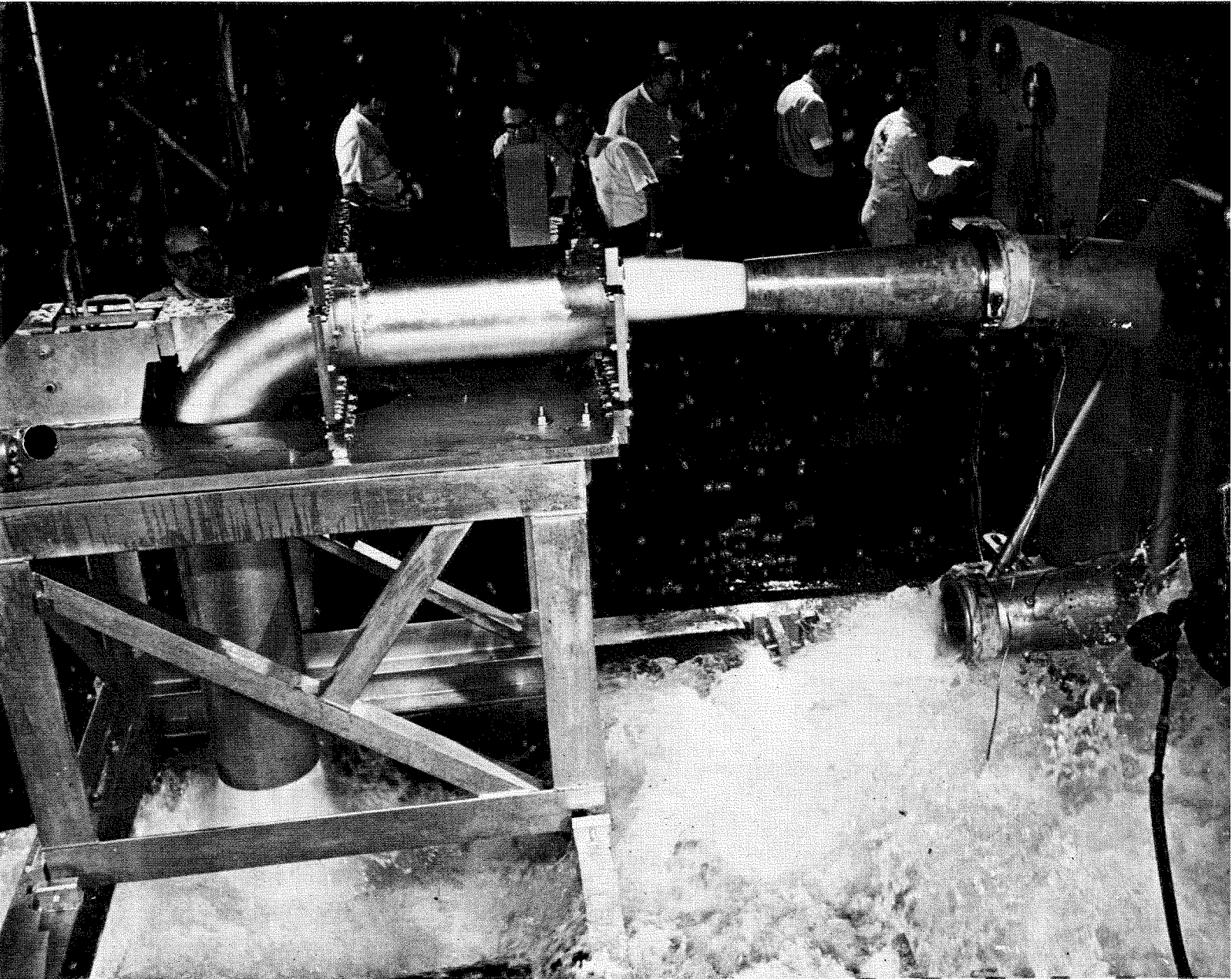


HOVERING CRAFT & HYDROFOIL

THE INTERNATIONAL REVIEW OF AIR CUSHION VEHICLES AND HYDROFOILS



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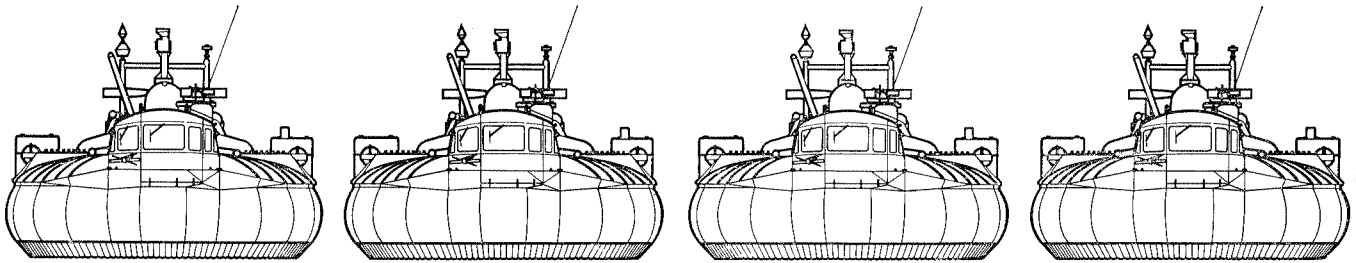
Volume 6 Number 8

MAY 1967



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BHC hovercraft have now joined the forces – as regulars enlisted for active service, at home and abroad, with the Royal Corps of Transport Hovercraft Squadron. This vital decision by the British Government to purchase BHC SR.N6's for the world's first fully-operational hovercraft squadron, marks the full establishment of hovercraft as front-line vehicles with a vital role in military operations and will undoubtedly influence defence planning throughout the world.

BHC hovercraft lead the world. Incorporating systems and components proven in over 20,000 hours of operation all over the world, the 10-ton SR.N6 carries 30 fully-equipped troops or over 3 tons of freight, and is able to mount the latest weapons systems. It cruises at 56 knots and is unrestricted by reefs, sandbanks, underwater defences, ice, tide state or shallows, giving military forces a freedom and speed of movement by day or night far in advance of anything feasible for conventional craft.

BHC hovercraft are the only hovercraft that have been used on military operations – both by British Defence Forces and by the U.S. Navy. They have proved themselves in extremes of climatic conditions, from tropical jungles and deserts to the frozen arctic – from Sweden to Sarawak, from Thailand to the far north of Canada. BHC strength is further emphasised by the recent Government decision to order both the fast attack and the logistic amphibious versions of the larger 40-ton BH.7. The 10-ton SR.N6 is in full production with the 40-ton BH.7 to follow shortly.

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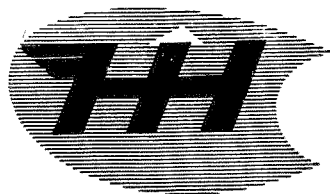
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HOVERING CRAFT & HYDROFOIL

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MAY 1967

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JUANITA KALERGHI

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INTERNATIONAL HOVERCRAFT RALLY

THE HOVERCLUB OF GREAT BRITAIN together with John Player & Sons are the organisers of this year's International Hovercraft Rally. The meeting is also sponsored by the *Daily Express*; it will take place on June 3rd at Apethorpe, near Peterborough.

There are three trophies for competition in the main events and also one for model hovercraft.

The **Lord Brassey Challenge Trophy** will go to the "man and machine" combination that gains the highest marks.

Encouragement to amateurs in this new sport is given by the **Player's No 6 Trophy** to be presented for the craft which leads in performance, general design and appearance.

The fastest craft over both land and water will win the "**Daily Express**" Trophy.

Model craft builders are given a 15 ft radius tethered circuit and also a radio-controlled course. The "**Peterborough Evening News**" Challenge Trophy goes to the one entry with the highest points.

The main hovercraft obstacle course on land is about 550 yards in length and lies alongside the water course in the lake, which was the scene last year of a number of mishaps. The water course is about 250 yards in length, entry and exit being adjacent.

The varied land obstacles consist of a ditch, "corrugations", slalom, ramp with 1 in 10 slopes, random mounds and hollows. Safety is covered by a rescue boat and double fences 6 ft apart to protect the spectators. Adequate guarding of propellers in the craft, and in some cases fans, will be mandatory.

The rally takes place in conjunction with the Apethorpe Village Festival.

Player's No 6 Hover Award is separate from the rally, but is announced in advance of the events for autumn. The presentations will be made in London in April 1968.

The award is divided into three categories:

1. **Design and Application** for individuals in a private capacity who are successful in advancing hovercraft design or technology. The value of the award in this section is £3,000; entries must be submitted to the Hoverclub of Great Britain by October 31st, 1967, or earlier if possible.

2. **Achievement.** A general award open to all, including industry, of cash to the value of £1,000 and a Perpetual Trophy. Recommendations should be submitted to the Hoverclub of Great Britain by October 31st, 1967.

3. **Concours d'Elegance.** Open to inter-club competition, branches of the Hoverclub of Great Britain or affiliated clubs are eligible; it will be for a craft built by a club or a group in a club, entered and completing the course in the annual National Rally. A Perpetual Trophy and £1,000 cash is the prize; the cash has to be spent on furthering the development of the winning club.

The National Rally will be held in September 1967 and entries must be with the Hoverclub by August 31st, 1967.

News is also given of regional rallies, the first of which is in the Isle of Wight on June 24th, 1967, and the other at Sutton in Ashfield, Nottinghamshire, on August 12th and 13th.

Additional opportunities to see the Player's No 6 Prototype will be given on the following dates at the places mentioned:

May 27th, Shropshire Aero Club Open Day, Sleaford Aerodrome.

(Continued on page 30)

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COVER PICTURE: The water-jet propulsion pump for United States Navy's new hydrofoil gunboat undergoes thrust test. The aluminium pump is at the right. In the centre of the photo can be seen the jet of water being pumped. Each of the pump's two sections spews 60 tons of water a minute. At left, piping bends the stream of water into an open tank. The pump was built for the Boeing Company by the Byron Jackson Division of the Borg-Warner Corporation, and the test took place at Byron Jackson's hydraulic laboratory in Los Angeles, California. (For further details see page 10.)

The Hovercraft Pioneers

by

Bryan Cooper

The first two Hover-commanders to be profiled in this series, Leslie Colquhoun and Peter Lamb, both began their careers in the industry as test pilots with the two major manufacturing companies. Peter Ayles, the third of the pioneers in developing techniques to pilot hovercraft, was with the first of the smaller organisations to join the "hovercraft club" — Britten-Norman Ltd on the Isle of Wight. Although he was responsible for much of the testing of the Britten-Norman "Cushioncraft", as a former commercial air-pilot he has spent more time on the operation side of the business. He is now a director of Hoverwork Ltd, and it was under his guidance that the world's first Hovercraft Training School was started last year which offers courses not only to individuals sponsored by operators and the armed forces, but to members of the public as well.

THE businessman from Alaska was keenly interested in the possibilities of hovercraft. But he decided he should know how to drive one first. The problem was, where can one learn? After making inquiries, he found that a Hovercraft Training School had been established at Ryde last summer by Hoverwork Ltd, under the direction of Peter Ayles. He enrolled as a trainee, and after a course of lectures and instructional films, as well as ten hours' instruction at the controls of an SR.N6 at £50 an hour, he became the first member of the general public to learn to pilot a hovercraft.

"Mind you," says Peter Ayles, "most of the people we get are sponsored by companies and other organisations. We have just finished our first course for the Army."

Six serving officers took part in the six-week course, during which time each one received twenty-five hours' piloting instruction in the SR.N6. Ayles, who has now been appointed an approved hovercraft instructor and examiner by the British Hovercraft Corporation, finds that the average pupil can go solo after about twelve hours. The certificates he gives are similar to those for pilots who qualify under the BHC's own training scheme.

During the three years in which Ayles and his team of Hover-commanders have been operating the Hovertravel service on the Solent between Ryde, Southsea and Gosport, they have made over 25,000 four-mile crossings and carried some 480,000 passengers without incident. Ayles alone has over 5,000 commercial operating hours to his credit.

Born in London on May 22nd, 1919, Peter Ayles began his career as an apprentice to Lagonda Motors in 1937. He always wanted to fly, but at the outbreak of war he was unable to join the Auxiliary Air Force and served in the Army instead, reaching the rank of major in the Royal Hampshire Regiment. He was mentioned in dispatches during the North African campaign, and also saw service in Italy, Greece and the Middle East.

On leaving the Army, he spent his gratuity on learning to fly at his own expense, and so fulfilled a long ambition. He took his licence at the Herts and Essex Aero Club at

Broxbourne, and stayed on at the club to become an assistant instructor himself. The club later moved to Stapleford Tawney in Essex, and from 1948 to 1958 Ayles was the chief flying instructor. He left to become a freelance pilot for two years, and then in 1960 he joined the firm of Britten-Norman. As chief pilot he flew several crop-spraying missions in the Sudan. It was after his return from one of these missions in 1962 that he found his firm had entered the hovercraft business. John Britten had designed and built the CC-2 "Cushioncraft", and he let Ayles have a trial run in it. From that time on, Ayles was a devoted hovercraft enthusiast. Early in 1963 he took over responsibility for all the testing of the CC-2, and when, a year later, Britten-Norman went into partnership with Westland and P. & A. Campbell for the SR.N2 Solent service, Ayles was seconded to the Westland team of Peter Lamb and Harry Phillips to be checked out as an SR.N2 pilot.

"It was a beautiful craft to pilot," Ayles recalls, "the best I had ever sat in. The biggest difference I found was in having to think further ahead, because it was heavier and one's calculations had to be extended. Also, one had to remember to be careful about the approach speeds."

As he puts it, Ayles was "the first person outside the works to be let loose on a big hovercraft". In mid-summer the SR.N5 came on the scene, and Ayles also did much of the piloting of this. Then came another spell of flying conventional aircraft in the Sudan. By the time he returned to the UK at the end of 1964, he had decided that he wanted to fly hovercraft full-time, and seized the offer to do so when it came along, joining Hovertravel as chief Hover-commander. By now the first SR.N6s were appearing, and he did a certain amount of test-flying on this craft, under the jurisdiction of the works. He watched Hovertravel's own SR.N6 being built, and actually accepted it from Westland on behalf of the company. When it came into service on the Solent in June 1965, Ayles began to train other pilots for the ten-hours-a-day, year-round service. The first of these was Tony Smith, just out of the Royal Air Force, and who, like Ayles, lived on the Isle of



Peter Ayles

Wight. Then came others, until now a six-man team of Hover-commanders has been built up. Not all are former aircraft pilots. To keep a balance, mariners were recruited as well, and one was a former captain with Blue Funnel steamers.

It was from training these pilots that the idea arose of extending the courses to include pilots who were increasingly in demand from the military and industry. When in June last year Hoverwork was formed as a subsidiary of Hovertravel, one purpose of the new company was to undertake the chartering of hovercraft and the other was to train engineers and pilots. And when the Hovercraft Training School was started, it was decided that, where possible, it should be open to all comers.

Peter Ayles has found that in training new Hover-commanders his experiences have been similar to those of his two fellow pioneers in this field. "You've got to be careful the trainees don't try to run before they can walk," he says. "The commonest mistake they make is in underestimating the space needed for travel in a hovercraft. It is important to have good judgment of water speed and drift."

As a director of Hoverwork, Ayles has been given responsibility for operating the hovercraft service for Expo 67 in Canada. He left the UK in April, together with two other Hover-commanders in his team, to pilot the two SR.N6s which are being used in Montreal.

Living close to the Britten-Norman airfield at Bembridge on the Isle of Wight, Ayles still enjoys an occasional flight in a conventional aeroplane and has kept his commercial pilot's licence up to date. But, like so many of his colleagues who were also pilots before, he finds that piloting hovercraft offers more personal satisfaction and interest.

LEOPOLDO RODRIQUEZ
SHIPYARD
MESSINA - ITALY

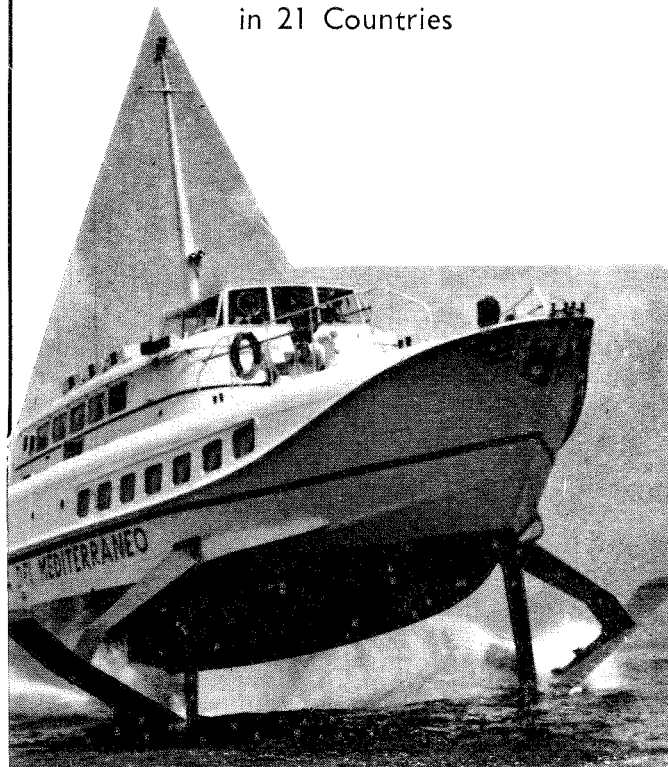


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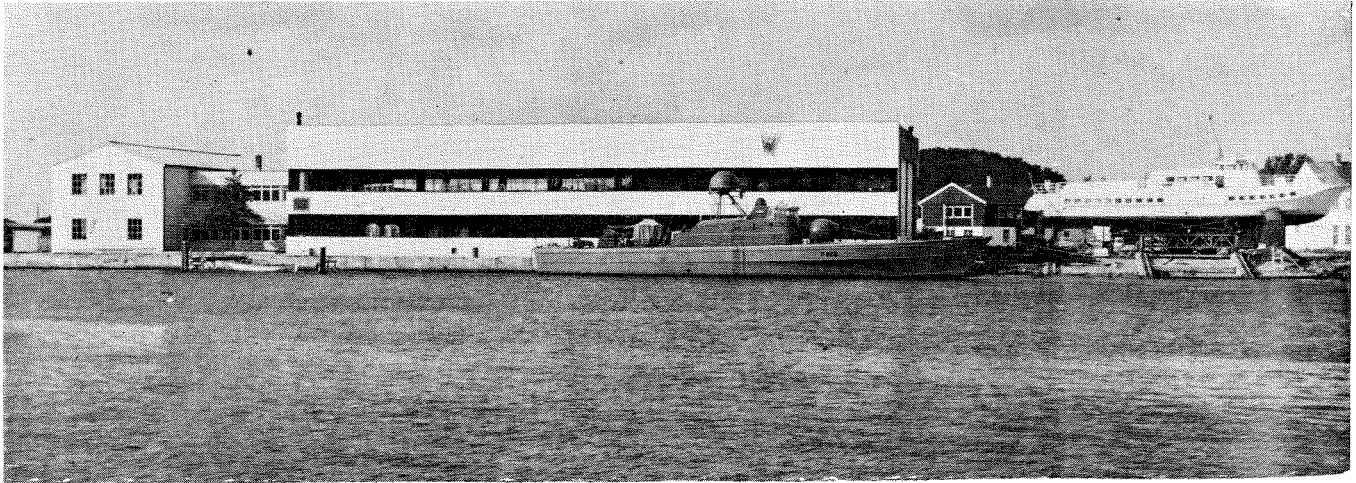
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A/S WESTERMOEN HYDROFOIL

Haakon Martinsen
 Managing Director
 Den Norske Creditbank
 Mandal

Last autumn, the newspapers and Norwegian radio announced that the largest hydrofoil in the world was to be built at Westermoen Hydrofoil A/S. The name seemed well known to us, so we pursued the old motto of our bank: "Let us drop in there to become more acquainted".

If anybody should find it sensational that a shipyard makes big business in Mandal, we can mention that this most southern town of Norway, by using initiative and courage to press forward, has become one of the largest industrial towns in Norway according to the number of its inhabitants, and this is, I think, something to note. Well, we called on Westermoen Hydrofoil A/S.

Such an enterprise usually has a long history. But this yard is only seven years old. Its history belongs to its Manager, who is the initiator and dynamo behind the enterprise. The name is Toralf Westermoen — inherited boatbuilder, an active personality on religious organisations, local politician, member of countless committees and boards, and, among other things, a member of the well-known "Pancake Club" of Mandal — a "lunch pause club" — where some of the men of the town meet each other — if possible every day — and do anything else but eat pancakes.

Toralf Westermoen came to Mandal in 1930, at the age of sixteen, from Landvik at Grimstad. After six months of work at one of the small shipyards in this town he earned as much as a skilled worker. His father had been a good teacher. Five years later he went to Fredrikstad and started building sailing boats under the supervision of the world known boat builder, Mr Bjarne Aas.

In 1941, during the difficult years of the war, the young Westermoen returned to Mandal and, together with his brother, founded Brothers Westermoen Batbyggeri. They used a couple of old buildings which lay where the bus station of Mandal is situated today. Here for some years they produced rowing boats and fishing boats (the fishermen were the only ones who were allowed to buy engines during the war).

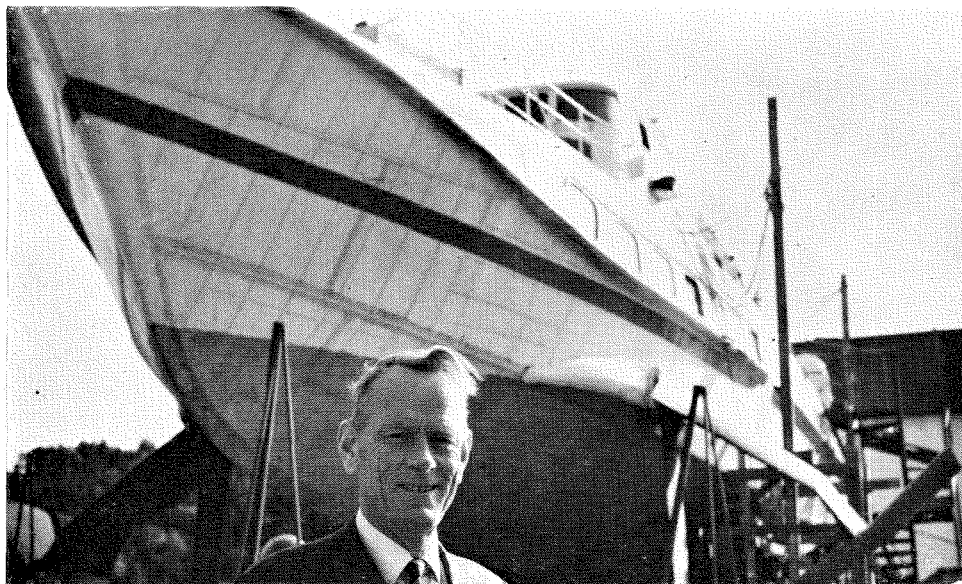
In 1948 the brothers separated, and Toralf bought a hangar, built by the Germans, situated at Vestnes in Mandal. Together with the shipowner, Mr Torrey Mosvold, he founded a company named Westermoen Batbyggeri & Mekaniske Verksted A/S. The base of the hangar was on 5,000 square metres, and gave the opportunity for a large increase in the boat building. In 1948 the number of workers was twenty-five, and in 1961, 260. They produced rowing boats, fishing boats, sailing- and motor yachts for home and abroad. But first and foremost the yard started the production of the Norwegian constructed MTB for the Norwegian Navy, later the famous Nasty Motor Torpedo Boats and Minesweepers. At the same time they were building coastal vessels in steel, and one type especially, the so-called "299-tonnere" became very popular.

In 1956 Mr Mosvold left the company as shareholder, and other interested persons joined it. The yard obtained the licence for the building of Supramar hydrofoil boats. In 1961 Mr Toralf Westermoen left his company, and took over the hydrofoil licence.

Together with the shipowner, Mr Kr Haanes, Westermoen founded Westermoen Hydrofoil A/S. They bought the shipyard in which Toralf, at sixteen years old, had started to work in Mandal, and the plans of the new plant were put forward. Today Westermoen Hydrofoil A/S has become a very beautiful factory situated at the mouth of the Mandal river, near the beach "Sjösanden". Visitors have asked for a taxi to "the hotel at Sjösanden", and taxi drivers have had to answer that there was no hotel there, but a hydrofoil shipyard.

The keel of the first hydrofoil boat was laid without having a buyer. Mr Westermoen himself acts as "travelling salesman", and one and all are charmed by his natural and convincing personality. The first hydrofoil boat was sold to a shipping company in the Bahamas.

All work is executed indoors. The yard has at present a contract for six gunboats for the Norwegian Navy. The boats will be delivered before the end of October 1967. Three have already been delivered.



The yard is negotiating with several countries for building hydrofoils, and Westermoen is convinced that such boats will be more and more common in the future, and will be able to cover much greater distances.

The previously mentioned hydrofoil, PT-150, which is being built, will carry 250 passengers or 150 passengers and eight cars. It will be delivered in June 1968. The company has plans for hydrofoils of about 350 tons, but drawings and calculations will not be ready for two or three years.

We went into the building hall, and were met with a

terrible noise from the welding apparatus and the riveting hammers. It was impossible to make normal conversation, so we went along the boats, contemplating, admiring, smiling and nodding.

When the vessels are ready, they are led through large gates in the eastern end of the hall, on large slip cradles, to the river bank where they are launched. The company has today 150 employees, and the working conditions seem very good. The men follow the development of work in their yard with special interest.

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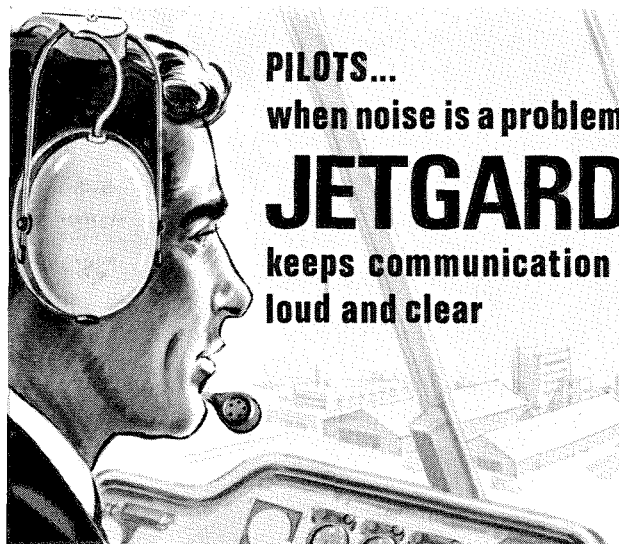
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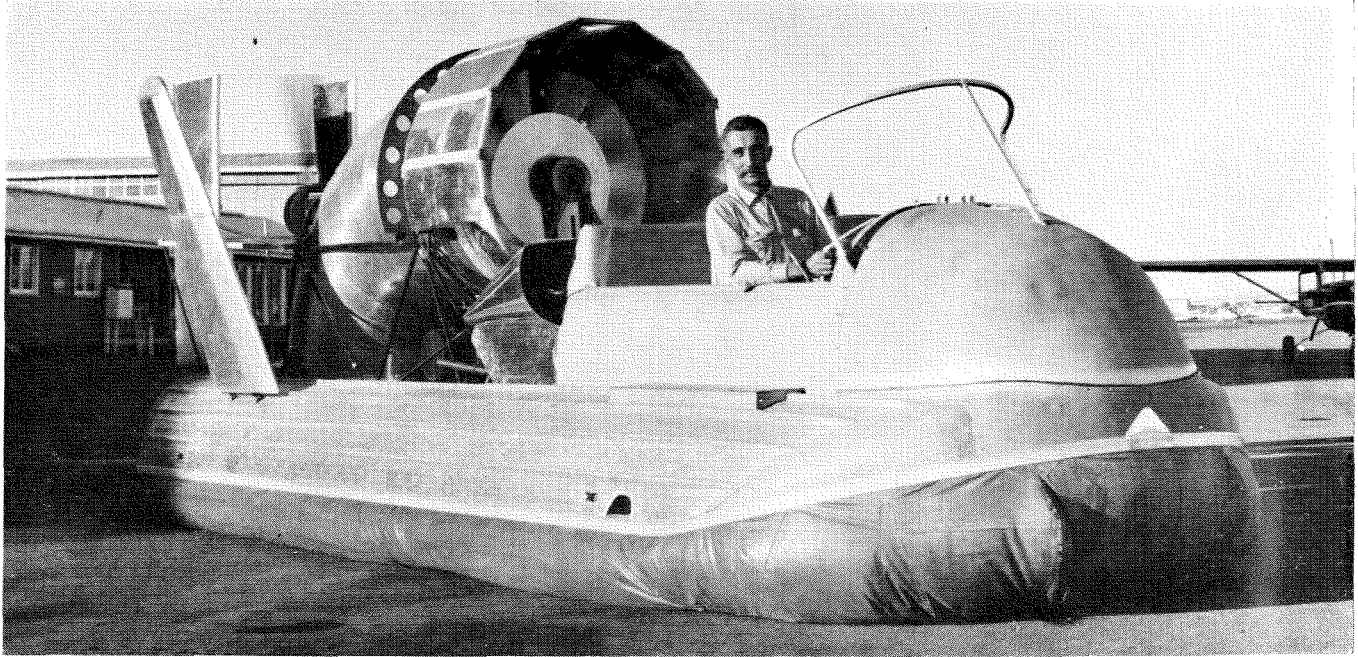
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Designer Mr Geoffrey Green demonstrates his Gemcraft air cushion vehicle on the tarmac at Parafield Airport, Adelaide (see below)
(Australian News and Information Bureau Photograph)

People and Projects

An aeronautical expert in Australia has designed an air-cushion craft which he claims is the only one of its size in the world to use one engine for both cushion and propulsion. He is **Mr Geoffrey Green**, forty-six, a Technical Officer in the wind tunnel section of the Weapons Range Establishment at Salisbury, South Australia.

"There are air-cushion craft driven by twin and triple engines, but as far as my machine is concerned, it is unique", he said.

Named the Gemcraft, the vehicle is 21 ft long and weighs 1,000 lb. It is powered by a standard Volkswagen industrial engine developing 45 hp. The vehicle is made of non-corrosive aluminium and designed to carry four people. In tests it has carried nine people weighing 1,700 lb.

The machine uses super-grade petrol, similar to that used in ordinary cars, gives about 20 miles to the gallon and in trials travelled at 35 mph.

Mr Green said the tests showed the air-cushion craft had a definite potential for commercial production.

Mr Graham Treloar, Managing Director of Ross Aviation Facilities, which backed and built Mr Green's machine at Parafield Airport, said a similar model to the prototype could be built for \$10,000.

Mr Green became interested in air-cushion craft about five years ago and designed several working models before starting on the full-scale prototype in 1965. The Gemcraft took six months to complete.

Born in Essex, Mr Green has been in the aircraft industry for more than thirty years. He worked for the Fairey Aviation Co and the Royal Aircraft Establishment at Farnborough before migrating to Australia sixteen years ago.

Soon after arriving he took up his job as a wind tunnel technician. He has helped design wind tunnels for supersonic research missiles and for Australia's latest Mirage fighter planes.

Mr Green said the Gemcraft could be quickly converted into a two-seat transport vehicle with a load capacity of $\frac{1}{2}$ ton. Alternatively it could be fitted to carry two stretcher cases. An added advantage was that the craft could be placed on a trailer without dismantling and did not contravene wide-load laws.

Mr Green said the Gemcraft offered a great potential to the Armed Services as a liaison vehicle or for light ambulance duties. He was hoping to get the Australian Armed Services interested in it as a suitable vehicle for providing basic training for future air-cushion craft pilots. The Gemcraft could be best used in marshy country, such as Vietnam, where other vehicles could not travel.

★ ★ ★

George Galitzine has joined Sperry Gyroscope as the Division's Director of Marketing. Born in Russia in 1916, his family emigrated after the revolution and became naturalised British subjects. George Galitzine was educated at Lancing and St. Paul's, and obtained an Honours Degree (BA) at Oxford University. He served in the Welsh Guards throughout the Second World War, is a member of the Institute of Directors, and speaks Russian, French, Italian, German and Spanish.

★ ★ ★



Seen on the Hovermarine Ltd stand at the recent International Sea Transport Exhibition in Gothenburg, Sweden, are (left to right) Mr Stig Axelson, Director of the Port of Gothenburg, Viscount Simon, CMG, and Mr R. L. Trillo, chief development engineer, Hovermarine. Object of interest is a model of the 60 seater HM.2 hovercraft.

A fast **fire-fighting and rescue hovercraft** has been developed by Hovermarine Ltd in conjunction with Merryweather & Sons Ltd. A full specification has been submitted to the London Fire Brigade, who have been considering the use of hover fireboats on the River Thames, and other potential users are expressing interest in this new concept of fire-fighting.

Hovermarine was recently granted a licence by Hovercraft Development Ltd (the NRDC subsidiary) to develop, build and market rigid sidewall type hovercraft. Low cost is ensured by Hovermarine's policy of adapting its range of standard hull construction to a variety of roles, of which the fire-fighting craft is one. It is, in fact, based on the HM.2 sixty-seater passenger hovercraft, the first two of which are being built by Halmatic Ltd.

The Hovermarine-Merryweather hovercraft will have a service speed of 35 knots in calm water. When connected to the craft's Cummins diesel engines, the two Merryweather MM2-8 pumps can deliver 2,000 gal per minute, each at 100 lb/sq in. Higher pressures are available for foam generating duties. By means of fluid drives, the propellers can be used at the same time to maintain the craft in position against the thrust of the monitors. The largest monitor can deliver a foam/water mixture, and approximately 300 gal of concentrated foam compound are carried on board. A dry powder unit can be fitted if the foam capacity is reduced.

The craft is fitted for casualty evacuation and a casualty station and dispensary are provided just behind the wheelhouse. Two six-man inflatable liferafts are stored in waterproof containers on the fore deck, and a two-man inflatable rubber boat can be supplied as well as the liferafts. Supplementary fire-fighting/rescue equipment on board includes six sets of breathing apparatus, four sets of protective clothing, a suction lift fitting for salvage work, and a portable R/T set.

The wheelhouse — with radar, compass, echo sounder, log and radio set — has a complete all-round view. The fire-fighting deck is amidships and extends the whole width of the craft at deck level. The casualty station and engine room canopies give it some protection from the weather without interfering with the operation of the monitors, fore and aft. The monitors and hose connection boxes are sited for easy working, and access to the hose-room beneath is through hatches on each side of the deck.

Particular attention has been paid in siting the machinery to provide easy access for maintenance and inspection. The pump intake strainer boxes can be cleared from inside the engine-room, and also situated there are the control valves for the fire-fighting water main. Otherwise, the engines are remotely controlled from the wheelhouse and it is only necessary to man the engine-room during fire-fighting operations.

★ ★ ★

The basic Hovermarine hull structure is of glass reinforced plastics, giving robust construction, relatively low initial cost, minimum maintenance, and ease of repair in case of damage. All internal grp surfaces are treated with fire-retardant paint.

Hovermarine Ltd and Merryweather Ltd claim that compared with existing fire tenders, their hovercraft offers the advantages of much higher speed, a smoother "ride" in all sea conditions, and shallower draught. And due to the inherent stability of the hull shape, it provides a more stable platform for fire-fighting than a conventional tender of similar size.

★ ★ ★

Designed and developed by **United Aircraft of Canada**, the ST6, a 550 shp turbine engine weighing only 275 lb will serve as an auxiliary in the Royal Canadian Navy's hydro-foil programme.

The ST6, which can burn anything from jet fuels to diesel oils and natural gas, was conceived for aircraft but has proved to be capable of a wide range of industrial uses.

It has been used in crop-dusting aircraft in the Sudan, charter flight operations in Nepal, Laos and Alaska, and executive flight operations in Kuwait. It is propelling a snowplough for the British Columbia Department of Highways, through the Rocky Mountains, and has provided power for a portable belt-driven woodchipper which reduces complete tree trunks into chips for paper-making. In this application, exhaust heat from the engine is used to help dry the chips. Four of the engines have been rigged together into the world's most powerful oil well fracturing unit.

★ ★ ★

Channel Islands Hover Transport Ltd has been registered as a company, and has applied to the States of Jersey to construct a hoverport suitable for craft up to the size of the BH.7.

The company has been in touch with SEDAM and the French authorities at Cranville and Cherbourg concerning the construction of a hoverport on the Normandy coast. Cherbourg has offered Port de Dielette which is equidistant from Jersey and Guernsey, but is, in the opinion of the directors, too exposed. They would prefer Havre de St Gerinarn a large estuary surrounded by sand dunes fifteen miles from Gorey (on the East coast of Jersey).

It is hoped eventually to carry around 10,000 vehicles and 100,000 people between Jersey and France each season, and to run a reduced service during the winter.

The directors of the company are as follows: The Hon T. L. E. Lowther, a Director of Lowther Marine Services Ltd, Jersey, a Master Mariner and Member of the British Computer Society; Monsieur B. De St Denis of Caen, who runs the present passenger service from Cateret to Jersey; Mr P. G. Baker, an officer in the Parachute Regiment during the war, and now President of the Jersey Chamber of Commerce (the oldest Chamber of Commerce in Britain); Commander Peter Clayton, RN, AMIMEchE, AFRAeS, previously on the staff of RAE Farnborough.

The Hon T. L. E. Lowther retired from the Royal Navy in 1953 and subsequently took part in the hydrographic survey of Lake Nyasa, and Operation Noah, on Lake Kariba. He builds fibre-glass catamarans in Jersey.

Both Commander Clayton, who served in the Fleet Air Arm during the war, and Mr Baker are keen yachtsmen.

★ ★ ★

Developing 24,000 lb of thrust, the world's largest water jet propulsion pump was tested successfully for The Boeing Company by the pump builders, the Byron Jackson division of the **Borg-Warner Corporation**.

Spewing up to 120 ton of water a minute, the high-performance pump will power the US Navy's 71-ft hydrofoil gunboat Tucumcari which is under construction at Boeing facilities in Seattle, Wash.

In operation the pump will suck up water through the gunboat's aft foil struts and jet it out under the boat's stern, propelling the new craft at speeds of more than 40 knots.

Water jet propulsion produces the same type of thrust as a jet engine. In fact the thrust rating of the pump tested at Byron Jackson's hydraulic laboratory in Los Angeles, Calif, is comparable to the 18,000-lb thrust produced by the largest jet engine in commercial airline service.

In the gunboat the lightweight aluminium pump will be driven by a Bristol-Siddeley Proteus gas turbine engine which has a maximum rating of more than 4,000 shp.

The pump is in two sections with one rotor mounting two impellers. Each section has two water inlets and a single-thrust nozzle.

The pump now has completed two series of tests. One was a test of general pump performance. The final run just completed was a test of the pump thrust rating.

The pump will be delivered to Seattle for installation in April. The gunboat is scheduled for launching in mid-summer.

In designing the gunboat, Boeing engineers selected water jet propulsion over the conventional marine propeller because of its simplicity. The water jet propulsion system eliminates the complex shafting, gearing and lubrication required to drive a propeller submerged far under a boat at the end of a foil strut.

★ ★ ★

The Defence Ministry is seeking Treasury Board funds to continue development of the 200 ton **FHE-400 ASW hydrofoil** at de Havilland Company's Marine Industries Ltd's yard in Sorel, Quebec. Launching is planned for mid-1968 and completion by mid-1970 after contractor's sea trials, weapon systems installation and systems evaluation. Some \$15 m will be required to repair the \$32 m fire damage suffered in Sorel and complete the project, bringing the total cost to around \$40 m against the original estimate of \$21 m.

The FHE-400 will have a crew of twenty and a speed up to 60 knots, and will be armed with homing torpedoes. Canadian Westinghouse is designing and building the navigation, detection, communications and armament systems.

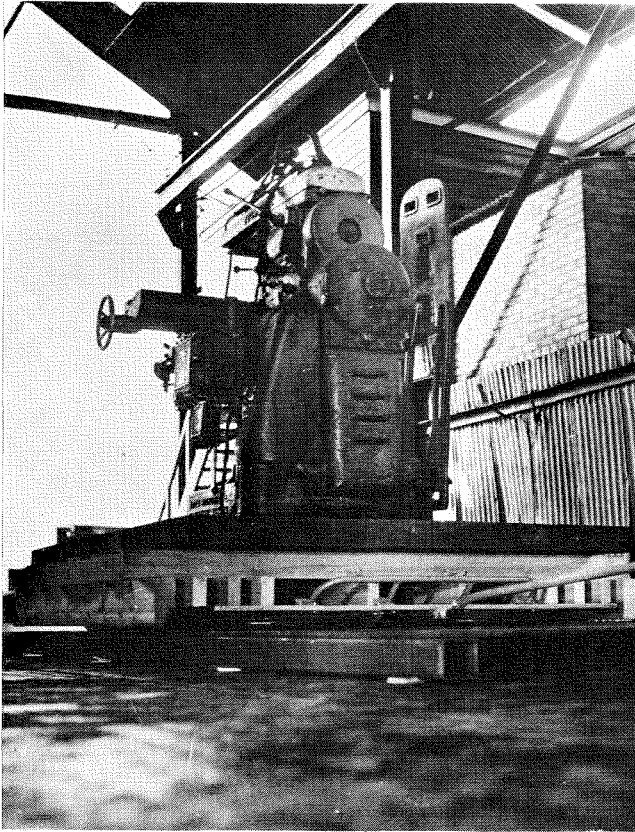
★ ★ ★

Dr Jeremy Bray, Parliamentary Secretary, Ministry of Technology, has told Members of the House of Commons that the next stage in hovertrain development is under very active consideration. He said that in due course the work would reach a stage when a test-track was needed for at least a large man-carrying vehicle to travel at very high speeds.

★ ★ ★

Mr John Osborn, MP, has mooted the use of hovercraft as a means of inter-city transport, reaching speeds of possibly over 250 mph. He has stated that it is vital that the Government should give thought to the administrative arrangements which would be best for developing fast inter-city travel.

★ ★ ★



A large machine tool literally floating on air on one of the "Floataload" hover-pallets now being put into production by British Hovercraft Corporation. The use of the air cushion allows this 4½ ton load to be moved about by just one man

Captain Bert Mead, a Director of Canada's first hovercraft charter company, Hoverwork (Canada), has qualified as a hovercraft pilot after six months' training on the Solent, and has returned to Canada to become Director of Operations of the company — a subsidiary of Hovertravel, of Ryde, Isle of Wight.

The Canadian company is at present running the first hovercraft service in Canada ferrying passengers to and from the Expo '67 World Fair in Montreal.

★ ★ ★

Mr N. D. Piper, Managing Director of Hovermarine, and **Mr G. C. J. Hodgson**, Commercial Production and Sales Director, are to visit Rome, Genoa and Naples for talks with companies and Government Departments, in a bid to interest Italian companies as well as the Italian Navy in British hovercraft.

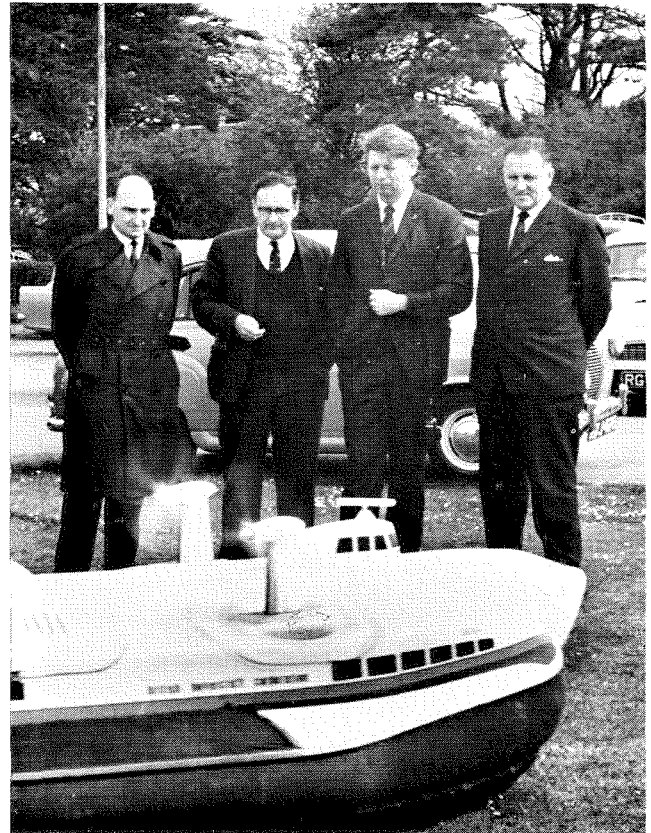
★ ★ ★

The world's first **hovercraft stowaways** have been discovered on the St Lawrence river.

The stowaways, two Canadian boys, were found under the back seat of a British hovercraft running a service from Montreal to the Expo '67 world fair.

Captain Peter Ayles, of Bembridge, Isle of Wight, who found the boys, said: "They had been hiding under the back seat for several hours. It must have been most uncomfortable for them.

"Canadian kids are really going wild over this new form of transport. They have never seen anything like it before."



On Monday, April 24th, 1967, the MP for the Icelandic Western Isle, Mr Jon Sigurdsson, accompanied by Mr Crisli Juliussen and Mr Neat made a tour of the production facilities of British Hovercraft Corporation at East Cowes. They saw the SR.N4 production line and later the experimental and research facilities. The picture shows (left to right) Mr Neat, Mr D. Williams (BHC), Mr. Sigurdsson and Mr Juliussen watching a radio-controlled SR.N4 demonstration model speed past

INTERNATIONAL HOVERCRAFT RALLY

(continued from page 3)

May 29th, RAFA Open Day, North Weald Aerodrome.

June 21st-30th, Island Industries Fair, Ryde Airport, Ryde, Isle of Wight.

July 1st, Chasewater Festival, Brownhill.

July 28th-August 1st, Inland Waterways Festival, Leicester.

August 18th-19th, King's Cup Air Race, Tollerton.

Many will remember the Express' Air Rider; this year the Air Rider Mark II will be competing at Apethorpe. It is a single-seater and has been produced by the hovercraft engineers of a London school.

There are fifty machines entered for the Apethorpe Rally. It is hoped that there will be many visitors from overseas and that the new sport will quickly find enthusiasts all over the globe. Competition between nations will develop craft on a number of different lines and benefit the sport as a whole.

Hydrofoil Systems in 1967

by

Christopher Hook

IT is interesting to note that today everybody wants incidence controlled or lift controlled hydrofoils, whereas when I began my experiments in South Africa in 1942 this idea was pure heresy because reefing foil area was supposed to be the only way to use a hydrofoil and attain speed, and this meant Vee or step ladder foils. Little by little these have faded out of the picture and now it has become a matter of how the control is to be accomplished, with fully rotating foils, flap controlled foils or air bleed lift spoiling.

The first battle was over the relative efficiency and it was common in those days to hear the opinion advanced, even by more or less technical men, that any foil *under water* must offer high resistance as compared to a wing in air. Therefore progressive emergence must be better: but this idea is based on a fallacy because it is only the L/D that counts, and this is very similar in either air or water because the adjustment for the far heavier density of water is made by a massive reduction of area.

Next it had to be shown that the "informed" fully submerged foil could reduce vertical g in a seaway, and this presented great difficulties because naval architects would deny that there existed any starting point from which to take conclusive measurements, the very waves themselves defying well-defined classification; which is of course true, and can be defended to the last ditch — and was.

Today we have scientific evidence that, if good enough for firms like Boeing, is good enough for us too. The Vee foil has an advantage over planing hulls in the smaller waves in that it tends to lose as waves increase in size so that, for example, two 80-tonners of each type must reduce to 40% of top speed in 8 ft waves, although the Vee foil can maintain 83% in 6 ft waves. For the fully submerged foil, however, the speed can be 85% in 8 ft waves.

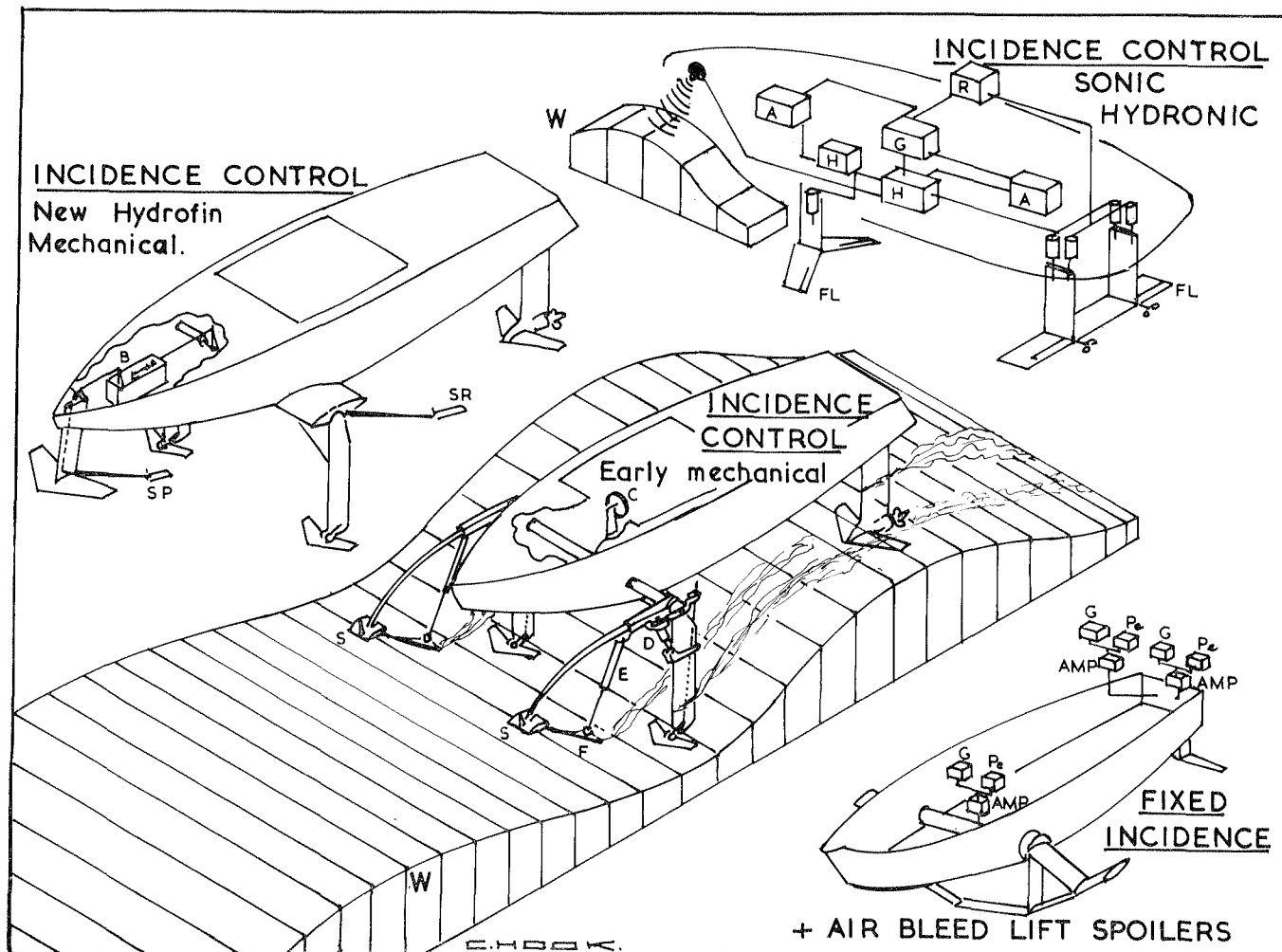
This is partly due to the fact that the fully submerged foil can select its own gain and damping of the wave-produced signal (whereas the Vee foil is a fixed gain system) and partly because *active* (ie moving) transverse roll corrections from foils or foil parts moving in opposite directions produce tremendously powerful rolling moments (ie stability), as was shown by equations in the first set of tank tests ever made on fully submerged foils under incidence control, ie the Farnborough Hydrofin report of 1947.

It is not correct to say that the better platforming of the fully submerged foil is only realised with complicated electro-hydraulic control systems. The hydraulics are unavoidable on hydrofoil craft that use sonic echo measurement as the primary signal, but the British naval architect now agrees that in view of the close proximity of the hull to the water surface the introduction of such a costly, sophisticated and basically unreliable method is not justified and mechanical collection is the obvious method. If he next wants to convert the mechanical signals to electronic impulses it is generally because he is not aware of the fact that the servo system already provided for mechanical collection of information is adequate to master the very small feedback forces from the foil that could tend to "wag the sensor" instead of the other way round.

Perhaps I should here explain that the reason why I stuck to forward-pointing outrageous feeler arms for so long was that I had been advised by Farnborough to begin like that so as to collect enough information to design a more acceptable method. Meantime the arms did at least master the foils *and also prevent the sea crash* (which the sonic beam does not), but why this should be so is not at once obvious. In fact the dampers transfer a small load on to the arms when a front foil makes surface, and the trimming moment, well up in front of the bow, is enough to stop the hull falling to the surface while the air is shed from the foil and the circulation is restored.

Any hydrofoil craft with incidence control not provided with some anti-crash protection will break up its control system at the first serious crash, and it follows that I could not abandon the arms until I had found a substitute for the combination of arm and damper.

It must also be clearly understood that while the Vee foil designer can use quite different shapes for the higher-placed portions of his foil set (and thus mitigate the effects of the sea crash), the fully submerged foil designer cannot do this. As a result the effects of the crash tend to be far worse for fully submerged foils than for Vee foils: a very good reason, in my opinion, for not building any crashers if hydrofoils are to become popular. However, marine conservatism dies very hard indeed and designers prefer to produce an orthodox-looking crasher rather than an unorthodox-looking non-crasher, and thus is partly explained



A, Accelerometer; AMP, Amplifier (pneumatic); B, Mechanical controls mixer; C, Control column (pilot's interference control for banking, etc); D, Damper (hydraulic); E, Spring unit; F, Heel — spring-loaded to arm; FRH, Fully rotating hydrofoil; FL, Flaps; G, Rate gyroscope; H, Heave control; Pe, Pendulum; R, Roll; S, Sensor; SP, Sensor for pitch; SR, Sensor for roll; W, wave shape.

by the fact that until it has been actually experienced in a rough sea the sea crash and its effects tend to be ignored by aircraft-trained men who think of it as only a failure to control.

The only thing that might change this whole picture would be some new invention that eliminated the lift breakdown on a foil making surface, but up to now this has not been done. It is certain that nearly all the early failures of hydrofoil boats were due to this problem, which was confused with cavitation. There was generally a parallel refusal to believe in the absurdly small sizes of the foils as found from calculation. As a result the area was doubled "just to make sure", with the result that (a) the speed was rather lower than the same boat without foils, and (b) the loading was so reduced as to eliminate the crash danger because even with upper side lift lost the foil could still carry the load because of its size. The result was that the project was dropped as pointless because of (a), and the sea crash problem was never encountered and therefore never solved.

It is indeed interesting to note that the Supramar team have found a way considerably to improve their performance in waves, and they are to be congratulated on this success. This is, however, essentially an improvement to an existing fleet of boats and of interest primarily to their owners. Any company or country considering hydrofoil craft and the systems that are available should not lose

sight of the fact that it has the choice now between three basic concepts, as follows:

1. Incidence control by purely mechanical means.
2. Incidence control by computerised and amplified sonic signals.
3. Lift control of fixed incidence foils by air bleed lift spoiling.

Possibly we should include incidence control by hull trim in the Canadian form, which is certainly an improvement on the original Grunberg and Dutch system in that the bow riding foil is not so brutal, but the Canadian system is purely for military purposes and could hardly have any commercial applications.

The main heresy one has to unmask today is the belief that incidence controlled hydrofoils can generate feedback forces that can only be mastered by power systems that small mechanical sensors will be inadequate to handle. This is totally incorrect and the introduction of servo power in the first place was dictated by the use of sonics, not by the pitching moments of the foil which are easily held by the damping, as is proved by the fact that the pilot can operate his interference control without difficulty. Even a small sensor is its own servo and feedback system, and if the anti-crash function is entrusted to a preventer foil, then these can be quite small.

The Development of the Hovercraft and its Possible Uses in Somerset

by
Leslie Hayward

The following is the text of a lecture delivered to the Association of Somerset Surveyors on April 18th, 1967. Although primarily directed to a local audience, the findings of the author are relevant to similar areas throughout the world.

ANY form of device which derives the major proportion of its support from a cushion of air which is above atmospheric pressure falls under some definition of a ground effect machine. The air cushion is formed between the underside of the device or vehicle and the surface over which the vehicle is operating. The surface may be water or land, or various combinations of these elements. Fig 1 shows diagrammatically various forms of machines: the plenum chamber type where the sustained height is related to the leak rate of air around the base edge, the annular jet type where a curtain of high momentum air encloses a cushion of air at a lower pressure, recirculation systems which attempt to conserve air flow, and last, but not least, flexible skirt systems which allow considerably higher clearance between the base platform of the machine and the ground or water surface. These machines would all be suitable for operation in the Somerset area. There are other forms such as sidewall machines having rigid walls always immersed in the water, labyrinth seal machines having various forms of sealing to prevent loss of the air cushion, and levapad machines which operate at very small ground clearance over specially prepared surfaces. Such machines do not appear to be favourable for practical local operation in the Somerset area.

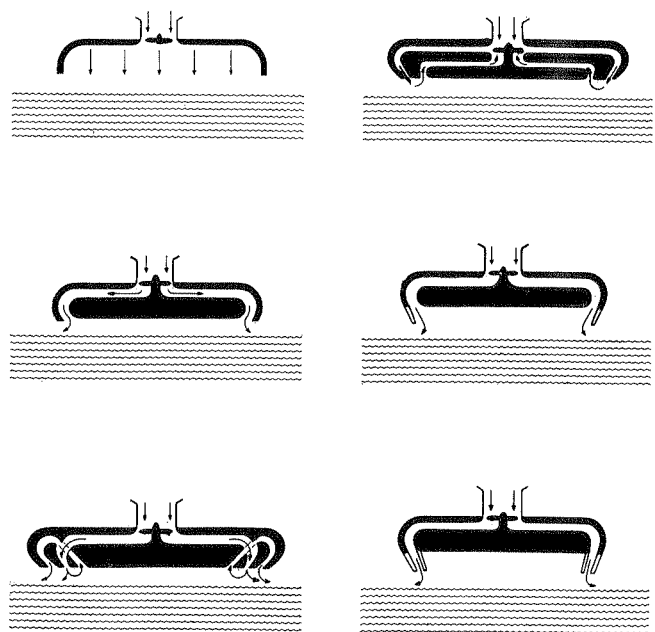


Figure 1

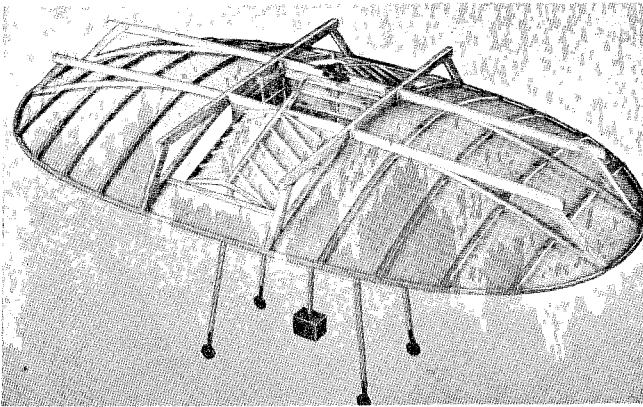


Figure 2

It may come as a surprise to many people to learn that ground effect machines, or hovercraft as such devices are now often called, were proposed during 1716 by the Swedish scientist, philosopher and mystic, Emanuel Swedenborg. Fig 2 shows a model constructed to his design, the manually operated "air oars" being closed on the upward stroke and open on the downward stroke. Swedenborg knew that the machine would not fly and stated that it required more power to operate it than is available in the human body. He also suggested that in time a suitable power plant would become available.

One hundred and sixty years later, in 1876, John Ward of California, USA, improved on the Swedenborg proposal and in addition to providing a mechanical power plant for driving both lift and propulsion fans he added a movable wing structure in an attempt to obtain extra lift at high speed.

In 1882 Gustav de Laval modified a ship's hull to have an air duct system so that compressed air was forced out through a large number of jets under the waterline. The theory was that the air would form a "lubricating" layer between the hull and the water and hence the speed of the ship could be increased. On trials the ship was in a perpetual fog caused by rising spray, and as far as I know that was the end of Laval's air lubrication experiment. At least 100 air-lubricated ships of many different forms have been proposed or constructed during the period 1882 to date. Probably the most deadly but little-known craft was the air cushion torpedo-carrying boat, constructed for the Austrian Navy in 1916. This small vessel achieved speeds up to 40 knots powered by engines totalling 480 hp.

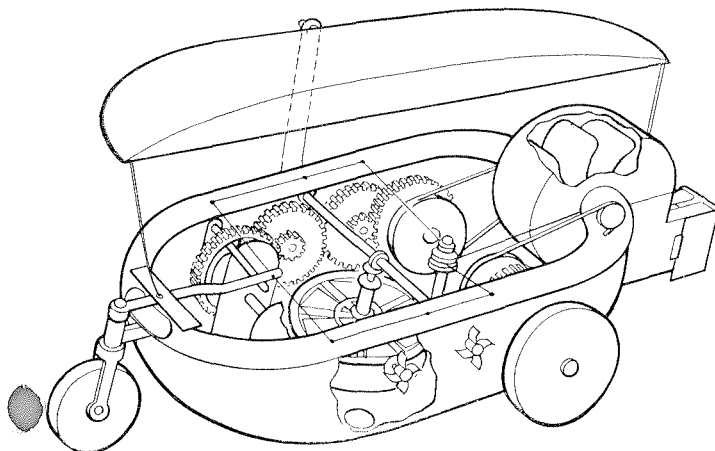


Figure 3. Machine proposed by John B. Ward in 1876

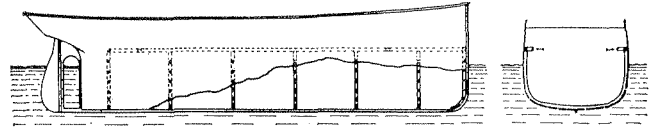


Figure 4. Gustav de Laval, the Swedish inventor, planned this air cushion boat in 1882

Again it may come as a surprise to learn that sliding or air cushion railways have been known since 1881. In 1889 an experimental service was operated in Paris and in 1891 a similar railway was demonstrated at the Crystal Palace in London. Various forms of air cushion railway have been proposed throughout the years and once again there is an experimental research section of track being operated on the outskirts of Paris. In this country we have concentrated on amphibious vehicles, but research models of air cushion trains are already in being.

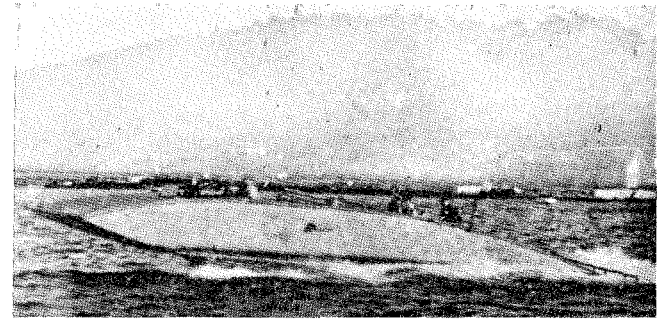


Figure 5. In 1921 M. A. Gambin, a Frenchman, applied for a patent covering this design for a large sidewall craft

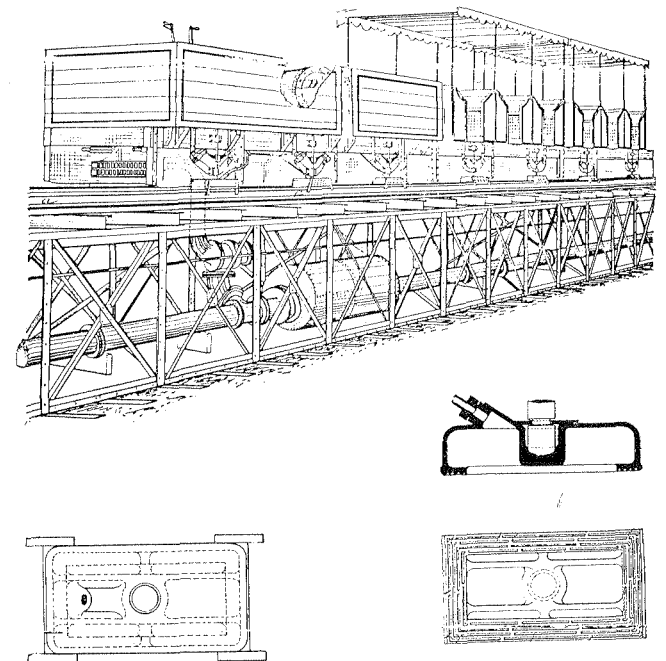


Figure 6. General form of the railway developed by Louis Girard and Charles A. Barre in France in the 1880's

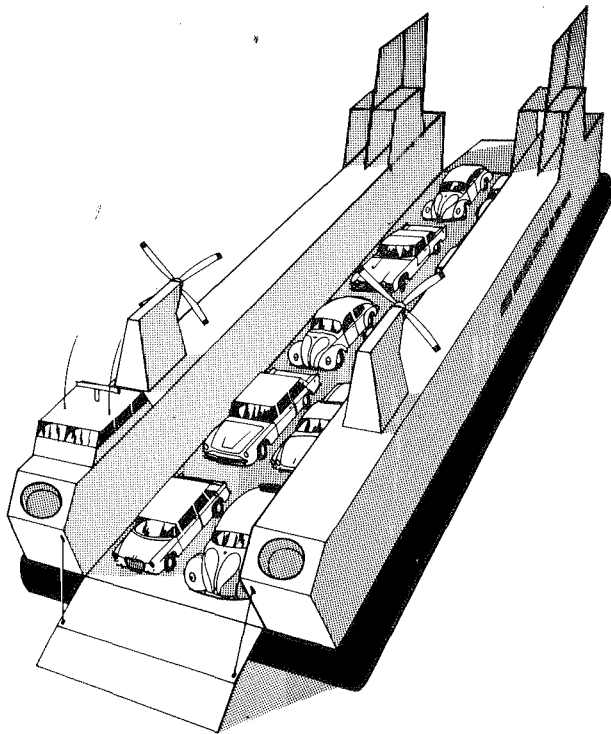


Figure 7

Let us now turn to the use of any form of air cushion vehicle in *Somerset*.

If one considers the territory within the jurisdiction of the Somerset County Council, that is, excluding the County Borough of Bath, the towns providing greatest influence can be considered to number, say, seven or eight, and those providing slightly less influence approximately a dozen. Of these nineteen or twenty towns, four — namely, Minehead, Burnham-on-Sea, Weston-super-Mare and Clevedon — lie on the Bristol Channel coast, whilst the remainder lie principally to the south and east of the county. Now whilst the tides in the Bristol Channel are alleged to have the second highest rise and fall in the world, with a speed of about 6 knots during the middle two hours of their ebb, which obviously limits the activity of coastal shipping entering and leaving any docking facilities which may be provided, the Channel provides a ready-made track for amphibious hovercraft which can operate at all hours and during all states of the tide. Thus a high-speed coastal tramping service could be provided which, without incurring large financial outlay to provide harbour installations, could readily be expanded to provide transport facilities for new industries which may wish to move into some of the smaller coastal towns, or for such contemporary utilities as the nuclear power station at Hinkley Point.

An external route that could prove profitable is one across the Bristol Channel between Minehead and South Wales at, possibly, Aberthaw which would be conveniently placed for connection with Rhoose Airport, the industrial and commercial centres of the region, and provide access to the touring and holiday areas of South Wales. Such a route would enable many Somerset people to reach an airport more quickly than they can now travel to Lulsgate or Exeter Airport! This connection would obviously have a greater summer traffic than winter traffic, as it would open an attractive route via Central Wales for those travelling between the south-west and the north-west area, and would offer a very useful facility for those inclined to tour

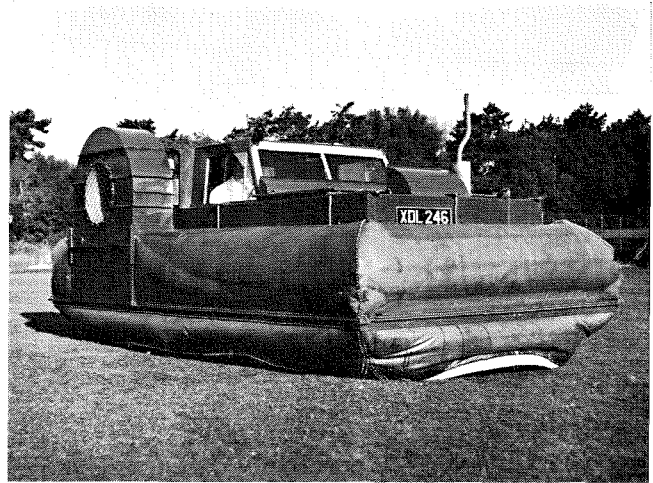


Figure 8

the south-west regions of both England and Wales. It would also provide the possibility of a residential commuting area for industrial South Wales. Such a link would save about 120 miles of motoring and many tedious hours in holiday traffic, compared with a road journey by way of the Severn Bridge. Perhaps it would open a new marketing area in the north-west regions for produce from Devon and Cornwall by way of the new motorways and, in fact, with the eventual completion of the M4 and South Wales motorway system could provide a fast route to London and Covent Garden. In July/August 1963 an experimental service, with an experimental craft, the now renowned Westland SR.N2, was operated between Weston-super-Mare and Penarth, the eleven miles being covered in twelve minutes. Records show that on 100 scheduled journeys approximately 3,800 passengers were carried, thus indicating a very considerable public interest.

The type of air cushion vehicle that would probably serve this route most economically would carry ten popular family-sized cars such as Ford Cortinas or combinations of vehicles or freight which would with passengers total about 13 tons. It would be a utility class of short-haul vehicle of 80 ft by 40 ft planform having a central freight channel, allowing a "drive-on" and "drive-off" facility, with covered passenger cabin and engine room structure extending fore

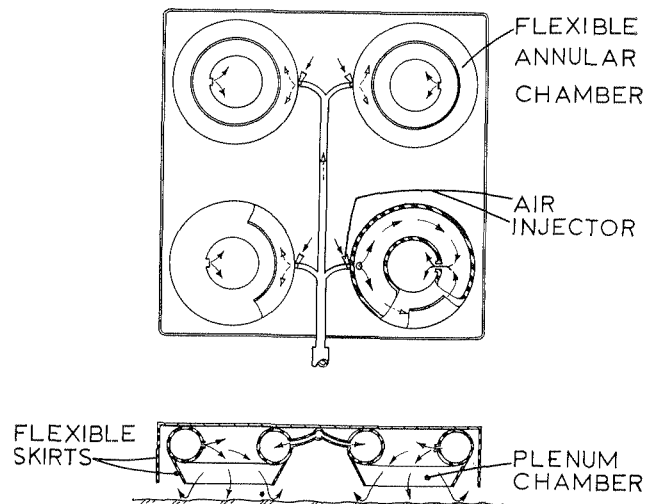


Figure 9

and aft of both sides. The bridge, flight-deck or driver's compartment (whichever you prefer) is above the fore part of the starboard structure. Propulsion and principal directional control would be by way of an airscrew on a swivelling pylon on top of each structure abaft the line of the bridge. The power units would be 2,000 hp internal combustion engines interconnected by automatic clutch means to drive both airscrews in the event of failure of one engine and maintain the cushion-generating fans in operation.

This type of craft would be very suitable for the tramping services along the coast, as previously mentioned, and for obvious extensions of the services to and from Wales, Bristol, Gloucester and along the Devon and Cornish coasts. I suggest that such a craft could be built for about £60,000, giving an approximate operating cost with profit of 6s 6d per ton per mile, say £4 for the average car to be taken across the Bristol Channel.

Turning to the interior of the county, there is a very extensive area of low-lying ground below 100 ft known as the "Moors" extending from Bridgwater to the Poldens in the north and Kingsbury Episcopi in the south, and it is in this area that the industrial uses of air cushion devices become evident. Here it becomes difficult for the workers on the land to move heavy equipment during many weeks of the year when the ground is waterlogged, so that vehicles and trailers which have at least part of their weight supported by an air cushion would facilitate movement about the moors at such times. The agricultural engineer, often called out to repair or retrieve equipment in the field, could, for example, be equipped with a four-wheel-drive utility which is skirted to provide a plenum chamber beneath the chassis. An air compressor mounted on the vehicle could pressurise the chamber, and when driving from a firm surface to a soft one the air cushion would relieve the road wheels of some of the weight upon them and save the vehicle from becoming bogged down whilst still allowing them to supply the necessary traction. If a lot of equipment has to be carried a skirted trailer can be towed behind the utility. A simple flexible duct from the compressed air system of the utility can convey the air to pressurise the plenum chamber formed by the skirt arrangement beneath the trailer chassis, and again its road wheels can be relieved of part of their load.

As part of a retrieval kit, the agricultural engineer could have on his trailer a device which can be put under a bogged vehicle (or crashed aircraft). In its simplest form such a device resembles a car inner tube with a skirt hanging from it. The tube has a series of small holes around its inner periphery and an inlet port which is at least equal to the total area of the small holes. If this is placed in a collapsed condition beneath a flat surface of the bogged vehicle and coupled to an air-line the tube will inflate, raise the vehicle and form a plenum chamber under the flat surface. Air flows from the small holes into the chamber, lifting the vehicle to a height equal to the extent of the skirt. Several of these elements may be needed under an object to be retrieved, and three or four elements may be connected together in an impervious upturned box.

The moors of Somerset often pose a problem for the public services. The Fire Service is frequently unable to deal in the best possible way with farm, heath and forest fires, the ground being too soft to enable appliances to be moved off the road to a favourable position to fight such fires. By co-opting the art of the air cushion it is possible to provide a skirted chamber beneath a fire engine or pump appliance. The pump motor could be adapted to drive a fan unit to pressurise the air cushion so that the road wheels are relieved of some of their load. The skirt could

be lowered at the point when the appliance is to leave the road or hard ground, the cushion pressure would be generated and the appliance driven, winched or pushed to its required position, where the full power of the pump motor is switched to produce water jets. If the appliance is in danger of becoming bogged to an extent beyond which the regenerated air cushion could make it mobile again, a mesh "mat" would be unrolled for the appliance to be parked on. When providing a water-tender with this facility it is necessary for the tender to have its own fan to create its air cushion.

I submit that other public services would benefit from the ability to operate their vehicles as air cushion vehicles; these services could include the rural authorities, regional electricity boards, water boards, river boards, gas boards, agricultural authorities and others.

Agriculturalists, generally, can benefit from the air cushion principle. The farmer could traverse his land during continuing wet periods. A tractor can have an air cushion supported trailer. The market gardener would find applications in crop-spraying. If large acreages are involved it might be more prudent to use a wheeled vehicle partially supported on a cushion of air, but in the case of relatively smaller areas it may well be of benefit to use apparatus that is entirely cushion supported. A modified commercial vehicle with pivotally mounted spray booms extending from the side is shown in Fig 11. A retractable flexible skirt extends downward to provide a reasonable ground clearance for the underside of the rigid structure; this avoids damage to plants and also to the underside of the vehicle. It is possible that a much less costly and simplified version of this vehicle will be developed for operation on small acreages.

When considering hovercraft as public transport vehicles within the County of Somerset it appears that there are no suitable natural tracks such as rivers between towns requiring connecting services, nor are there towns which have a sufficient commuter requirement or sustained daytime interchange of travellers to warrant the expense of constructing and maintaining prepared tracks — not even between Bristol and the dormitory areas around it, nor to convert the now disused Bridgwater and Taunton Canal in a manner as was proposed in March 1964 for a service between Paddington and London Airport using the old Grand Union Canal system. Where branch line railways have been closed and ballasted-beds are left, such as the route between Yeovil and Taunton — which incidentally I consider could economically have only one intermediate stop at approximately mid-point, say Langport — it would be impracticable to use air cushion vehicles because of the bridges met en route. The extent of drift due to side winds on unguided machines would also be a problem. The only overland travelling by public transport in the county could be on an express hovertrain linking the principal towns of the South-west to London, by way of a prefabricated track of reinforced concrete. The service would provide an average speed of, say, 180 to 200 mph and necessitate minimum stage lengths of about thirty miles. These would be sophisticated versions of the experimental system shown in Fig 12.

One form of transportation incorporating an air cushion that might be seen in Somerset is the air cushion heavy load transporter. This transport complex was devised to allow the Central Electricity Generating Board to convey by road large transformers, weighing 190 to 250 tons, from factory to installation site. Recent proposals envisage carrying 300-ton loads. Using what we know as orthodox vehicles, at each wheel in contact with the surface of a bridge, even on a 250-ton-carrying vehicle having fifty

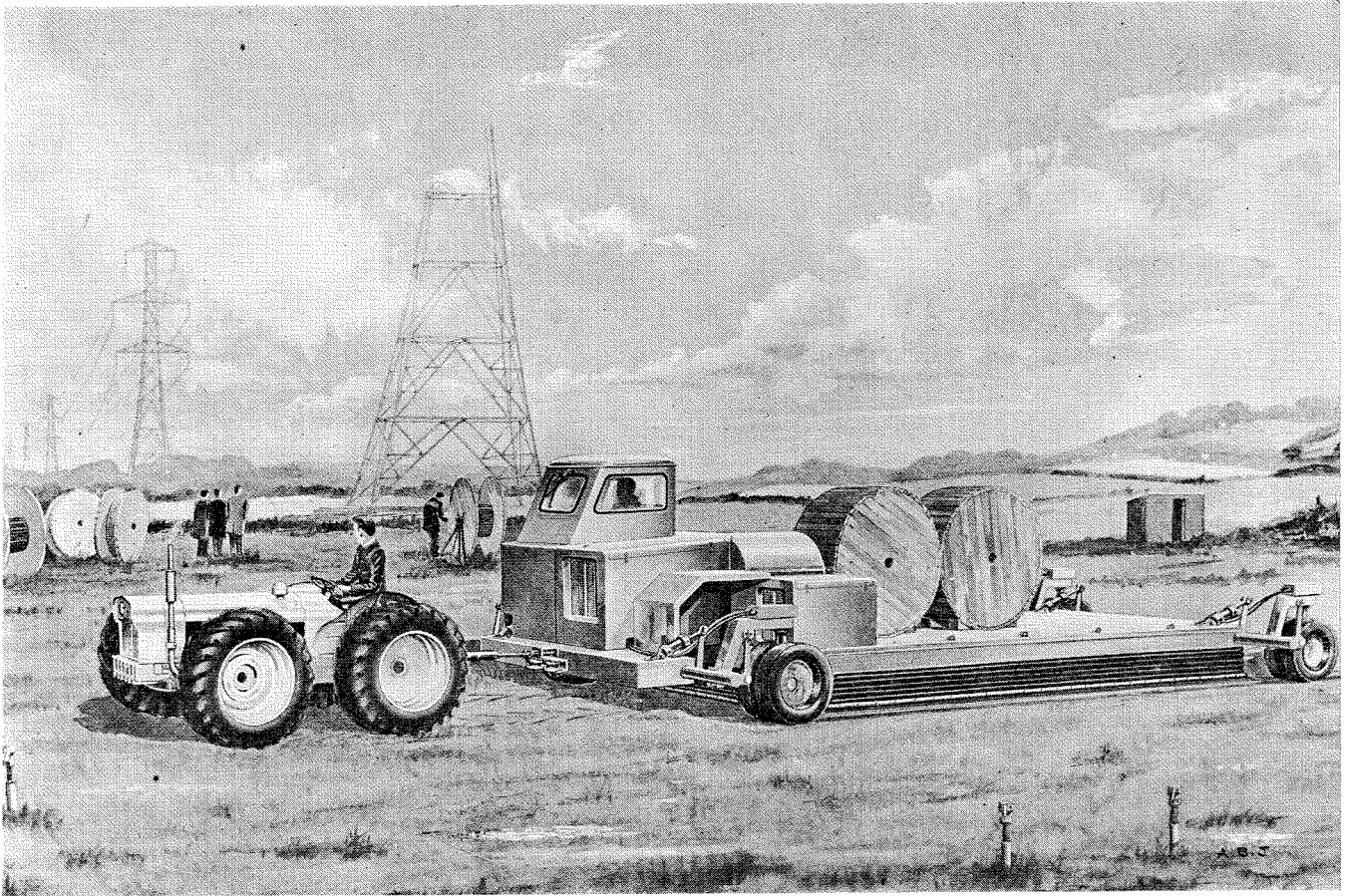


Figure 9A. Carrier being drawn to site by tractor

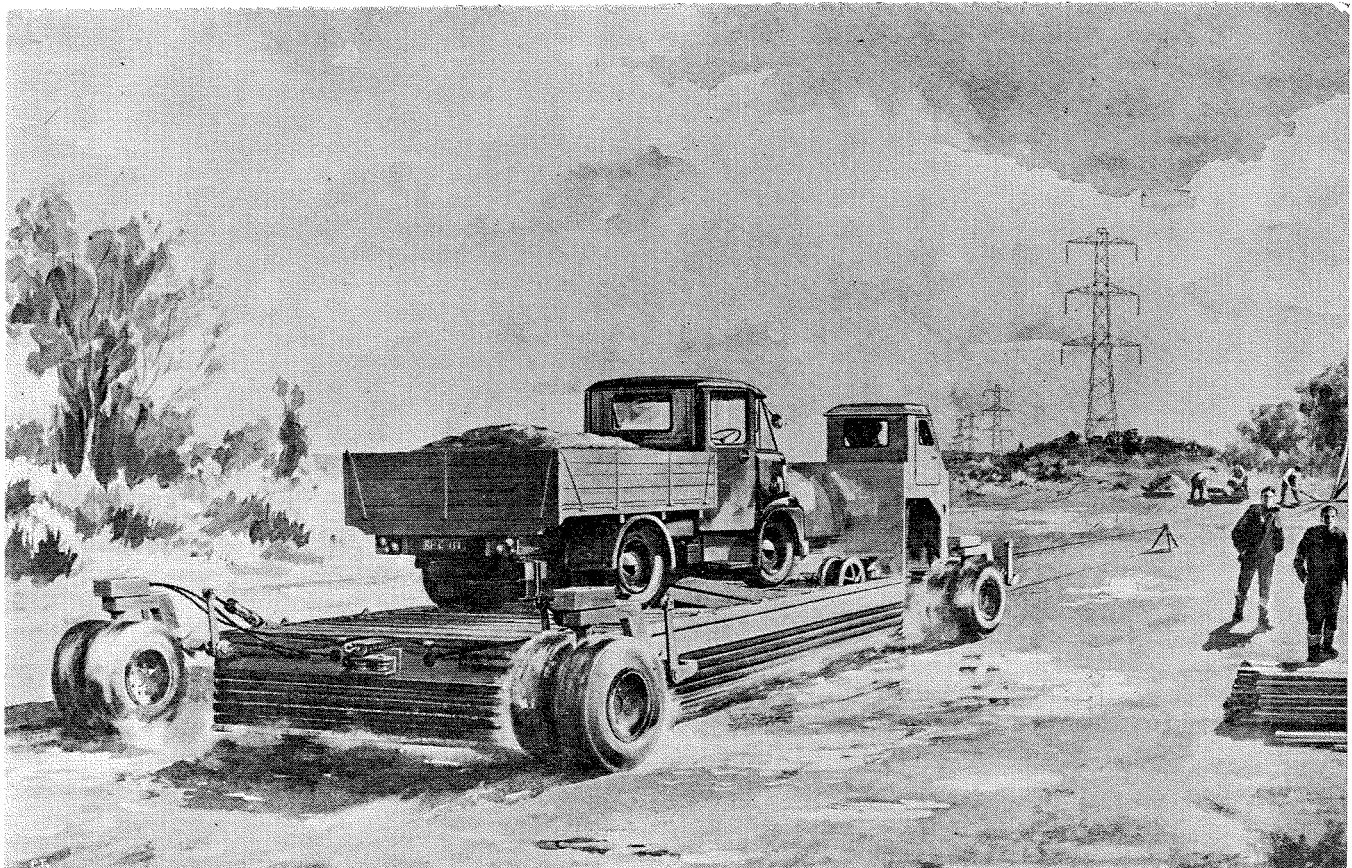


Figure 9B. Carrier being winched over rough ground

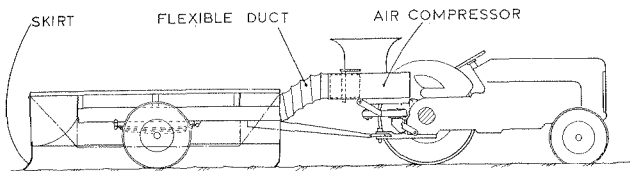


Figure 10

pairs of wheels, the point loading must exceed 2½ tons. An air cushion created beneath the main load-supporting element of the transporter greatly reduces the point loading. The transporter illustrated has a length of 90 ft and maximum width of 16 ft 10 in, the load being supported on a bogied trailer which is not air cushioned until it is required to traverse a bridge or weak road structure. The air cushion chamber is contained in an area 32 ft long by 14 ft wide by a rubberised flexible skirt. Plates attached to the skirt hem reduce abrasive wear caused by road contact. The only escape of air from the cushion is through the gaps between the plates and the road surface. When the air cushion is not required the skirting can be readily retracted or detached from the transporter and stowed away. The lifting capacity of the cushion is 155 tons at a cushion pressure of 5.4 psig.

Four internal combustion engines each delivering 235 hp power the fans generating the air cushion. Each engine

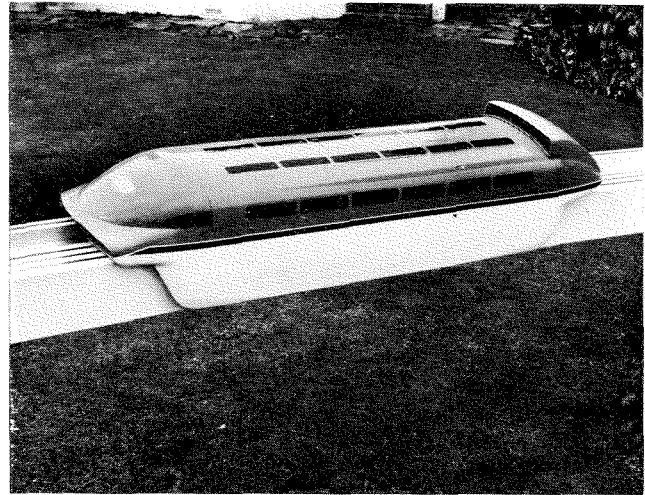


Figure 12

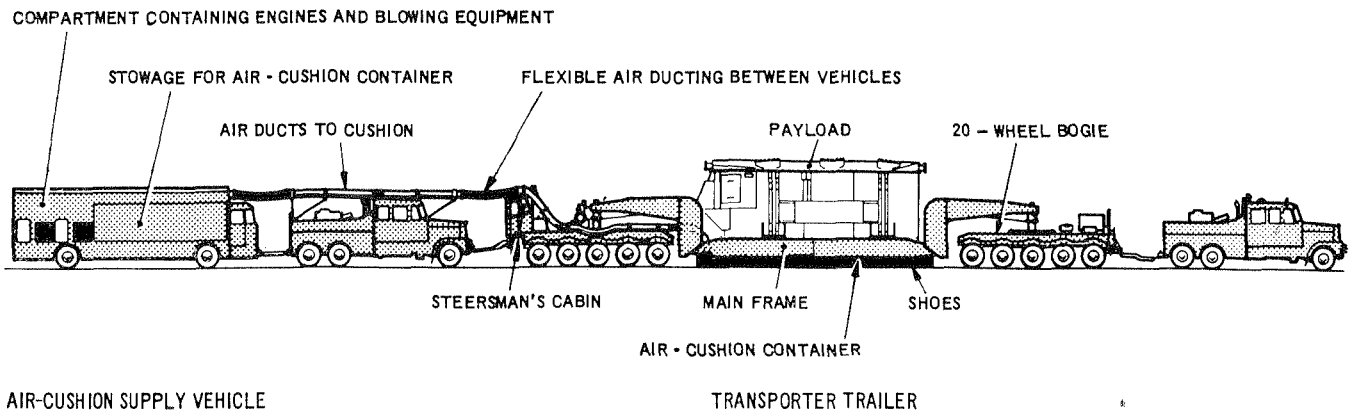
drives, through a gearbox, its own centrifugal compressor, the engine, gearbox and compressor units being mounted together as a complete working unit in soundproofed chambers on a road vehicle chassis. This vehicle, which also contains stowage space for the folded skirt, is attached to the rear of the transporter train whenever it is required for a bridge crossing. Four 1 ft diameter flexible air ducts convey air to the cushion area.

Various applied cushion pressures provide different amounts of relief of load on the wheels of the transporter so that the weight is more evenly distributed. On bridges which have a longer span than the transporter the advantages of air cushion support reduce, as there is no relief in shear stresses and only a small amount in bending moments. On bridges where the span is less than the length of the transporter a cushion pressure which supports about 40% of the weight of the transporter and its load is all that is required. As an example, a trailer carrying a load of 150 tons crossing a bridge having a 50 ft span could, if provided with an air cushion, carry 215 tons across the same bridge without subjecting it to any higher stresses.

Cushion pressure is controlled automatically to within fine limits, and in the event of failure of any one of the four power units, that unit is immediately and automatically sealed off so that air is unable to escape back through the fan from the cushion. During normal operation 25% of the air generated is deliberately wasted, so that a reserve is always available in the event of an emergency.



Figure 11



AIR-CUSHION SUPPLY VEHICLE

TRANSPORTER TRAILER

Figure 13



Figure 14

If such devices come to be generally used for transporting such large loads, then the roads through or around some or perhaps all of the larger towns in Somerset will need to be replanned to give such vehicles an easy passage. I do not see such a vehicle being able to pass through Yeovil at the present time.

In addition to freighting, air cushion devices can also be used in the County of Somerset in the industrial field. Heavy elements such as castings, bales of skins, machine tools or tanks of liquid can be moved over a shop floor, along a production line or through an assembly shop by mounting the load on a base platform adapted to ride on an air cushion. On specially prepared floors there is no need to provide a flexible skirting around the periphery of the platform, but if the pallet has to traverse small fixed objects set in the shop floor the skirt would be of advantage. The skirt also prevents small objects from rolling under the pallet and causing damage.

The air cushion supported pallet lends itself most readily to the movement of batches of small items about a factory and between departments providing different stages of manufacture. A small motorised truck having air cushion

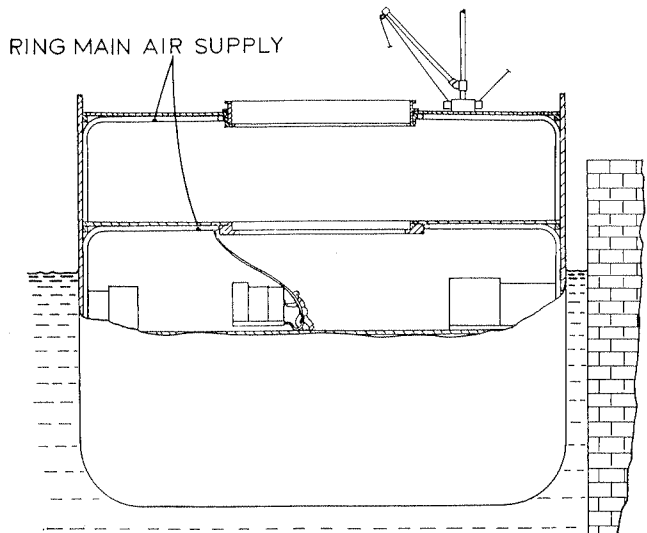


Figure 16

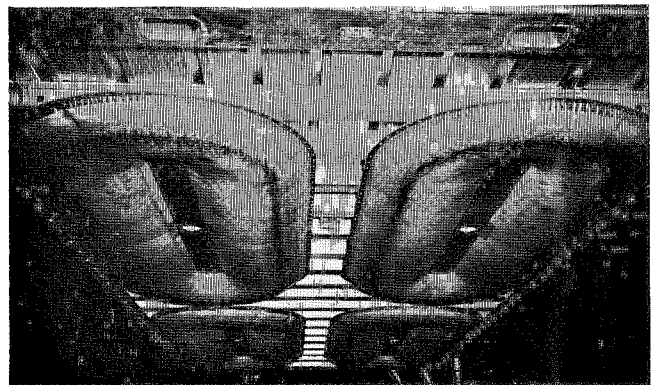


Figure 17

trucks substituted for the usual support wheels and having an independtly sprung wheel for traction has the advantage over the usual wheeled version of providing a means of carriage free from shocks normally passed from the road surface through the wheels. The risk of damage to fragile articles or fine surface finishes on the articles being transported is greatly reduced. The pads are attached to the bottom of the vehicle by a part-spherical or ball joint allowing the air cushion pad to follow small deviations in ground contours.

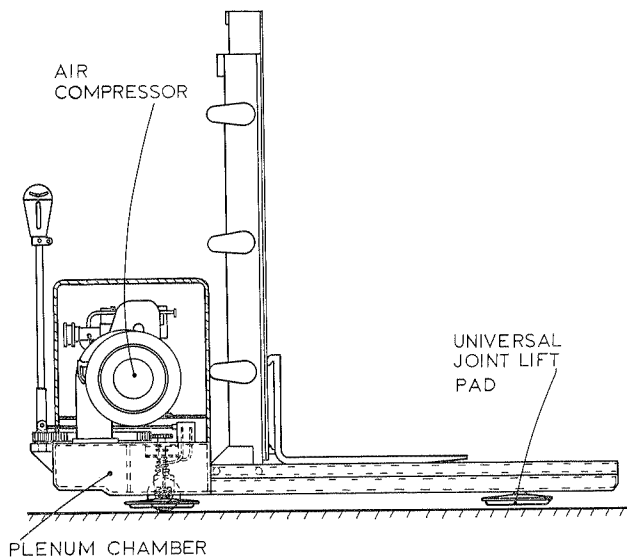


Figure 15

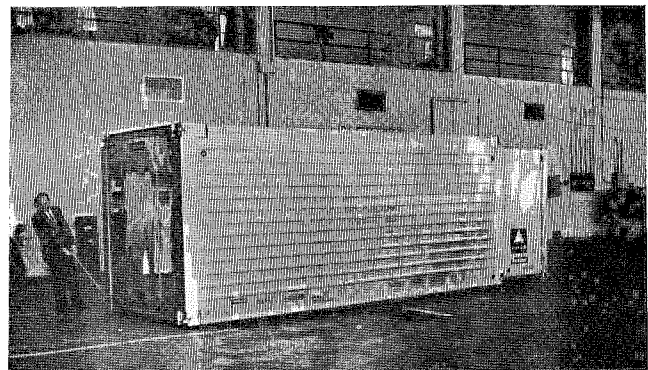


Figure 18

In general freighting, it is more convenient for loads to be kept on pallets throughout the journey from factory to destination, including storage within the warehouse, movement on road or rail transport, and on board ship or aircraft. Factories and warehouses can be fitted with overhead air-lines from which long flexible hoses are suspended and connected to pallets operable on the air cushion principle, or alternatively small mobile compressor units can be coupled to the pallets, ensuring warehouse and factory manoeuvrability and loading on and off vehicles. Similar arrangements with overhead lines can be installed in the holds of ships, and lorries fitted with small air compressor and flexible hoses can transfer loads to and from loading bays or other transport vehicles having beds of the same height. This system of freight movement, if adopted on a national and international scale, would speed up the transport of freight and to a large extent remove the heavy manual work at present required.

In the United States air cushion pad membranes are available "off the shelf" for fitting to the customer's own structures. They are now also available in Great Britain. The pad membrane forms a flexible bladder on the underside of a rigid platform; the edge and centre part of the membrane is sealed to the platform and forms a flexible pocket or cavity. Compressed air inflates the membrane and passes out through a series of holes to form an air cushion in the cavity. The pad membranes, produced in various shapes and sizes to suit various platform configurations and loading requirements, can be arranged in various patterns beneath the platform to provide the greatest stability to suit the load. Freight containers, 8 ft by 8 ft by 20 ft long, can be manoeuvred at will on four large pads. One electrical horse-power (746 watts) provides the power for supplying sufficient compressed air to support a weight of 5,500 lb.

Air cushion devices are already used in association with machine tools in various manufacturing industries. Movement of heavy components or jigs, particularly on the beds of drilling and milling machines, is greatly facilitated. Two methods of forming the supporting cushions are used: a work-piece support member can have air passageways in its under surface, or alternatively a conveyor bed can have valved ports which open when a load is over them. A simple form of valve comprises a steel or nylon ball, biased into a seat, so that part of the ball projects above the surface of the conveyor bed and is depressed when the load passes over the valve, to permit air from within the bed to build up a cushion under the load and provide support.

The building industry, one of our most ancient crafts but always slow to adopt new ideas and techniques, seems to me to be totally unaware of the advantages obtainable from the use of the air cushion principle.

Housing estates, trading estates, shopping precincts, factories and large establishments such as nuclear power stations rarely seem to have the road systems laid prior to commencement of building operations. This results in considerable difficulty in moving materials about the sites, the requirement of considerable manual labour, and an expensive waste of time. For the movement of large loads, some of the embodiments already described such as tractors with air cushioned trailers or air cushioned self-powered transporters could be used, and for smaller loads of say five to eight bags of cement, an equivalent weight of bricks, fireplaces, stoves, baths, water tanks and cylinders, timber, flooring materials, tiles, electrical and gas equipment, it would be a simple matter to move such items on cushion supported pallets.

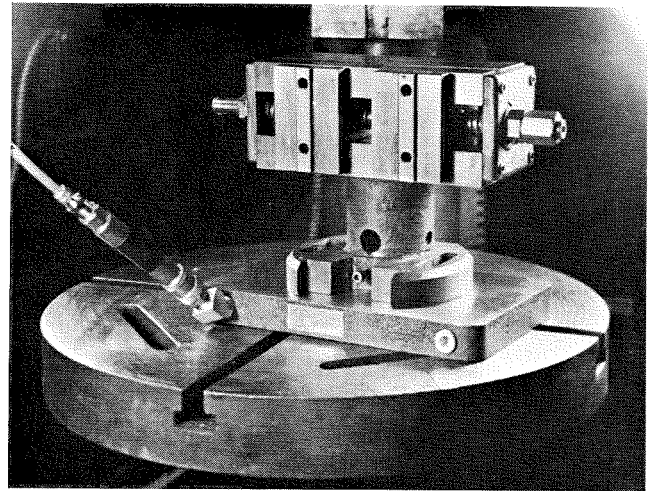


Figure 19

Towards the end of 1960 a Kentish builder constructed an air cushioned barrow for his workmen. It consisted of a simple plenum chamber supporting a walled platform on which the load was placed. Air was conveyed to the plenum chamber by means of a fan in a vertical central duct. The fan was driven by a small petrol engine, and propulsion was provided by the operator. On large sites where compressors are necessary to provide power for digging trenches for various services a ready-made supply of air is available, but a small 10 hp compressor would appear to be all that is necessary to fulfil most requirements.

From the building of homes it is a natural step to look at the completed home and see where the air cushion can be of use. Already we see one application at work in the garden, namely the air-supported lawnmower. The obvious advantage over the traditional types of lawnmower which we have all struggled to push at some time or other is that the resistance to motivity is almost completely removed. The only resistance is between the rotary cutters of the machine and the grass, this being negligible. Naturally, as there is no tractive resistance these mowers do tend to "slide downhill" and have to be controlled by muscular effort of the user, who also provides the necessary propulsion for his mower.

Perhaps we shall find a more sophisticated wheel-less barrow than the experimental one of the Kent builder being offered to the gardener in the near future. The power units for these devices may be either petrol engines allowing complete freedom of movement, or electric motors having the limitations of a trailing lead; and, although it is not present-day practice for householders to have air compressors in their garages, it may be a common thing of the future, in order that air cushion devices of various types may be used outdoors in the garden and indoors in the house.

RUBBER GROMMET PROVIDING BALL LOCATION AND SEAL

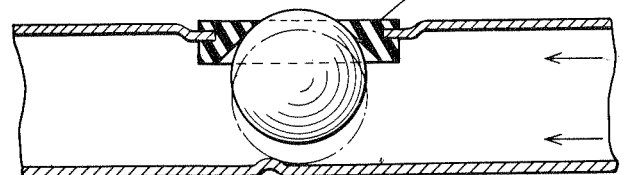


Figure 20



Figure 21

For use in the house I can envisage that the compressor in the garage could be a reversible unit providing, alternatively, pressurised air delivered by ducting into the house, or vacuum pressure withdrawing air from the house through the same ducting. The ducting would be installed in the house during its construction and would have an outlet in each room, hall and landing, permitting a flexible hose to be plugged into the outlets to provide a vacuum cleaning facility or alternatively the delivery of a pressurised flow. In the home the requirements for an air cushion become most evident during spring-cleaning and similar occasions when it is necessary to move heavy pieces of furniture and equipment.

It is not essential to have an elaborate system installed before one can apply the feature of an air cushion for this purpose, for in nearly all the homes in the kingdom there is a suitable source of power, the electrically powered domestic vacuum cleaner. The lifting powers of such a cleaner are considerable. A simple tubular domestic cleaner is capable of providing an air cushion to support a load of 336 lb plus the weight of the supporting structure. In applying this capability of the vacuum cleaner I propose arrangements similar to those shown. A cleaner is depicted with its hose attached to its discharge outlet, the free end of the hose being connected to a lift pad arrangement. This arrangement is designed to fit a standard slot or recess in the base of a wide range of heavy household equipment, such as cookers, washing machines, refrigerators, storage heaters, deep freeze cabinets, etc.

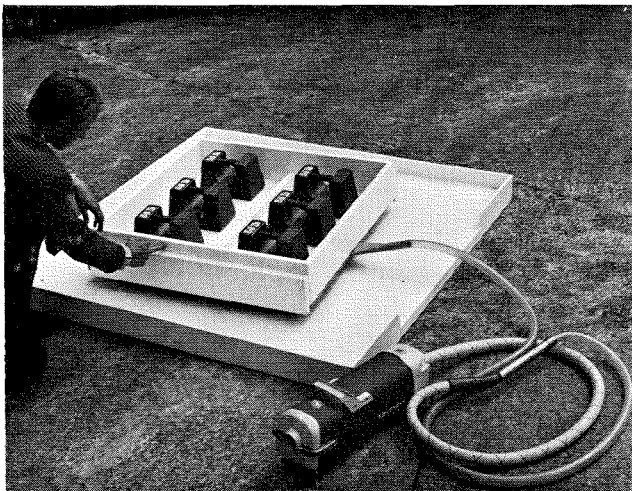


Figure 22

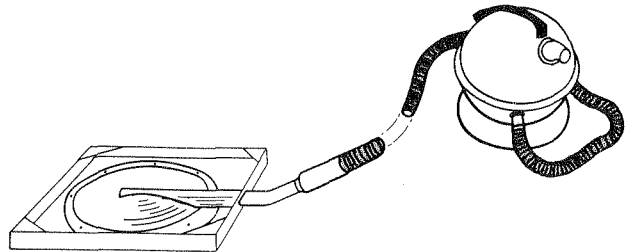
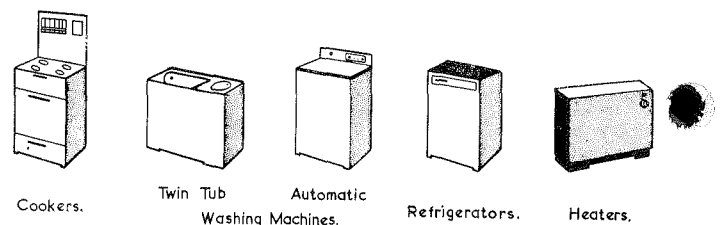


Figure 23

Many local authorities are kind enough, on refuse collection days, to "allow" householders to place their dustbins at the kerbside. Where there are no deep steps to negotiate, an air-line supplying pressurised air to a hoverpad fitting beneath the dustbin would, I am sure, be of great help.

In the larger towns where municipal cleansing departments provide night collection of large amounts of refuse from hotels and commercial establishments, in very big waste containers, the hoverpads connected by hoses to a small compressor on the collection vehicle would facilitate handling and manoeuvring of the containers into the hydraulic lift and tilting apparatus on the vehicle. It would also result in reducing the noise level of the operation.

In the medical field, an air cushion supported stretcher device has undoubtedly value for the movement of injured or wounded persons over rough or boggy ground. An experimental unit carrying two stretcher cases has already been produced. In 1965, the Royal National Orthopaedic Hospital at Stanmore installed an experimental "hover-bed" over which the patient was wholly supported by air. This unit was developed for research into the treatment and care of persons who were very badly burned. Air supplied to a chamber beneath the bed is brought to body temperature and sterilised before delivery under the patient at a pressure of $\frac{1}{4}$ psi. One valuable feature of the bed is that wounds were dry in approximately $1\frac{1}{2}$ hours whereas under usual treatment the wounds took twenty-four to thirty-six hours to dry.

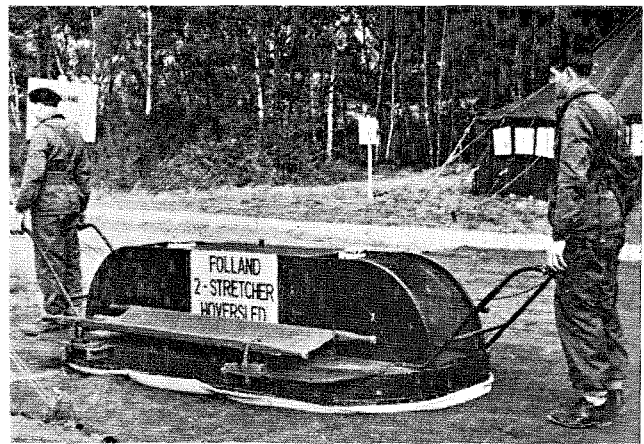


Figure 24. Air cushion supported stretcher device

While everything I have said this evening may seem to be just a bubble of air, and you have probably been wishing that you had an air cushion to relieve some of the load upon your chair during the past hour, I believe that we are now entering the practical era of air cushioned devices. Applications which I have not mentioned have no doubt crossed your minds—snow clearance from airfields, air cushion supported crash-tenders at airfields, particularly where the approach or take-off flight paths are over stretches of water such as at Shannon, John F. Kennedy and many other places; inter-island ambulance services; weed control in rivers; and the manoeuvring of vehicles in

car parks to make maximum use of available space. Movement off the road of overturned or crashed vehicles to keep traffic flowing without the use of cumbersome lifting tackle is another possibility. Inflatable sporting type craft will probably appear on our beaches, lakes and rivers in the near future, these craft being carried to and fro in a collapsed state on the roof rack of the family car.

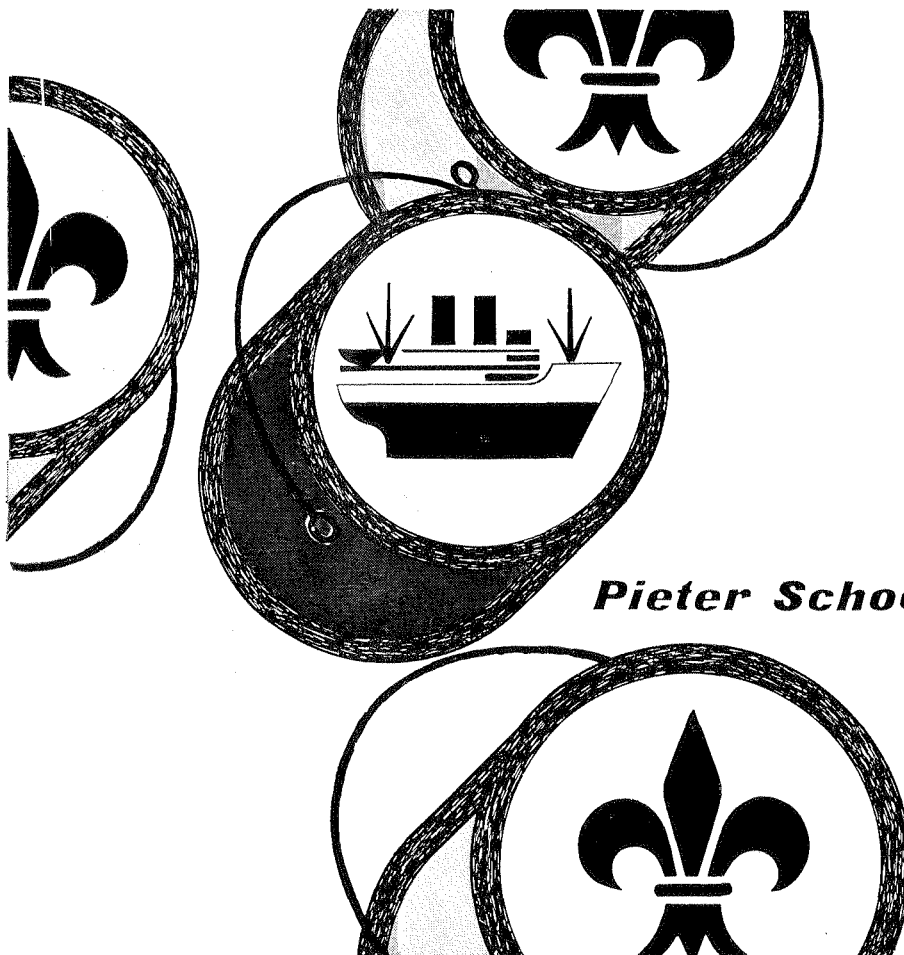
I suggest that the intelligent use of the air cushion principle could make life easier and more pleasant for many of us and I further suggest that, in the positions which you hold, you are the very people who could speed its adoption in many ways.

THE HISTORY OF AIR CUSHION VEHICLES

by **Leslie Hayward**

UK and Europe, 5s 6d (incl. postage)

Canada and USA, \$1.25 (incl. postage)



Pieter Schoen & Zoon Ltd.

MARINE PAINTS

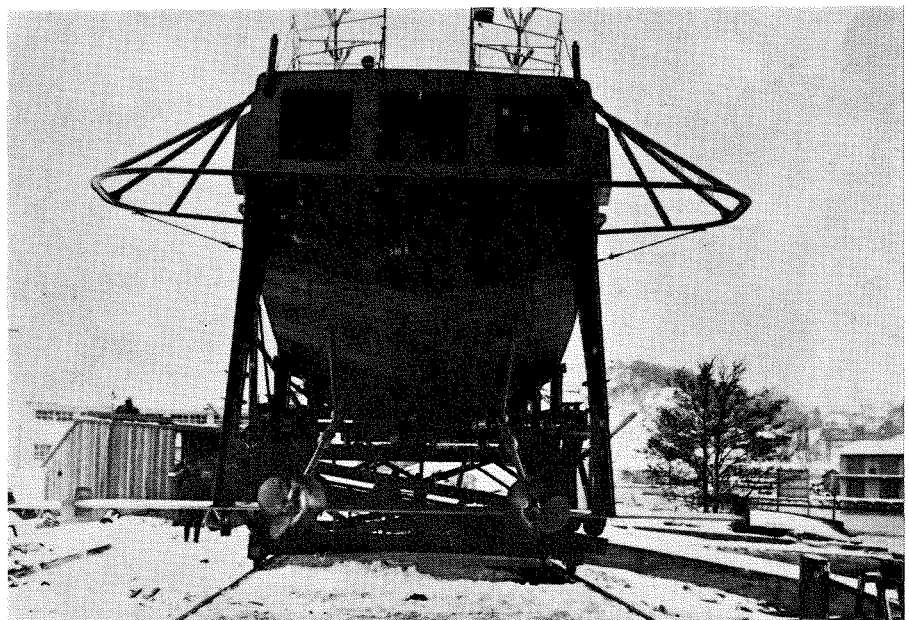
Stocks and agents
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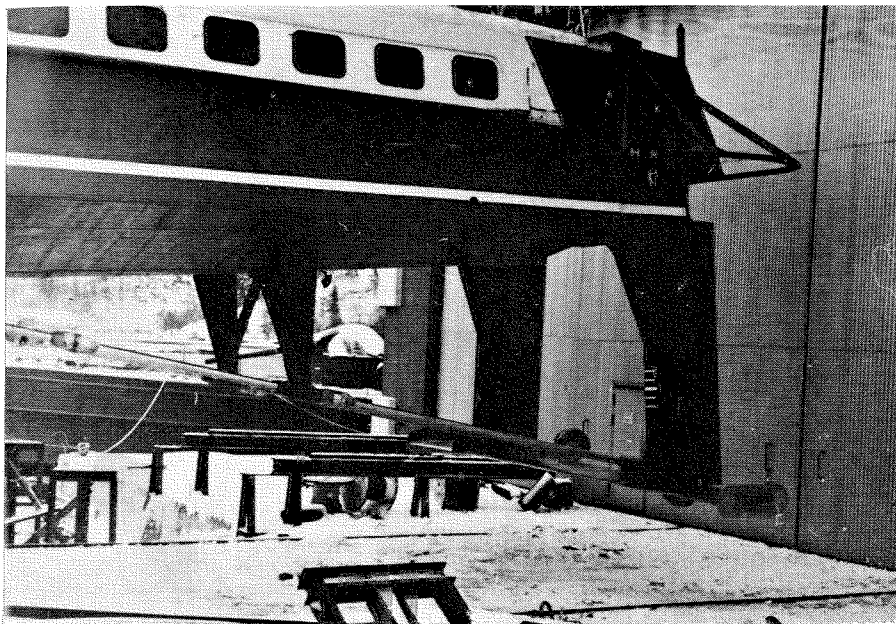
A Pictorial Introduction to the First Air-Stabilised Supramar PT 50 Hydrofoil

On February 8th, 1967, the first air-stabilised Supramar PT 50 hydrofoil craft *Flipper* was demonstrated at Mandal, Norway. The vessel had been built several years previously by Westermoen Shipyard, and at the end of 1966 supplied with a fully submerged air-stabilised rear foil in place of the conventional surface-piercing configuration. An article by Baron Hanns von Schertel, describing the system and the test trials appeared in the March, 1967, issue of *Hovering Craft and Hydrofoil*.

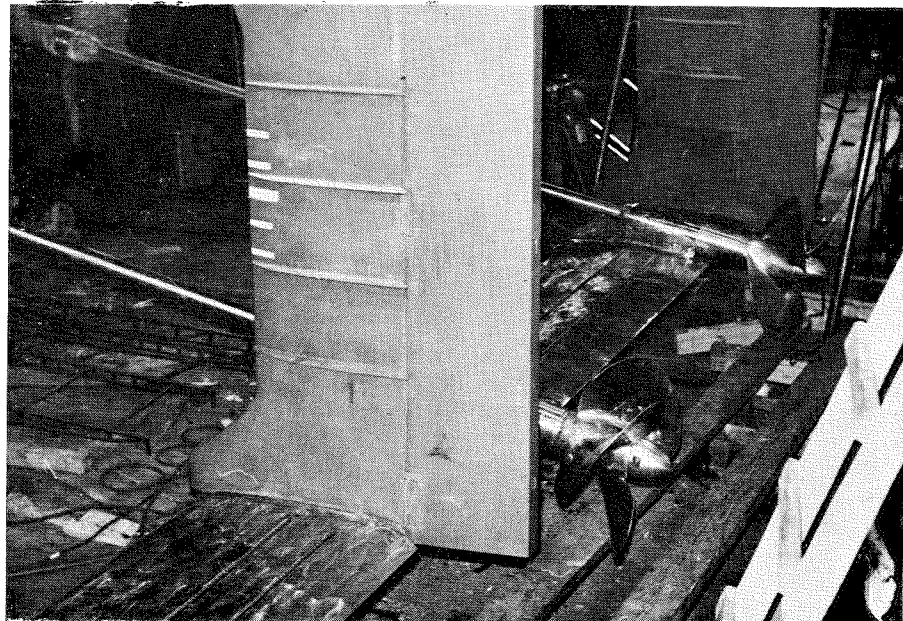
FOIL SYSTEM—Schertel-Supramar partly stabilised	BREADTH extreme	...	...	10.65 m
DISPLACEMENT IN FULL LOADED CONDITION	DRAUGHT floating	...	...	3.50 m
... 65 tons	DRAUGHT foilborne	...	...	1.40 m
LENGTH OVERALL	...	...	...	28.20 m

The vessel seen from astern. The stern foil's lifting support section is horizontal, and the propellers are situated abaft the foil. Notice the powerful repelling arrangement on the stern frame.

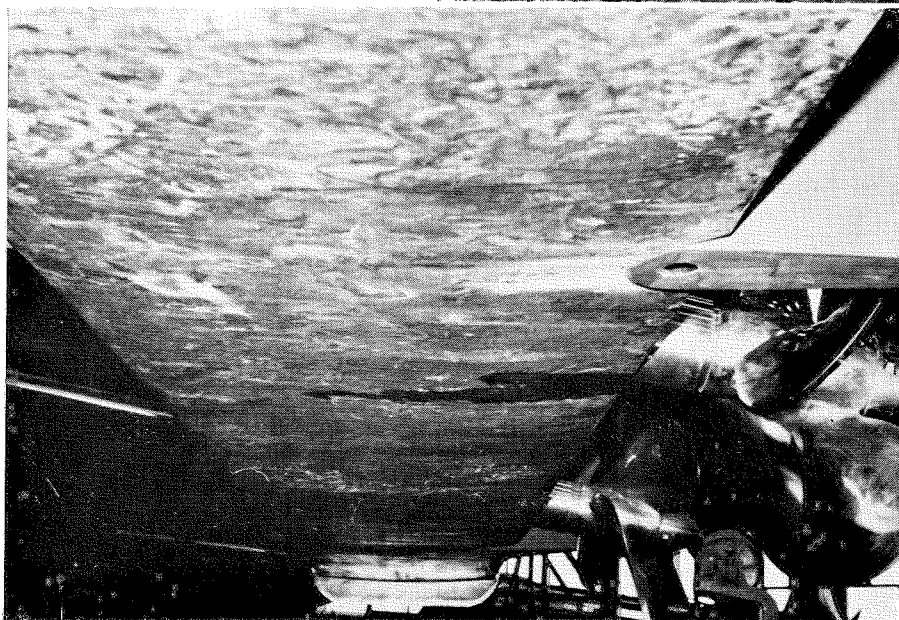




The stern foil seen from abeam. The foil supports, with depth marks, are clearly visible. The middle depth mark indicates the craft's "cruising waterline". The inclination of the propeller shafts is approximately 12° with the horizontal plane.

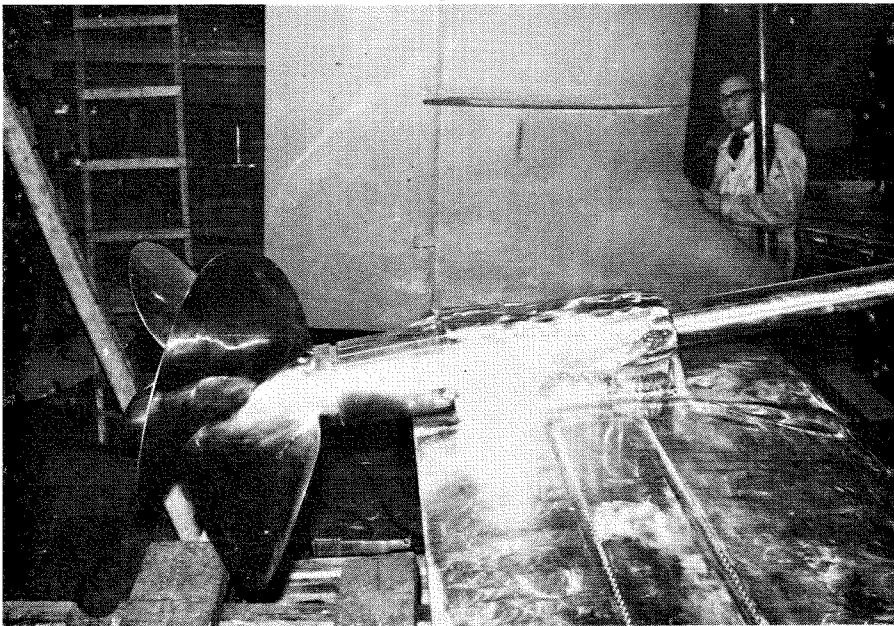
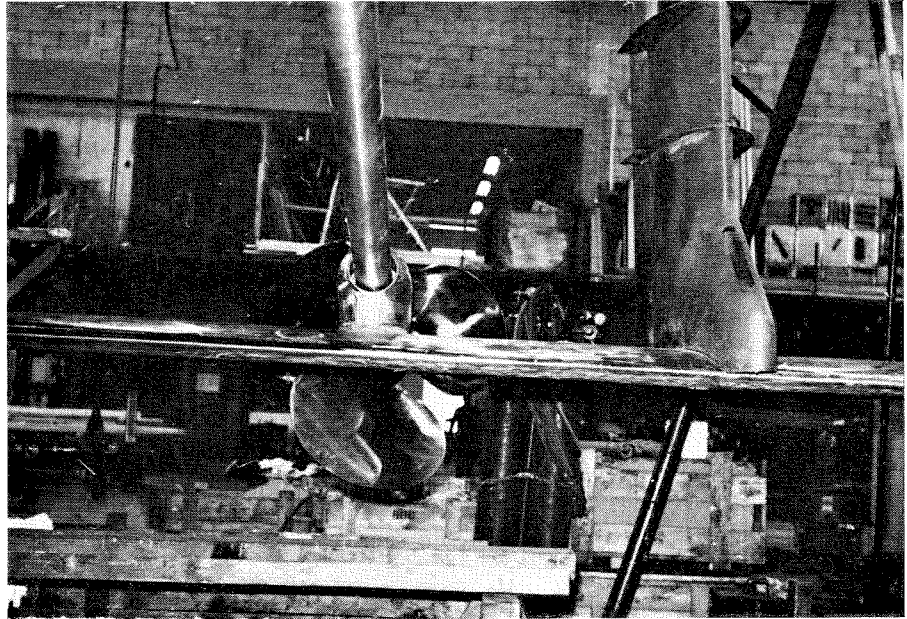


The photograph shows the upper side of the stern foil seen towards starboard, with foil supports; the air holes in the upper side of the foil are easily visible.



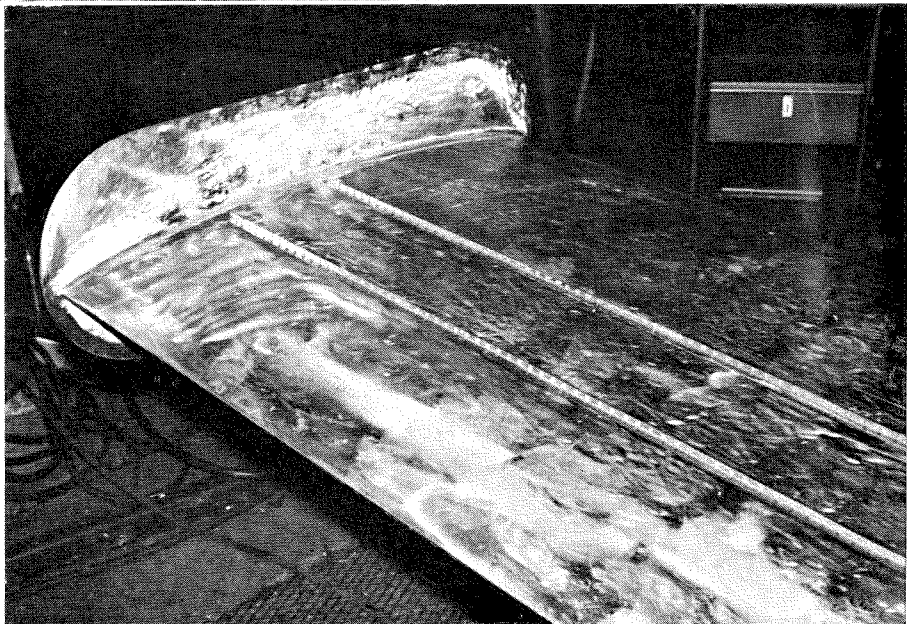
The underside of the stern foil with air bulkhead at the end, underside of rudders, and the propellers with streamlined bodies. The foil profile is based on the known NACA 66-Q10 profile.

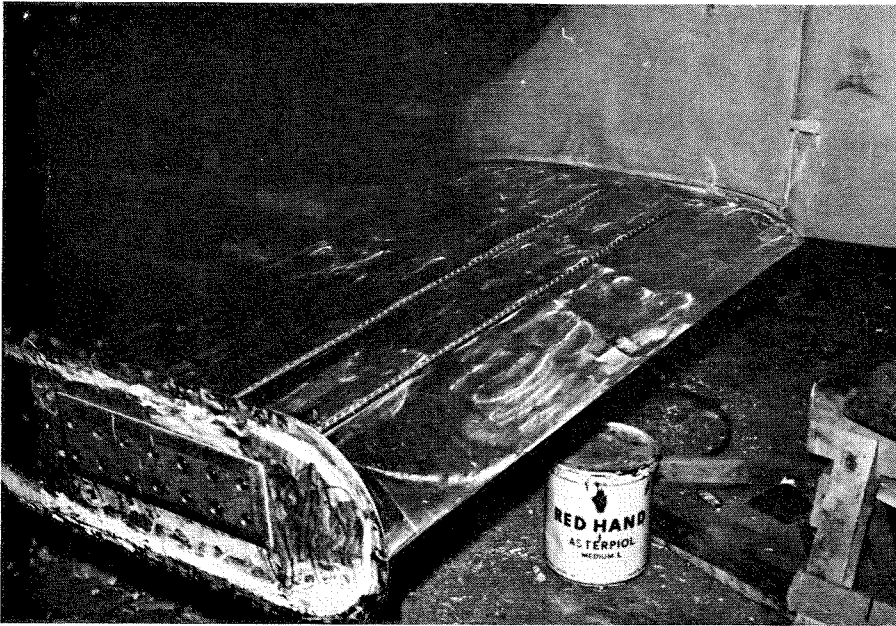
The foil seen sternwards shows the propeller shaft's housing in the bearing, and foil support with air bulkhead and opening for cooling water to the main machinery to port.



Propeller shaft with bearing. Streamlined body, propeller and boss. The foil support has six air holes on each side for propulsion of the two pneumatic servo controls. The two grooves, with air holes, are easily seen in the foreground.

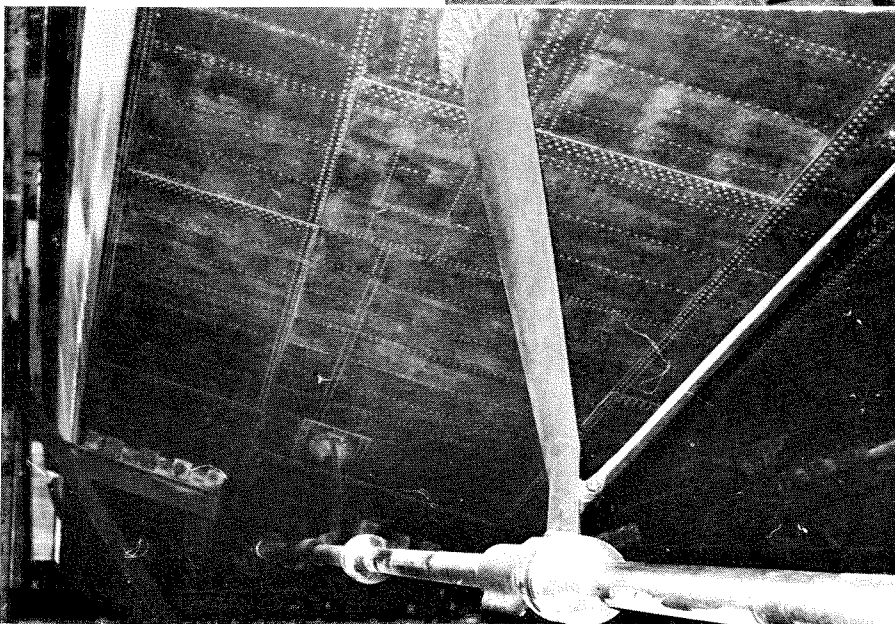
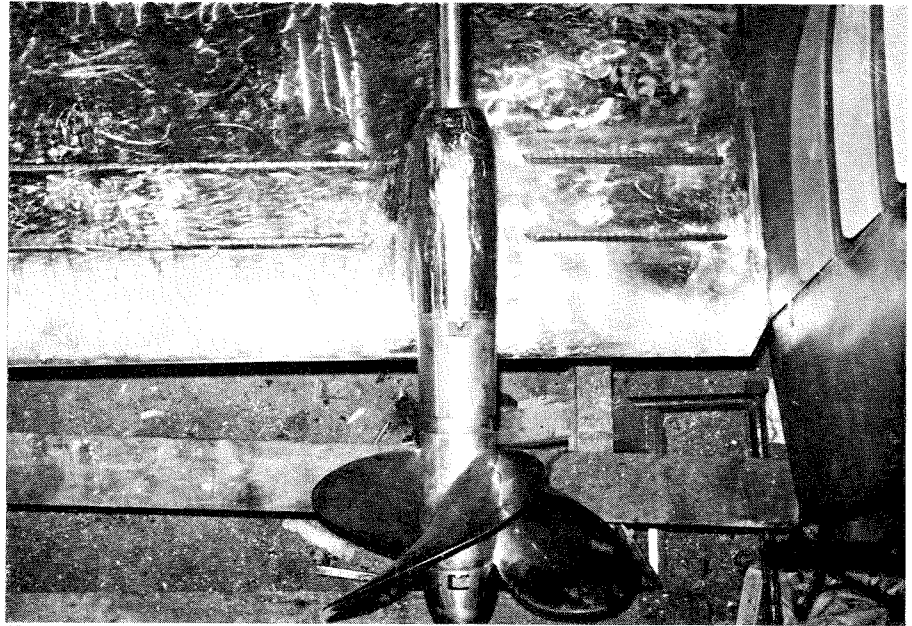
The stern foils, extreme port side, with air bulkhead at the end. The air holes extend to the foil tip to give maximum strength for the craft's gravitation point, for heeling moments.





The foil tip seen towards the centre line, with air bulkhead, two rows of air holes, and lower section of the foil support. The air bulkhead serves to maintain the foil's full lifting power at its extremities.

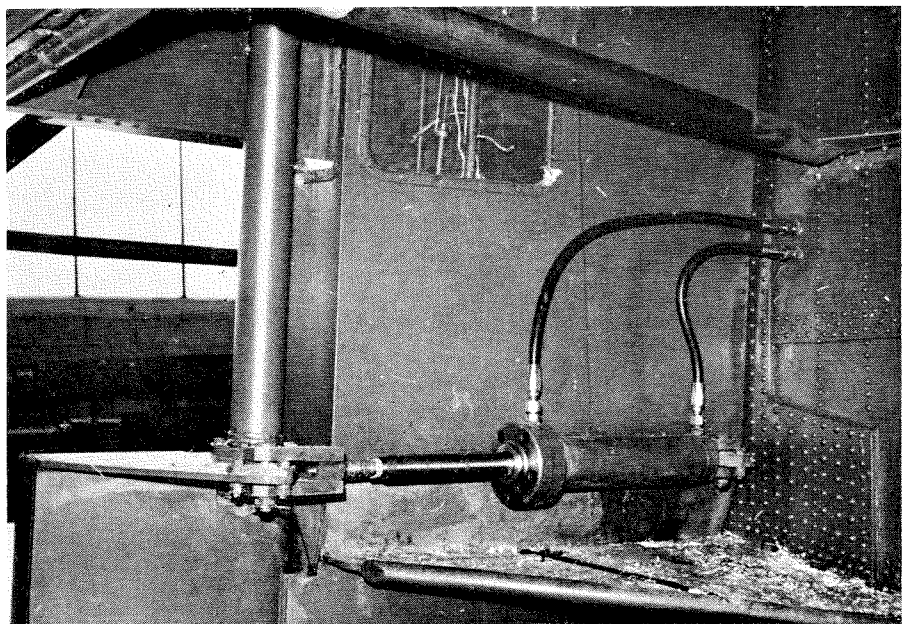
The foil in the vicinity of the propeller shaft bearing housing, streamlined body, propeller and boss. The foil support is on the right, with air bulkhead and rudder hinged at the aft edge.



The propeller shaft (diameter 90) is borne in four rubber bearings, type Continental — hardness shore 60°. It consists of three parts, and is joined with flange couplings which are packed in glass fibre reinforced plastic bodies. The photo shows the propeller shaft seen looking forward, with after and forward brackets, and with entry into the hull.



The upper section of the foil support, with rudder and rudder cylinder. The rudder shaft is extended upwards in compliance with the Shipping Directorate's demand for an emergency rudder.



The rudders are operated hydraulically by conventional hydraulic cylinders, which are coupled into the system which also operates the flaps on the bow foil. The base of the "black box", which contains the "brain" of the stabilising system, can be seen in the upper part of the photo.

Air Cushion Vehicles — A Selective Bibliography

(June-December 1966)

by A. A. West

INTRODUCTION

This bibliography supplements that which appeared in *Hovering Craft & Hydrofoil*, Vol 6 No 3, and is a selective, yet comprehensive list of the reports and papers on ACV fluid mechanics. Some references to ACV economics, power plants, control and handling, etc, are also included.

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ACKNOWLEDGMENTS

I would like to thank colleagues, both in this country and abroad, who have drawn my attention to miscellaneous reports, and the Science Research Council under whose sponsorship this bibliography was prepared.

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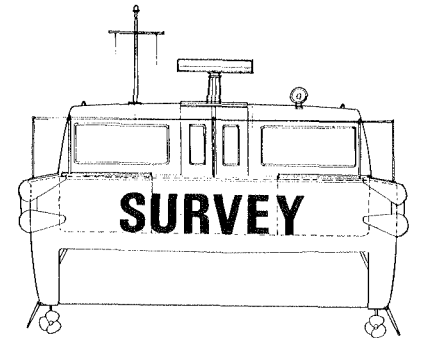
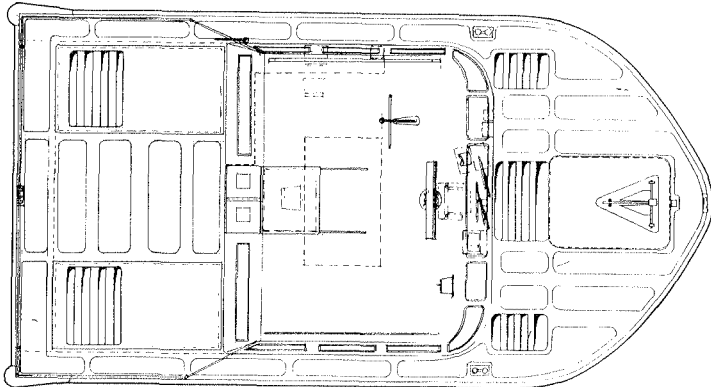
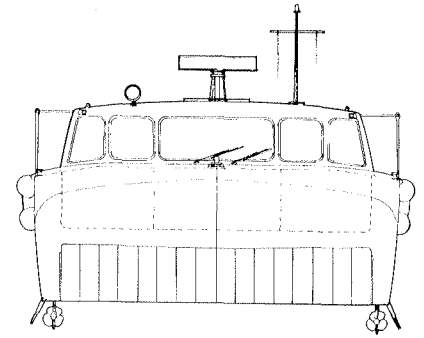
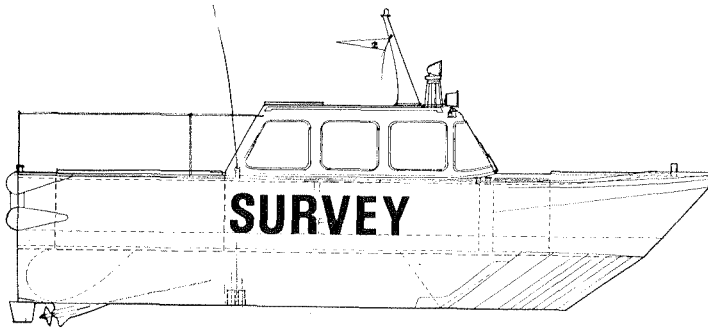
New Construction

A MESSAGE to builders of hovercraft and hydrofoil in all countries.

The number of craft being built of all sizes in various manufacturing countries is of considerable interest to all concerned in these two new industries. Existing ferry owners together with those who are not yet involved directly in the industries want to know who is building what and where. Manufacturers of equipment want to know who is likely to buy their equipment, and what progress is being made toward completion of the new building.

A number of marine journals publish such lists for the shipbuilding industry to the advantage of all concerned. It is felt that the time has come with the large numbers of craft that are being built and planned to justify this journal printing this information every quarter.

It would be appreciated if builders will take note that this feature is to be included as soon as possible and would they send in the information under the following headings: Yard Number; Builder; For whom ordered; Size; Power Unit; Seats; Completion Date.



Hydrography and Hovercraft

* A model and specification of a hovercraft designed for hydrographic survey work were displayed at the Ninth International Hydrographic Conference and Exhibition in Monte Carlo which ended on May 4th. Hovermarine Ltd has adapted one of its standard craft for such work, and experts attending the conference were asked to comment on the design.

THE HOVERMARINE HYDROGRAPHIC SURVEY CRAFT is a high speed sidewall hovercraft designed for operation in rivers, lagoons and estuaries where restricted draught conditions change due to tidal and other causes and constitute a hazard to deep draught vessels. The basic hull, which is constructed from glass reinforced plastics, and contains normal marine type machinery and associate systems, is similar to the standard range of Hovermarine craft designed for series production in England.

The principal particulars of the craft are as follows :

Length overall	36 ft	10.98 m
Beam overall	20 ft	6.09 m
Height above hovering waterline	11 ft	3.35 m
Draught hovering	2 ft 3 in	0.67 m
Draught floating	4 ft 10 in	1.47 m
Craft all up weight fully loaded ...	8.5 ton	8636.4 kg
Normal disposable load	2.5 ton	2540.0 kg
Cruise speed fully loaded calm conditions	35 knots	65 kmh
Normal operating range	150 nm	240 km
Craft capital cost (not including * survey equipment)	£30,000	

The craft has side keels (sidewalls) which extend below the base of the main hull to form a seal to the air cushion. The air is retained at the fore and aft ends by flexible skirts. The sidewalls house the echo sounding transducers which remain immersed even when the craft is "hovering" and underway at speed. Since the sidewalls extend into the water they provide a substantial "keel effect" which provides the craft with positive directional control. Also they provide roll stability in the same manner as a catamaran. There is very little spray generated when the craft is hovering and visibility from the cabin is excellent. The craft uses conventional marine handling and mooring methods.

Both the lift and propulsion systems are powered by well proven Cummins diesel engines. Other lightweight units (including petrol or gas turbine installations) may be accommodated to suit operators' particular requirements. Conventional marine propellers are mounted in line with, and below the sidewalls and further protected from surface debris by substantial skegs. The craft will operate at 35 knots in calm conditions and at 30 knots in 2 ft waves. The marine propulsion system used to propel the craft is of course quiet in operation and therefore will not cause any public disturbance when operating on waterways which are close to populated areas.

The hull, decks and superstructure which are constructed from glass reinforced plastics are very resilient and capable of absorbing the hardships encountered in normal service usage. The sidewalls are foam-filled and the craft has substantial reserves of buoyancy. In the unlikely event of lift engine failure the craft can make headway as a displacement craft at reduced speed. If required the craft can be designed to have a limited amphibious capability, that is, it can be brought up on to a suitable slipway or beach.

The craft will be constructed and fitted out in accordance with both Lloyd's requirements and the Air Registration Board's Rules for Air Cushion Vehicles.

Special Features for Hydrographic Survey Applications

The main cabin has dimensions of 14 ft long by 16 ft wide, which contains all the equipment for hydrographic survey work and allows ample room for the surveyor-in-charge, the helmsman and a crew member; a sliding hatch and door provide access to the cabin. The propulsion engine spaces which are sound insulated are abaft the cabin space and flush hatches are arranged above the engines so that they are readily accessible for routine maintenance. The rear deck space (10 ft long by 19 ft 6 in wide) is designed for the carriage of additional survey gear as well as providing a useful working platform for mooring the craft, etc. The lift engine compartment is below the foredeck and again a large hatch is provided for access to the engine and lift fans.

The disposition of the survey gear is obviously a matter for each hydrographer's preference. The apparatus illustrated on the General Arrangement is as follows:

- * Echo sounding equipment consisting of transducers mounted in the sidewalls, a transmitter and a recorder.
- * Radar equipment comprising scanner, transmitter and display. The display is arranged so that it is conveniently sited for the surveyor-in-charge and the helmsman.
- * Automatic pilot including autohelm control and course selector.
- * Standard navigational equipment including compass,

helm indicators, chronometer, chart table, etc.

Depending on the application envisaged other features eg galley space, toilet and wash-room can be incorporated. Additional fuel tank space can be readily accommodated if longer ranges are required.

The Potential Advantages of the Sidewall Hovercraft as a Hydrographic Survey Craft

The principal advantage that the sidewall hovercraft offers to the hydrographer is speed. Speed of surveying may be radically increased and speed to and from the area under survey means that days, even months on occasion, may be saved by being able to "catch a tide". The draught of this craft (2 ft 3 in on the waterscrew propelled craft and 1 ft on the developed water-jet version, when hovering allows it to operate in shallow water regions with ease. Discussions with survey instrument manufacturers have assured us that their instrument speeds with increased paper output speed can accept these much higher surveying speeds (in excess of 30 knots).

The air cushion provides the craft with a pneumatic damping system which is particularly advantageous when operating in choppy sea conditions. Under such conditions the hovercraft will provide a much smoother ride than a similar planing craft and the craft will be less affected by the sea conditions. This relative insensitivity of the craft to waves of smaller amplitude than the sidewall depth means that surveying can continue at speed in wave amplitudes of up to 3 ft. In rougher sea conditions surveying could still continue by operating the craft at a lower speed.

The hovercraft provides a stable easily controlled platform with adequate reserves of buoyancy when floating. The material used in the main structure — glass reinforced plastics — is robust and resilient and easily repaired in the event of damage. Furthermore, being non-magnetic and acoustically "transparent" it has distinct advantages for echo sounding applications.

The diesel engines of both the lift and propulsion systems are of similar family of manufacture consequently spares holdings may be kept to a *minimum*. The engines are modestly rated in this application (100 hp for lift, 160 hp each for propulsion) and a long "time between overhaul" period is virtually assured. Marine propellers are shown on this craft although later versions may employ water-jets. The wide spacing of the propeller thrust lines means that large turning moments may be effected at low speeds and very tight turning circles can be achieved, station keeping characteristics are also improved.

Spacious cabin and deck spaces are provided on a near-rectangular platform. This means that much more effective cabin and deck space is provided compared to a similar length displacement craft. The disposition of instruments to the hydrographer's preference can be readily achieved and additional equipment or personnel may be readily carried up to the design disposable load without loss of performance.

If there is a need to bring the craft up on to a slipway or on to the stern ramp of a mother ship then Hovermarine can provide this facility at slightly increased cost without detracting from the advantages previously outlined. The basic operating cost assuming a 10-year craft life and 1,000 hr per year utilisation amounts to approximately £10 per hour.