirement. The philosophy behind these craft was that political developments in various parts of the world were bringing into existence newly independent countries, many of which had coastlines which needed protection. They needed boats to patrol these coasts, when the forces of the old colonial powers were withdrawn. The stock of suitable craft which could be obtained second-hand was dwindling, and the boats were in any case often unsuitable. These countries were short of skilled seamen and engineers and needed to train their own people to operate the craft which were to patrol their coasts.

This requirement was the one Vosper set out to meet. The designs which resulted were for steel-hulled boats of round-bilge form and powered by diesel engines, the two main versions having lengths of 103 and 110 ft. Their top speeds range from about 25 to over 32 knots. For craft of this size and speed range the round-bilge form has less resistance than would a hard-chine hull, but at their highest speeds these boats are beginning to plane, and the Vosper designs all have marked knuckles in the forebody to deflect spray, and flat sections aft, with something closely approaching a chine near the transom.

Diesel engines are available in wide variety in the power range needed for these boats, and can be accommodated as twin or triple screw arrangements in straightforward installations. They are also very economical in fuel consumption. With widespread servicing arrangements already in existence for a variety of makes, they are the natural choice of propulsion unit in this type of craft, where the special advantage of the gas turbine, power/weight ratio, is not a prime requirement, and greater need for endurance on patrol makes fuel consumption more of a consideration.

Steel construction makes it possible to use standard shipbuilding techniques, including prefabrication and welding, and shows some advantage in cost over the more sophisticated methods of construction used in the fastest craft. Much of the success of the Vosper steel craft, however, has come from applying strict weight control measures and refinement in structural design to save weight based on lessons learnt in the pursuit of outright speed. The superstructures of these craft are in aluminium alloy. The 110-ft boats are built on the longitudinal system, which is lighter than the conventional transverse framing scheme used for the 103-ft craft.

At the time of writing the numbers of the 103-ft boats built or on order stands at thirty-three, twenty-four of which were for the Royal Malaysian Navy and proved themselves in the confrontation with Indonesia. Six 110-ft boats were built for Peru in 1965, and six more to a modified design have




**The Vosper non-retractable fin stabilizer resembles a rudder mounted near the turn of the ship's bilge, so as to remain within the overall beam and draught dimensions and avoid damage when berthing, docking or taking the ground. They are usually fitted in pairs. Hydraulic actuators, responding to signals from a roll-sensing gyroscope, incline the fin to the water flow so as to exert a force which counters the roll.**

**A Fin**
**B Stock**
**C Bearing bush**
**D Gland**
**E Hydraulic actuators**
**F Hydraulic check valves**
**G Fin angle feed-back transmitter**
**H Manual adjusting gear**

recently been built for the Republic of Singapore Navy, four of them at the Singapore shipyard*.

Most armament needs in these craft are met by guns of up to 40-mm calibre, but a variety of weapons can be carried, including missiles such as Seacat, while a 76-mm gun with modern fire control has been fitted in some of the 110-ft vessels.

The principles behind these patrol craft led the company to design for the first time a larger warship, a corvette of some 450 tons displacement. Three of these, the Mk I and IA corvettes, have been built, one by Vickers Ltd., for the navies of Ghana and Libya. These are vessels of relatively modest top speed, 18–20 knots according to engines, but they were an important step forward for the company, towards its achieving the status of a major warship builder. The construction of one corvette by Vickers resulted from an agreement between the two companies.

These steel vessels are built at the yard at Broad Street, Old Portsmouth, which was modernized for the purpose, but the corvettes in particular were of a size which could only just be accommodated within the rather cramped site there. Further development in the direction of bigger ships was going to call for expansion.

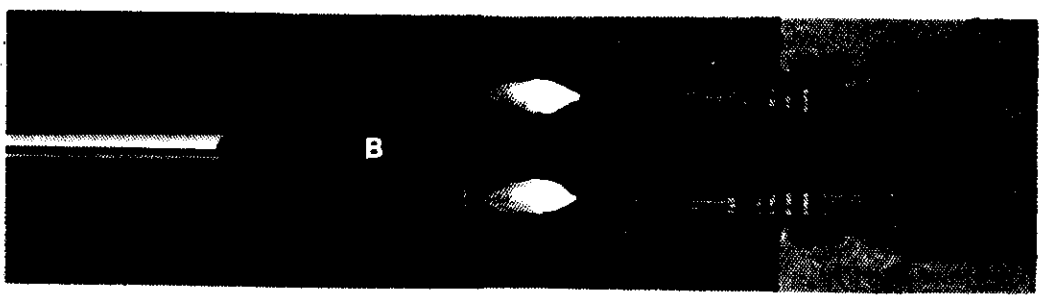
An important contribution to the success of the steel patrol craft and corvettes was made by a fin stabilizer system developed by Vosper. Based on research and development, some of it carried out in the company's cavitation tunnel, a stabilizer system was designed, utilizing non-retracting fins, operated hydraulically and controlled by a gyro. By substantially reducing the rolling which small power vessels commonly suffer in heavy seas, these stabilizers gave to the patrol craft and corvettes a capacity for sea-keeping which would otherwise have called for a larger ship. These stabilizers have formed the basis of a separate division of the company which designs and manufactures them for ships and boats built by other companies as well, ranging in size from ferries of 10,000 tons to motor boats 30–40 ft including many frigates and destroyers. Reducing rolling in itself often makes a contribution to speed.

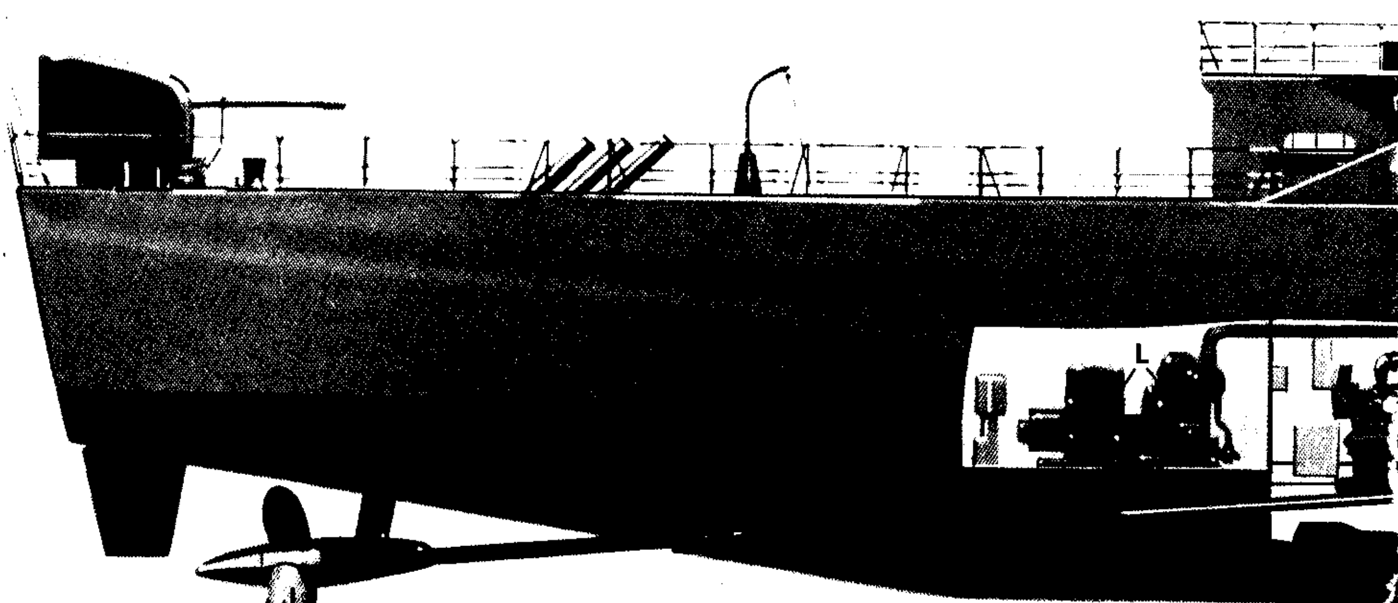
The decisions of the late 1950s, which led to the exporting of the two main classes of craft, gas turbine FPBs and diesel patrol craft and corvettes, were by the early 1960s beginning to bear fruit in terms of profits for the company. It was in 1963 that Sir David Brown became Chairman of Vosper Limited, and shortly afterwards the David Brown Corporation acquired the controlling interest in the firm from Minerals Separation Limited. This was to provide an assurance of stability which later made possible the merger with Thornycroft and recognition of the company as builders of major warships.

*The merger between Vosper and Thornycroft brought into the Group the shipyard facilities of Thornycroft (Malaysia) Limited, now Vosper Thornycroft Private Limited.

TYPICAL FRIGATE CODOG PROPULSION ARRANGEMENT, AS IN MARK 5 AND MARK 7 FRIGATES

**A** Gas generator
**B** Power turbine
**C** Air intakes
**D** Splitters
**E** Gas turbine uptakes
**F** Reduction gearing
**G** Diesel propulsion engine
**H** Fluid coupling
**I** Propeller pitch control box
**J** Controllable-pitch propellers
**K** Machinery control room
**L** Diesel generator sets
**M** Propulsion diesel uptakes
**N** Diesel generator uptakes
**O** Torque tube/flexible coupling assembly
**B** Cardan shaft/flexible coupling assembly

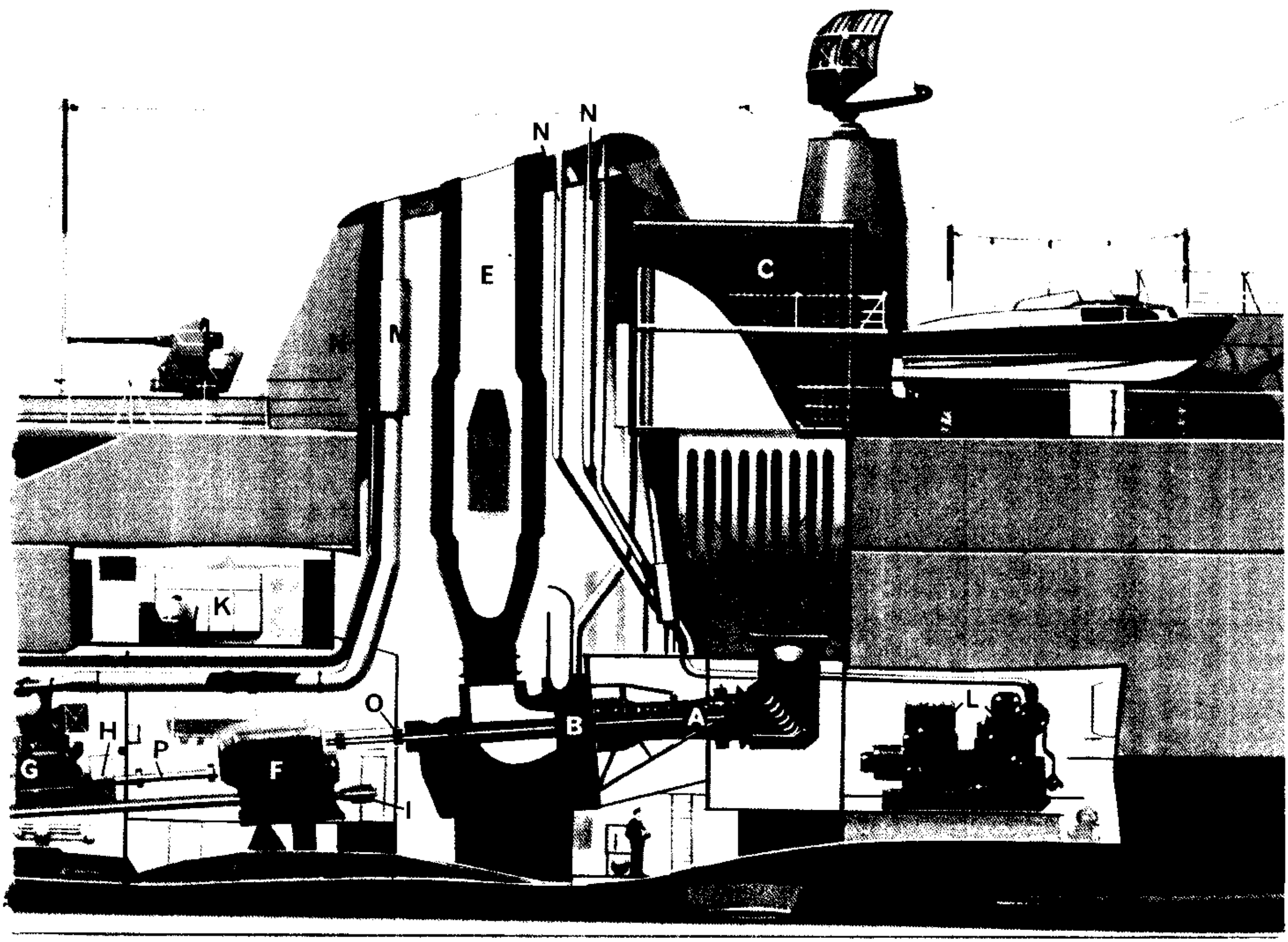


# 6

# On To Bigger Things

THE DECISION actively to seek exports had, ten years later, proved wise. The sales organization which had been built up (at a time when such things were rare in British shipbuilding) not only succeeded in selling abroad the type of boat which Vosper had made very much their own, but had also detected needs abroad for types of vessels which fitted neatly into the firm's capacities, but which they had not built before. Such were the steel patrol craft and corvettes. The same type of feed-back from the market made it clear



that there was a demand for a type of frigate or small destroyer, cheaper and capable of operating with a smaller complement than such general-purpose frigates as the Royal Navy's *Leander* class.

It was in 1965 that the Vosper team completed the preliminary design stage of their first frigate, the Mark 5, still with the collaboration of Vickers. This was a vessel of about 1300 tons displacement, which exploited recent developments in gas-turbine propulsion to give a top speed of 40 knots. What was not at this time certain was how and where such a ship would be built, should orders be secured.

As it turned out events fell neatly into place, and the company began to move forward at an accelerating pace. Firstly, early in 1966 Vosper Limited, helped by the strength and financial expertise of the David Brown Corporation, agreed terms with John I. Thornycroft & Co. Ltd., Southampton, for a merger of the two companies. This at once made available to Vosper the facilities for building larger ships, and the experience in warship design and construction, of their old rivals, to whom they in turn brought a fresh approach to the problems of marketing vessels for overseas navies in particular, based on success with smaller craft. The two companies were complementary in many ways, and geographically close neighbours. Thornycroft also had a substantial ship repairs organisation in Southampton, and a thriving boatbuilding subsidiary in Singapore. Both of these are still very active, and the Singapore company, Vosper Thornycroft Private Limited, has expanded rapidly since the merger.

This merger took place shortly before publication of the Geddes Report (*Shipbuilding Inquiry Committee* 1965–1966 *Report*, Cmnd 2937), which advocated, among many other things, the formation of major groups of shipyards under centralized managements, and the reduction to only three of the yards specializing in surface warships, an activity which, the report indicated, could not successfully be combined with merchant shipbuilding in the same yard. It followed that six or seven yards then competing for this type of work could not expect to continue in the field: the management of the newly formed Vosper Thornycroft Group were determined that it should be one of the survivors and there followed an all-out effort for recognition as builders of warships in this class. One main weapon the management had was the fact that it had already applied, admittedly only to shipbuilding on a small scale, many of the recommendations of the Geddes Report.

The next event which worked in the group's favour was the securing of orders for four of the Mark 5 frigates, in a variant classified as fast destroyers, for the Imperial Iranian Navy. In accordance with the standing agreement, two of these were to be built by Vickers. Shortly afterwards orders were received from Libya for a maintenance and repair ship, to act as a base for a squadron of three Vosper FPBs, and a frigate to a new design developed from that of the Mark 5, the Mark 7, all of which were built at the Thornycroft yard at Woolston, Southampton. The granting of the Queen's Award to Industry in 1966 to the David Brown Corporation was in part a recognition of the pre-merger technical and export achievements of Vosper; that to Vosper Limited in its own right in 1969 was mainly in respect of these major orders for the Woolston yard.

The design of warships is inseparable from the consideration of their weapon systems. The application to frigates of the principle which Vosper had followed over the years of carrying out original design work based on their own technical resources and assessment of market needs required the addition of weapon specialists to the design team, which already covered hull design and construction, propulsion and electrical engineering.

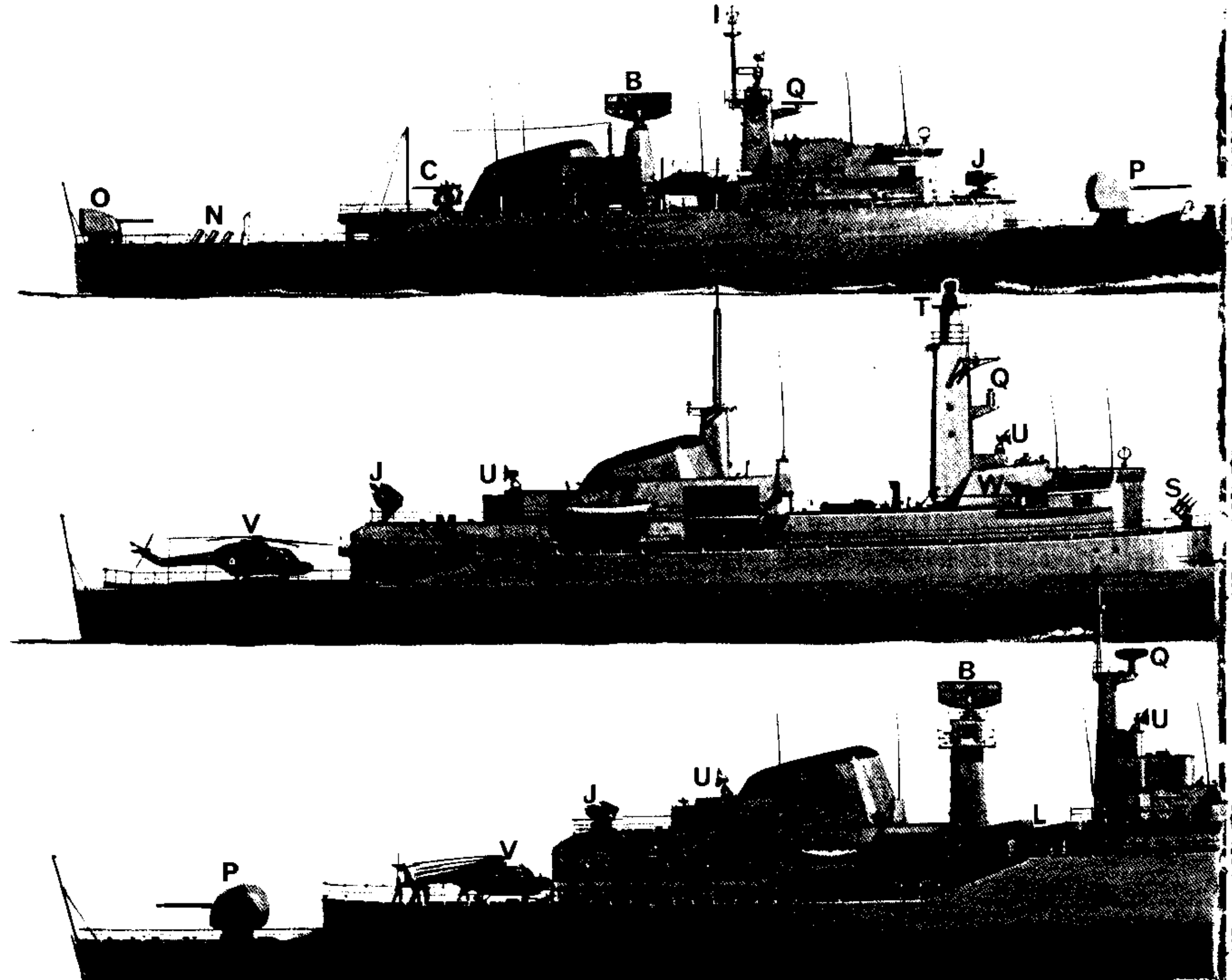
The vindication of the policy of original design, as distinct from the traditional pursuit of contracts to build to Admiralty designs, and official recognition of Vosper Thornycroft as frigate builders, came in 1968, when the Government announced that it had placed with the company a contract to design a new class of frigate, the Type 21, to be carried out in collaboration with Yarrow (Shipbuilders) Ltd. This was in fact the first time a major British warship had been designed outside the Ministry's own establishments for many years. There followed building contracts for the first of class, HMS *Amazon*, launched by Princess Anne in April 1971, and two more to the same design, while a fourth ship was ordered from Yarrow. The Type 21, a ship of some 2500 tons displacement, has a COGOG propulsion scheme consisting of two Olympus main gas turbines and two Tynes for cruising. Her top speed is about 34 knots.

In 1970 an inquiry was received from Brazil for a new large frigate, and Vosper Thornycroft prepared outline designs for their Mark 10 to meet this specific requirement. In the face of international competition the contract was secured to design and build four of these ships, and to supply lead yard services and materials for a further two of them to be built in the naval dockyard at Rio de Janeiro. Few of the world's navies today aspire to warships much larger than the Mark 10, and with a range extending down to the smallest patrol craft the company had at this point clearly established itself in its specialized field.

Recent additions to the warship range, as proposals only at present, are two fast corvettes designated Mark 8 and Mark 9.

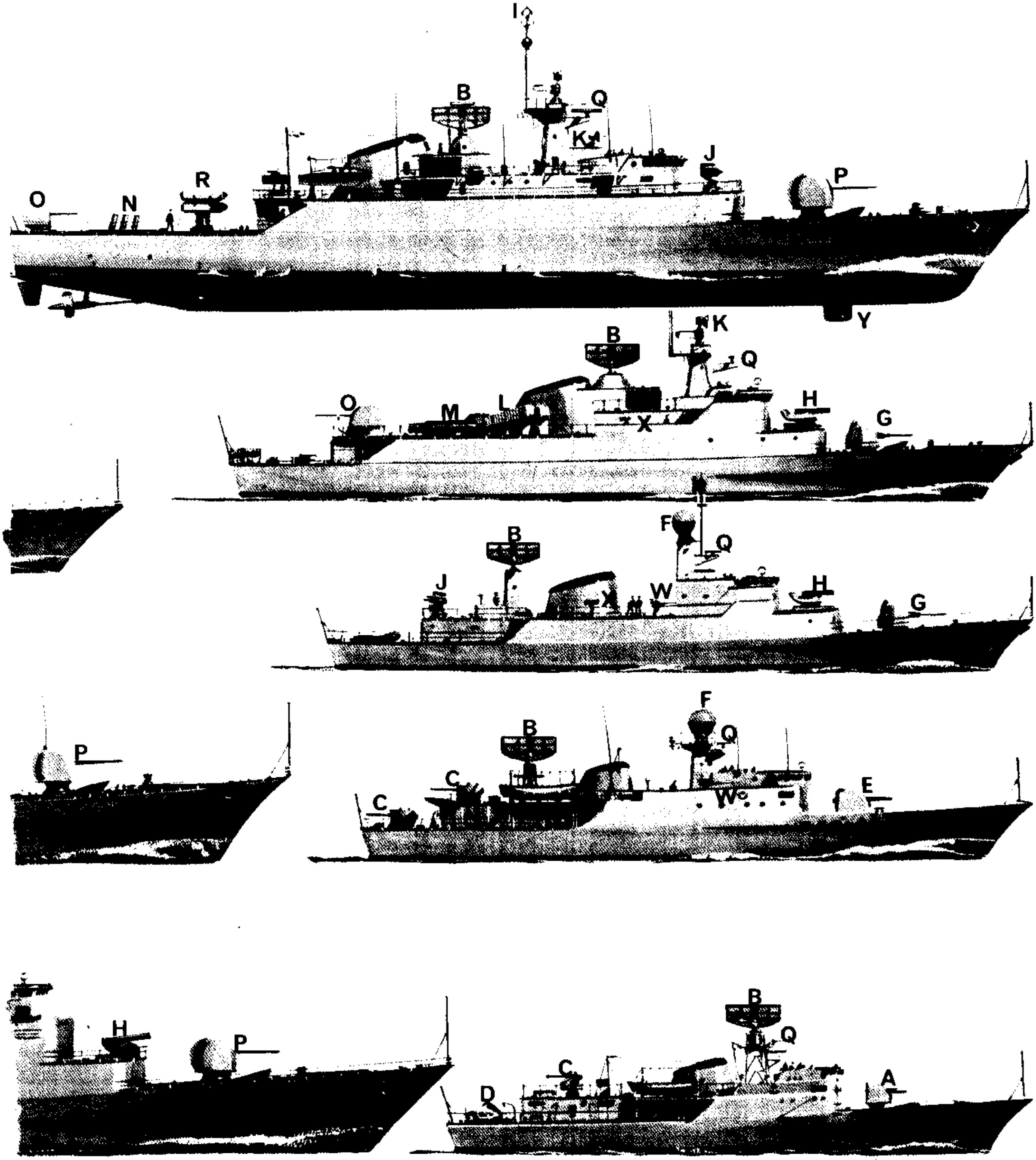
The frigate is the maid of all work in today's navies, and exists in forms with differing degrees of emphasis on the various roles. These involve engagement

1. Mark 7 frigate (Libya), 333 ft, 1600 tons displacement, twin Olympus and diesels (CODOG), 37 knots.
2. Type 21 frigate (Royal Navy *Amazon* class), 384 ft, 2500 tons displacement, twin Olympus and Tyne (COGOG), 34 knots.
3. Mark 10 frigate (Brazil), 425 ft, 3500 tons displacement, twin Olympus and four diesels (CODOG), 30 knots.
4. Mark 5 frigate or fast destroyer (Iran), 310 ft, 1300 tons displacement, twin Olympus and diesels (CODOG), 40 knots.
5. Mark 8 corvette (proposal), 241 ft, 850 tons displacement, one Olympus and twin diesels (CODOG), 32 knots.
6. Mark 9 corvette (proposal), 220 ft, 740 tons displacement, four diesels coupled to twin shafts, 28 knots.
7. Mark 3 corvette (Nigeria), 202 ft, 600 tons displacement, twin or triple diesels, 19-24 knots.
8. Mark 1 corvette (Ghana and Libya), 177 ft, 450 tons displacement, twin diesels, 18-20 knots.




A 4″ S2 Mod 1 single mounting
B Plessey air warning radar
C 40 mm single mounting
D Mk 4 A/S mortar
E 4″ Mk 19 twin mounting
F HSA M22 fire control radar
G 76 mm compact Oto Melara
H 375 mm Bofors A/S rocket launcher
I High frequency direction finder
J Seacat launcher
K Contraves Sea Hunter fire control radar
L Exocet missile launchers
M A/S torpedo tubes

KEY TO TYPICAL WEAPONS SHOWN IN ILLUSTRATIONS 1-8



N Mk 10 A/S mortar
O 35 mm Oerlikon twin mounting
P 4·5" Mk 8 automatic single mounting
Q Navigational radar
R Sea Killer missile launcher
S Rocket launcher
T Air warning radar
U Ferranti fire control radar
V Lynx (WG 13) helicopter
W 20 mm Oerlikon single mounting
X Illumination rocket launcher
Y Sonar transducer (fitted on all ships carrying A/S weapons)

with submarines, with other surface ships, and with aircraft. The armament in each case consists of equipment for detecting and locating the enemy, for destroying him, and, increasingly, for automatic data handling to help the men who form the links between the detection and location equipment and the weapons themselves.

The breadth of the modern frigate's scope is due to the latest weapon developments: a frigate today will carry an automatic gun, usually of 4–5 inch calibre, suitable for anti-ship and anti-aircraft use, directed by radar and associated fire control equipment. She will also have anti-aircraft missiles and larger and longer-range missiles for use against major surface targets—especially at the longer ranges where guns are not very effective.

For submarine detection she will have a comprehensive sonar outfit herself, and carry a helicopter with its own sonar. While the frigate herself may not always be particularly fast, she can delegate speed to her helicopter. The weapons for destroying submarines at long range are likely to be homing torpedoes (whether launched from the ship or the helicopter), with specialized arms, such as IKARA and ASROC for offensive use at medium range, and anti-submarine mortars for short range defence.

The existence of surface craft of high speed and manoeuvrability able to inflict serious damage (the modern FPB), as well as of aircraft, has been an important factor forcing the development of guided missiles and fire control systems. These in turn have proliferated to the point where the modern general-purpose frigate tends to have a multiplicity of weapons to deal with each of the main threats: aircraft, surface ships and submarines. In line with their traditions, Vosper Thornycroft's contributions in this situation have been aimed at breaking away from the trend towards increasing size and cost, and consequent reduction in speed. They have sought, by careful selection of the weapon fit for a specific duty, to make possible smaller and faster frigates, which cost less to build and maintain. The smaller size makes the higher speed possible, and lower costs allow a navy to deploy a larger number of such ships, giving all the tactical advantages which this brings. Such compact warships are made possible not only by the greater effectiveness of modern weapons but also due to the development of lightweight high-powered gas turbines.

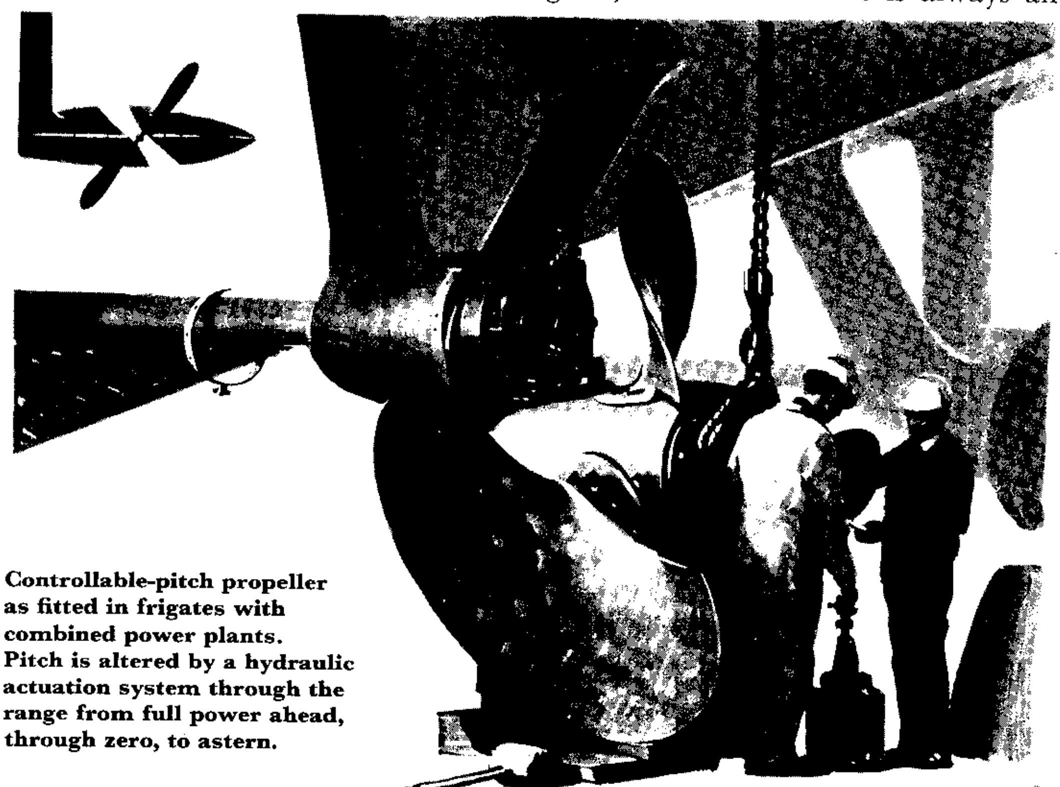
On the weapon side, guns have higher rates of fire and, with computer-assisted fire control, are aimed with greater accuracy, so that one gun can do as much now as the batteries carried ten or twenty years ago. Guided missiles, carrying warheads of great destructive power, home on their targets at ranges up to 20 kilometres or more. Data handling and display techniques using digital computers, such as the Ferranti CAAIS equipment, make it possible for the operations room team to keep abreast of rapidly changing tactical situations, and direct the weapons automatically to the chosen targets, by day and by night.

There is now a fair choice of weapons in each main category. Which are fitted depends partly on technical factors and partly on the political and strategic situation of the particular navy for which the ships are being built. A characteristic of Vosper Thornycroft warships is the high proportion of the total weight devoted to the armament. In Mark 5 frigates, for example, the armament weight is as much as 100 tons.

Anti-submarine weapon systems tend to be largely independent of the other armament. Although smaller sonars have been developed in recent years, the longest range sets are large and heavy enough to call for a frigate of some size. The helicopter is an important part of the anti-submarine armoury. Mark 5 frigates can be equipped to carry a Wasp helicopter but the larger W.G.13 type now coming into service would require a ship the size of a Mark 7 or larger.

Throughout all these armament developments the trend has been towards greater accuracy and certainty of a hit, at the expense of greatly increased cost and sophistication. But the weapons themselves are smaller and lighter, and fewer rounds need to be carried, so the ships can be smaller and faster.

Sea-keeping qualities are vital to frigates, and as sheer size is always an



**Controllable-pitch propeller as fitted in frigates with combined power plants. Pitch is altered by a hydraulic actuation system through the range from full power ahead, through zero, to astern.**

**Type 21 frigate of the Royal Navy's *Amazon* class, with WR 13 anti-submarine helicopter**

advantage in heavy weather Vosper Thornycroft had to study very carefully the behaviour in heavy seas, particularly of the smallest frigate, the Mark 5. Model tests were used, and the results compared with those for the British *Leander* class frigate, whose sea-keeping qualities are renowned. The resulting hull form, which has proved very successful, is finer at the ends than would have been chosen purely from considerations of resistance, and has more deadrise. A pronounced knuckle forward is used to reduce wetness on the foredeck.

The slightly larger (and not quite so fast) Mark 7, has a similar, but rather more conventional hull form, with the ends a little fuller and less deadrise. From this design (which, incidentally, was the first to be carried out entirely by the combined Vosper Thornycroft team) was developed the hull form of the Type 21 frigate for the Royal Navy. In all the frigate designs stabilizers make an important contribution to comfort in a sea way, and to creating a stable platform for gunnery.

Structural materials and design in frigates do not differ fundamentally from those for other ships, although, as in smaller craft, a considerable effort is made to limit weight. In frigates this involves such matters as the extensive use of aluminium alloys in the superstructure above the weather deck, and minor bulkheads, which also helps with stability and makes possible good accommodation in a small ship.

The CODOG arrangement for fast patrol boats was proven and well understood at Vosper when the designers turned to larger vessels. Its application to ships had to wait for the availability of gas turbines of much higher powers than the Proteus. Substantially more powerful free-turbine turboprops were not developed as aero-engines, as the jet became the almost universally used type. The development of high-powered marine engines, notably the Rolls-Royce Marine Olympus, was based on the use of a complete jet engine as a "gas generator", the jet itself then being ducted to a separate power turbine driving into the ship's main gearbox. The Olympus, first used in HMS *Exmouth* with Proteus cruising engines to give a COGOG (Combined Gas-Turbine or Gas-Turbine) installation, has also been used in twin-shaft CODOG schemes in the Vosper Thornycroft Mark 5 and Mark 7 designs. The cruising engines in these ships are Paxman Ventura diesels. The Royal Navy's Type 21 has a twin-shaft COGOG power plant, using the Rolls-Royce Tyne. The Mark 10 frigates for Brazil will also have twin Olympus gas turbines, plus a total of four diesel engines, two to each shaft.

The gas turbine, apart from its excellent power/weight ratio, brings great practical advantages in ease of maintenance and replacement of power units, and almost immediate readiness for use at full power, leading to increased ship availability. Progress is being made in reducing its fuel consumption.

Installing gas turbines in ships, as in small craft, poses a number of problems, among which the design of ducting for the vast quantities of air they breathe is one of the most difficult to solve. Although in the process of adapting aero-engines to marine use certain changes in materials are made, so that components are more resistant to marine corrosion than their airborne counterparts, the quantity of salt spray which can be allowed into the engines without shortening their lives is limited. Air intakes have been developed consisting of a system of baffles, drains and filters, to remove as much salt as possible from the air before it reaches the engines. The intakes themselves are sited in positions which give as much protection from spray as possible, high in the superstructure.

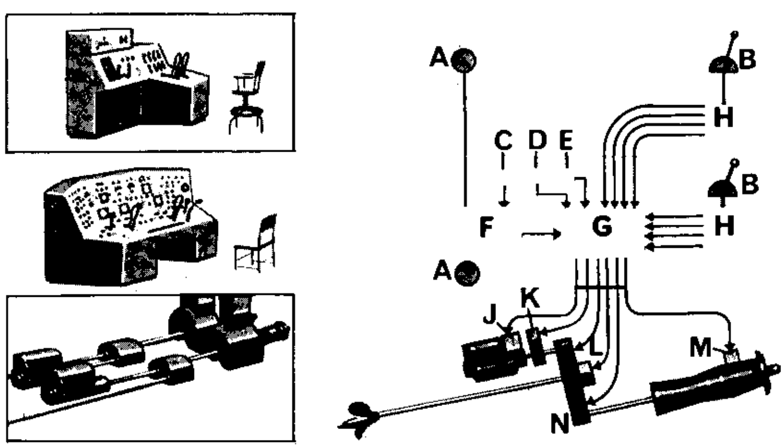
Controllable-pitch propellers, in which a mechanism, usually hydraulically actuated, rotates the blades so that propeller pitch is adjusted, have great advantages with CODOG and COGOG installations, since they are better able to operate at good efficiencies at both cruising and maximum speeds than fixed-pitch propellers. They can also solve the manoeuvring problem with gas-turbine power units, since by reversing the pitch they can give astern thrust while the engines continue to turn in the same direction, so eliminating any need for a reverse gearbox.

Controllable-pitch propellers are used for the Vosper Thornycroft Mark 5, Mark 7, Mark 8, Type 21 and Mark 10 frigate designs.

The transmission system which connects either the boost gas turbines or the cruising engines to the screws in a frigate's combined power plant has a good deal in common with that for a fast patrol boat, although on a very different scale. SSS clutches isolate the engine not in use from the main reduction gearing, which for powers over 25,000 b.h.p. is a very substantial and sophisticated unit. The fact that David Brown Gears are leading specialists in this field has been helpful to Vosper Thornycroft as members of the same group by providing direct access to their expertise.

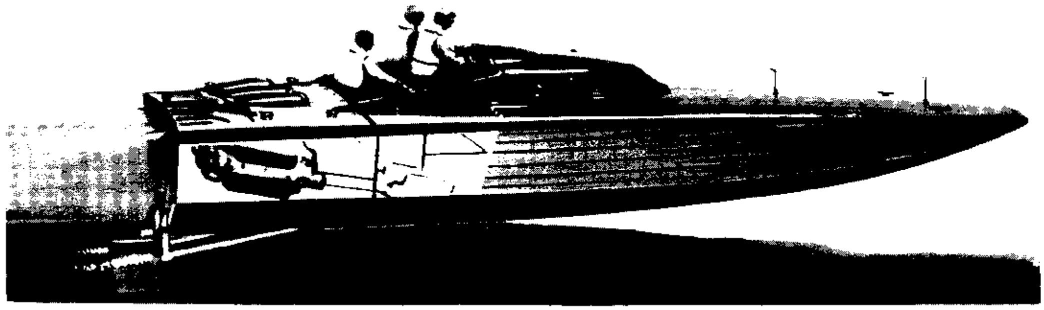
The use of controllable-pitch propellers eliminates the need for a reverse gearbox, but a fluid coupling is introduced between diesel cruising engines, which are of relatively modest power, and the main gearing. This makes it possible for the diesel to overcome the great inertia of the transmission system and propellers, which have to be designed for the full power of the boost gas turbines—often more than ten times that of the diesel engine.

The use of combined power plants, together with the need to reduce the frigate's complement as far as possible, has led to engine control being removed from the machinery spaces themselves and concentrated in a separate compartment, the machinery control room, which also houses the instruments




SCHEMATIC OF ELECTRICAL CONTROL SYSTEM FOR CODOG PROPULSION SCHEME

- **A** **Indicator showing position of lever at alternative control position**
- **B** **Power/pitch control lever**
- **C** **Switch for transfer of control from one position to the other**
- **D** **Independent pitch control (to vary pitch/power relationship)**
- **E** **Switch to select gas turbine or diesel**
- **F** **Control position change-over unit**
- **G** **Logic sequence unit with safety interlocks**
- **H** **Power/pitch control transmitter unit**
- **J** **Cruising diesel throttle actuator with receiver and amplifier**
- **K** **Fluid coupling actuator unit**
- **L** **Propeller pitch control unit**
- **M** **Gas turbine throttle actuator unit**
- **N** **SSS clutches**



*Flying Fish*, **a 38 ft aluminium offshore power boat, achieved some 57 knots and performed well in rough water**

which monitor the performance of all main and auxiliary machinery, and electrical switchboards. A second main engine control position on the bridge is also now normal. To provide interconnected controls for this rather complex arrangement Vosper Thornycroft's Controls Division developed an electrical system which gives single-lever throttle control of each shaft, with alternative control positions in the machinery control room and on the bridge. This system provides simultaneous control of engine power and propeller pitch to keep the two matched throughout the speed range, using a single lever for each shaft.

The change in size, both of the company and of its main products, has inevitably brought about a change in character, but the efforts which achieved acceptance as major warship builders did not mean smaller craft were abandoned. Three main lines of development on these vessels, closer to those of the pre-merger days, were followed into the later 1960s.

The first, which stemmed from Commander Du Cane's continuing personal enthusiasm, was in boats for the growing sport of offshore power boat racing. Two of these, the *Tramontanas*, had already been successful: *Tramontana I* won the 1962 Daily Express race, and *Tramontana II*, a smaller boat to meet the revised rules, would have been third in 1963 in spite of a failure on one of her four engines but for inadvertently rounding the wrong buoy in the Needles area. Most interesting technically was *Flying Fish*, a 38-ft boat of welded aluminium construction, which was leading the field in rough going off Portland Bill in 1966 when some failure, probably of a propeller blade, caused her to sink quickly. All these Vosper racing boats were at their best in rough water.

A second type of craft, boats for a variety of duties such as police and customs patrol, and for use by pilots and as fast lifeboats, has been built following an agreement which led to the merger with Vosper Thornycroft of the Isle of Wight firm of Keith Nelson & Co. Ltd. These boats, based on a range of standard glass-reinforced plastics hulls, are fitted out in various ways to suit the particular duty for which they are intended.

1. *Scimitar* **class fast training boat for Royal Navy, 100 ft, twin Proteus and diesels, 40 knots.**

2. *Susa* **class FBB for Libyan navy, with SS 12 missiles, triple Proteus and twin diesels, 57 knots.**

3. *Tenacity*, **private venture prototype guided missile FPB, shown with Sea Killer and twin 35 mm Oerlikon gun; 102 ft, triple Proteus and two Paxman twin diesels, 40 knots.**

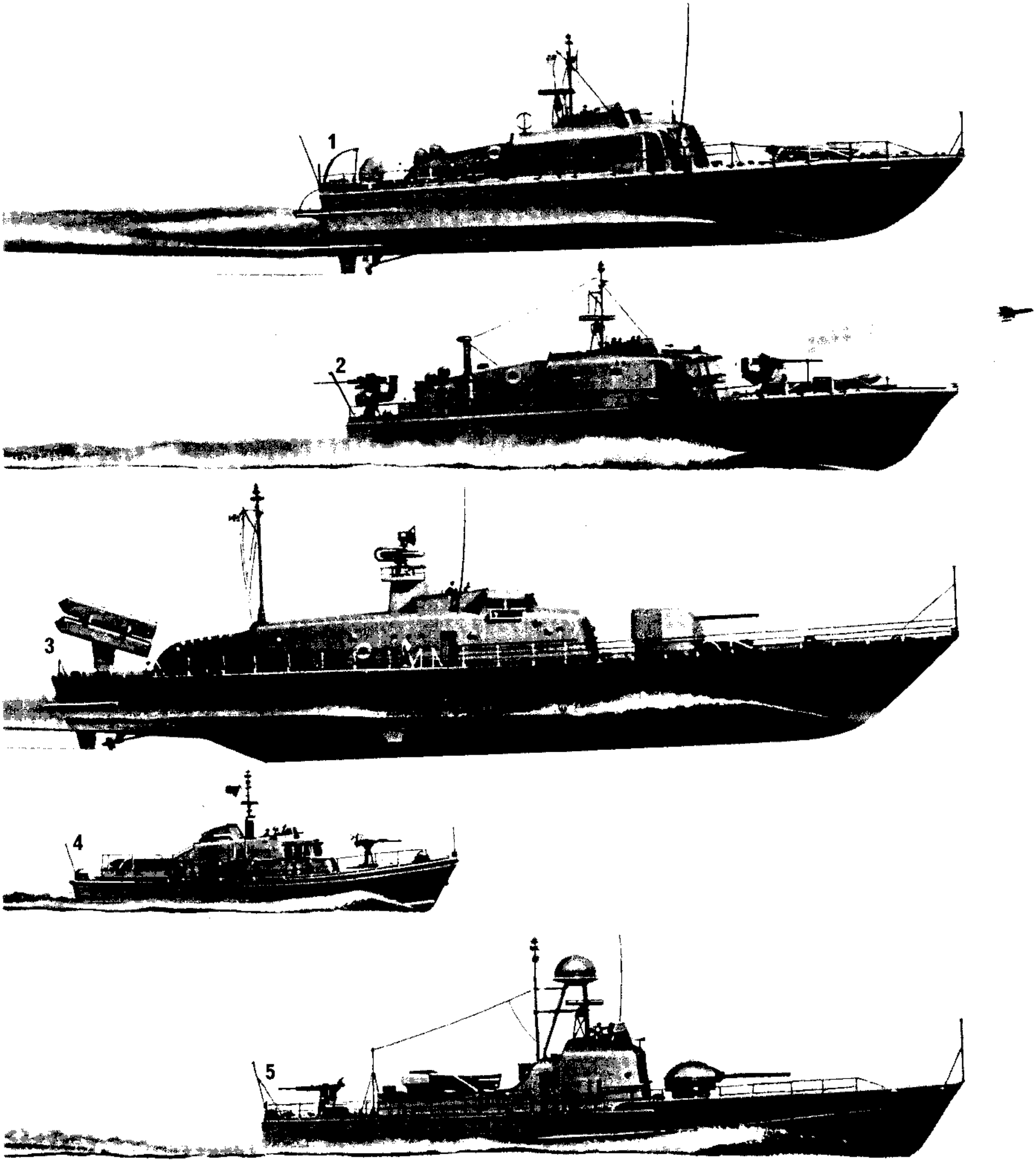
4. **Keith Nelson glass-reinforced plastics hull completed as police patrol craft; 60 ft, twin Caterpillar diesels, 20 knots.**

5. **Recent steel fast patrol boat with 76 mm Oto Melara gun and Hollandse Signaalapparaten fire control; 110 ft, diesels, 30 knots.**

The recent development of the fast patrol boat has been dominated by the introduction of the guided missile as its prime weapon against other ships. An early example was the fitting of wire-guided Nord Aviation SS 12 missiles in the three 96-ft gas turbine boats of the *Susa* class, for Libya. These boats were otherwise very similar to those built for Malaysia. The missiles are carried in launchers on either side of the superstructure. After launching they are guided by electrical signals transmitted down fine wires, which run out from a coil in the missile itself, the signals being derived from a sight worked by an aimer. In a patrol craft he sits in a shock-absorbing seat and aligns his sight with the target, while the control signals act to bring the missile on to this sight line. Such missiles can carry a warhead with a destructive power roughly comparable to that of a 4.5 inch shell, so can inflict severe damage on a ship. The main problems with this system are related to the extent to which the aimer can keep the target accurately in his sights while experiencing the accelerations imposed by a fast patrol boat in rough going, and the limited range of the missiles themselves.

The gas-turbine fast patrol boat armed with wire-guided missiles is nevertheless able to attack ships at rather greater range than would ensure a hit with a torpedo, but the necessity for very high speed and manoeuvrability of the torpedo-carrying FPB remains. A major step forward, however, can be taken by arming fast patrol boats with beam-riding or other radar-controlled or homing missiles with ranges of 20 kilometres or more. This at once makes the FPB a serious threat to major warships. It does, however, require a rather larger type of patrol craft, though the outright top speed requirement is less, by virtue of the greater range at which the vessel can fire its weapons.

In 1968 Vosper Thornycroft designed their own fast patrol boat to meet this requirement and, as they had with MTB 102 in 1938 and *Ferocity* in 1959, built their own prototype, *Tenacity*. The new design was for a 142-ft steel boat capable of 40 knots, with a triple-screw CODOG propulsion scheme consisting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of three Proteus gas turbines and two Paxman diesels. A variant with four diesel engines was also proposed. *Tenacity* is capable of carrying Contraves Sea Killer missiles and Sea Hunter fire control, or other comparable weapon systems, together with a modern automatic gun directed by the same fire control equipment. She has proved herself on trials and during periods with the Royal Navy, and is representative of what is likely to be the major future FPB type. At much the same time as *Tenacity* was being designed and built, Vosper Thornycroft entered the hovercraft field, a development which is outlined in Chapter 8.

The most recent gas-turbine fast patrol boats built by Vosper Thornycroft were the three fast training boats of the Royal Navy's *Scimitar* class completed in 1970. Fitted with twin Proteus turbines and Foden diesels in a CODOG arrangement, these boats have a modified hull form with a longer bow overhang and some vee remaining in the bottom at the transom. In other respects they are very similar to earlier Vosper 96-ft gas-turbine boats. They have replaced the recently retired *Braves* in providing the Royal Navy with a nucleus of FPBs for training and exercise duties.

The year in which Vosper reached its centenary has been one of consolidation. The immediate problems are those of production, administration and management to ensure that the important contracts in hand, for Mark 10, Type 21, Mark 7 and Mark 5 frigates, for Mark 3 corvettes, and a variety of patrol craft and other vessels, are successfully completed, while new orders are secured to follow them. The signs are that the immediate problems resulting from the change of scale when Vosper and Thornycroft merged have been solved. Now it is a question of keeping the overall operation profitable at a time when the British shipbuilding industry as a whole is in a position which is by no means secure. Chapters 7 and 8 will give an indication of future trends of technical development.

With the exception of the period 1919–1931, for which records are scanty, the centenary of Vosper's existence has been spanned by three managing directors only. H. E. Vosper was in full charge from the foundation of the firm until his retirement in 1919. Commander Du Cane was managing director from 1931 to 1963, when, with the appointment of Sir David Brown as chairman, he became deputy chairman with special responsibilities as research director. He was succeeded by Mr. John Rix, who remains managing director today, and has led the company through the recent period of rapid growth, and its recognition as a major warship-building organization.

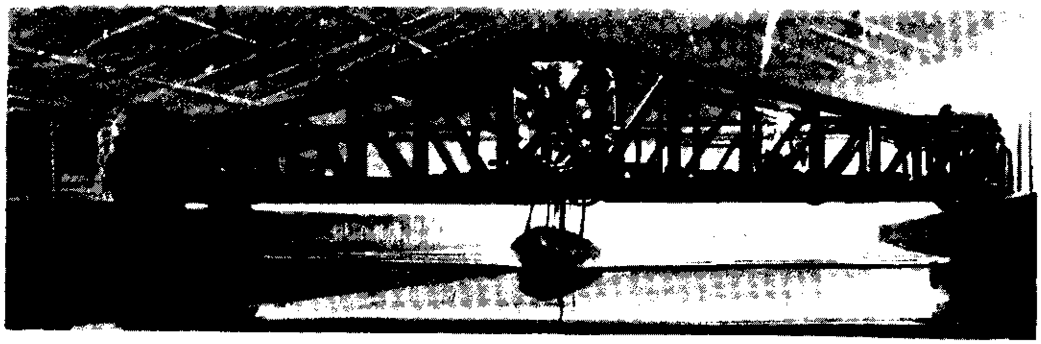
# 7

# Research and Development

USING EXPERIMENTAL techniques in the pursuit of knowledge is essential if reasonable certainty of success is to be combined with technological advance and innovation. Traditionally in shipbuilding advances have been made in greater or smaller steps as a ship was designed and built, so that trials and operational experience with ships built to order were in fact the sources of experimental data. As ships grew bigger, more complex and more costly this process inevitably became too wasteful to be accepted where alternatives could be found.

At Vosper it was Commander Du Cane who first began to apply scientific methods to the gathering of information of use in design. More than one launch or jolly boat of the 1930s is listed in the records as experimental, and these vessels were the means of trying out the hull forms and machinery installations which later became successful. He also saw to it that proper theoretical studies were carried out, and note taken of progress in other relevant fields, especially aeronautical engineering.

The two main techniques used by Vosper in the development of hull form have been manned models and models tested in a towing tank. These are largely complementary: the manned model can give the experienced observer/helmsman a clear indication of the boat's performance in a seaway and its behaviour in response to controls. Commander Du Cane himself attributes much to the experience he personally gained in this way. Such models do not, however, lend themselves to the precise measurements of resistance which are needed to refine hulls for the highest possible speeds from the available power units. The towing tank's carriage is equipped with intruments to measure the forces on the model as it is towed along. Most tanks are equipped with wave-making equipment, so that the hull form's response to waves from ahead (or, sometimes, astern) can be studied. A different type of tank, in which free models controlled by radio, or towed from a complex two-axis carriage, can be manoeuvred to encounter seas from any angle, is also used at some establishments.



**A substantial proportion of the tank testing of Vosper designs has been done at the Admiralty Experiment Works, Haslar. Such facilities consist of long basins crossed by a carriage running on rails from which the model is towed at a pre-determined speed. Instruments on the carriage measure the forces on the model, from which the resistance of the full-size hull can be calculated. The Haslar tank's carriage is capable of very high speeds.**

Vosper have made use of the tank facilities of a number of organizations, including the Admiralty Experiment Works at Haslar, National Physical Laboratory Ship Division, Westland Aircraft Limited (Saunders Roe Division)—now part of the British Hovercraft Corporation, the establishment at Wageningen in Holland and the Davidson Tank in the U.S.A. In particular tests were carried out at Haslar on models of *Bluebird II*, which gained the world water speed record in 1939 at 141.7 miles per hour, and on $\frac{1}{16}$ scale models of *Crusader*. Even this tank, however, was unable to test *Crusader* models at a scale speed corresponding to the 250 miles per hour she had been designed for.

As a result of this limitation Vosper developed a free model testing technique using rockets which was at first applied to the $\frac{1}{16}$ *Crusader* models, but later to one-sixth scale models fitted with a gyro-controlled auto-pilot and a more powerful rocket. These models reached speeds of nearly 100 miles per hour on the torpedo range on Horsea Island in Portsmouth Harbour, corresponding to about 240 miles per hour at full scale. The tests made possible progressive refinement of the design, and the decision to go ahead and build was taken on the basis of the results obtained.

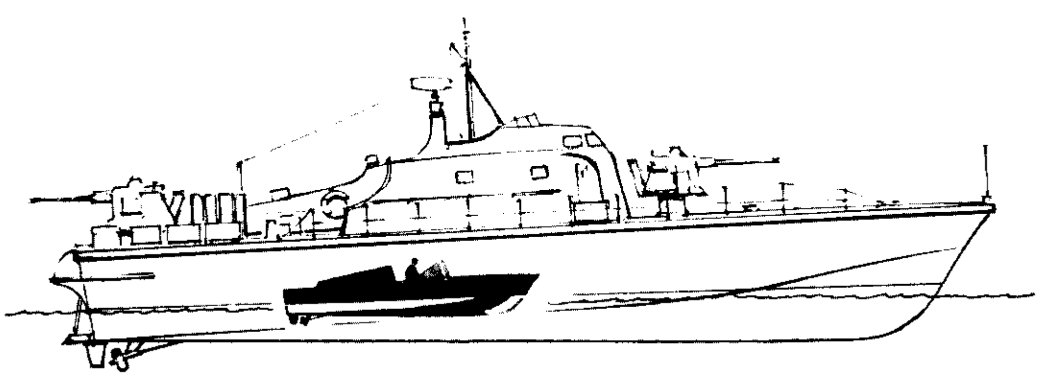
The limitations of towing tanks, apart from the maximum speeds they can attain, arise from effects of scale, and, for fast craft in particular, it is difficult to ensure similar behaviour in model and full-size craft, particularly in regard to the effects of spray and appendages, which are much influenced by the viscosity of the water. The naked models, without appendages, used for tests on larger and relatively slower ships, are not truly representative of fast craft. It therefore pays to use models to as large a scale as possible. This is one reason for Vosper's use of manned models of high-speed craft.

When the first Vosper hovercraft, VT1, was being designed extensive use was made of model testing, both in towing tanks, with free, remotely controlled models, and finally with VT1-M, a two-fifths scale manned model, which, after providing invaluable information which was used in the design of the full-sized craft, has been equipped for studies of future hovercraft configurations, including the use of water jets instead of propellers.

The advantages of being able to carry out tests at full scale have been contributory factors in Vosper's decisions to build their own prototypes when radically new designs were brought out, as with MTB 102, *Ferocity* and *Tenacity*. The company has also, on a number of occasions, agreed with service customers that specific experimental work could be carried out in their vessels, as with MTB 1601 and one of the 68-ft HSLs for the Air Ministry. Much use is of course also made of results obtained on contractors' and acceptance trials, which provide a constant feed-back of information for the designers.

The investment in a towing tank is something few shipbuilders can afford, and the requirement for high towing speeds and models of reasonably large scale means that a substantial and costly tank is really needed for accurate results. Vosper have never had their own tank, but the merger with Thorny-

***Ferocity* was one of the Vosper designs which was developed with the help of a manned model.**



croft gave access to the small tank at Steyne on the Isle of Wight where Sir John I Thornycroft had carried out many experiments. In this tank the model is towed by a miniature winch powered by a falling weight. The Steyne tank still proves useful for obtaining quickly results for small-scale models which give acceptable accuracy for preliminary studies.

The main hydrodynamic facility owned by Vosper is the cavitation tunnel which was installed during the development programme for the *Brave* class, mainly to provide the data required in order to design the fully cavitating propellers which were needed to give the boats their design speed. Commander Du Cane became convinced of the need for this facility after touring the hydrodynamic research stations of Europe, and it was as a result of this that Vosper installed it, at their own expense. They remain the only shipbuilders in Britain having their own. At the same time they engaged a staff hydrodynamicist to operate it, a position which exists to this day.

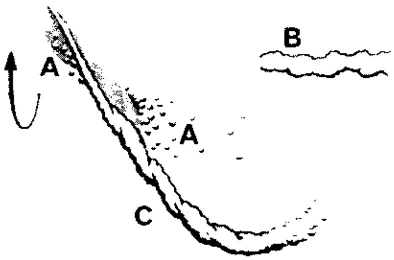
A cavitation tunnel consists of a closed circuit round which water is pumped. A section at the top is provided with glass panels so that the model propeller being tested can be watched and photographed. Arrangements are made to ensure an even, regular flow of water to this test section. The arrangement at

TYPICAL CAVITATION PHENOMENA

**A Bubble cavitation, which is unstable and can damage propellers**
**B Hub vortex cavitation**
**C Tip vortex cavitation**
**D Super cavitation, with the cavity closing downstream so that the propeller is not damaged. This is the type used on very high speed supercavitating propellers**

THE VOSPER THORNYCROFT CAVITATION TUNNEL

**A 18 h.p. propeller motor**
**B Torque dynamometer**
**C Thrust dynamometer**
**D Adjustment for propeller shaft and motor**
**E Guide vanes**
**F Honeycomb section to reduce turbulence**
**G Working section 500 × 500 mm**
**H Impeller motor**
**J Impeller**
**K Heating jacket**
**L Working section for axial flow**
**M Working section arranged with propeller on shaft inclined to flow direction**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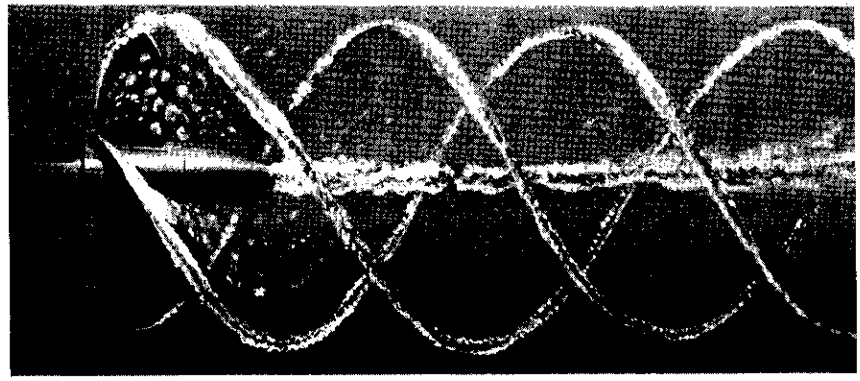

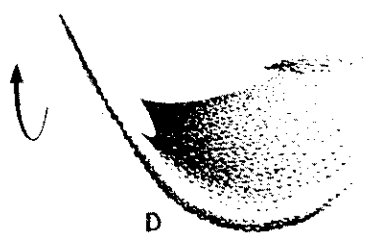
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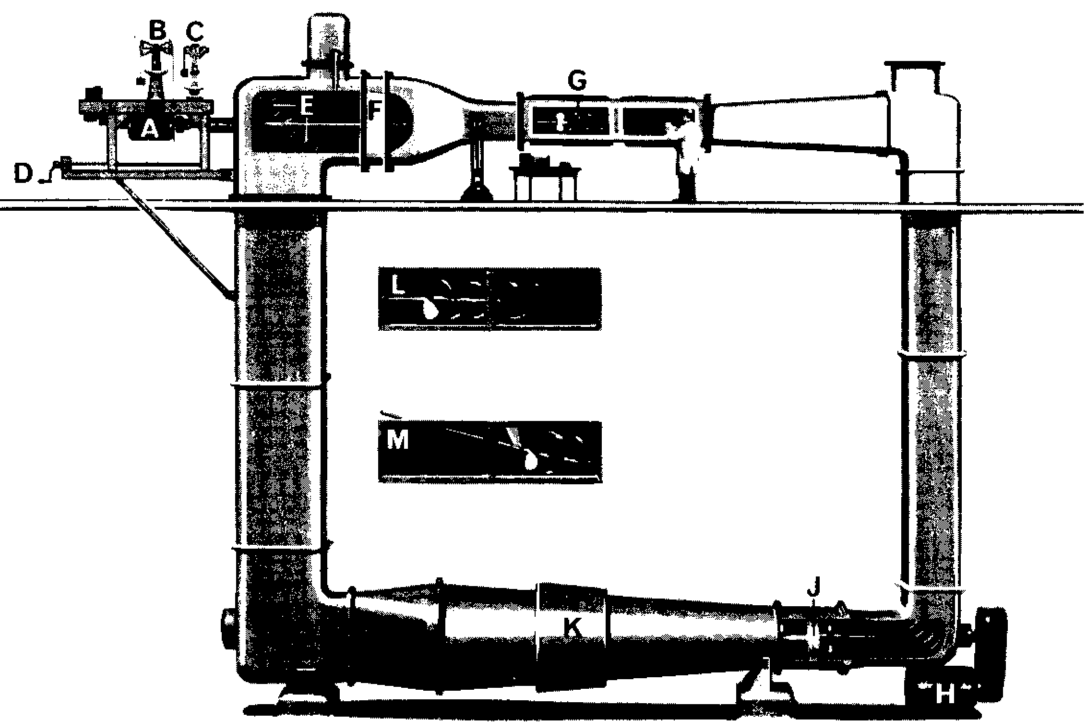
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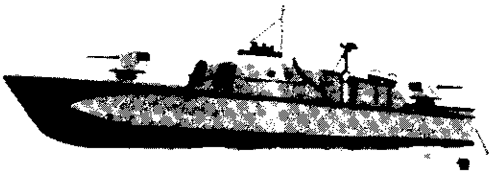
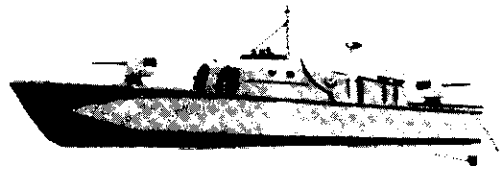
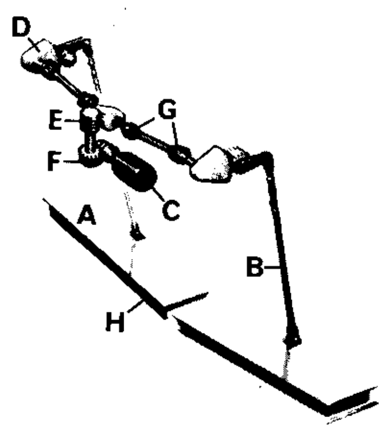
**Main function of the transom flap is to optimize the running trim of a planing hull.**



**Normal trim**



**Flap operating**




TRANSOM FLAP ACTUATION SYSTEM

**A Transom flap**
**B Operating rods**
**C Electric motor**
**D Spur quadrant assembly**
**E Worm quadrant**
**F Worm reduction gear**
**G Flexible couplings**
**H Hinge line**

Vosper is the normal one of a loop in a vertical plane, so that on leaving the working section the water passes down, where the increasing hydrostatic pressure helps it to re-absorb any air bubbles which may have formed as a result of the cavitation phenomena in the working section.

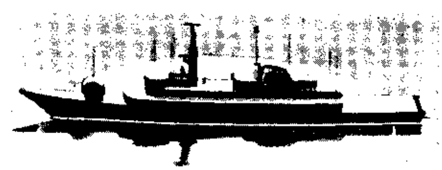
The model propeller is rotated by an electric motor and dynamometers are arranged to measure propeller thrust, torque and r.p.m. from which the power absorbed can be worked out. This gives the designers the means to match the propeller to the chosen engines at the predicted boat speeds. The conventional cavitation tunnel only provides for the mounting of propeller models with the shaft axis parallel to the water flow. The Vosper tunnel was, quite early on, provided with an inclined shaft rig, which made possible visual observation of cavitation patterns on propellers mounted as they would be in a high-speed craft, at an angle to the flow. A later and more advanced rig allows accurate measurements of propeller thrust, torque and other forces in oblique flow conditions.

Although originally installed for propeller studies the cavitation tunnel has a number of other uses. Rudders are extremely important, since at high speed cavitation forms on them, and it has been found that it pays to use a wedge-shaped section with a blunt trailing edge when this type of flow applies. The inclined shaft rig makes it possible to check for any interactions between propeller and rudder: damage to the rudder can result from the action on it of the cavitation downstream from the propeller. These studies have often led to the practice of siting the rudders, in high speed craft, away from the propeller axes.

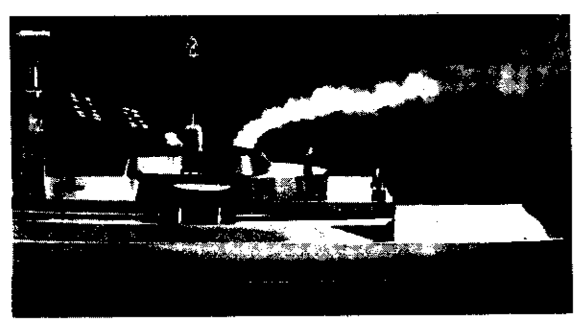
Flow under cavitating conditions past stabilizer fins and hovercraft skegs has also been studied in the Vosper cavitation tunnel. The skegs, which are fins extending down from the hovercraft's hull through the water surface, called for the development of a technique in which the working section of the cavitation tunnel is run with a weir upstream of the model to generate a free water surface in the section.

The presence of a staff hydrodynamicist has proved invaluable in solving design and development problems not connected with the operation of the cavitation tunnel, although it is the existence of the tunnel which enables Vosper to attract highly qualified specialists to the post. One such problem, which was encountered on trials of the gas turbine fast patrol boats for Malaysia, was a form of directional instability on broaching which was connected with the transom flaps. These flaps had been used experimentally before the *Braves* were built, and an installation involving remote control of their postion was incorporated in their design.

The main purpose of transom flaps is to adjust the running trim, especially at those speeds when the bow tends to rise. Suitable flap settings can reduce



**Radio interference tests are carried out using copper models, in this case of the Type 21. These tests are carried out at Admiralty Surface Weapons Establishment, near Portsmouth.**



**Aerodynamic tests carried out in the wind tunnel at Southampton University help to develop superstructure shapes which will not cause problems with smoke or turbulence for the helicopter. For the Type 21 these tests were with the same copper model as the radio interference tests.**

the craft's resistance, keep the bow down to minimise slamming in head seas or keep the bow up to improve the ride in following seas.

The problem of broaching in the Malaysian FPBs was ultimately traced to ventilation at the after part of the boat's bottom due to the propeller flow drawing air through the gap between the flaps and the transom, and introducing a flexible seal at the hinge was found to be an effective cure.

The techniques of research and development are now applied in the course of design of ships of all classes. Hull forms are thoroughly tank tested as a matter of course. Two other techniques involving the use of models are the study of the aerodynamics of superstructures, to ensure, for example, that smoke from the funnel is not drawn down to the helicopter landing deck aft, and the measurement of mutual interference between the antennae of the radio communications equipment, and of the impedance of high frequency and medium frequency antenna systems.

As well as experiments aimed at providing information needed in connexion with particular designs Vosper carry out or initiate at other suitable establishments research studies of a more fundamental nature: subjects which have been covered include the structural strength of beams, panels and propellers, measurement of water pressure on hulls, the whirling of shafts and the analysis of shafting alignment using fair curve alignment theory, together with longitudinal vibrations in propulsion shafting, among many others.

The company has recently carried out a detailed analysis, with the help of a computer, of the reliability, maintainability and availability of ships' main propulsion, auxiliary, electrical and control systems. This has assessed the probability of the ship being able to meet the staff operating target, in terms of days at sea per year, and predicted the likely requirements of off-schedule maintenance. Such techniques had until then only been applied in the aerospace field. The necessary computer programs were developed in collaboration with the British Ship Research Association. Another recent development making use of the computer is the assessment of sea-keeping qualities from the lines drawing which defines the hull shape.

The techniques of research and development have played an important role in the progress of Vosper since the early 1930s, and they have devoted a substantial proportion of their resources to their application. This parallels the company's emphasis on self-contained design capacity and has made an important contribution to it.

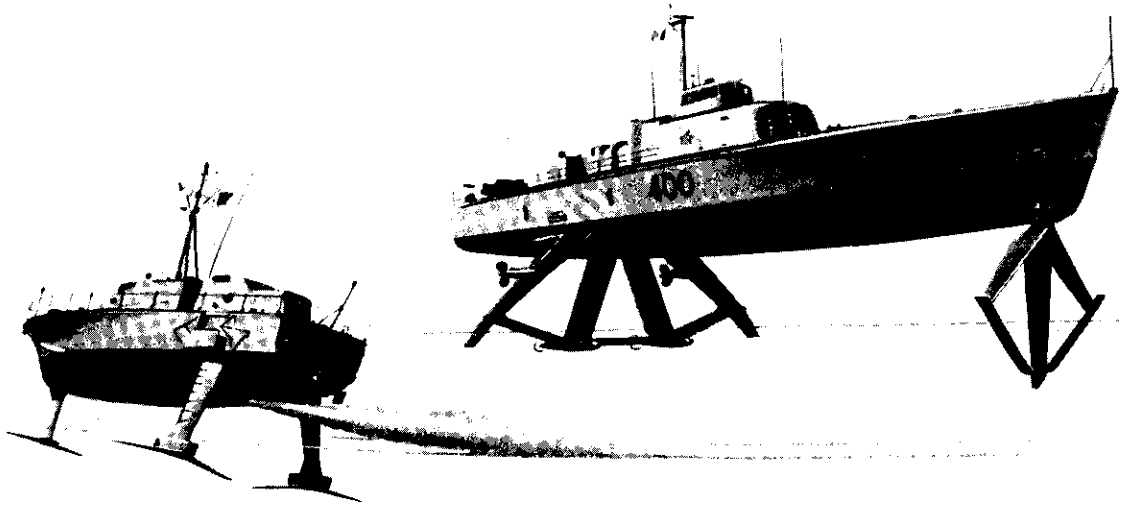
# 8

# Future Prospects

A POINT has now been reached where higher speeds at sea can only be achieved with difficulty, and at great cost. Although the world water speed record stands at 285.213 miles per hour (248 knots), and racing offshore powerboats' speeds are creeping up in the 60–80 knot range, the problems of achieving such speeds in the open sea in vessels capable of carrying a useful load, whether weapons, fare-paying passengers, or freight, are immense. The limiting factors are the steepening rise in resistance with speed, so great powers are needed to increase speed substantially; the violence of the motion experienced by passengers and crew in high-speed craft in a seaway; and the rapidly increasing risk of damage to hull or appendages if a floating object, such as a log of wood, is hit at speed.

Nevertheless, there will always be cases where more speed is an advantage. In commercial operations speed can sometimes be justified economically, and there is still a gap between the economic and performance characteristics of the fastest practical craft on the water and those of aircraft. For military roles speed is always an advantage. Already nuclear submarines, benefiting hydrodynamically by moving away from the sea's surface, attain speeds approaching those of the fastest of the frigates intended to hunt them, and, although frigates delegate speed to their helicopters, these are of limited range. In any encounter between surface warships the vessels which have the advantage in speed retain control of the tactical situation. The need for more speed is there.

Three main types of craft are being developed to make possible higher speeds afloat: the hovercraft, the hydrofoil, and the normal planing or semi-displacement vessel. The balance of advantage between these types depends on the duty for which they are intended, and is still, in any case, a matter for discussion and the evaluation of service experience. Vosper are interested in all three, but at the moment are actively engaged only on hovercraft and planing boats.



**The Boeing hydrofoil *Tucumcari* is supported on retractable submerged foils, most of the weight being carried on the two after ones. The forward foil provides steering and stabilization in pitch. Water jet propulsion is used, having intakes at the roots of the after foils, discharging through the bottom of the hull. A separate jet is used for cruising on diesel power, the main engine being a gas turbine.**

***Bras d'Or*, the Canadian naval hydrofoil, has surface-piercing foils, and is driven by water propellers. Twin super-cavitating screws are mounted low on the main foil structure for foil-borne operation under gas turbine power, while smaller controllable-pitch screws are driven by diesel engines when operating as a displacement craft.**

Hydrofoils, in which the main hull is lifted out of the water on wing-like planes which are mounted below it, come in two main forms: those in which the lifting foils are kept immersed and those in which they are so arranged that part of their area pierces the surface. The first kind needs control surfaces to keep the foils at the right depth below the surface but is more efficient hydrodynamically. The surface-piercing hydrofoil takes up a natural equilibrium position, depending on the speed, but this has to be paid for in losses at the surface, and unwanted perturbations from waves.

Hydrofoils are operating successfully at speeds up to about 40 knots on commercial routes on Russian rivers, in the Solent area, the Channel Islands, the Mediterranean, and elsewhere. They have the advantages over planing craft of making less wash, which can be important in confined waters, and of offering some economy in installed horsepower, and therefore fuel consumption. *Bras d'Or*, a more sophisticated surface-piercing hydrofoil designed for anti-submarine duties in the Royal Canadian Navy, has attained speeds of over 60 knots, in smooth water, and 50 knots in rough weather. A number of submerged foil craft have been built for the US Navy, one of the most successful being the Boeing-built *Tucumcari*, a 57-ton gunboat with water jet propulsion, designed for speeds of about 45 knots.

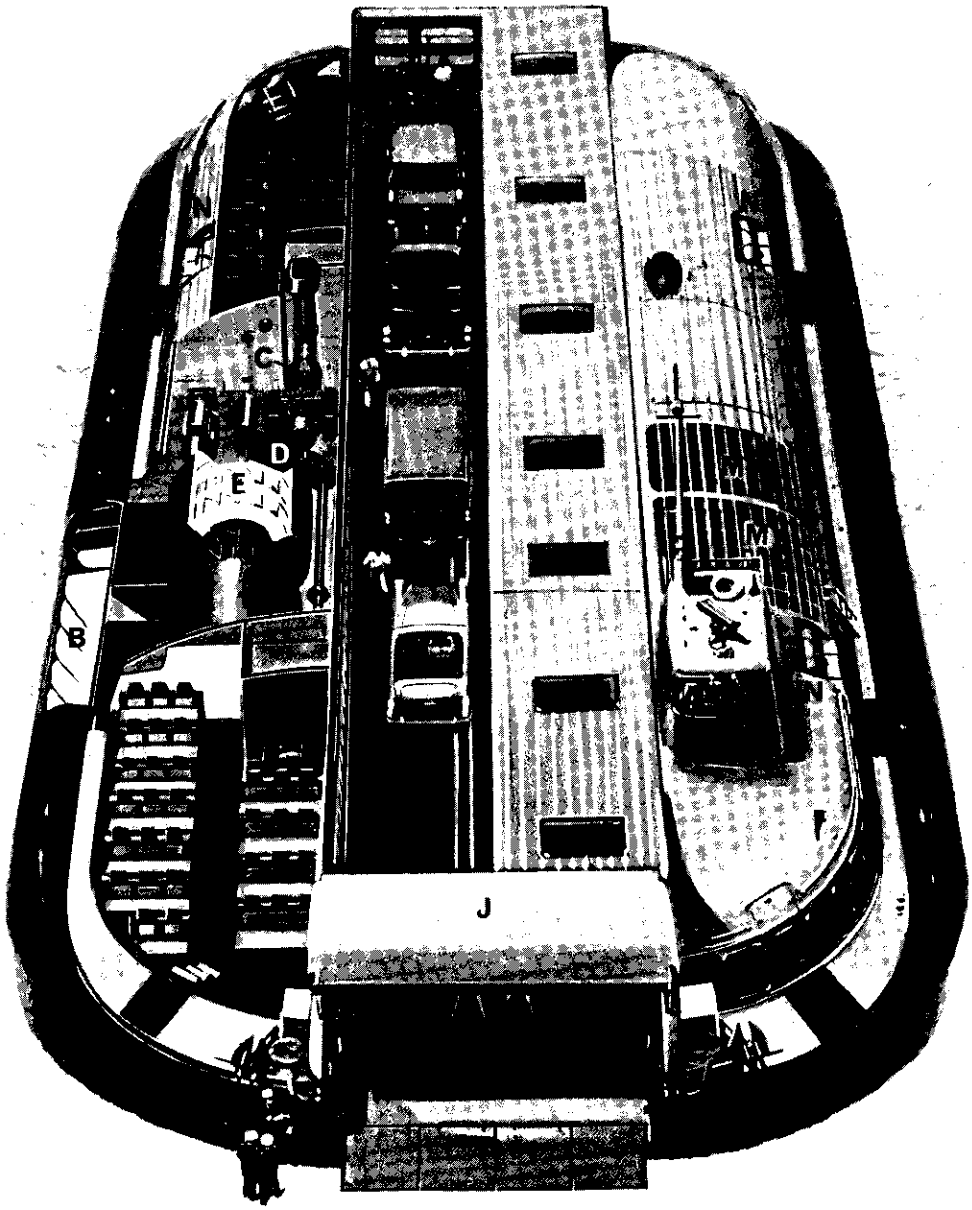
It followed naturally from the company's continuing studies of fast seagoing craft that Vosper should enter the field of hovercraft or hydrofoils and, since resources did not allow them to tackle both, the choice fell on hovercraft. One reason for this was that there seemed to be special contributions an advanced shipbuilding organization could make to hovercraft development, a field so far dominated by the aircraft industry.

A second, more technical, reason is that the hovercraft offers, at least in theory, an advantage in relative power needs as it gets larger. Vosper do, however, continue to watch closely developments in the hydrofoil field as well.

Vosper began work on hovercraft in 1967, and announced their first design in 1968. The prototype, VT1-001, began trials in 1969. The VT1 design was for a vehicle and passenger ferry, to a requirement stated by Hovertravel Ltd., for which company VT1-001 was built. The craft has a full peripheral skirt, and water propellers mounted on fins or skegs below the hull. The skirt followed the lightweight type developed by the Government-sponsored group, Hovercraft Development Limited, at their establishment at Hythe, on Southampton Water. Before VT1, water propulsion had only been associated with the sidewall type of hovercraft, in which the air cushion is contained at the sides by two deep fins, which are always in the water and can therefore carry water propellers and rudders. Flexible skirt segments on sidewall hovercraft are confined to bow and stern. Water propellers were chosen for VT1 because they promised to give maintained thrust in adverse conditions, were quiet, and not unduly complex or costly. The full peripheral skirt adopted for VT1 gave a better ride, particularly in rough water, and made it possible to design the skegs which carry the propellers in such a way that the craft can be nosed up on to a suitable ramp for loading and unloading. This leads to VT1 being described as a semi-amphibious craft.

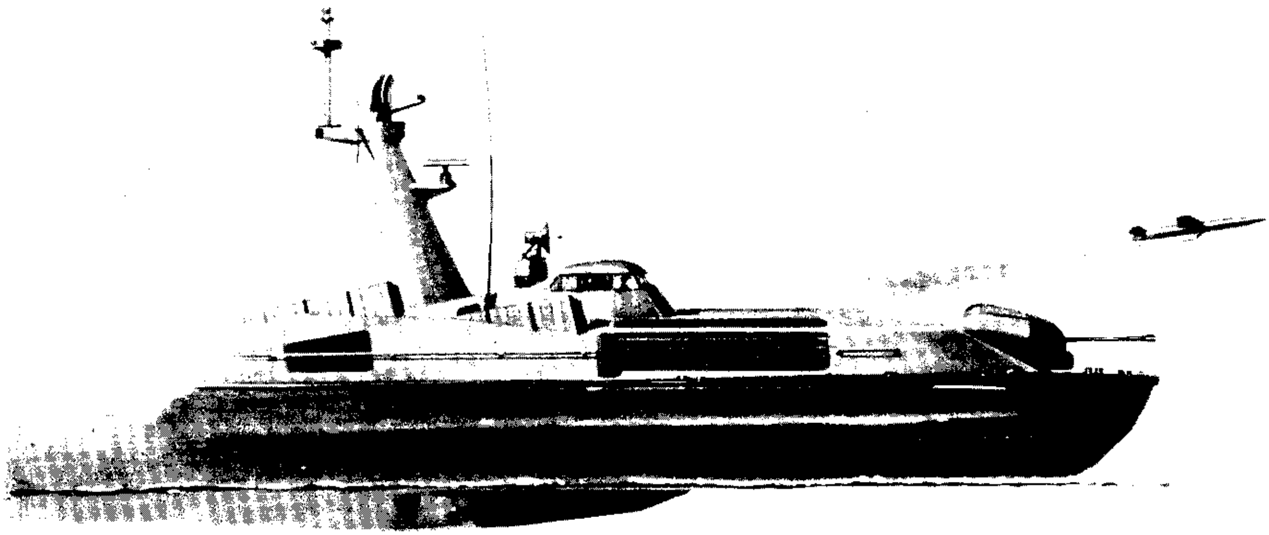
In VT1 the benefits in terms of reduced resistance at high speeds over water are exploited by reducing the installed power, to improve operating economy, rather than to move further up the speed scale. VT1 is a 40-knot ferry, designed to be economical to buy and to operate so as to compete successfully with conventional ships on suitable routes. Experience on trials in rough seas is most encouraging, proving that a hovercraft can carry a very substantial load and provide a stable platform and sustained speed in rough seas.

More recently Vosper Thornycroft have prepared a proposal for a military development of VT1 to operate in the fast patrol boat role. This is generally




VT1 HOVERFERRY ARRANGED FOR 150 PASSENGERS AND TEN CARS

**A** **Peripheral skirt**
**B** **Skirt fingers**
**C** **Lycoming gas turbine, 1850 b.h.p.**
**D** **Transfer gearbox**
**E** **Centrifugal lift fans**
**F** **Passenger cabins**
**G** **Car bay**
**H** **Guide rails for car wheels**
**J** **Bow loading door**
**K** **Ramp**
**L** **Control cabin**
**M** **Air intakes**
**N** **Life-rafts**



**Fast patrol hovercraft proposal: a 100 ton craft capable of 46 knots with engines totalling 5000 h.p. Possible armament includes Exocet missiles and twin 35 mm Oerlikon gun under Contraves fire control. The skegs with water propellers and rudders follow the same arrangement as in VT1.**

similar in size and configuration to VT1, with the same type of full peripheral skirts, and fixed skegs with water propellers and rudders. More powerful gas turbines, one on each side of the craft as in VT1, bring the total power to about 5000 h.p. This makes possible a top speed of 46 knots.

The hovercraft therefore becomes an attractive alternative to the semi-displacement or planing boat for fast patrol craft duties. The proposed Vosper Thornycroft fast patrol hovercraft would be heavily armed, carrying four Exocet or similar missile launchers as the main anti-ship weapons, and a twin 35-mm Oerlikon for anti-aircraft defence and use against smaller surface vessels. Both weapons would be directed by a modern automatic fire control system.

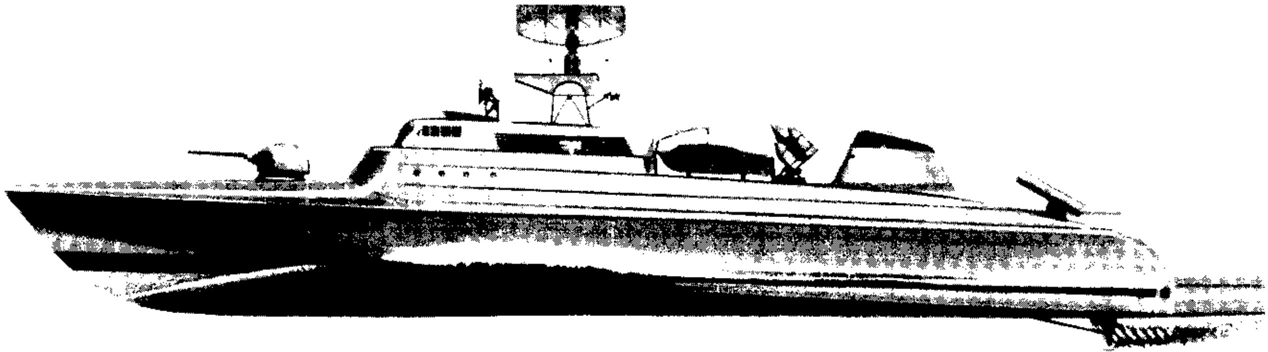
This type of fast patrol hovercraft promises to offer a combination of speed, stability as a weapon platform, powerful armament, and sea-keeping ability, which it would be difficult for a conventional boat to match, unless substantially larger and heavier, and having very much greater installed horsepower for propulsion. The hovercraft proposal has a useful speed margin over any known major warship, and only a few FPBs are as fast. Its armament would make it a serious threat to ships of any size. It seems reasonable to expect that if a requirement called for higher speeds still the necessary means of propulsion could be developed to meet it with a hovercraft of this kind.

It is revealing to look at the installed horsepowers and speeds of three types of Vosper craft of much the same size.

| Craft | Overall length | Loaded weight (approximate) | Installed horsepower | Maximum speed |
|---|---|---|---|---|
| Gas-turbine FPB | 96 ft | 100 tons | 12750 | 57 knots |
| Diesel FPB | 110 ft | 116 tons | 7200 | 32 knots |
| VT1 hovercraft | 96 ft | 86 tons | 3700 | 46 knots |

The diesel patrol boat needs almost twice the hovercraft's power to achieve less than three-quarters of the speed. The gas turbine patrol boat, of highly developed planing hull form, has nearly doubled the diesel boat's power, for substantially less than double the speed. The hovercraft's gain in operating economy will be obvious, and conversely the prospects for developing the craft to extend the speed range upwards from 60 knots without impossibly large horsepowers, are better with the hovercraft than with normal planing hulls. There is, however, still scope for development in planing craft, to larger sizes and higher speeds. The Vosper proposal for a 177-ft planing corvette, powered by Olympus gas turbines to give a speed of 50 knots, and Deltic diesels for cruising at 18 knots, was prepared to meet the same requirement as the Canadian hydrofoil *Bras d'Or*. It would have been substantially

**High speed on a small scale which could be applied to something larger: Cdr. Du Cane's ram-wing trimaran.**



**The Olympus corvette: a Vosper proposal for a 50 knot hard-chine warship 177 feet long.**

cheaper in first cost, although its top speed in smooth water was less. Tank tests suggested that its motion in a seaway would have been less severe than is normally expected of planing craft. This proposal is some years old and some improvement in performance could probably now be obtained.

A recent design by Commander Du Cane for his own use, which might be scaled up for a patrol boat or other fast craft, has a trimaran configuration with the two outer hulls well back and supported on struts which form swept-back wings to generate aerodynamic lift, so helping to reduce the water resistance. These "ram wings" are very efficient because they are near the water surface and benefit from what is called "ground effect". The lift of the wings acts at a point abaft the centre of gravity of the craft, so bringing it down gently and in a horizontal position when it bounces clear of the water, and the sweep-back of the wings prevents the forepart of the craft from lifting, as in the case of a catamaran. The boat, driven by a 120-h.p. Mercury outboard, has reached speeds of over 80 miles per hour (69.5 knots), and performs well in the open Solent. A Mercury power trim, operated by the pilot, alters the angle of thrust so that the trim is always at an optimum for the prevailing conditions and can be adjusted as necessary when fuel is used up.

Apart from radically new craft types, and much greater powers to drive them, what other means of increasing speed might there be? Polymers for injection into the water to reduce skin friction have been studied. Vosper calculate that, in the most favourable case, a speed increase in the order of ten knots could possibly be achieved with a planing fast patrol boat, using these materials, but the quantities needed are so large that for any useful endurance at these higher speeds the extra weight would completely offset the theoretical advantage. For a frigate, the theoretical speed gain using polymers is only about $1\frac{1}{2}$ knots.

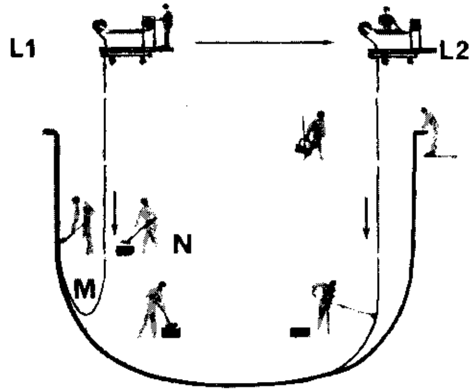
KEY TO ILLUSTRATIONS ON THE OPPOSITE PAGE:

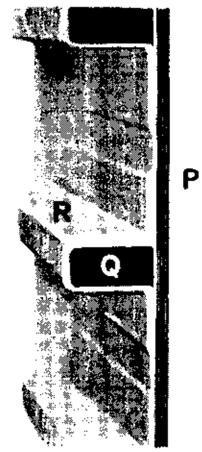
**A** **Steel hull mould**
**B** **Moulded hull shell**
**C** **Temporary protective covering**
**D** **Gantry and lay-up scaffolding**
**E** **Bulkhead being inserted**
**F** **Bulkheads bonded in**
**G** **Deck panel in position**
**H** **Heat control and ventilation units**
**J** **Frames**
**K** **Deck and bulkhead lamination on flat or cambered mould surface**
**L1 and L2** **Glass cloth impregnating and dispensing machine at the beginning and end of the lay up**
**M** **Impregnated cloth being laid in mould**
**N** **Working platforms for laminators**
**P** **Laminate shell**
**Q** **Plastics foam core former for stiffener**
**R** **Stiffening laminate laid over foam core**

Another area which has been much studied is that of the twin- or triple-hulled ship—the catamaran and trimaran configurations applied to larger displacement or semi-displacement vessels. There are theoretical hydrodynamic advantages to be derived from the trimaran in particular; under the right conditions it can have a little less resistance than a conventional ship of the same size. In practice the gains are largely offset by the immense structural problems (and consequent weight increases) of tying three separate hulls together. There is also the fact that such vessels can be overturned; initial stability is very high, which for certain special duties may be the overriding consideration, but the range of stability is limited, giving rise to doubts about ultimate safety. Even some of the theoretical benefits in terms of resistance may well be lost owing to the drag produced when spray thrown up by one hull hits another.

Increasing speeds impose the need for constructional materials and techniques which save weight while maintaining or increasing strength. For fast patrol boats the use of wood has been developed about as far as it can go, and most of the newer and larger craft have steel as the main material. Structural design in steel has itself been progressively refined to the point where the opportunities for further weight savings are few and the benefits likely to be small. Aluminium alloys, already extensively used in superstructures and the natural choice for both hydrofoils and hovercraft, could be used more widely still, but only at considerable cost. Once again it is a question of how far the benefits in potential speed increases can justify a rise in building costs. The marine environment is a severe one and some materials which are attractive in themselves make heavy demands on maintenance when used in ships. Many of the newer materials are too expensive to be used except for relatively small components at key points.

One possibility is the further extension of glass-reinforced plastics to larger vessels than the boats for which it is already widely used. At present this material is being studied more for the benefits it may bring in reducing

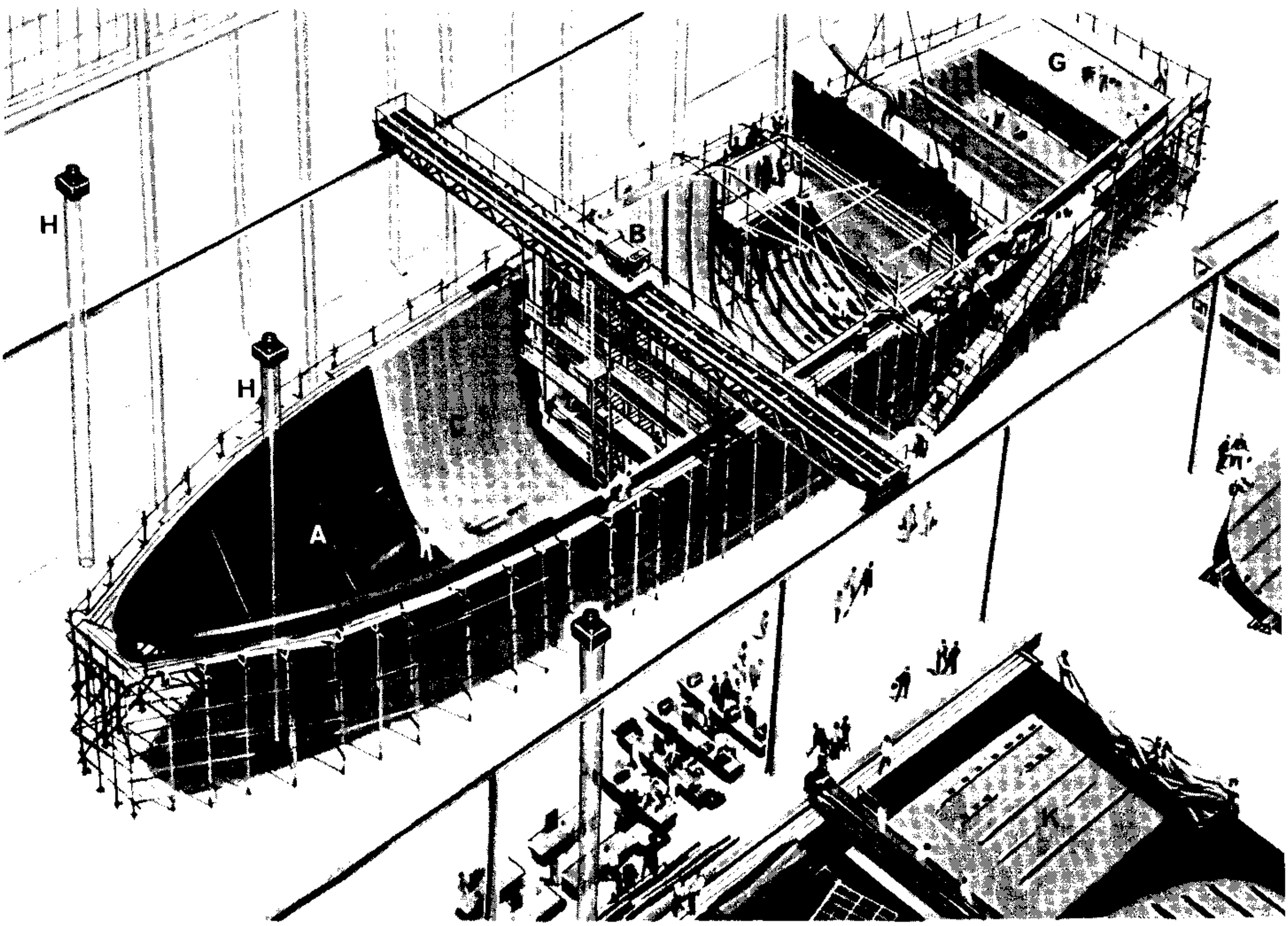



*Left:* **Semi-mechanized lay-up arrangement.**

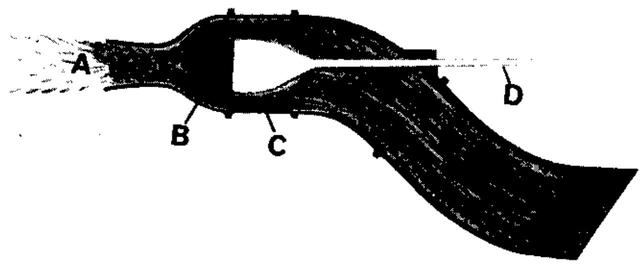
*Immediate left:* **Stiffening frames for the moulded shell and panels are formed over cores of expanded plastics foam.**

*Below:* **Construction of a glass-reinforced plastics minehunter for the Royal Navy. The work proceeds in a continuous sequence.**



**Water jet units lend themselves to installation in the skegs of hovercraft of the Vosper Thornycroft type, as well as in hydrofoils and planing craft. The design of the intake to keep losses to a minimum is important if overall efficiency is to be maintained.**

**A Nozzle**
**B Stator guide vanes**
**C Impeller**
**D Drive shaft**
**E Water intake**




maintenance costs, while having the non-magnetic properties required in mine countermeasures ships, than for any potential savings in weight there may be.

The g.r.p. minehunter being, at the time of writing, built by Vosper Thornycroft, is a vessel of some 450 tons displacement, larger than any other known ship in the material. Her structure is laid up in a steel female mould, using semi-mechanized methods, from woven rovings glass cloth, and a specially developed polyester resin. Decks and bulkheads, and some other parts, are moulded separately and bonded in complete. The foam-core frame technique is used for stiffening both hull and flat panels. This vessel for the Royal Navy is a prototype to prove the suitability of plastics for ships of this size.

While there are real prospects of steadily increasing speeds for relatively small vessels, as development continues in all the relevant branches of technology, major increases in the speed of larger ships, such as frigates, pose more severe difficulties.

Frigates are expected to operate in the open ocean under all weather conditions, which may restrict the use of hovercraft for their kind of duty. The use of hard chine planing hull forms in vessels some 400 ft long would indicate a speed of 60 or 70 knots, and there is scope for further development of conventional round bilge forms for higher speeds than are at present normal in ships of this size. This in itself should not present much difficulty: it is providing enough propulsive power which creates problems for the designers.

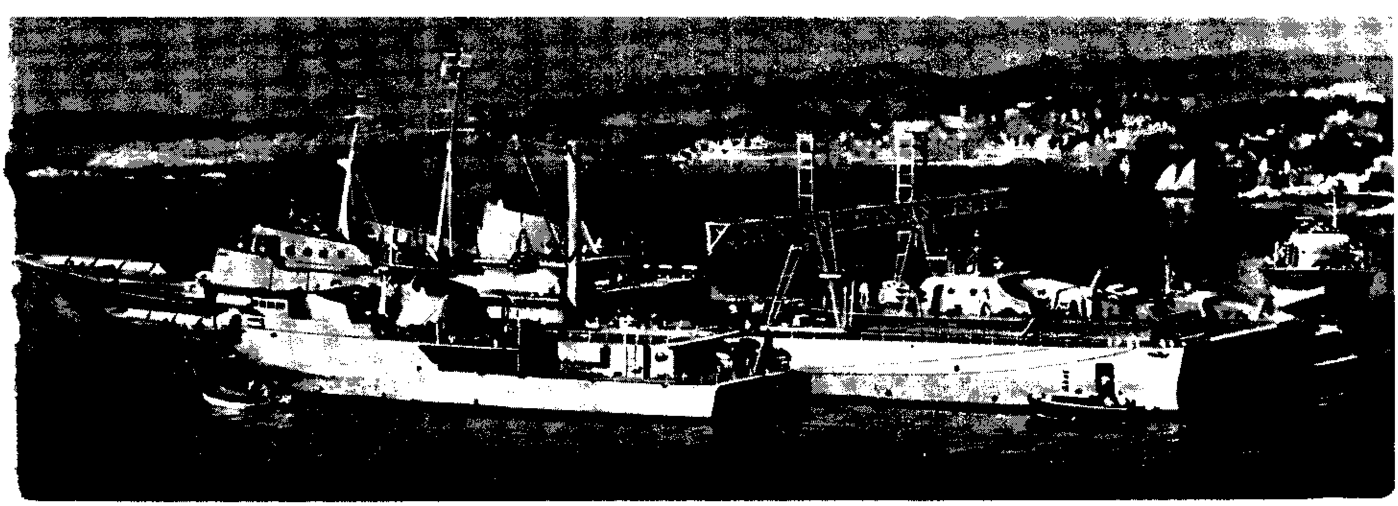
Present gas turbines are likely to be developed to powers of 30,000 b.h.p. or more, but four of them would be needed to drive a 3000-ton ship at 40 knots, and accommodating these engines, their air intakes, exhaust uptakes, and propellers, would pose a number of problems. The alternative of coupling two or more gas turbines to a shaft much increases the complexity of the transmission, and multi-engine installations tend to introduce problems in any case. The present twin-shaft CODOG or COGOG power plants are reasonably simple and are the natural choice for most duties. Much larger gas turbines than are now available are not in prospect, and the cost of developing them purely for marine use is likely to be prohibitive. Existing successful marine gas turbines, derived as they are from aero-engines, have not had to bear the full development cost of such power units.

Unfortunately the development of nuclear power units does not seem likely to provide the high powers needed in a form suitable for ships of modest size, because of the great weights of the reactors, and of the steam turbines associated with them.

If the prospects for much increased powers to drive sizeable ships at higher speeds are few, what of the means of transforming engine power into forward thrust? Fully cavitating propellers can drive vessels whether ships, boats, hovercraft or hydrofoils at speeds up to about 80 knots, at which point the water jet begins to become more attractive. Water jets might also be used to overcome cavitation problems on the propellers, and reduce sensitivity to impact damage. Vosper are studying the possibility of using them in hovercraft.

Although Vosper remain deeply interested in all aspects of speed at sea it is the naval requirements which come first in the minds of their design team. The present trend is for the frigate to become the maid-of-all work for the world's navies, with only a few major naval powers building larger ships. There is also a resurgence of interest in the fast patrol boat, thanks to recent weapon developments. Navies do need faster ships, but, with existing and anticipated

**The Libyan navy's *Zeltin*, with docking facilities for fast patrol boats and a derrick capable of lifting out the main engines of the corvette *Tobruk*, shows on a small scale what can be done to provide a mobile maintenance base for modern warships.**



power plants, speed and size are in opposition. Much as naval authorities would like to be able to develop frigates capable of substantially higher speeds than those of today, they have to devote much of the resources available to weapon systems. The small frigate can be faster, but does have its limitations.

One development which could help in this search for faster frigates is a change of emphasis in the way they are operated. With modern communications and automatic control devices there is no need for ships to carry with them the men, materials and facilities for all aspects of maintenance. This principle has been recognised from the start with aircraft, and with submarines. The nuclear submarine displacing 7000 tons has half the complement of a present-day frigate of under 3000 tons, yet can be away from base for long periods. If the same reliability and techniques of power operation, automatic control, repair by replacement, and planned maintenance by shore staff, can be applied to frigates they can carry smaller crews and, with modern weapons and weapon control systems, be much smaller and faster ships, even with only the knowledge of today. Backed by suitable maintenance and repair ships or bases, and taking advantage of rapid transport of spare parts by air, they can still operate anywhere in the world.

The pace of development in warship design and construction is, perhaps, less spectacular than that in some other defence fields. A new generation of naval weapons is being brought into service while the gas turbine is already the natural first choice of power plants. What navies are now seeking, above all, is cost-effectiveness. There is an increasing awareness that these factors favour a breed of compact, powerfully armed warships, capable of the highest speeds which can be obtained at reasonable cost. Nations are turning away from the purchase of the great powers' superannuated ships, and seeking vessels matched to their own needs. Such ships can only be designed and built by a handful of companies around the world, companies which, like Vosper Thornycroft, have specialized in this type of work for many years, and have built up the necessary resources and technical experience. Technical ability has also to be backed by managerial skills to ensure contracts are carried out profitably and on time.

These diverse problems present a more complex picture than the relatively single-minded seeking of higher sustained speeds at sea with which Vosper were associated in the 1930s. The growth in the company's size means that it is less readily subject to the driving force and vision of one man than it was in the early days. But its technical progress in its chosen field of achieving and putting to practical use high speed at sea stems from this vision, and the readiness to tackle problems which others have thought too difficult. This approach remains an essential ingredient for future progress.

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# Some Vosper craft

## Appendix

At the time when Vosper took on its new character, with the appointment of Cdr. Du Cane in 1931, the yard or job numbers which had been issued for various craft, and probably also engines, boilers, refit jobs and other items, totalled about 1600. They were, as Chapter 1 has indicated, diverse and in many cases small craft. In any case no comprehensive record has survived.

From 1931 there is a complete, or nearly complete, list of craft, although details and precise identification is lacking for some of them. The two tables which follow respectively cover the various Vosper designs built in some numbers in the forty years since then, with the MTBs and similar craft of the Second World War listed separately. It is these vessels with which the Company is most closely associated.

In the same period there were of course a large number of individual craft built wholly or partly to the Company's own designs. Some of the most important being mentioned in the text. In addition Vosper built a substantial number of craft which they did not themselves design, notably over 80 small tugs for the War Department, eight fast patrol boats of the *Gay* and *Dark* classes, five 107-ft inshore minesweepers of the *-ham* class and five 117-ft seaward defence boats. There were also a number of wartime landing craft. It is, however, in the vessels of their own design that the greatest interest lies.

TABLE I Main Vosper designs built in numbers 1931-71 (including some still under construction but excluding the MTBs of the Second World War listed in Table II)

| TYPE | LENGTH | ENGINES | SPEED KNOTS | DATES BUILT | NOS. BUILT | OWNERS | REMARKS |
|---|---|---|---|---|---|---|---|
| Jolly boats | 13 ft | | | 1931-61 | 12 | Various | |
| | 15 ft | | | 1932-35 | 12 | Various | |
| | 16 ft | Vosper/Ford 4/49 | 27 | 1931-39 | 130 | Mainly Admiralty | Known in the Navy as 'skimming dishes' |
| | 18 ft | | | 1932-38 | 8 | Various | |
| Boom patrol boats | 16 ft | Lagonda | | 1944-45 | 17 | Admiralty | For parachuting into fjords |
| Speed launches | 19 ft | | | 1947-56 | 28 | Various | |
| Launches | 20 ft | | | 1947-48 | 5 | Portugal | Aluminium alloy construction |
| Launches or picket boats | 25 ft | 1 Vosper/Ford V8 | 20 | 1935-39 | 96 | Mainly Admiralty | High-speed "Flotilla" type, also used as admiral's barge |
| Fast motor boats | 30 ft | | | 1946-54 | 11 | Admiralty | |
| Picket boats | 35 ft | 2 or 3 Vosper/ Ford V8 | 22 (2 engines) | 1936-44 | 44 | Admiralty | Also used as admiral's barge, etc. |
| Day cruisers | 38 ft | 2 × 140 b.h.p. Gray petrol | 25 | 1949-52 | 4 | Various | |
| Motor barges | 40 ft | | | 1938 | 3 | Admiralty | One also built as Royal Barge for Victoria & Albert |
| Seaplane tenders | 40 ft | 3 Vosper V8 | 24 | 1939 | 3 | Air Ministry | |

| TYPE | LENGTH | ENGINES | SPEED KNOTS | DATES BUILT | NOS. BUILT | OWNERS | REMARKS |
|---|---|---|---|---|---|---|---|
| **Picket boats** | **45 ft** | **4 Vosper/Ford V8** | **23** | **1935-37** | **4** | **Admiralty** | |
| **Refuelling barges** | **45 ft** | **2 Vosper/Ford 4/49** | **10** | **1938-42** | **73** | **Air Ministry** | **Steel boats for pumping fuel into flying boats' tanks** |
| **Crash tenders** | **46 ft** | **2×375 b.h.p. Rover petrol** | **29** | **1952** | **2** | **Air Ministry** | |
| **Motor yachts** | **60 ft** | **2×100 b.h.p. Perkins diesels** | **13** | **1946-59** | **14** | **Various** | **The Vosper Viking design** |
| **High speed launches** | **68 ft** | **2×Rolls Royce Griffon petrol** | **40** | **1953-58** | **16** | **Air Ministry** | **For air-sea rescue duties** |
| **Air-sea rescue launches** | **73 ft** | **2×Thornycroft +2×V8 petrol** | **25** | **1942** | **15** | **Air Ministry** | |
| **Patrol craft** | **78 ft** | **2 Rolls Royce diesels** | **15** | **1967-70** | **8** | **Kuwait** | **Steel construction** |
| **Fast patrol boats** | **96 ft** | **3 Proteus** | **50** | **1960** | **2** | **Admiralty** | *Brave* **class, composite construction** |
| **Fast patrol boats** | **96 ft** | **3 Proteus + 2 GM diesel** | **Up to 57** | **1962-69** | **16** | **Germany, Denmark, Malaysia, Brunei, Libya** | **Modified** *Brave* **type, all wood construction and CODOG machinery arrangement (4 built by Royal Danish Dockyard)** |
| **Fast training boats** | **100 ft** | **2 Proteus & 2 diesel** | **40** | **1970** | **3** | **Royal Navy** | *Scimitar* **class, all wood construction** |
| **Patrol craft** | **100 ft** | **2 Rolls-Royce diesel** | **18** | **1968-69** | **4** | **Libya** | **Steel construction** |
| **Fast patrol boats** | **103 ft** | **2 diesel** | **25** | **1963-71** | **33** | **Malaysia, Trinidad, Kenya, Panama** | **Steel construction** |
| **Fast patrol boats** | **110 ft** | **2 diesel** | **Up to 32** | **1965-71** | **8** | **Peru, Singapore** | **Steel construction; 4 also built in Singapore** |
| **Mk 1 corvettes** | **177 ft** | **2 diesel** | **Up to 20** | **1964 and 1966** | **2** | **Ghana and Libya** | **One also built by Vickers** |
| **Mk 3 corvettes** | **200 ft** | **3 Mtu diesel** | **25** | **1971-72** | **2** | **Nigeria** | |
| **Mk 5 frigates** | **310 ft** | **2×Olympus + 2×Paxman diesel** | **40** | **1967-72** | **2** | **Iran** | **Two also built by Vickers** |
| **Type 21 frigates** | **384 ft** | **2×Olympus + 2×Tyne** | **34** | **1970-74** | **3** | **Royal Navy** | *Amazon* **class: one also built by Yarrow** |
| **Mark 10 frigates** | **425 ft** | **2×Olympus + 4×Mtu diesel** | **30** | **1972-78** | **6** | **Brazil** | **Two of six building in Brazil** |

**Note: Since 1970 a number of g.r.p. Keith Nelson boats of 34, 40, 56 and 60 ft have been built for various customers and duties.**

TABLE II Vosper MTBs and similar craft of the Second World War

| BUILDING NO. | NAME OR NO. | LENGTH | MACHINERY | ARMAMENT | SPEED KNOTS | REMARKS | YEAR |
|---|---|---|---|---|---|---|---|
| 1763 | MTB 102 | 68 ft | 3 Isotta Fraschini 2 V8 | 2 × 21 in torpedoes 2 × quad ·303 in gun turrets | 48 | Private venture MTB, later taken over by Royal Navy | 1937 |
| 1942-1945 | MTB 20, 21, 23 MTB 22 | 70 ft 3 in | 3 Isotta Fraschini 2 V8 | 2 × 21 in torpedoes 2 quad ·303 in gun turrets | 42½ | MTB 20, 21, 23 built for Rumania as *Viforul*, *Viscolul* and *Vigelia*, taken over by Royal Navy | 1939 |
| 2023, 2024 | MTB 29, 30 | 70 ft 3 in | 3 Isotta Fraschini 2 V8 | 2 × 21 in torpedoes 2 × quad ·303 in gun turrets | 42½ | | 1940 |
| 1980 | MTB 103 | 70 ft | 2 × Packard 4M | | | Stepped hull. Finally completed as C/T boat, 05 | 1939 |
| 1983, 1984 | Swedish T3 and T4 MTB's | 60 ft | 2 Isotta Fraschini 2 V8 | 2 × 18 in torpedoes | 42½ | Guns fitted in Sweden | 1939 |
| 1993 | MTB 69 | 70 ft 3 in | 3 Isotta Fraschini 2 V8 | 2 × 21 in torpedoes 2 quad ·303 in gun turrets | 45 | Built for Greece and taken over by Royal Navy | 1939 |
| 1992 | MTB 70 | 70 ft 3 in | 2 Isotta Fraschini 2 V8 | 2 × 21 in torpedoes 2 quad ·303 in gun turrets | 38 | Built for Greece and taken over by Royal Navy | 1939 |
| 2037-2040 | MTB 31-34 | 71 ft | 3 Isotta Fraschini 2 V8 | 2 × 21 in torpedoes 1 twin 0·5 in gun turret 10 depth charges | 42 | 1939 programme | 1940 |
| 2018-2021 | MTB 5 and 6, Royal Norwegian Navy MTB 71, 72 | 60 ft | 2 Isotta Fraschini 2 V8 | 2 × 18 in torpedoes 1 twin ·303 in gun turret 4 depth charges | 39½ | MTB 71 and 72 taken over from Norway by Royal Navy | 1940 |
| 2041-2046 | MTB 35-40 | 71 ft | 3 Hall-Scott 1 V8 | 2 × 21 in torpedoes 1 twin 0·5 in gun turret 10 depth charges | 28 | 1939 programme MTB 33 was destroyed by an explosion in 1940 MTB 37, 39, 40 destroyed by enemy action 1941 | 1940 |
| 2057-2060 | MTB 218-221 | 71 ft | 3 Hall-Scott 1 V8 | 2 × 21 in torpedoes 1 twin 0·5 in gun turret | 28 | Ex Greek order 1939 programme | 1940 |
| 2069-2078 2187-2189 2202 | MTB 57-66 MTB 347-362 | 70 ft | 3 Packard 4M 2 V8 | 2 × 21 in torpedoes 1 twin 0·5 in gun turret 2 depth charges | 38 39·5 | 1939 Extension programme MTB 350, 357, 359 were sub-contracted to Harland & Wolff MTB 351-354 were built at Wivenhoe MTB 360-362 were sub-contracted to Morgan Giles | 1941-43 |

| BUILDING NO. | NAME OR NO. | LENGTH | MACHINERY | ARMAMENT | SPEED KNOTS | REMARKS | YEAR |
|---|---|---|---|---|---|---|---|
| 2079 | MTB 108 | 45 ft | 1 Packard<br>1 V8 | | | Single step design<br>Destroyed by enemy action and not replaced | 1941 |
| 2080 | ML 149 | 112 ft | 2 Hall-Scott | 1 × 3 pounder gun<br>2 × ·303 in guns<br>1 Holman projector<br>12 depth charges and depth charge Y gun | 20 | Fairmile B | 1940 |
| 2081-2106 | MTB 73-98 | 70 ft | 3 Packard<br>2 Ford V8 | 2 × 21 in torpedoes<br>1 twin 0·5 in gun<br>4 depth charges | 39 | 1940 programme<br>MTB 74 modified for St. Nazaire Raid<br>MTB 78-81 built at Wivenhoe<br>MTB 86, 95 and 98 built at Morgan Giles Ltd<br>MTB 87-92 built at Harland & Wolff<br>MTB 93-94 built at Berthon Boat Co | 1941 |
| 2115-2124 | MTB 222-231 | 70 ft | 3 Packard<br>2 V8 | 2 × 21 in torpedoes<br>1 twin 0·5 in gun<br>2 depth charges | 39 | 1940 programme<br>MTB 222-228 built by Hugh Maclean<br>MTB 229-231 built by McGruer Ltd | 1941 |
| 2153-2156 | MTB 242-245 | 70 ft | 3 Packard<br>2 V8 | 2 × 21 in torpedoes<br>1 twin 0·5 in gun<br>2 depth charges | 39 | Replacements for MTBs 33, 37, 39 and 40 | 1942 |
| 2157-2166 | MTB 232-239 | 70 ft | 3 Packard<br>2 V8 | 2 × 21 in torpedoes<br>1 twin 0·5 in gun<br>2 depth charges | 39 | MTB 232-235 built by Berthon Boat Co<br>MTB 236-239 built by Camper & Nicholsons Ltd<br>MTB 240-241 built by Morgan Giles | 1942 |
| 2225, 2239-2254 | MTB 379-395 | 73 ft | 3 Packard<br>1 V8 | 4 × 18 in torpedoes<br>1 twin 20 mm gun<br>2 twin ·303 in guns<br>2 rocket projector | 35 | 1943 programme<br>MTBs 291-395 built at Wivenhoe | 1943-1944 |
| 2186 | MTB 510 | 100½ ft | 4 Packard | 2 × 18 in torpedoes<br>1 6 pounder gun<br>1 twin 20 mm gun<br>2 twin 0·5 in guns<br>1 Holman projector<br>2 depth charges | 36 | Experimental<br>Never went into service | 1943 |
| 2285-2292<br>2294-2298 | MTB 523-530<br>MTB 532-536 | 73 ft | 3 Packard<br>1 V8 | 2 × 18 in torpedoes<br>1 6 pounder gun<br>1 twin 20 mm gun<br>2 twin ·303 in guns<br>1 rocket flare launcher | 36 | 1944 programme<br>MTB 532, 533 built at Wivenhoe<br>MTB 534, 535, 536 cancelled | 1944 |
| 2293 & 2299 | C/L 44 and 45 | 73 ft | 3 Packard<br>1 V8 | | | Ex MTBs 531 and 537 | 1944 |
| 2300 | MGB 538 | 74 ft | 3 Packard | | 42 | Later MTB 1601 | |

# Index