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Omslag

Wereldscheepsbouw toch uit het dal?

In het commentaar op de meest recente statistieken over de wereldscheepsbouw van Fairplay International Records & Statistics (FIRS) wordt gezegd, dat het afgelopen jaar toch minder hard is aangekomen dan aan het einde van 1978 werd gevreesd en dat er aanwijzingen zijn om op een langzaam herstel van de vraag naar nieuwbouw te rekenen. Bemoedigende conclusies dus, die geschraagd worden door enkele belangrijke cijfers.

In 1979 werd er over de gehele wereld voor 29,5 miljoen dwt nieuwbouw in bestelling gegeven, meer dan het dubbele van de 13,6 miljoen ton, waarvoor een jaar eerder contracten werden getekend. Nederland heeft helaas niet aan deze opleving deelgehad: kwamen er in 1978 voor ons land bestellingen voor 114.334 dwt uit de bus, in 1979 was daarin met 110.720 ton nauwelijks enige beweging gekomen.

FIRS stelt dan ook nadrukkelijk voor ons land vast, dat er 'veel' te weinig orders voor de in nood verkerende Nederlandse scheepsbouw binnenkwamen' en dat het grote merendeel daarvan dan nog voor binnenlandse rekening was. Een uitzondering moet worden gemaakt voor de met veel verlies geboekte order door Van der Giessen-de Noord voor twee containerliners voor de Zim en voor een produktencarrier van 2100 dwt, welke Pattje van Britse zijde ontving.

Tenslotte wordt met name genoemd de waardevolle order die de IJssel-Vliet combinatie boekte van de Nederlandse 'Deen' Marinus Smits voor de bouw van twaalf schepen van 2500 dwt elk, een opdracht die een waarde heeft van ƒ 150 miljoen en waarvoor ook de Nederlandse overheid fors in het krijt is getreden. Maar dat was dan voor Nederland wel ongeveer alles.

Oneindig veel indrukwekkender is weer het nieuws van Europa's eeuwige concurrent Japan. Zij die van mening waren, dat ook dat land langzaam terrein had verloren aan andere interessante scheepsbouwlanden, zoals Zuid-Korea, Brazilië, Polen en Spanje, dienen zich aan de hand van de FIRS-statistieken te realiseren, dat l'histoire, voor zover het Japan betreft, se repète; achteraf bezien misschien niet zo verwonderlijk.

Terwijl eensdeels door de geheel andere economische en sociale structuur van het Westen, anderdeels door de behoefte om in het Westen altijd enorm veel stampij te maken, de inkrimpingen en aanpassingen in de diverse scheepsbouwnaties daar het karakter kregen van een ware, en vooral luidruchtige revolutie, gingen de Japanners in alle rust en doelmatigheid over tot het af- en bijschaven van hun werfcapaciteit, om, toen er eenmaal weer nieuwbouworders opdoken, beter dan het Westen tot ontvangst daarvan bereid te zijn.

Ziet naar de resultaten: van alle contracten welke het vorig jaar werden geplaatst ging 52 procent naar Japan, naar tonnage gerekend: 15,3 miljoen ton, om exact te zijn.

Er zijn een aantal direkt aanwijsbare factoren, die op deze gang van zaken van invloed zijn geweest. De Japanse werven kwamen met hun waardevermindering van de yen tegenover de Amerikaanse dollar gunstig te zitten; tal van contracten werden dan ook meteen genoteerd op basis van de Japanse munt waarin betaald moet worden. Ook het besluit van de OESO om de kredietvoorwaarden voor bestellingen te herzien in die zin, dat er voortaan tachtig procent in plaats van zeventig over 8½ jaar, in plaats van 7 jaar, moest worden afbetaald, deed een stroom van rederijen, die op de verbetering van deze voorwaarden hadden zitten wachten (zoals in Noorwegen) onmiddellijk naar Japan koers zetten.

De Japanners hebben bovendien met name geprofiteerd van de niet te lessen dorst naar nieuwe schepen onder de in Hongkong gedomicilieerde rederijen: van

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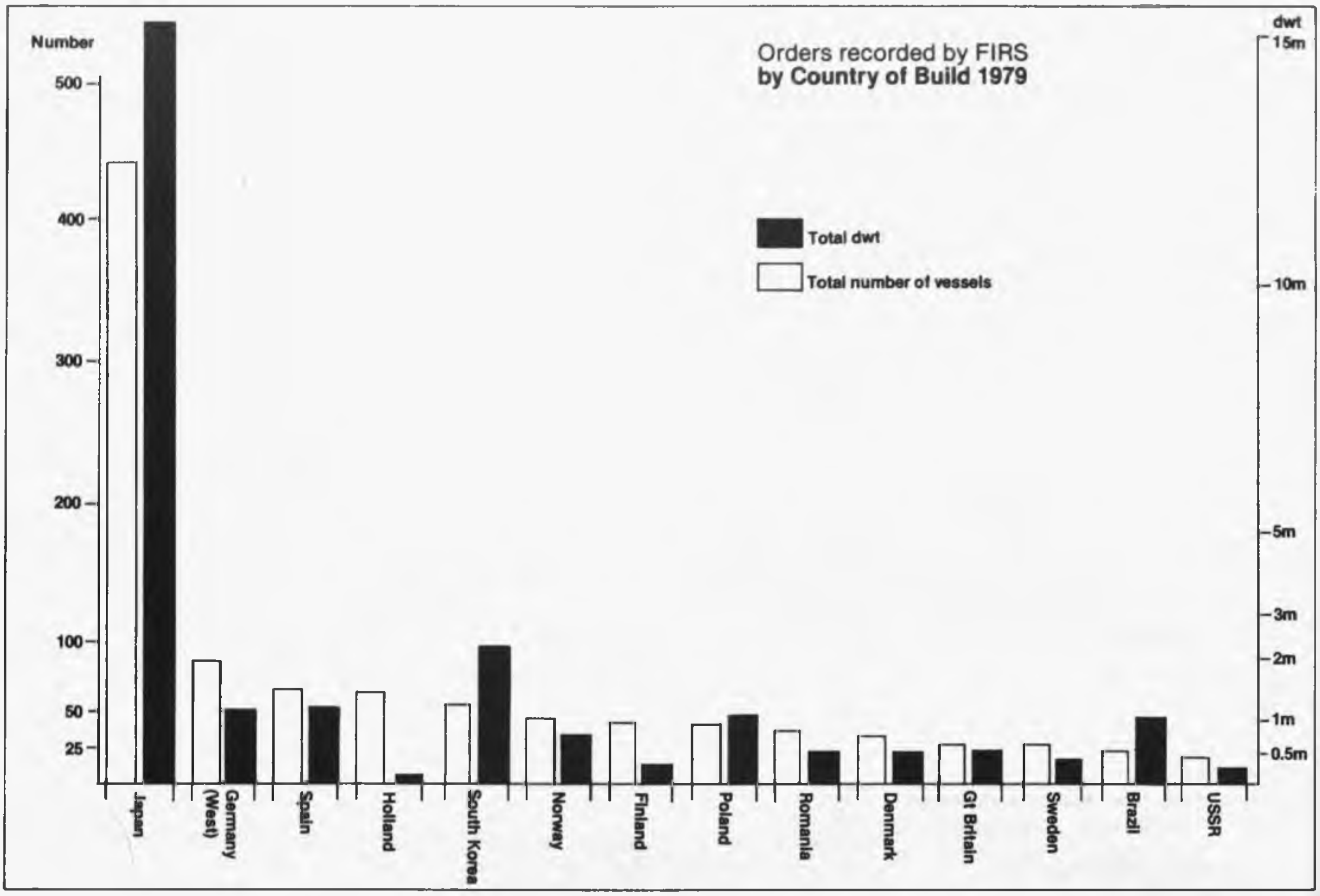


Uit deze grafiek blijkt de enorme voorsprong van Japan in 1979 bij het bemachtigen van nieuwe orders. Nederlands aandeel komt met recht nauwelijks kijken.

de 73 schepen die vanuit deze Britse kolonie werden besteld gingen er niet minder dan 58 naar Japanse werven. Wat dan ook de beweegredenen mogen zijn van de 'Hong Kong operators' om zoveel nieuwe tonnage te bestellen, Japan ligt daar kennelijk weer even goed in de markt als vroeger het geval was met de speciale transacties.

De in drommen opdagende Noren waren in Japan meer dan welkom, zij krijgen in elk geval een heel wat warmer onthaal dan de Grieken, die bij de Japanse bouwers niet meer zo hoog staan aangeschreven sinds zij in de depressiejaren weigerden om voor bestelde schepen te betalen. Ishikawajima-Harima moest daarvoor bijvoorbeeld 42 contracten voor 'Fortune'-schepen elders zien onder te brengen of anders annuleren.

Sinds enige tijd kloppen ook veel West-duitse reders op Japanse deuren; het blijkt, dat de scheepsbouwkosten in West-Duitsland zo hoog zijn gestegen, dat de bedrijven liever naar Japan gaan, ondanks de zeer aanzienlijke subsidies van de overheid.

Een blik op de overige verdeling van de wereldorders leert dat geen enkel land ook maar in de schaduw kan staan van Japans 15 miljoen ton. Op zeer grote afstand volgt als tweede Zuid-Korea met een totaal van 2,2 miljoen dwt nieuwe opdrachten, en daarna komen vier landen met elk meer dan één miljoen ton: Spanje, Polen, West-Duitsland en Brazilië. Onder de éénmiljoengrens komt Noorwegen nog als beste tevoorschijn met 844.125 ton, maar van de vroegere Europese giganten zijn maar weinig evidente sporen te vinden. Groot-Brittannië kwam op 560.240 ton, Zweden op 474.050 ton, Frankrijk en Italië op resp. 151.250 en 106.070 ton. Veelzeggend is dat de povere Nederlandse resultaten nog werden overvleugeld door België, waar voor 358.200 ton aan nieuwbouw binnenkwam, o.a. van de onstuitbare Tsvi Rosenfeld en zijn Antwerp Bulk Carriers.

Overigens stond het afgelopen jaar in het teken van de verhoogde belangstelling voor de bulkcarriers, waarvan er 314 werden besteld van samen 11 miljoen dwt. Het is nog te vroeg om te stellen, dat deze trend zal voortduren, al is het wel zo, dat de contracten voor het allergrootste merendeel werden geplaatst op basis van een reeds gesloten charter. In die hoek zitten ook de meeste opdrachten uit het schepenparadijs van Hongkong (45 schepen van 2,7 miljoen dwt) en de grootste uitdeler van al dat goeds was Sir Yue Kong Pao met zijn World-Wide Shipping.

In de eerste helft van het jaar was er een bovenmatig grote belangstelling voor tankschepen van 80.000 dwt of daaromtrent, die moeten beantwoorden aan de nieuwe eisen van IMCO inzake de bestrijding van vervuilingen (Zoals bekend, worden deze voorschriften in het verkeer op de USA in juli 1981 van kracht). In de laatste zes maanden van het jaar trokken daarentegen produktencarriers van 30.000 dwt en bulkcarriers van het 'Panamax'-type de meeste aandacht; naar FIRS vermoedt, als gevolg van de gestegen tonnagebehoeften voor het vervoer van graan naar de Sowjet Unie, waaruit de belangstelling voor meer bulkers in het algemeen is voortgevloeid. Of deze trend er nu, als gevolg van de recente politieke gebeurtenissen, nog steeds in zit, moet worden betwijfeld.

Tenslotte lijkt het er op of veel Europese overheden een beetje moe zijn geworden van het uitbetalen van subsidies aan de werven. Het trieste resultaat is in veel gevallen, dat het geld in een bodemloze put verdwijnt, zoals ook in Nederland hier en daar is gebleken. Dat zelfs gesubsidieerde werven het niet kunnen bolwerken is een bewijs voor de stelling, dat de vraag naar tonnage in de subsidieperiode van nature ongezond is. Het lichtpunt is dat, naar het wereldtotaal gemeten, mogelijk toch het tijdperk van een geleidelijk herstel is aangebroken.

De J.

Progress on the development of the Doxford Oil Engine* I

By G. G. Jackson**

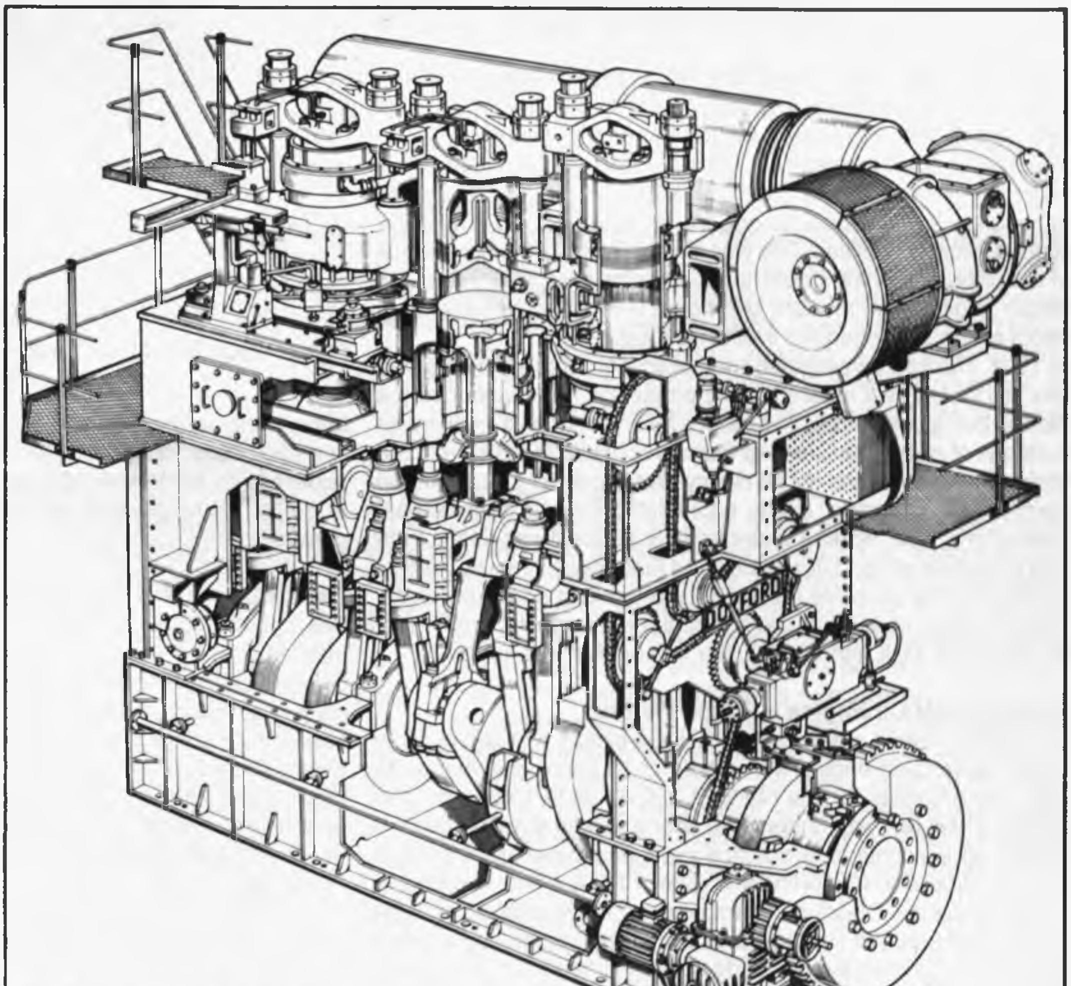
SYNOPSIS

For many years, Doxford have been the only British-Designer of large high-powered, direct drive oil engines for marine propulsion, and in particular are the only company in the world to have produced large three cylinder opposed piston marine oil engines, in the first instance as normally aspirated and now as constant pressure turbo-charged units.

Reference is made to the evolution of the internal combustion engine, and a brief history of the development of the opposed piston engine is followed by an explanation of the advantages of the opposed piston configuration, which enables a range of engines to be designed and developed with excellent balance characteristics, low stresses and a minimum number of holding down bolts. Crankshaft and crosshead development are discussed as well as cylinder liners and cylinder lubrication etc. There is some discussion of progress as wel as some detailed improvements in current engines which have contributed to improved performance, reliability and ease of maintenance.

Due to the intensive distillation and cracking of crude oils, mention is made of 'problem fuels'.

Reference is also made to the latest design of constant pressure turbo-charged 580 mm bore short stroke three cylinder engine which has the ability to burn low grade fuels without seriously increasing maintenance costs. The proposed new simplified starting positioner for three cylinder engines is mentioned. The first of a series of vessels the 'City of Plymouth' to be fitted with the 58JS3C engine, is already at sea and has been operating on homogenised fuel. Other vessels will follow in the very near future. A general description of these vessels has been given.



THE DOXFORD 58JS3C ENGINE.

* Tekst van de lezing gehouden op 13 dec. 1979 te Rotterdam en op 14 dec. 1979 te Amsterdam voor de leden van de NVTS.

** Technical Manager Liaison Doxford Engines Ltd. Pallion Sunderland England.

1. HISTORICAL INTRODUCTION

It is commonly understood that in an internal combustion engine, an explosion takes place in a cylinder which causes a force to move a piston. About 1680, a gentleman called C. Huygens and then Messrs Papin and Haatville, tried to bring about a continuous sequence of events from successive explosions by gunpowder in a cylinder fitted with a piston. 140 years later in 1820, Farish of Cambridge built a small engine to be driven by gunpowder. At that time, the idea of driving a piston by a force or explosion was commendable but the means proposed was impractical and was flirting with disaster.

At Cambridge in 1820 there was also evolved what is probably the first working gas engine. Cecil used as his fuel, an explosive mixture of hydrogen and air and this was used in engines invented by other people.

Beau de Rochas in 1862 laid down the principles to be adopted to obtain maximum economy for gas engines, and this was suction, compression, explosion and expansion then exhaust, in effect a four stroke engine. In 1876 Dr. Otto, working on the de Rochas or four stroke cycle, improved the efficiency of the principle by using flame ignition, this was really the beginning of the internal combustion engine as prime mover. (1)

Other engineers, although appreciating the work done by de Rochas and Otto, considered that there was a disadvantage in this sytem, because there was only one working stroke in every four strokes of the piston, and the only way to obtain smooth running of the crankshaft was to fit one or two large flywheels to iron out the cyclic variations.

Credit must be given to Clerk, who in 1881 at the Paris Exhibition introduced the world to two cycle operation for an internal combustion engine and to Herbert Akroyd-Stuart for demonstrating at Bletchley, Buckinghamshire in February 1891 the benefits of compression ignition, and in 1897 the engine of Dr. Rudolf Diesel, although at first designed to operate on coal dust, confirmed the Akroyd-Stuart principles. This was the beginning of the dominance of the oil engine which would, to a great extent, replace that of the steam engine. The modern oil engine is a collection of various peoples' ideas expounded in different ways.

In 1902, Doxford investigated the application of gas engines and gas producers as a means of ship propulsion but abandoned the idea as being unsuitable. This search for an alternative to steam as a means of ship propulsion led them to consider in June 1905 the immense potentialities for efficiency and economy of the internal combustion oil engine. It was appreciated that such an engine, operating at sea, worked under entirely different conditions from that prevailing on land. It was decided that this problem could only be resolved by intensive research, development and experiment. Designs were made, changed and scrapped. A special experimental shop was built and in 1911 the first engine was running.

Experimental Oil Engine – Single Piston

This engine was a single cylinder, single piston, two stroke cycle valve-scavenging engine with a bore of 19.5 ins., a stroke of 37 ins., and a normal service rating of 250 b.h.p. at 130 r.p.m. The design of this unit was undertaken after a careful study of the best contemporary continental practice and it was to represent a single unit of a proposed four cylinder engine of 1,000 b.h.p. The engine operated on the Diesel constantpressure cycle with air or blast injection of fuel, the compression and maximum pressure being about 35 bar. The mechanical design being based as far as possible on the characteristically rugged construction of established marine steam reciprocating engine practice.

Experimental work, between 1911 and 1912 proved that this engine was capable of exceeding its designed performance, but several inherent weaknesses were disclosed. This engine suffered from the same problems as other orthodox two-stroke cycle engines at this time. There were defects in the cylinder cover, which was weak due to large valve pockets and suffered from high pressure and thermal stresses. The transmission of heavy loads through the engine structure and main bearings, plus a high lubricating oil consumption created difficulties. After some months of experimental work, a decision was taken that only a drastic change in design could produce an engine reliable enough for marine purposes.

Fig. 1. Experimental Oil Engine – Single Piston (1911).

Oechelhauser Gas Engine

The principle of exhausting an internal combustion engine by means of the piston uncovering ports positioned at the extremity of its working stroke had been extended to utilise two pistons performing work in one cylinder by moving away from the combustion space at the centre. This had been used with some success in the Oechelhauser gas engine at the end of the last century.

Fig. 2. With this engine, one piston drove the crankshaft by means of a centre connecting rod whilst the other piston acted on a transverse beam attached to a pair of reciprocating rods, each

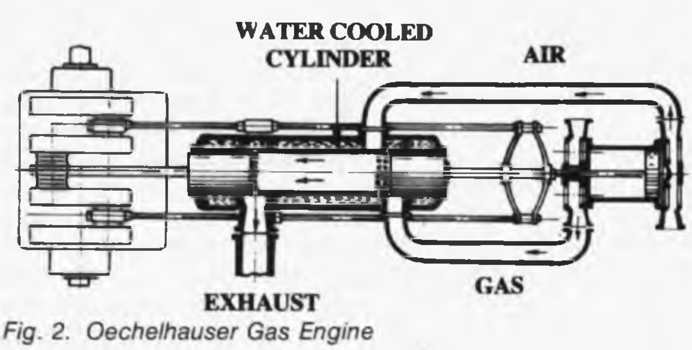


Fig. 2. Oechelhauser Gas Engine

acting as a piston rod for a supplementary crank at either side of the centrally directly-driven crank and pitched at 180 deg. to it. In spite of the rather disappointing continental experiences with opposed piston oil engines, and to overcome the never ending problem with cylinder covers and structural stresses, Doxford decided to apply the principle to their second experimental engine and so eliminate cylinder covers at the same time provide even better scavenging than the port and valve arrangement of the first engine; the high gas loads from the pistons would be carried on the running gear and crankshaft and not transmitted through the engine frame. The main bearings were relieved of combustion loads and the engine frame had only to withstand torque reaction forces. It was realised that, although the crankshaft was more complicated than in orthodox engines, the removal of the heavy combustion loads from the main bearings would considerably reduce wear-down and help to eliminate the danger of crankshaft failure from bending-fatigue stresses. In addition, the safety of the crankshaft was enhanced by the use of spherical bearings, which permitted the slight displacements necessary to accommodate distortion under load. With the design as it was then, this was a wise precaution.

Fig 3. Experimental Opposed Piston Oil Engine 1914

First Experimental Oil Engine – Opposed Pistons

The first experimental Doxford opposed piston oil engine, designed in 1913, was a single cylinder unit with a bore of 500 mm and a stroke of 2 × 750 mm, and a normal service rating of 450 b.h.p. at 130 r.p.m. It represented one unit of a four cylinder engine to give 1800 b.h.p. Fig. 3. The engine was designed to operate on the Diesel constant-pressure cycle with air-injection of fuel, the three stage air compressor and scavenge pump being driven by levers from the centre connecting rod crosshead. The air injection pressure was between 98.5-112.5 Bar, compared with the more conventional 60-70 Bar. The two fuel valves at the combustion space were arranged to deliver slightly tangential to the bore to encourage a certain amount of swirl during the injection period. The distance between the flat topped pistons when at inner dead centre was 75 mm. Each fuel valve had two saw cut orifices 50 mm apart, and these were arranged to discharge a flat sheet of oil mist across the face of the adjacent piston.

The engine began testing in July 1914 and after some preliminary running at load well in excess of its designed rating, on the 16th November 1914 at 19.13 hours it started a continuous run at full power under the supervision of Lloyd's Register, which was to be completed at 10.00 hours on 21st December 1914. The performance figure was 630 i.h.p. at 115 r.p.m. with a mean indicated pressure of 120 p.s.i. and a mechanical efficiency of 75%. Fuel consumption 194 gr. per bhp/hr., using a Mexican fuel with an S.G. of 0.91 and containing about 3% sulphur.

During experimental running in 1916, the air compression piston seized due to a lubrication problem and it was decided to eliminate blast injection and concentrate on the common rail fuel system with solid injection of fuel. (2) This was successful, and the engine never worked again on the constant pressure cycle of Dr. Diesel's patent. Distilled water was used from the very beginning for cooling purposes. The first engine produced for ship propulsion had four cylinders of 580 bore with 2 × 1160 stroke, and produced 3,000 b.h.p. at 78 r.p.m. The engine weighed 400 tonnes and was 17.25 metres long. These engines represented the largest horse power per cylinder and total power on a single screw at that time. The first engine went to sea in 1921 in the 'Yngaren'. It was subsequently followed by many more, such as the m.v. 'Pacific Commerce' in February 1922 and continued in service, in later years as the 'Norbryn' until 1958.

First 3 Cylinder Engine

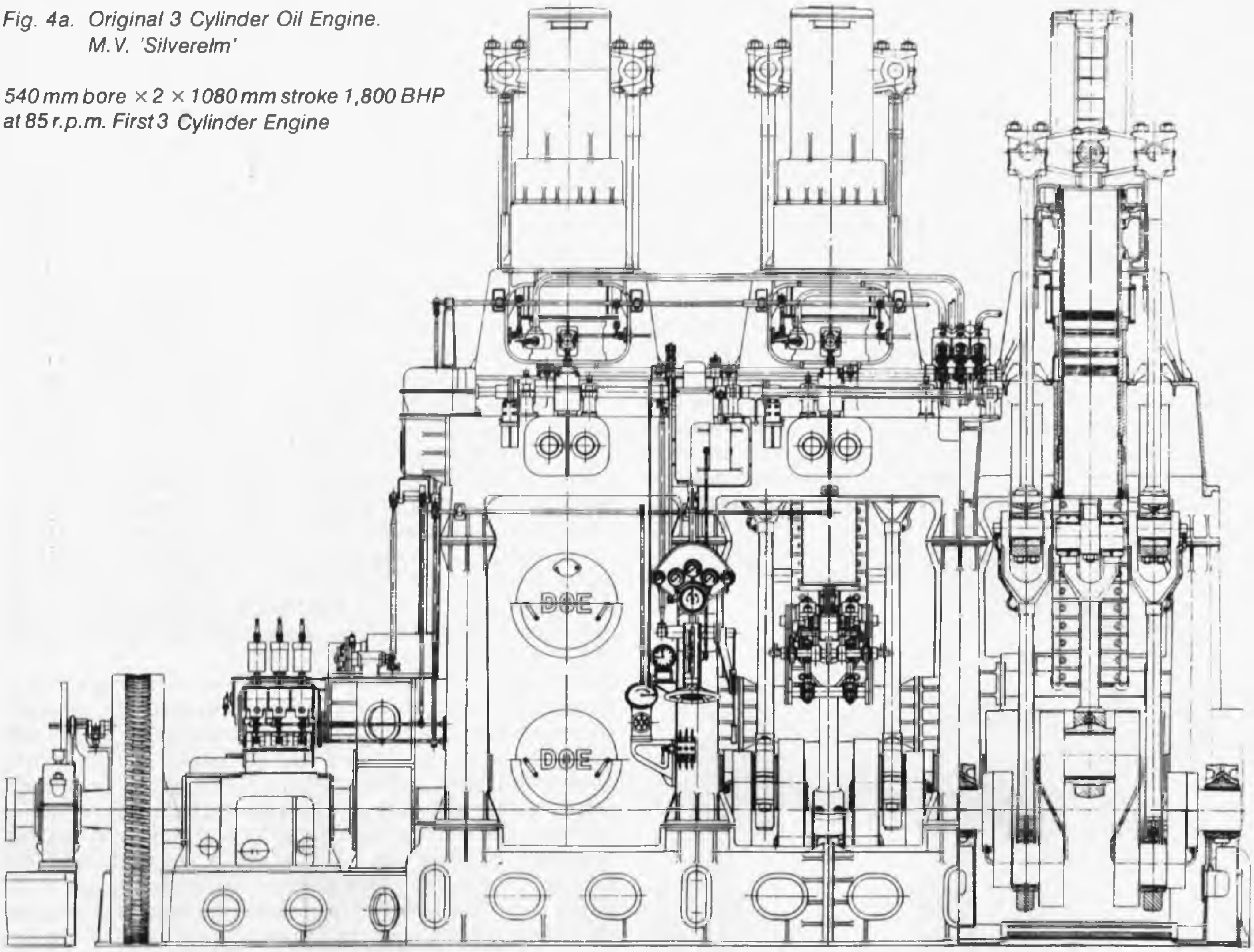
To compete with the steam engine, which was popular with tramp steamers, Doxford, in 1924 produced their first three cylinder engine (fig. 4a) of 540 mm bore by 2 × 1080 mm stroke, developing 1,900 b.h.p. at 85 r.p.m. with an overall length of 11,100 mm (37'6"), height 9,114 mm (30'0") and a maximum width of 5,410 mm (17'9") the weight being 220 tons, with a power to weight ratio (h.p./ton) of 8.9/1. The engine drove its own auxiliary pumps, i.e. lub. oil, sea water and distilled cooling water. The front and back camshaft were driven by gears from the crankshaft. The engine was fitted into a vessel (Fig. 4b) the 'Silverelm', which was broken up thirty six years later in 1960. About 140 normally aspirated three cylinder engines have been built since that time, with cylinder bores down to 400 mm and powers as low as 650 b.h.p.

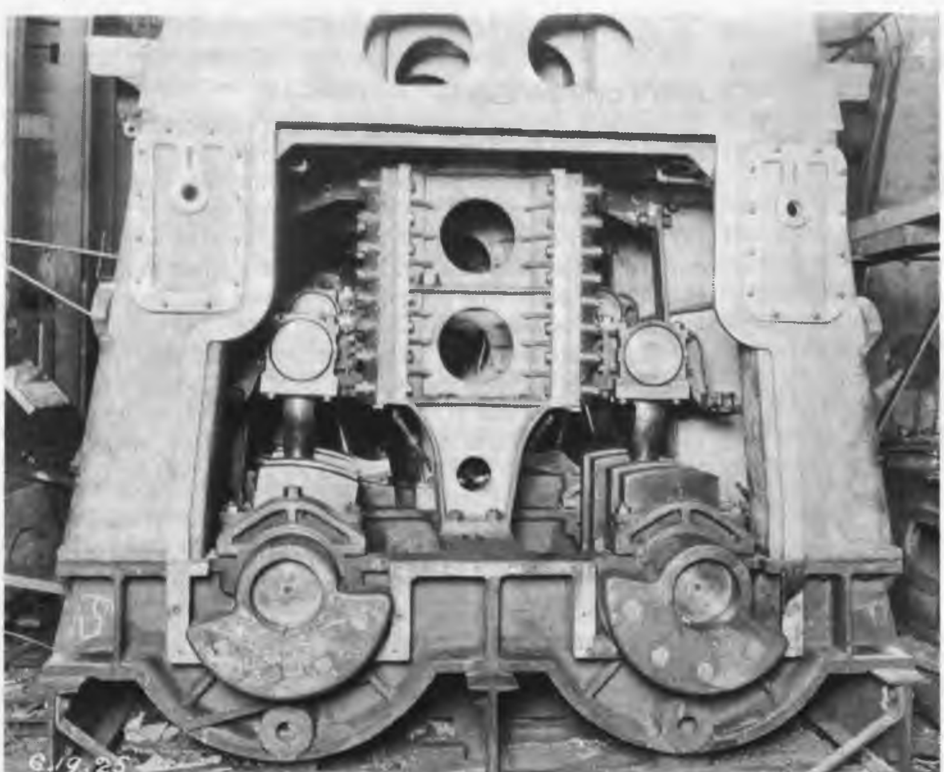
Twin Bank Engine

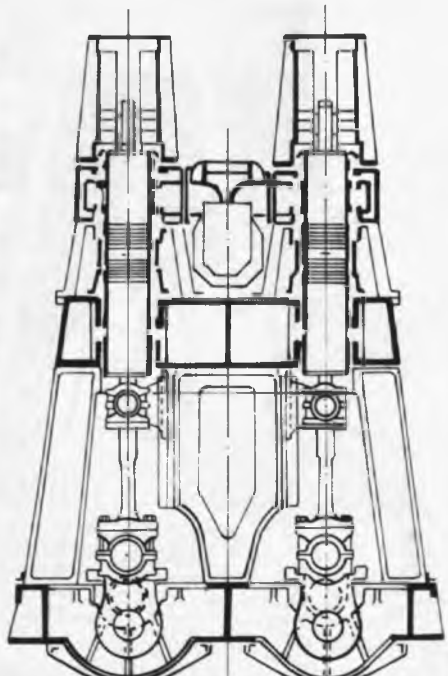
In 1925, Sun Shipbuilding & Engineering Co. of America built a twin bank Sun Doxford opposed piston engine which had two rows of 13" bore cylinders arranged on a common bedplate, each with its own crankshaft driving a separate propeller. The stroke was 22" × 17" combined stroke 39" with a b.m.e.p. of 72 lbs. in.^{2} and was rated at 750 b.h.p. per shaft at 200 r.p.m. The columns and entablature were of cast aluminium alloy. This was one of the first engines to have a differential stroke, the firing order of 1-3-2-4 suggests that there might have been a small residual secondary couple for each row of cylinders. This engine Figs. 5a and b was built for the motor yacht 'Sialia' which belonged to Henry Ford of

Fig. 4a. Original 3 Cylinder Oil Engine. M.V. 'Silverelm'

540 mm bore × 2 × 1080 mm stroke 1,800 BHP at 85 r.p.m. First 3 Cylinder Engine







(b)

Fig. 5. Cross Section of Twin Bank Engine m.v. 'SIALIA' 1925. 13" bore, 22" × 17" stroke. 750 B.H.P./Shaft at 200 r.p.m.

Each 4 cylinder crankshaft drove its own propeller

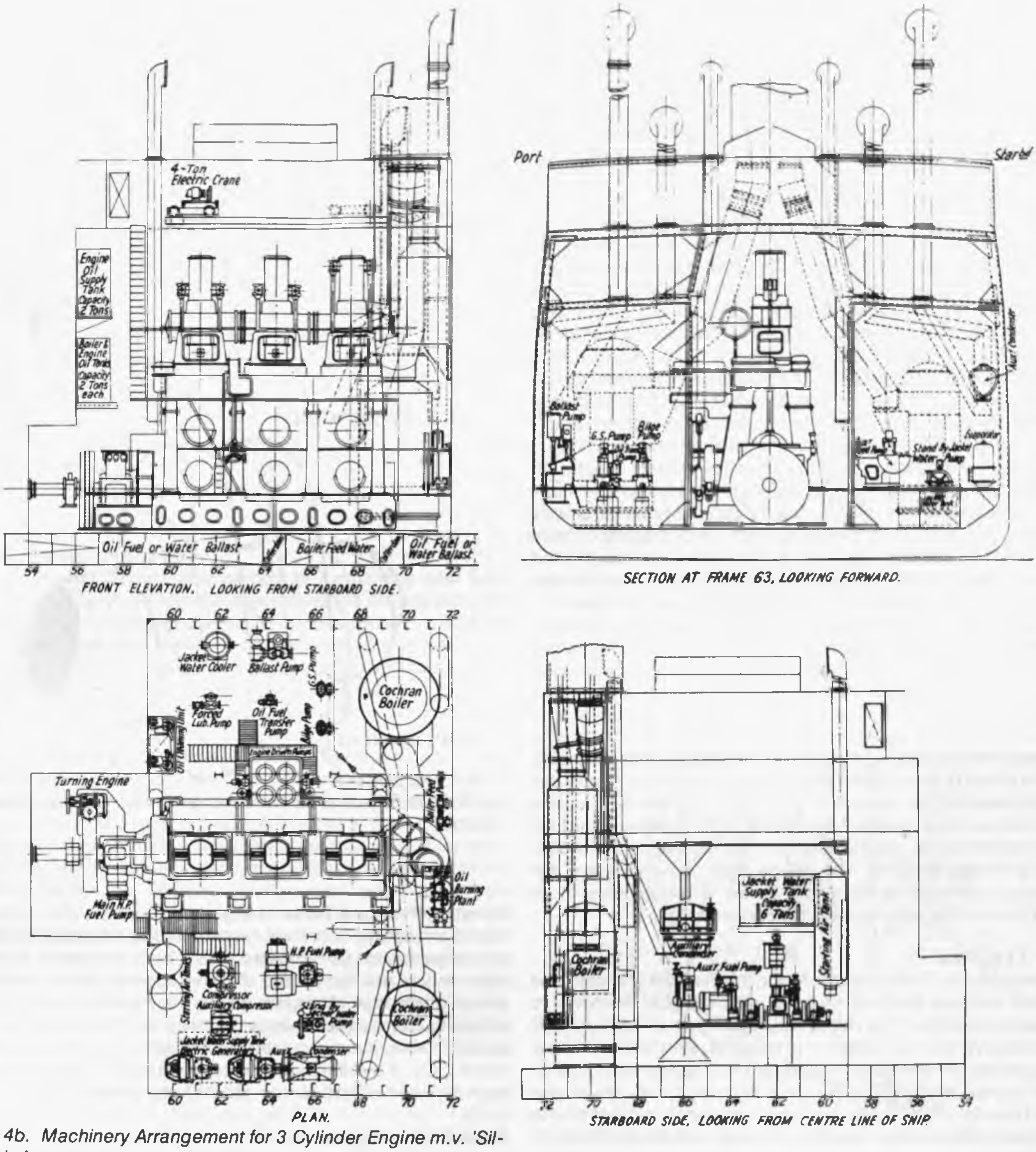


Fig. 4b. Machinery Arrangement for 3 Cylinder Engine m.v. 'Silverelm'

motor car fame.

Ford subsequently sold the vessel and after passing through the hands of three private owners, it was purchased by the Clipper Line in 1938 and renamed the 'Yankee Clipper'. The U.S. Navy took her over as a patrol vessel and she was renamed the 'Coral'. The last information received stated that the engine was still operating satisfactorily well after the war had ended.

Balancing

Early engines had equal upper and lower piston strokes, but the running gear of the upper piston was heavier than the lower, so that the balance was not perfect, although at that time, much better than single piston engines. To give perfect balance, in 1926, the upper piston stroke was reduced and the running gear weights adjusted and this was the start of the LB range of engine, which was built by licensees all over the world and powered approximately one quarter of the merchant motor ships, used in World War II.

Fabrication

Design to increase the power to weight ratio succeeded in 1933, with the introduction of electrically welded fabricated steel structures. As well as reduction in weight and dimensions, the fabricated structures were much more rigid, due to the higher modules of elasticity of steel, compared to cast iron.

Power Increase

In the 1950's shipowners were looking for better fuel economies and the demand for higher powered engines was increasing. It was not surprising that there was a growing use of higher viscosity fuels; at the same time the incidence of crankcase contamination increased and the diaphragm gland was introduced to completely isolate the crankcase, and there is no danger of acids or other objectionable constituents mixing with the crankcase lubricants and causing damage to running gear. At the same time, the lower piston skirt was eliminated and the centre crank rod ratio was reduced to 3.55 : 1 instead of 4 : 1. Further improvements were also incorporated, such as the swinging links for water cooling being replaced by telescopic pipes for oil cooling of lower pistons.

Turbo-Charging – Pulse System

To meet the demand for higher cylinder powers for marine propulsion, Doxford decided to build a three cylinder engine of 600 mm bore by 2,000 total stroke to run at 125 r.p.m. and to supercharge it to produce 30% more power than the normal aspirated 600 bore engine whose maximum output was 2,700 b.h.p. at 115 r.p.m. And in 1954, sea trials showed that the engine installed in the 'British Escort' could produce 3,580 b.h.p. at 120 r.p.m. (Being a three cylinder engine) The ports in the cylinder liner had to be increased in size to permit the charging and exhaust of the large volumes of air and gas and therefore occupied more than 120° of crank angle. This meant that the engine would not start in every position, as there were dead spots around the top centre of every cylinder. To overcome this, the ports would require to be reduced and this in turn would reduce the power. This engine did however provide Doxford with the basic information for the turbo-charging of future engines. This first turbo-charged engine is still in service. The hull of the 'British Escort' was scrapped but the engine was removed and refitted into another hull and is still sailing as the 'Avalon'.
Since the advent of this engine, subsequent turbo-charging developments were concentrated on the elimination of scavenge pumps and with obtaining satisfactory slow running and manoeuvring characteristics. Experiments were carried out on a six cylinder 650 mm bore turbo-charged engine without scavenge pumps, manoeuvring, slow running and starting were achieved, but with some smoke from the engine. It was therefore decided that electrically motor driven fans would be fitted to supplement the air supply and would automatically come into operation during the slow running and manoeuvring periods. Although the turbo-charging of the LBD type engine was successful and over fifty had been built by Doxford and their licensees, the engine was long and heavy and although extremely reliable, the power to weight ratio 17.59 h.p./ton was low and naturally the cost was high.

P & J Engines

To improve the power to weight factor, the P engine was designed in 1958 and over forty were subsequently built. (3) The power to weight ratio was 26.6 h.p./ton and the power output from each 670 mm bore cylinder was 1,660 b.h.p. However, there was an increasing demand for more powerful engines for the propulsion of large bulk carriers and VLCC's etc., and although the P type engine could develop 10,000 b.h.p. in six cylinders and the crankshaft was much stronger and more rigid than those of the LB type, it was not an economical proposition to build it with more than six cylinders. The problem of developing an engine with a reduction in length and weight was solved by using the side crankwebs as main journals. Fig. 6. This naturally results in a large diameter bearing. Due to the opposed piston principle, no combustion loads are transmitted to the main bearings and they only have to cope with the weight of the moving parts. A further advantage in using the side webs as journals, is the simplification of the forging for this section of the crankshaft.
The first engine designed to this principle was called the J engine and was of 760 mm bore by 2180 stroke and with pulse turbo-charging produced 2,500 b.h.p./cyl. with a b.m.e.p. of 9.5 bar. With the advent of the J engine, research and development work was intensified with investigations into all the major parts as well as cylinder lubrication, scavenging, overhauling, reliability and lowering the fuel consumption. The success of the 76J range of engines brought about the introduction of the 67J and 58J engines, also operating on the pulse turbo-charged system.

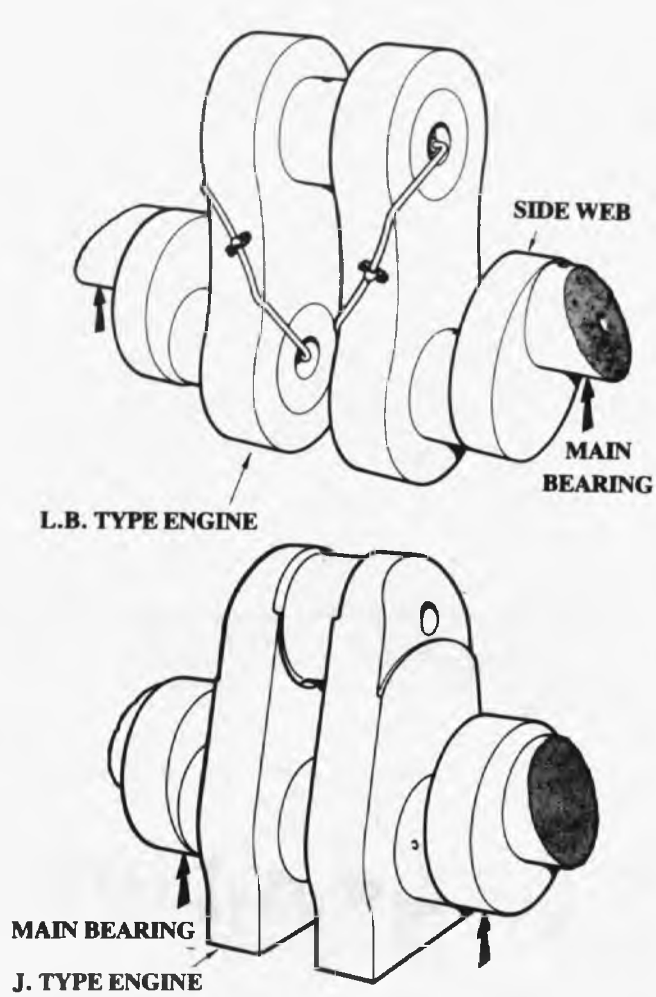


Fig. 6. Comparison of LB and J Engine Crankshaft Main Bearing Journals

Constant Pressure Turbo-charging

Taking advantage of the very extensive development work and design experience gained over the last 17 years on the 'J' engine, together with the knowledge that the opposed piston concept permits the design of engines having a low number of cylinders whilst retaining excellent mechanical balance. The development of constant pressure turbo-charging brought to a head the re-introduction of the three cylinder engine and such engines have been included in the 670 mm and 760 mm bore ranges.

Short Stroke Engines

Shipowners are becoming increasingly apprehensive about the problem fuels that will be available in the future and Doxford were approached to see if an engine with a diaphragm and crosshead could be made available to produce 5,500 b.h.p. at 220 r.p.m. and this initiated a range of short stroke engines, all running at an increased r.p.m. but having the same output per cylinder as the standard range. A great deal of experimental work has already been conducted during extended development work on the 580 mm bore Seahorse project. Tests had been carried out on this engine at cylinder outputs approximately 40% above the maximum continuous rating for the new 58JS. C engine, together with tests on fuel injection equipment, bearing materials and the constant pressure turbo-charged system.
The forerunner of the 58JS3-C engine has been produced and is at sea. Others will follow in the very near future but development work will still go ahead to investigate and improve combustion, the burning of problem fuels and the overall efficiency of the engines in general.

Power Range

Doxford have been criticised for not pursuing a 'bigger cylinder bore' policy for 48,000 b.h.p. engines, but events have proven their decision to be correct. The following table shows the break-down of all two stroke engines being built in the world at the present time and the Doxford range of engines is within 5,500 to 27,499 b.h.p. which encompasses 88% of all two stroke engines under construction.

Brake Horse Power Range of Two Cycle Engines Building 1978	Percentage of World Total	No. of Engines building
5,500 to 7,400	14.78 %	120
7,500 to 12,499	43.84 %	356
12,500 to 17,499	21.059%	177
17,500 to 22,499	8.49 %	69
22,500 to 27,499	9.48 %	77
27,500 to 32,499	1.6 %	13
32,500 to 37,499	0.49 %	4
37,500 to 42,499	0.123%	1
42,500 to 47,500	0.123%	1

Opposed Piston Engines

Fig. 7 shows a pictorial arrangement of the running gear for a 58JS-C engine from which the operation of the moving parts are shown with the pistons reciprocating about a central combustion space. With the equal areas of the upper and lower pistons ensuring that the gas loads are transferred to the crankshaft as pure torque and not transmitted to the engine frame. The structure must, however, accept the torque reaction of the engine in the form of horizontal thrust from the guide shoes.

The side cranks are phased at 180° to the centre crank and during operation air is compressed in the cylinder between the pistons and shortly before reaching the point of minimum volume (inner dead centre) fuel at high pressure is injected through the injector nozzles. After combustion of the fuel in the cylinder is completed, the hot gases continue to expand, forcing the pistons apart until the exhaust ports in the upper liner are uncovered by the upper piston. As the exhaust ports open the hot gases in the cylinder, now at a reduced pressure, are discharged to the exhaust gas main and then at constant pressure to the turbine of the turbochargers, the pressure in the cylinder falling to a level just below that of the scavenge air. At this point, the air inlet ports in the lower liner are uncovered by the lower piston, so allowing air under pressure, which is delivered by the turbocharger compressor, to flow through the cylinder expelling the remaining burnt gases.

This very efficient method of air scavenging is called 'through scavenging' or uniflow scavenging, and with the absence of valves ensures an extremely high breathing capacity in relation to bore and stroke. During the inward compression stroke of the pistons, the air inlet ports are closed just before the exhaust ports. The air in the cylinder is then compressed and the cycle repeated. In spite of the high asphaltene fuels being burned today, the Doxford Engine with its high scavenge efficiency is not plagued by port fouling.

Because the combined stroke of the two pistons can be much greater than the stroke of a single piston, without incurring excessive inertia forces, and for the same mean indicated pressure and mean piston speed, the power per cylinder of an opposed piston engine is correspondingly greater than that of a single piston engine of the same bore. This is true even of the short stroke versions and indeed, the bore to stroke ratio of short stroke 'J' engines is of the same order as the long stroke versions of competitive single piston engines. This makes for shorter engines and reduced maintenance. Ease of maintenance is also enhanced by the absence of cylinder covers, with or without valves and by the simplicity with which pistons can be removed for overhaul. A pair of pistons on a Doxford engine can easily be removed in less than

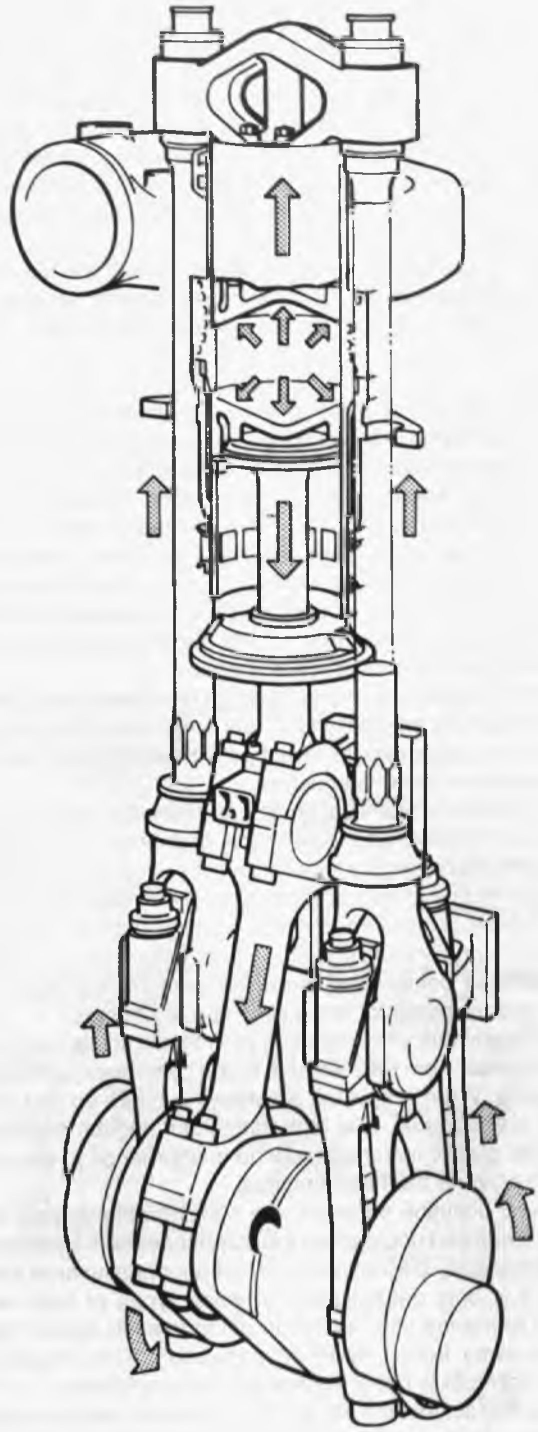


Fig. 7. Pictorial Arrangement of Running gear 58JS-C Engine

one hour. This was very important in the days when piston rings only lasted for about 2,000 hours and is still a useful feature today when rings and pistons last up to ten times as long.

As the first order inertia force from the lower pistons is balanced against the corresponding force from the upper pistons and an engine in complete primary balance is obtained, means that even 3 cylinder engines avoid the unbalanced couples which plague some single piston engines of less than six cylinders. Even when the balance of a six cylinder single piston engine is good, the opposed piston design, having the gas forces transmitted through the running gear and not the structure, has no couples which tend to distort bedplates and cause bearing troubles. This naturally has led to an engine structure which is basically simple in design, exceedingly stiff, strong and relatively free from stress. This led to an investigation which resulted in a four cylinder 580 mm bore J engine being mounted in a ship on only twelve chocks, instead of

the usual 70 to 200, thus materially cutting down installation time and costs and this applies to all Doxford engines. (4) Further the engine seating does not require to be as strong as that of the comparable single piston engine. Because the upper piston water cooling system is completely separate from any of the lubricating oil systems, there is no chance of contamination. When this occurs, a separate piston water purification system is required. With the Doxford engine, this additional installation and maintenance cost is avoided.
The built in reliability of the engine, together with the use of shell bearings and hydraulic pre-tensioning equipment, have reduced overhauling costs and maintenance times considerably.

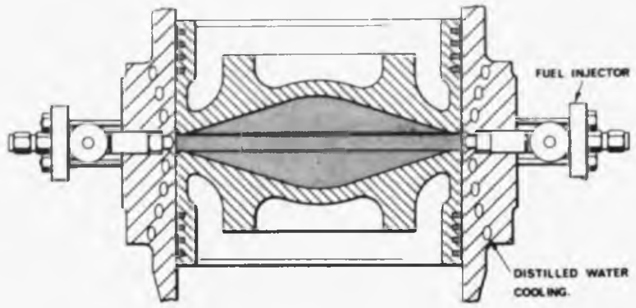


Fig. 8. Combustion Space

Fuel Oils
The operating costs of ships at sea have soared in the last few years, it is estimated that fuel prices soared by 285% in just three years, with the resultant laying up of some ships and slow steaming by others to conserve fuel. The spiraling increases in costs started in 1974 and with it came the realisation that hydrocarbon fuels were not as plentiful as had been imagined. Shipowners, therefore turned their thoughts to the most economical fuels and to machinery with the most economical fuel consumption and with the capability to burn the problem fuels that will be available in the future, with the minimum of maintenance.
The Doxford engine has proven, even in its earliest days, that it is capable of burning efficiently H.V. fuel and co-operation is taking place with oil companies to investigate problem fuels and other facets associated with combustion.
Generally distillate fuel can be stored, handled and used with minimum of filtration and purification problems. Residual fuels which are the more viscous high-boiling oils rejected by the distillates are too viscous at ambient temperature for easy handling and must be heated, purified and filtred before injection in the combustion space. Normally there is a fairly sharp division between the two fuels, distillates being used more for medium and high speed engines and residuals for large slow speed engines.
It is only natural that oil companies wish to extract as many distillates as possible from the available crude by extensive distallation and cracking. What is now left is uneven in make up and of poor quality, a problem fuel. The high vanadium, sodium and sulphur content has greatly increased routine maintenance at sea, especially with valve in the head engines.
Atmospheric pollution depends to a considerable degree on the quality of a fuel and not least on the sulphur content. Environmentalists will certainly discriminate against poor quality fuels for land use and it is only natural that the worst types of fuels will be relegated to marine use, as ocean going vessels spend most of their time away from centres of population. The already poor quality of this fuel is likely to deteriorate even further.
Accepting the fact that the worst type of fuels will only be available for marine use then it is up to the engineer to try to overcome the many problems that are bound to arise. The slow speed oil engine can tolerate many of the heavy fractions of fuel but there is no knowledge to date, as to the exact number of heavy constituents it can tolerate. What is known is that many residual products used in blending are difficult to burn with the resultant fouling of valves etc.
Heavy fuels cover many viscosity grades and are influenced by the amount of residual constituents. To meet the viscosity requirements of shipowners, heavy fuels have been blended with lighter distillates. Unfortunately, this can cause problems on board ship. During storage the heavier fractions may settle out in layers and it is not unknown for an engine to be arranged to burn medium heavy fuel to find that lighter fractions have been pumped through the system with the resultant gassing, due to the heating arrangement. Before taking on bunkers the engineer should ensure that the heating capability is such that it can cope with the viscosity of the fuel. Viscosity must never be used as a guide to quality, it only provides a guide to pumpability and to the requirements for heating.

The Doxford engine is extremely efficient when dealing with problem fuels. The opposed piston principle and the design of the piston form a quasispherical combustion chamber – Fig. 8, with ideal conditions for distributing the fuel amongst the air and results in a very high thermal efficiency. The fuel injectors are located at the periphery of the combustion chamber where the air movement is high and the combustion process which results has been found to be tolerant of a wide range of injection conditions whilst, at the same time, the injectors are located in a comparatively cool part of the chamber.

Fuel Consumption
Fig. 9 shows the improvement in fuel consumption since 1924. The fuel in all cases being Marine diesel. The factors which contributed to the improvements in the earlier years were:
1924: the use of tangential scavenge air ports to produce a turbulence and so intimately mix the air and atomised fuel.
1930: The adoption of the spherical combustion chamber to give a better spread of the fuel.
1935: The adoption of fabricated structures which gave a freer flow of air than the original cast units.
1957: The slightly higher compression and combustion pressure produced an improvement without affecting slow running. This curve is from an LBD pulse supercharged engine.
1978: Higher b.m.e.p. and more efficient scavenging, a scavenge press of 2.1 bar (abs) and constant pressure turbo-charging, together with improvements to the mechanics of the fuel system, have improved the consumption.
Continuous investigation and development should bring about a further reduction to the present-day figures.

Table 2: Characteristics of various Fuel Oils (5)

	Aruba	California	Arabian heavy	Iranian light	China	Libya
Density g/cm³ 15°C	0.976	0.979	0.969	0.950	0.903	0.906
Flash Point °C	78	109	95	178	76	92
Pour Point°C	3	15	4	12	16	42
Water Vol.%	0.3	trace	<0.1	0.8	0.12	0.12
Sediment wt.%	0.01	0.03	0.02	0.09	trace	trace
Carbon residue (CCR)wt.%	12.9	10.5	8.0	7.8	7.0	7.5
Ash wt.%	0.085	0.01	0.036	0.024	0.014	0.020
Sulphur wt.%	2.30	0.70	3.55	2.62	0.56	0.33
Na ppm	60	15	33	101	20	4.0
Ni ppm	51	13	22	11	6.8	7.1
V ppm	336	15	67	47	9.0	3.0
Pb ppm	—	44	43	—	—	—
Viscosity SR1 38°C	2933	3310	5580	1400	600	673
Viscosity kinematic mm²/s 50°C	313	354	600	168	78.7	87.44

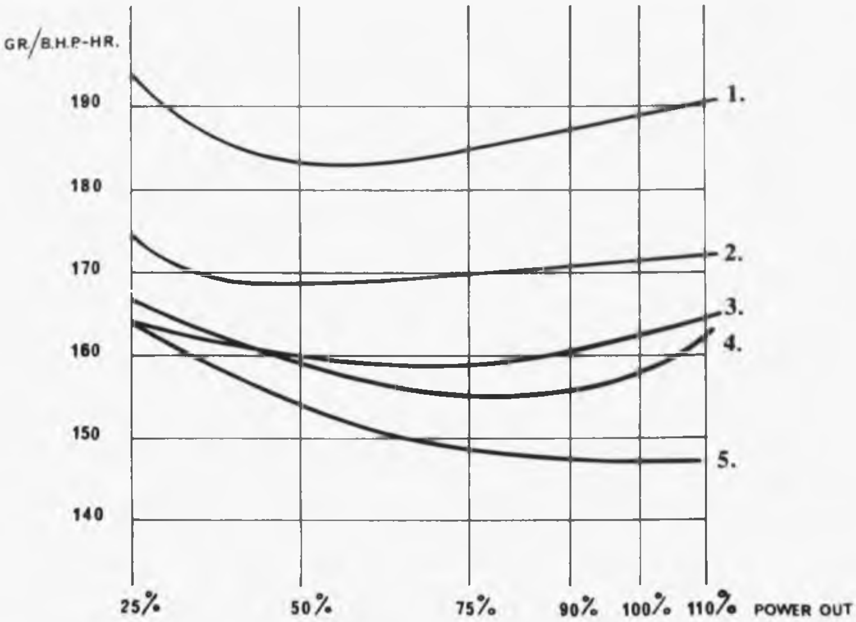


Fig. 9. Fuel Consumption 1924 to 1978.
1. *1924-2,900 B.H.P.*
2. *1930-2,850 B.H.P.*
3. *1935-1,800 B.H.P.*
4. *1957-8,000 B.H.P.*
5. *1978-5,500 B.H.P.*

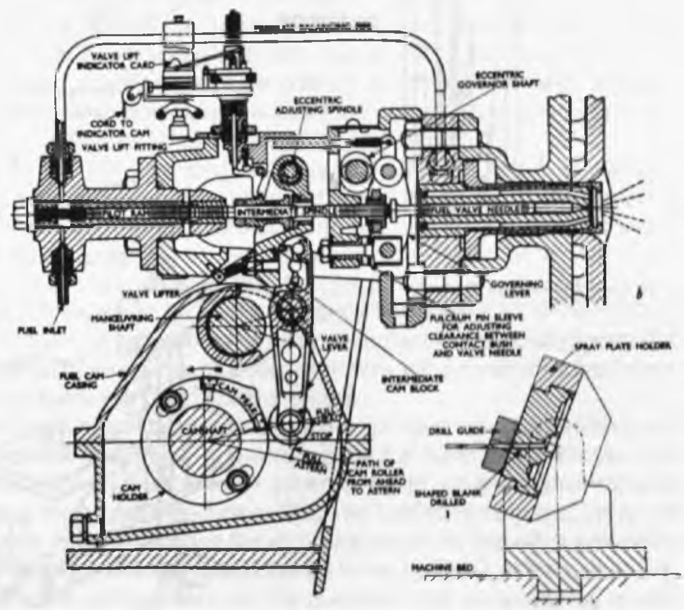


Fig. 10. Fuel Valve Mechanism 1950

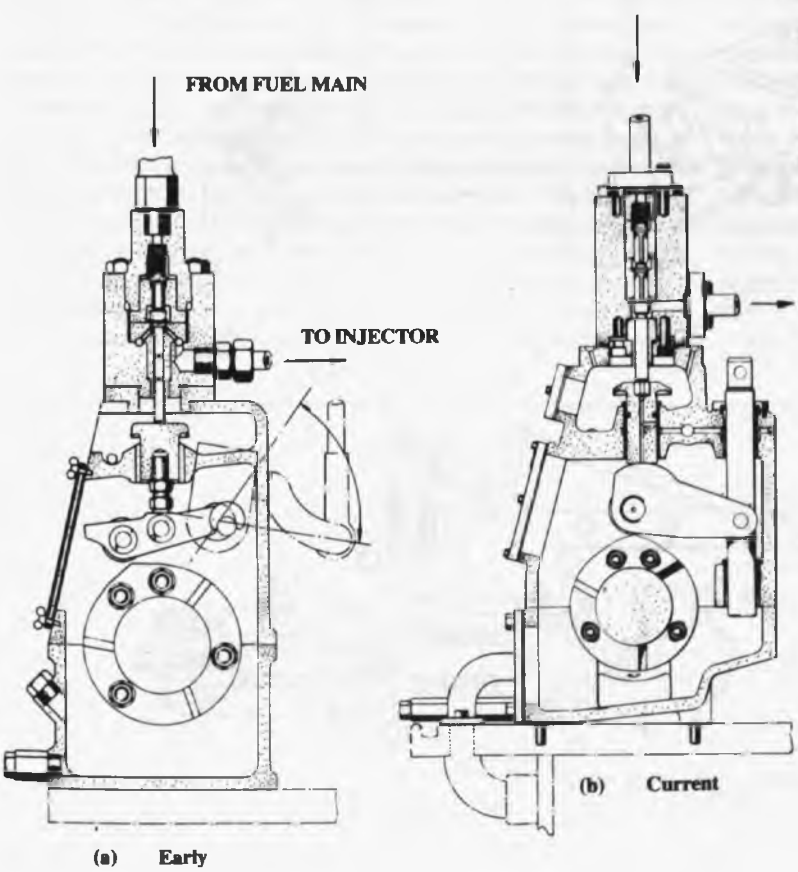


Fig. 12. Design of Fuel Timing Valve

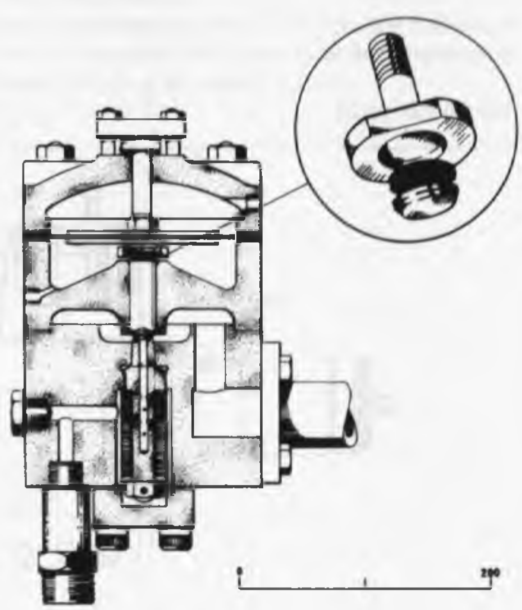


Fig. 13. Fuel Relief Spill Valve

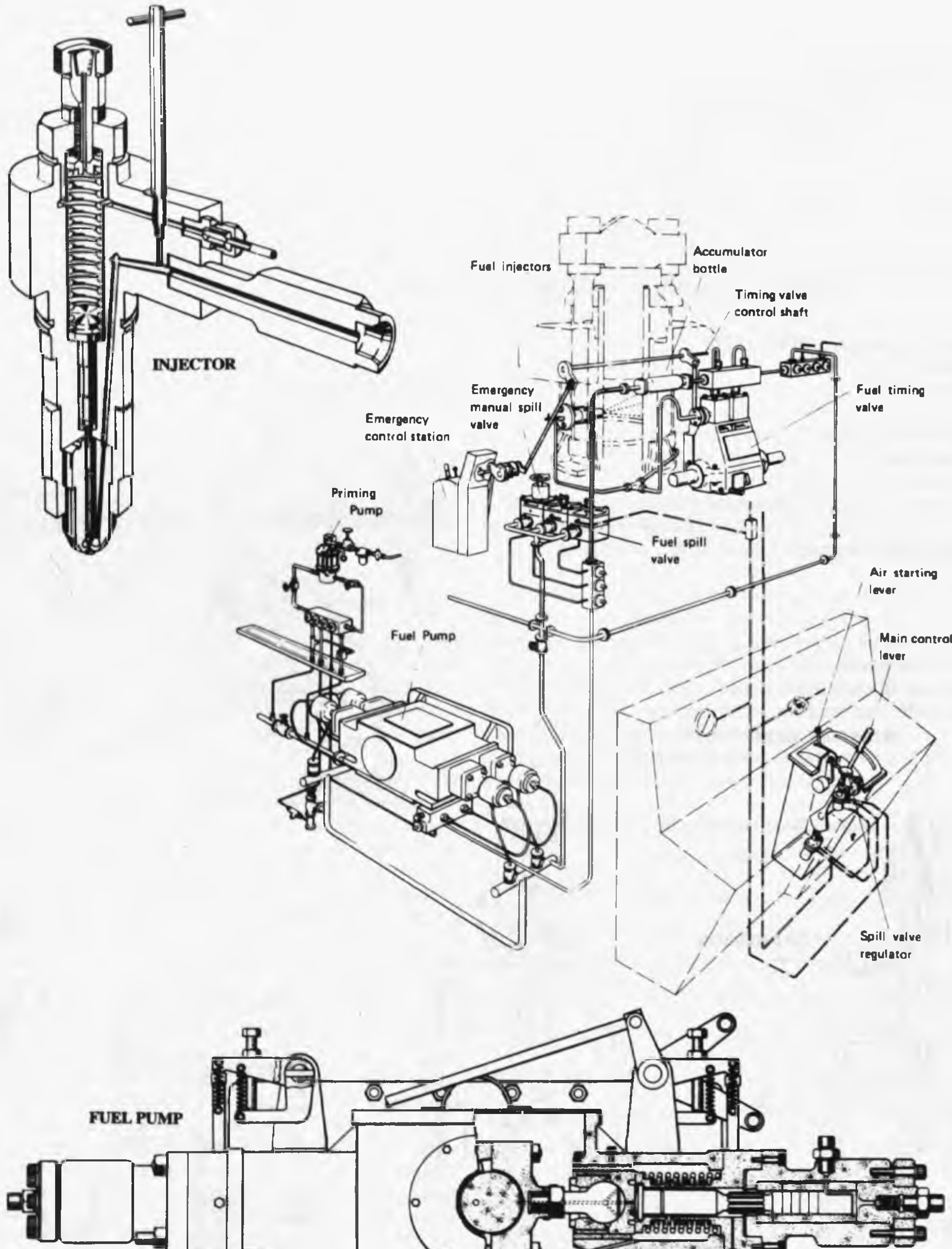


Fig. 11. Arrangement of Fuel System.

Fuel System

The common rail fuel system, in one form or another, has been used bij Doxford since 1919 and until the 1950's a mechanical method of injecting fuel was standard for the LB type engines, with a camshaft at the front and back of the engine to operate the fuel valve mechanism (Fig. 10). The timing valve injection system is much simpler and has fewer parts with only one camshaft to do the work previously carried out by two. The operation of the system is basically hydraulic with spring loaded fuel injectors opening at a pre-determined fuel pressure. Fig. 11 shows an arrangement of the fuel system on the engine whereby fuel from the daily service tank is discharged via a booster pump, operating at approx. 5 bar through a steamjacketed self-cleaning 15 micron filter and then to the suction side of a multi-plunger fuel pump. Fuel at a pressure of approx. 250 to 490 bar is delivered from the pump to the fuel main which supplies all cylinders via the timing valves. The timing valves which are cam operated, control the start and period of injection for each cylinder, and therefore the load and speed of the engine. For each cylinder, the time of opening and period of injection can be adjusted independently. There is only one set of cams per cylinder; no special cams are necessary.

The timing valves which are mounted on the entablature are controlled by levers mounted on a shaft running the length of the engine. Fig. 12a shows an early type of timing valve and Fig. 12b the latest valve, which was designed to overcome casting problems with the timing valve lever and to increase the throughput. When compared with jerk pumps, the system is quiet in operation and no high torques or sudden peak pressures are imposed on any of the mechanical parts of the system as the pressure for the injection of fuel is stored in the fuel main over the complete engine cycle. One of the main advantages of the system is that, for any given setting of the timing valve, the pressure can be controlled by the quantity of fuel delivered by the fuel pump to the high pressure main. Variation of the pump output is effected by a helical scroll cut in the end of the plunger which uncovers the suction port. The position and therefore the quantity of fuel is controlled by a toothed rack which engages with pinion teeth cut in the plunger to make it turn in the sleeve. Movement of the main shaft which controls the timing valves is controlled by the electronic governor which has a pneumatic or hydraulic actuator to provide necessary power. The governor is controlled from the remote control station and can manoeuvre and regulate the engine as required. Should the main governor fail to function, then a purely mechanical control, which is mounted on the engine, can be brought into action and can also be used for setting the various cams on the camshaft. The fuel pump and timing valve operation are arranged by linkage in such a manner that the pressure in the fuel main for injection purposes is related to the corresponding load and speed of the engine.

A pneumatically operated pump is used as a circulating as well as a priming pump and the operating air pressure is so set that when the engine is stopped, the fuel pressure is automatically maintained at a maximum of 180 bars. As soon as the main engine is started, the main fuel pump comes into operation and increases the fuel pressure, when this reaches 300 bar, the priming pump stalls. As the load on the engine increases, so also does the fuel pressure until the working pressure of about 490 bar is reached. Heated high viscosity fuel is circulated through the fuel system prior to starting and the same pump is used. Bij adjustment of the valves on the suction and discharge side of the pump, the change-over from priming to circulating can be arranged. Prior to starting, hot fuel can be pumped through all the pipes to the injectors thus allowing the engine to be started and manoeuvred on heavy fuel.

Results from the experimental Seahorse engine showed that a better fuel consumption would be obtained if the instantaneous volume rate of fuel injection was improved. Consequently it was decided to re-design the mechanics of fuel system to overcome restrictions, the throughput area of the original timing valve was increased from 70 mm² to 120 mm².

Measurements taken on the early engines of the injector valve spindle lift and fuel pressure suggested that the volume of the system delayed the reduction of pressure after injection, so that the injectors were not closing as sharply as could be attained.

By reducing the bore of the pipes between timing valves and injectors, and at the same time increasing their relative outside diameter by redesign and thus reducing the volume of oil in the system, a better pressure pattern was produced with sharper opening and closing of the injectors, with a subsequent improvement in overall efficiency and the fuel system.

Even at very light engine loads, the common rail fuel injection system delivers a sharp burst of fuel at 300 bar or more, which is 105 bar above the nozzle opening pressure, so that a short sharp injection is produced. With a jerk pump system, at very low fuel quantities, it is possible that the injector valve is just cracked open and there would be some tendency to dribble.

Because of this, some engine manufacturers recommend that special fuel injectors be used for slow running conditions; this is not necessary with the Doxford engine.

At the aft end of the camshaft on the sprocket wheel, a centrifugally operated overspeed trip arrangement is fitted which comes into operation should the main governor fail to act and the revolutions have increased by a further 5%. The overspeed trip acts on an air valve, which maintains the air pressure on the fuel relief spill valve diaphragm which is one hundred times the area of the valve (Fig. 13). The air pressure on the diaphragm is controlled by a spill regulator valve, mounted at the main control station or at the control shaft for the timing valves.

When the overspeed trip is brought into operation, the fuel pressure in the main line is released to a drain tank and the engine stops. The overspeed trip must be reset by hand.

To be continued

NEDERLANDSE VERENIGING VAN TECHNICI OP SCHEEPVAARTGEBIED
(Netherlands Society of Marine Technologists)

Programma voor lezingen en evenementen seizoen 1979/1980

De bijdrage van brandstoffen en smeermiddelen tot een goed bedrijf van scheepsdieselmotoren
door J. J. H. Sundermeijer, Superintendent Marine Technical Service en G. W. van der Horst, Superintendent Product Development van B.V. Chevron Centrale Laboratoria, Rotterdam
21 feb. (do) Rotterdam
22 feb. (vr) Amsterdam
26 feb. (di) Groningen

Inert gas installaties*
door ing. B. Hoorneborg van HOLEC Gasgeneratoren, Nijmegen.

20 mrt (do) Rotterdam
21 mrt (vr) Amsterdam

Zwaar transport
Lezing met films door ir. A. Peterse van Mammoet Shipping v.o.f. te Amsterdam
10 april (do) Groningen

Oliebestrijdingsvaartuigen**
sprekers nader op te geven
17 apr. (do) Rotterdam
18 apr. (vr) Amsterdam
22 apr. (di) Groningen

Algemene ledenvergadering
23 apr. (wo)

Diagnostische documentatie als basis voor een onderhoudssysteem a/b van schepen*
door de heer H. Koelmans, Hoofd van de afdeling Diagnostische Documentatie Ontwikkeling van de Stichting Bijzondere Cursussen te Zwijndrecht
22 mei (do) Rotterdam

NB
Aanvullingen en wijzigingen van het programma zullen nog volgen.

***Lezingen in samenwerking met het Institute of Marine Engineers (Netherlands Branch)**
**** Lezing in samenwerking met de Sectie Scheepstechniek van het Koninklijk Instituut van Ingenieurs en het Scheepsbouwkundig Gezelschap 'William Froude'.**

Verenigingsnieuws

DE NIEUWJAARSBIJEENKOMST 1980
(Herplaatsing wegens misstelling)

De traditionele nieuwjaarsbijeenkomst van de Vereniging, welke op 3 januari 1980 in de Clauszaal van het Groothandelsgebouw te Rotterdam plaatsvond, stond wel in de belangstelling. 197 Leden en belangstellenden maakten van de gelegenheid gebruik om elkaar een gelukkig nieuwjaar en het bestuur een goed verenigingsjaar toe te wensen.
Dat het de vereniging, ondanks de recessie in de scheepsbouw- en aanverwante bedrijven goed gaat mocht blijken uit de toekenning van een zestal prijzen die in het afgelopen jaar aan vier pas afgestudeerden en twee wetenschappelijke medewerkers van de TH in Delft werden uitgereikt.
Volgens sommigen duurde deze ceremonie wat te lang door de vele redevoeringen die werden afgestoken. Toch moet men niet vergeten dat dergelijke gebeurtenissen de vereniging de nodige bekendheid bezorgen, met name bij de jongeren, die de moed hebben om een studie te voltooien in een tijd van economische teruggang in een studierichting die op de tocht staat! Vandaar wellicht de vele woorden die over de prijswinnaars en overige aanwezigen door de professoren werden uitgestrooid.
De afstudeerprijzen van ƒ 1.000,- werden toegekend aan:
– Ir. P. J. M. Fontijn, tot voor kort junior-lid, maar sinds 1 januari 1980 Gewoon lid van onze vereniging voor zijn scriptie: Voorspellingsmodellen voor het aanbod van Scheepsvervoerscapaciteit'; afgestudeerd bij prof. ir. N. Dijkshoorn van de afdeling Scheepsbouw- en Scheepvaartkunde.
– Ir. E. F. A. Land, afgestudeerd aan de afdeling Elektrotechniek bij prof. ir. H. R. van Nauta Lemke op de scriptie: 'Een adaptieve Baanvaarautomaat voor Schepen.'
– Ir. E. A. Kips, voor zijn scriptie: 'De Elastische Koppeling in de aandrijving van een Cutter; afgestudeerd bij prof. ir. J. de Koning van de afdeling Werktuigbouwkunde.
– Ir. A. J. J. Dijksman, afgestudeerd bij prof. ir. G. Prins op de scriptie: Een onderzoek naar de Overslag van Stukgoed en Stortgoed op volle zee tussen twee Zeeschepen.
Tenslotte werden twee prijzen voor de beste artikelen in Schip en Werf in 1979 toegekend door de Hoofdredacteur, prof. ir. J. H. Krietemeijer.

Deze prijzen vielen ten deel aan:
– Ir. E. Deetman voor zijn artikel over het onderwerp: 'Toetsen met CAI (Computer Assisted Instruction) toegepast in CAD (Computer Aided Design)' in Schip en Werf no. 15 van 20 juli 1979.
– Ir. P. Stijnen voor zijn artikelen over: 'Het ontwikkelingsperspectief van de Meettechniek in de Scheepsbouwkunde' in Schip en Werf no. 16 van 3 augustus 1979.
Totaal zijn er nu over 1979 21 prijzen uitgereikt, de laatste 4 prijzen werden uitgereikt aan 4 pas afgestudeerde Marineofficieren op 18 januari j.l. op het Koninklijk Instituut voor de Marine ten Den Helder.

P.A.L.

Verkiezing Hoofdbestuursleden
De resultaten van de verkiezing voor 3 leden van het Hoofdbestuur werden door een stemcommissie bestaande uit de heren C. van Dijk, ing. W. P. Stiekema en P. A. Luikenaar op 9 januari jl. als volgt vastgesteld:
Ingeleverd werden 979 stembiljetten.
De verdeling der stemmen was:

ing. C. W. van Cappelen	826	stemmen.
ing. J. G. F. Coolegem	125	„
ir. J. N. Joustra	822	„
ir. W. de Jong	144	„
Dhr. S. de Nobel	694	„
Dhr. J. den Arend	262	„
Blanco	62	„
Ongeldig	2	„
Totaal:	2937	stemmen.

De heer ing. C. W van Cappellen is dus gekozen als vertegenwoordiger van de afdeling Rotterdam in het Hoofdbestuur.
De heer ir. J. N. Joustra is herkozen voor een periode van 2 jaar.
De heer S. de Nobel is gekozen als lid van het Hoofdbestuur.

Personalia

Directiemutaties by RSV.

Met ingang van 1 februari 1980 is de heer Ir. F. C. Smit benoemd tot directeur van B.V. Machinefabriek 'Breda' voorheen Backer en Rueb (MFB).
Per dezelfde datum is de heer Smit teruggetreden als directeur van RSV Zware Apparatenbouw B.V. (RSV-A).
De heer Drs. Voogd zal per 1 maart 1980 zijn functie als directeur van MFB neerleggen.
Bij RSV Gieterij Middelburg B.V. werden met ingang van 1 januari 1980 benoemd de heer G. Peters tot directeur en de heer K. Reinders tot bedrijfsdirecteur.
De heer J. J. Ubbink zal met ingang van 1 juni 1980 zijn functie als directeur neerleggen wegens het bereiken van de pensioengerechtigde leeftijd.
De heer Peters was voorheen belast met de leiding van de NDSM-gieterij in Amsterdam.
De heer Reinders was Hoofd Productie bij RSV Gieterij Middelburg.

Verkochte schepen

AFON GOCH

Via bemiddeling van Supervision Shipping & Trading Company te Rotterdam is de onder Panamese vlag varende dieselelektrische sleepboot 'AFON GOCH' verkocht aan Deep Venture Ltd. te Cayman Islands.
Deze sleepboot werd in 1958 gebouwd door J. & K. Smit Scheepswerven te Kinderdijk voor Smit Internationale onder de naam 'SCHELDE'. Het schip heeft een vermogen van 3.000 I.H.P.
De overdracht heeft inmiddels te Maassluis plaatsgevonden. De nieuwe eigenaren zullen het schip gebruiken voor de diepzee duiksport.

Diversen

De Zuid Koraanse Scheepsbouw

In Zuid-Korea zijn er tekenen die erop wijzen dat een herstel is ingetreden in de scheepsbouw. De werven in dit land ontvingen vorig jaar bouwopdrachten voor een totale waarde van $ 813 mln. Het gaat daarbij om vijftig schepen met een gezamenlijke tonnage van 1,04 mln bruto ton. Dit was het beste resultaat dat in Korea is bereikt sinds 1972 toen een begin is gemaakt met de ontwikkeling van de Koreaanse scheepsbouw tot een belangrijke exportindustrie. Ook zijn de uitkomsten over 1979 aanzienlijk beter dan in het jaar daarvoor. In 1978 werden exportorders binnengehaald voor 56 schepen met een totale tonnage van 351.000 en met een contractwaarde van $ 272,5 mln. De vooruitgang wordt toegeschreven aan de vermindering van capaciteit in andere landen en de scherpere prijzen waartegen in Zuid-Korea schepen worden gebouwd.
E.D. 10-1-'80.

De Tsjecho-Slowaakse koopvaardijvloot

De Tsjechische koopvaardijvloot bestond op 1 januari 1980 uit 12 schepen met een totale tonnage van 221600 dwt. 7 schepen zijn lijnvrachtschepen terwijl de andere 5 schepen bestemd zijn voor het transport van stortgoed.
De handelsvloot zal in de komende jaren met 4 schepen van het 'Universal' type, elk met een draagvermogen van 15.400 dwt, worden uitgebreid. Volgens contract moet het eerste schip eind 1980 worden opgeleverd, de 2 volgende schepen in 1981, terwijl het laatste schip in 1982 wordt afgeleverd.
De Tsjechische koopvaardij vervoert per jaar 1,5 miljoen ton, waarvan 65% uit het land zelve afkomstig is, voornamelijk ijzererts. Het zeevervoer is gericht op de Perzische Golf, India, Latijns-Amerika en de Sovjet-Unie.

Het technisch en nautisch onderwijs in het schooljaar 1978/'79

Over de aantallen scholen, leerlingen en studenten bij het technisch en het nautisch onderwijs in het schooljaar 1978/'79, is een publikatie verschenen in de serie Statistieken van het beroepsonderwijs van het Centraal Bureau voor de Statistiek.
Tot het technisch onderwijs worden diverse schoolsoorten gerekend, waarvan hier als voorbeeld kunnen worden genoemd de lagere technische scholen, de scholen voor individueel technisch onderwijs, de middelbare en de hogere technische scholen, de scholen voor laboratoriumpersoneel en de avondscholen voor middelbaar en hoger technisch onderwijs.
Tot het nautisch onderwijs worden gerekend de opleidingen voor de binnenvaart, de visserij, voor matrozen bij de handelsvaart, haven- en vervoerscholen en de scholen voor de opleiding van stuurlieden en scheepswerktuigkundigen. Het technisch onderwijs werd in 1978/'79 gevolgd door 290 500 leerlingen en studenten (in 1977/'78: 287 800).
Het betreft hier 275 500 leerlingen en studenten bij het volledig dagonderwijs (19 of meer lessen per week) en 15 000 bij het partieel onderwijs (vorig jaar resp. 271 800 en 16 000). In de genoemde aantallen zijn die van de vrouwelijke leerlingen en studenten begrepen. Hun aantal bedroeg in totaal 15 300 in 1978 tegen 14 000 in het voorgaande jaar.
Van de 275 500 leerlingen en studenten die volledig dagonderwijs volgden, waren er volgens het C.B.S. 196 600 geplaatst bij lager, 51 400 bij middelbaar en 27 500 bij hoger technisch onderwijs. In vergelijking met de overeenkomstige aantallen van 1977/'78 is er bij het dagonderwijs een stijging van 3 700 leerlingen (1,1%), waarvan bij lager 800 (0,4%) bij middelbaar 2 000 (4,1%) en bij hoger technisch onderwijs 900 (3,0%).
Het nautisch onderwijs telde in 1978/'79 8 500 leerlingen en studenten, waarvan er 7 300 volledig dagonderwijs volgden (vorig jaar resp. 7 975 en 6 925).

Nieuwe regeling voor vervoer gevaarlijke stoffen van en naar zee

Om het vervoer van gevaarlijke stoffen van en naar zee zo veilig mogelijk te doen verlopen zal er op 1 maart 1980 een nieuwe regeling voor dit vervoer gaan gelden. Dit ter vervanging van de bestaande regeling, die niet meer is aangepast aan de ontwikkelingen van de laatste jaren. De nieuwe, door de minister van Verkeer en Waterstaat ingevoerde regeling is, evenals de oude, gebaseerd op de Wet Gevaarlijke Stoffen. Ze bevat een uitvoerige meldingsprocedure en regelt het vervoer van stukgoederen, ontploffingsgevaarlijke stoffen en gassen in bulk.
Nieuw is voorts dat ook het vervoer tussen zee en de Belgische havens via de Nederlandse wateren (Westerschelde, Kanaal van Terneuzen) onder de regeling zal vallen. Hierover is overleg gevoerd met de Belgische autoriteiten. Deze konden instemmen met de regeling maar maakten nog een voorbehoud wat betreft het bulkvervoer van gassen. Over dit laatste zal het overleg met België binnen enkele maanden worden afgerond. Daarna zal ook dit vervoer onder de nieuwe regeling vallen.
De voorschriften voor het vervoer van gassen in bulk houden voornamelijk in dat voor dit vervoer een vergunning nodig is van de minister van Verkeer en Waterstaat. Uitzonderingen zijn gemaakt voor een aantal gassen, en voor enige andere gassen voorzover de grootte van de schepen en van de tanks bepaalde maxima niet overschrijden. Alle gastankschepen moeten qua constructie, uitrusting en dergelijke, ten minste voldoen aan de eisen van de IMCO.
Bij het al of niet verlenen van een vergunning en bij de aan een vergunning te verbinden voorwaarden gaat het om de veiligheid op en langs de vaarweg. Aard en hoeveelheid van het gas, de aard van de vaarweg en de grootte van het schip spelen daarbij een rol. De voorwaarden betreffen vooral nautische en operationele zaken zoals verscherpte loodsplicht, weersomstandigheden, sleepbootassistentie, gebruik van radar en marifoon, en eventueel stilleggen van de overige vaart.

Voorlichtingsdagen mechanisatie van het lassen

Gezien de vele en snelle ontwikkelingen op het gebied van het mechaniseren van het lassen en de vragen die hierover regelmatig worden gesteld, heeft de Technische Commissie XII van het NIL (Nederlands Instituut voor Lastechniek) doen besluiten

in 1980 een tweetal voorlichtingsdagen te organiseren.
Het thema van deze twee dagen – welke gehouden zullen worden in de tweede helft van april 1980 – zal zijn: *Mechanisatie van het lassen in Nederland.*
De eerste dag zal o.m. gewijd zijn aan de volgende onderwerpen:
- status gemechaniseerd lassen in Nederland
- het gebruik van industriële robots
- richtlijnen voor de keuze van toevoegmaterialen bij het onder poederdeklassen en gasbooglassen.
- COD-beproevingen van gelaste konstrukties
- TIG-lassen
- gevulde lasdraden

De tweede dag zal als thema hebben: *wat kost lassen?*
Aan de hand van enkele voordrachten zal er gediscussiëerd worden over het kalkuleren van laskosten.
Degenen die aan deze dagen willen deelnemen, kunnen zich t.z.t. door middel van door het NIL te verspreiden inschrijfformulieren opgeven. Van de te behandelen onderwerpen zullen referaten verstrekt worden.

Misschien ten overvloede kan er nog op worden gewezen, dat de Technische Commissie XII één van de commissies is, welke binnen het NIL werkzaam zijn. Specialisten op verschillend gebied, van zowel verbruikers- als leverancierszijde houden zich nationaal en internationaal bezig met het mechaniseren van het lassen in al zijn aspecten.
Nadere inflormatie: NIL Laan v. Meerdervoort 2b 2517 AJ Den Haag, tel. 070-600937.

Conoco stakes 100 million NOK on offshore technology
The oil company Conoco Norway Inc. has now invited tenders for the first four projects in a comprehensive research and development programme. The company is to collaborate with Norwegian technical companies with a view to building up technology for the continental shelf. Conoco has signed a framework agreement with the Ministry of Petroleum and Energy and plans to invest about 100 million NOK in the programme.
The first four projects will cover the development of dynamics analyses computer programmes for the design of tension leg platforms for deep water, the development of improved fatigue analysis computer programmes for the design of offshore structures, the development of improved environmental analysis techniques, and the evaluation of several seawater filtration processes.

As soon as detailed plans have been prepared, a number of other projects will be offered to Norwegian industry and research. This is scheduled to take place in the course of the next few months. The entire research and development programme is planned to take about 3 – 4 years.
The whole programme will also cover participation in projects which have been supported by the Royal Norwegian Council for Scientific and Industrial Research (NTNF). The planning of these projects is now either underway or nearing completion.
Conoco has stationed a group of prominent offshore technologists in Norway whose job it will be to lead research work connected with the assignments. This group will be headed by Conoco's general manager for research and development in Norway. Mr. R. L. McGlasson who has been a key man in the development of offshore petroleum technology.

Three Norwegian companies to cooperate in cruise shipping
Three Norwegian shipping companies are to form a new cruise shipping company which will be among the largest in the world. The companies involved are Den norske Amerikalinje (NAL), Det Bergenske Dampskibsselskab and Det Nordenfjeldske Dampskipsselskap which will transfer the cruise vessels 'Sagafjord', 'Vistafjord', 'Royal Viking Star', 'Royal Viking Sky' and 'Royal Viking Sea' to the new shipping company Royal Viking Line. Turnover in the new company is expected to reach 750 million NOK next year. The aim is to cover all the important cruise markets.
The background for the merger is an acknowledgement of the fact that only large companies operating modern fleets will be able to competet on the cruise markets in the future. The cooperation is to begin at the new year, but it will take some time before all the practical details are arranged. Each of the founder companies is to have a one-third share of Royal Viking Line.

Warmte-overdrachtsproblematiek in zuigerverbrandingsmotoren

RECTIFICATIE
In het laatste artikel van prof. dr. ir. E. van den Pol in Schip en Werf no. 24 dd. 23 nov. 1979 zijn een tweetal fouten geslopen welke hierbij worden gerectificeerd.

1. Op blz. 508 in de formule van Nusselt (3.1) moeten de twee temperatuurstermen tot de vierde macht worden verheven dus:

$$\alpha_{g,w} = 1{,}166 \sqrt[3]{p^2 T}\,(1 + 1{,}24\, c_m) + \frac{0{,}421}{T - T_w} \left| \left(\frac{T}{100}\right)^4 - \left(\frac{T_w}{100}\right)^4 \right| \qquad \left[\frac{W}{m^2 K}\right]$$

2. In de lijst van gebruikte symbolen en voetnoten op blz. 513 staat ten onrechte achter ν = dynamische viscositeit; dit behoort te zijn: kinematische viscositeit η/ρ