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Heavy-Oil Engine Progress,

with special reference to the development of the combustion chamber and fuel injection system.

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The advance of the heavy-oil engine during the past fifty years has been mainly dependent on the progress made in the design and construction of the combustion chamber and fuel injection system. The *firm with which the author is associated has had 52 years' continuous experience in the development and production of heavy-oil engines, hence a survey of the practical results of this experience will give a typical view of the progress which has been made since the introduction of this type of prime mover.

Three main stages of development can be considered, each of which had its own requirements as to the type of combustion chamber and fuel injection system necessary for successful results.

I.—The low compression engine.

This had a compression pressure of 40 to 70lb. per sq. in., the fuel, injected during the suction stroke, being ignited mainly by the hot vaporizer surface. It was generally constructed as a single cylindered horizontal engine, developing 1½ b.h.p. at 400 r.p.m. to 66 b.h.p. at 160 r.p.m., but was also constructed in sizes up to 125 b.h.p. in one cylinder, and in both horizontal and vertical multi-cylindered types.

II.—The medium compression engine.

In this stage the compression pressures were from 180 to 280lb. per sq. in., the fuel, injected towards the end of the compression stroke, being ignited by the combination of the heat of compression with the heat of the hot vaporizer surface. The engines were built in sizes from 6 b.h.p. at 450 r.p.m. to 340 b.h.p. at 160 r.p.m., and with one or two horizontal cylinders.

III.—The high compression engine.

This is the engine constructed to-day, the compression pressures being from 380 to 500lb. per sq. in.; the fuel is injected towards the end of the compression stroke and ignited by the heat of compression alone. It is made in many sizes, types and speeds, from 3½ b.h.p. upwards.

The Combustion Chamber.

The stages in the development of the combustion chamber will be considered separately from the development of the fuel injection system.

Stage I.

In June, 1891, Messrs. Richard Hornsby and Sons, Ltd., obtained the licence to manufacture oil engines under the patents of Mr. Akroyd Stuart and in the same month exhibited two engines at the Royal Agricultural Show held at Doncaster. These were actually engines constructed by Mr. Akroyd Stuart and were similar to the engine shown in Fig. 1 and diagramatically in Fig. 2a.

The combustion chamber or "vaporizer" was of cast iron, cubical in shape, and was connected to the actual cylinder through a contracted neck. The inlet and exhaust valves were in a pocket at the bottom of the cylinder, only the exhaust valve being mechanically operated.

The use of a separate combustion chamber, with or without positive air scavenging, connected to the cylinder by a more or less contracted neck, sometimes disguised as a "pre-combustion chamber", "air cell", etc., has persisted throughout the whole period of heavy-oil engine development and is only now being gradually superseded for certain types of engines.

When manufacture of the Akroyd type engine was commenced, the design was modified in many respects. The valves were moved to a chamber at the side of the cylinder, where they were more accessible and both mechanically operated. A cylindrical vaporizer was adopted which was much more reliable than the original cubical type. (See Fig. 2b).

At first only small sizes of engines were built, but as the powers developed increased, trouble with overheating of the vaporizer on heavy loads and difficulty in maintaining sufficient heat to ensure regular firing on light loads led to the adoption, in 1895, of a partly water-cooled vaporizer on engines larger than 5 b.h.p. (Fig. 2c).

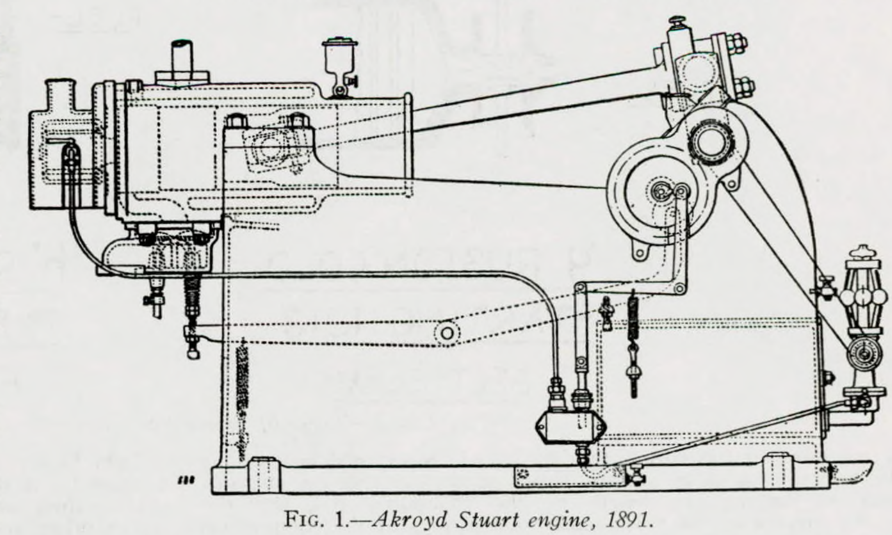


Fig. 1.—*Akroyd Stuart engine, 1891.*

The flow of water through the water jacket could be regulated and so give some measure of control over the uncooled section or "cap end". Much unnecessary trouble with these engines has been caused through the fitting of asbestos joints between the two sections of the vaporizer instead of keeping a metal to metal joint, and thus interrupting the heat flow with consequential overheating of the cap end.

It was soon found that different fuels had different ignition qualities and modifications were required to suit. These included

*Messrs. Ruston and Hornsby, Ltd.

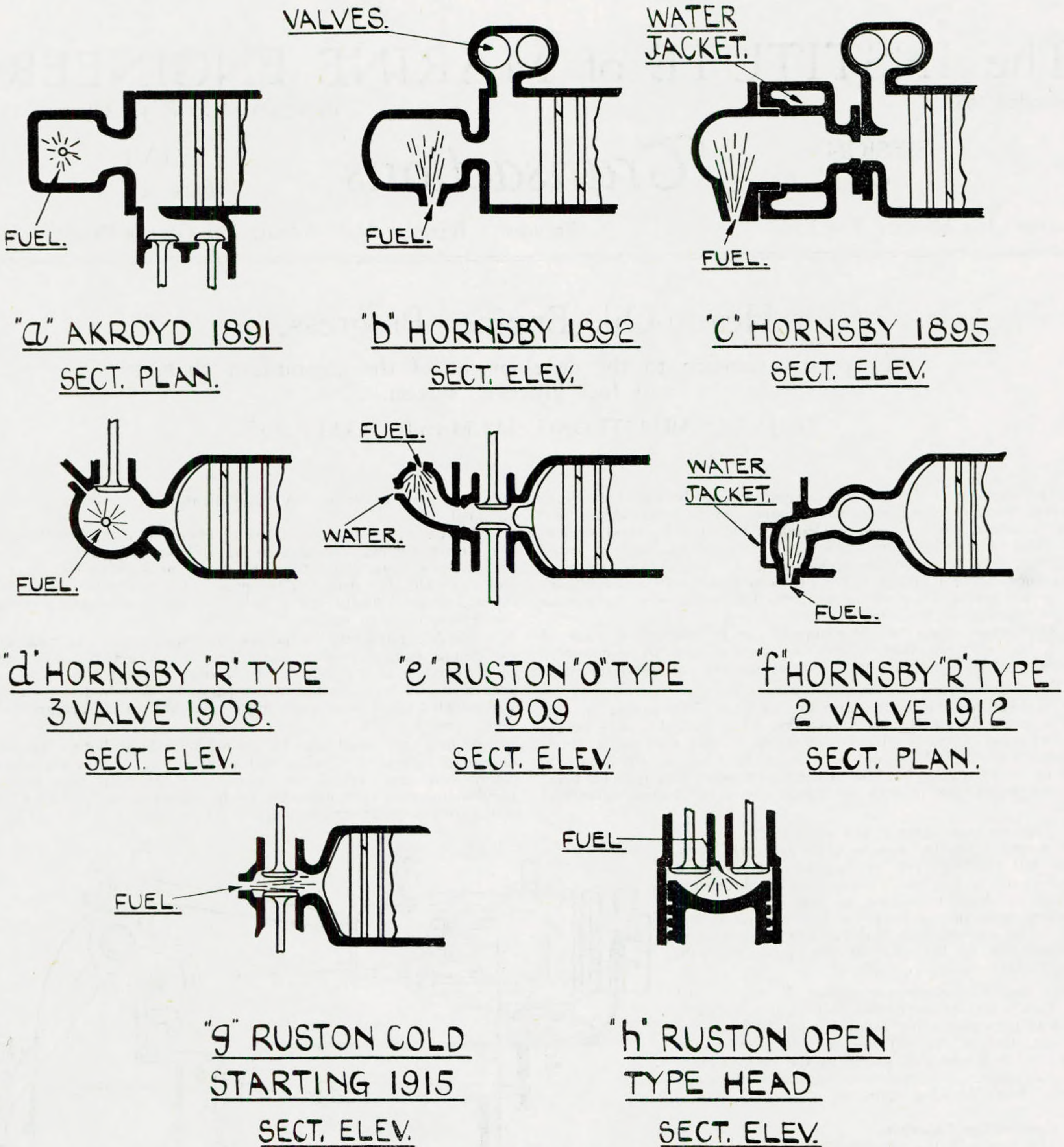


FIG 2.—*Types of combustion chambers.*

having more or less ribs in the interior of the cap end and making slight modifications by various means to the compression pressure, such as varying the length of the connecting rod, the size of the cover over the valves, and combinations of the compression blocks shown in Fig. 3.

Continuous experiments were made to ascertain the best proportions between the various details to give the best running results, with reduced consumption of fuel and increase in output for the same cylinder capacity. These included reducing the clearance space in the cylinder end so that more of the air was compressed into the vaporizer, which enabled higher compressions to be used, resulting in lower fuel consumption; increasing the length of the vaporizer and at the same time reducing the diameter, giving better running at light loads; increasing the length of the vaporizer water jacket, compared with the length of the cap end, which reduced trouble with sticky pistons; and finding the correct dimensions of the neck between the vaporizer and cylinder to give the best results on different fuels. For use with the heaviest residual fuels cap ends were made with quickly detachable covers, fixed by "strongbacks", so that the cap ends could be cleaned with the minimum of delay.

Although this type of engine was still being manufactured in 1922, the only other major alteration relating to the combustion chamber was made in 1905, when the air inlet valve was moved to a horizontal position, on the opposite side of the cylinder to the exhaust valve, which remained in its previous position. This alteration enabled a better scavenging of the cylinder to be obtained, so that

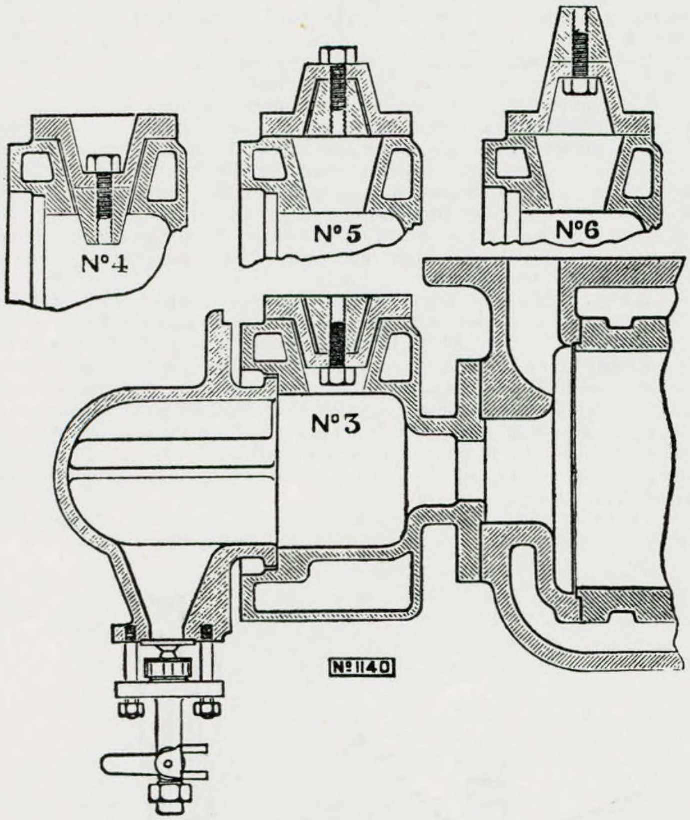


FIG. 3.—*Compression adjustment, Hornsby-Akroyd engine.*

higher compressions could be used without resulting in pre-ignitions, and this in turn gave lower fuel consumption. By varying the overlap of the valves, which could be simply and quickly carried out by means of a slotted valve lever, the amount of residual gases retained in the cylinder at the end of the exhaust stroke could be varied, so regulating the heat of the vaporizer when running for extended periods on reduced loads.

STAGE II.

In 1908 the firm introduced their 3-valve "R" type engine, of the medium compression type. The cylinder clearance was reduced to a minimum, practically all the air being compressed into a nearly spherical combustion chamber as shown in Fig. 2d. Only one valve opened into the top of this chamber, being used for both inlet and exhaust, the flow of which was regulated by two double seated ring valves, similar to Cornish type valves, operating in the port above the sealing valve.

The uncooled cap end was similar to that used on the previous type of engine, and after the correct size of neck between the cylinder and combustion chamber had been ascertained for each type of engine, the only modification made to suit varying grades of fuel was to fit cap ends with more or less internal ribs.

Concurrently with the introduction of the "R" type engine, Messrs. Ruston, Proctor and Co., Ltd., who had been manufacturing oil engines since 1897 but had been restricted to the external vaporizer type by the Akroyd patents, produced their "O" or "CC" type medium compression engine, shown in Figs. 2e and 4.

At the end of the cylinder was the valve chamber, containing the superimposed inlet and exhaust valves, and this chamber was connected to the distorted pear shaped combustion chamber or hot-bulb through a slightly restricted neck which was known as the "choke". Integrally with the combustion chamber was cast a large flange, which served as the water jacket cover of the cylinder head and enabled a normal type of joint to be used between the combustion and valve chambers.

For controlling the heat of the combustion chamber, more or less water was admitted through a valve fitted at the end of the chamber, but no modifications had to be made for different fuels.

During 1912 the 2-valve "R" type Hornsby engine was introduced, with a valve chamber similar to that used on the Ruston "O" type engine, but with a longer neck leading tangentially into the combustion chamber (Fig. 2f). Compared with the 3-valve "R" type engine, the compression had been raised from 180lb. to 280lb. per sq. in., and the fuel consumption reduced by nearly 25 per cent. For the smaller sizes of engines regulation to suit different fuels was still effected by varying the ribbing in the cap end, but for larger engines a partial water jacket was fitted, the effect of which could be regulated by varying the flow of water.

STAGE III.

After carrying out various experimental work, started in 1912, Messrs. Ruston, Proctor & Co., Ltd. in 1915 began to produce high compression cold starting engines. The first engines were similar in design to the "O" type engines, only the piston, cylinder head and injector being entirely new. The external combustion chamber was omitted, all the air being compressed into the valve chamber, which was connected to the cylinder by a short neck or choke (Figs. 2g and 5). No modifications were needed to suit varying fuels or load conditions, in fact only the slightest variation in the proportions of the combustion chamber has been made since this type of engine was introduced.

Although the use of a neck or choke between the combustion chamber and cylinder has been universal in all three stages of development it is realized that it imposes limitations when higher speeds, higher outputs for the same cylinder capacity, combined with lower consumptions of the fuels now being marketed are required, and this is one of the main reasons why the open type combustion chamber as shown in Fig. 2h has been adopted by the author's firm for their latest range of vertical engines. It should not, however, be considered that development has ceased, as progress is continually being made.

The Fuel Injection System.

STAGE I.

In the original Akroyd engine, shown in Fig. 1, the fuel pump was fixed on the side of the bedplate, under the crankshaft. A quick

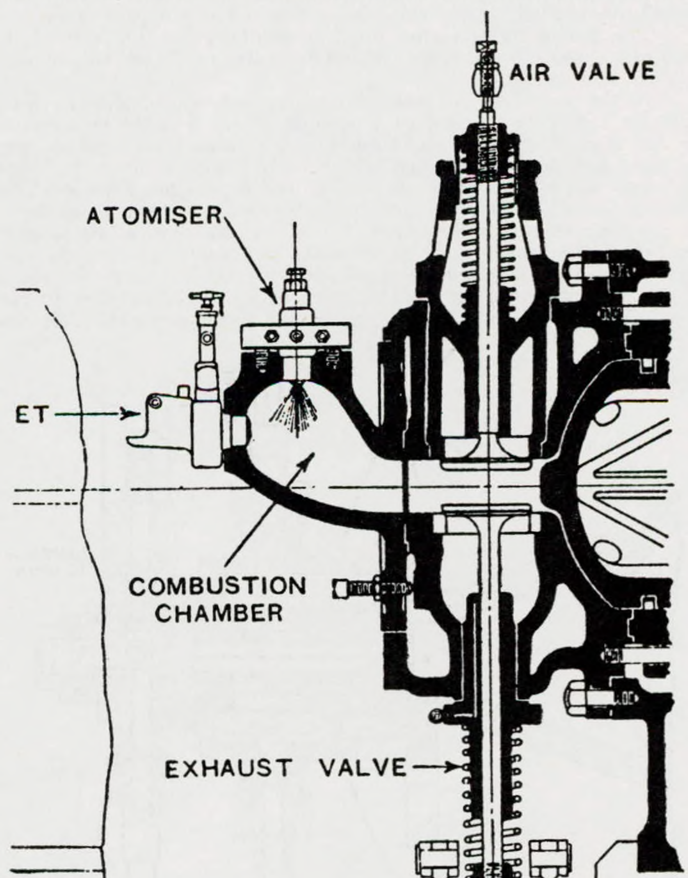


FIG. 4.—*Section of Ruston "O" type engine combustion chamber.*

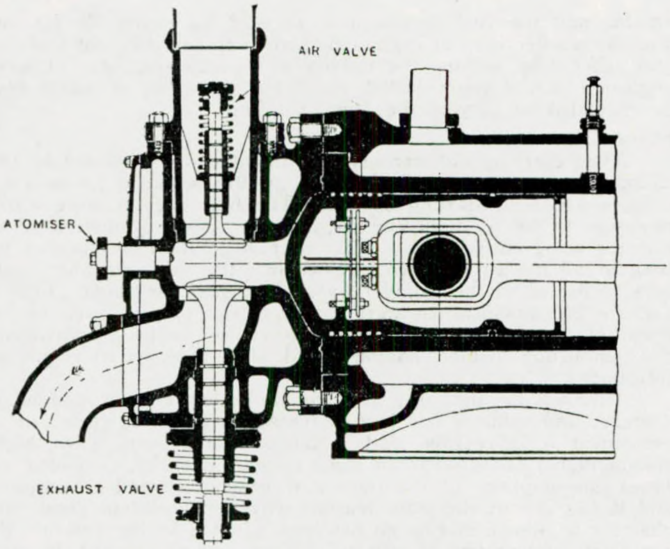


FIG. 5.—*Ruston high compression engine combustion chamber.*

acting cam raised the plunger on the suction stroke but the delivery stroke was spring operated. The delivery valves were in the pump body but the suction valve body was at the front of the engine, so that the valve lift could be controlled, for the purpose of speed regulation, by a belt driven Pickering type governor. Owing to air lock trouble this was modified and a normal type suction valve fitted, the original suction valve being retained as a bypass valve.

The simple fuel injector, fitted horizontally into the side of the vaporizer, was known as the "Vaporizer valve box", and this nomenclature still exists.

In the modified production design a side camshaft was fitted and the fuel pump moved to a position where it could be operated by the inlet valve lever. The pump had a bronze body, packed type plunger and double ball type suction valves with a single ball type delivery valve. It was so successful that it was but little modified during the whole thirty years production of this type of engine.

A diagram of the first type of fuel vaporizer valve box is given in Fig. 6, the bronze body being water jacketed to prevent the heat from the uncooled vaporizer producing vapour locks. A horizontal lightly spring loaded mitre valve acted as a non-return valve to prevent the blowing back of the fuel by the firing pressure. Adjacent

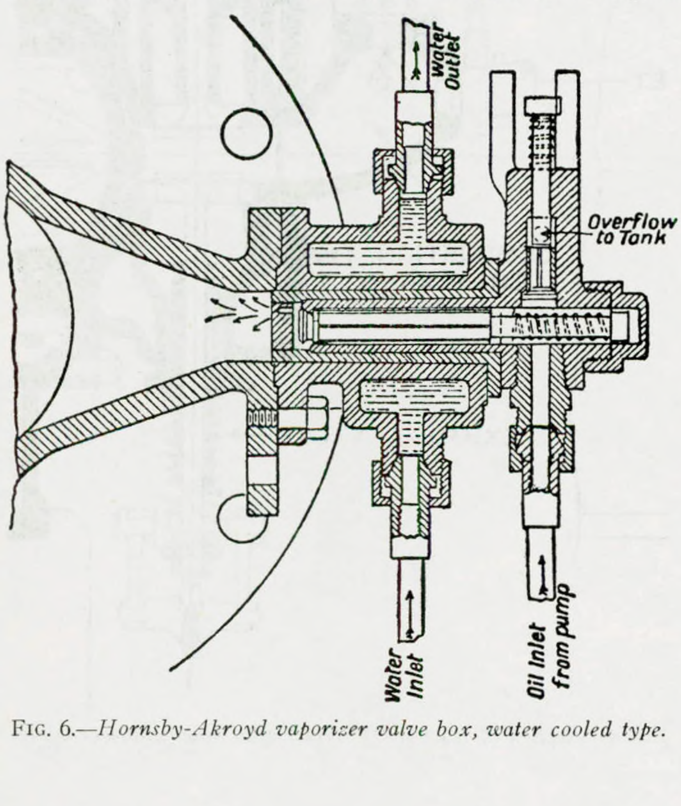


FIG. 6.—*Hornsby-Akroyd vaporizer valve box, water cooled type.*

to the head of this valve, and restricting its lift, was the nozzle, originally similar to a Primus nipple, but later modified to a screwed plug in which were drilled, off centre, one or more holes of ·009″ to ·012″ diameter. Through these holes the fuel was forced with sufficient velocity to give a fine spray inside the vaporizer.

The vaporizer valve box also contained another spring loaded mitre valve, arranged vertically at the side of the horizontal valve. Suitable linkage from the governor lifted this valve more or less off its seat in accordance with the speed of the engine and regulated the amount of fuel by-passed to the fuel tank, the actual quantity being visible in a small funnel attached to the side of the valve box. By mounting one of the operating levers on an adjustable eccentric fulcrum pin the valve could be held open for the purpose of priming the system or for stopping the engine.

Within limits, this simple method of fuel control was satisfactory, but on light loads the atomization was poor and the firing often "hit and miss". To reduce this trouble the pump stroke could be varied, whilst the engine was running, by adjusting the lost motion between the inlet valve lever and the pump operating stirrup, a check gauge being provided for a range of loads and to prevent excessive pump stroke being given which would result in carbon deposits in the vaporizer. In practice the method adopted was to reduce the pump stroke to suit the load so that there was only an occasional trickle from the bypass valve.

The adoption of water cooling for the vaporizer enabled the valve box water jacket to be omitted and the type shown in Fig. 7 became the standard.

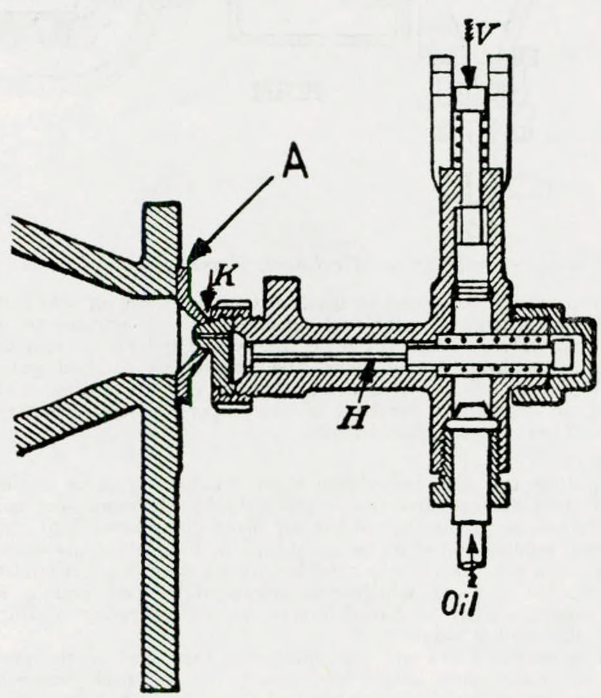


FIG. 7.—*Hornsby-Akroyd vaporizer valve box, later type.*
"A" spray pad; "H" horizontal valve; "K" nozzle pip; "V" vertical bypass valve.

This had a steel nozzle secured by a slotted nut, the spray holes being drilled into the nozzle pip which projected into an adaptor or "spray pad". A small contact area between the nozzle pip and spray pad, together with an asbestos washer between the spray pad and the vaporizer, resulted in a minimum of heat being conducted to the valve box.

Only one further modification was made to this fuel injection system during the thirty years period of its manufacture; this was to fit a separate cam for operating the fuel pump. The fuel was then injected at the beginning of the suction stroke instead of at mid-stroke, which allowed a longer period of time for the vaporization of the fuel with resulting economy.

STAGE II.

The fuel injection system of both the 3-valve and 2-valve Hornsby "R" type engines had several points in common with one of the most popular systems in use at the present day, i.e., the use of a long pump stroke of which only the middle portion was utilized for injection, commencement of delivery controlled by a port and reduction of fuel pressure at atomizer on completion of each injection, in order to reduce dribble from the injector.

The fuel pump was fixed vertically under the camshaft; its general arrangement is shown in Fig. 8. The suction and delivery valves were of the ball type, in duplicate, and their lift had to be restricted to close limits to obtain regular operation of the pump. During the first part of the delivery stroke the fuel passed upwards, through ports drilled in the end of the plunger, into a recess round the pump barrel and back to the fuel tank. This bypass was suddenly cut off by the movement of the plunger and the fuel was then delivered to the vaporizer valve box.

In 1911 experiments were made with the normal pump suction blanked off, the fuel entering the pump through the bypass ports and recess in a similar way to that adopted on the present day plunger controlled spill type of pump. Although the initial tests were successful the idea was not proceeded with, no doubt due to troubles experienced with the viscous types of fuels often used for engines at that time.

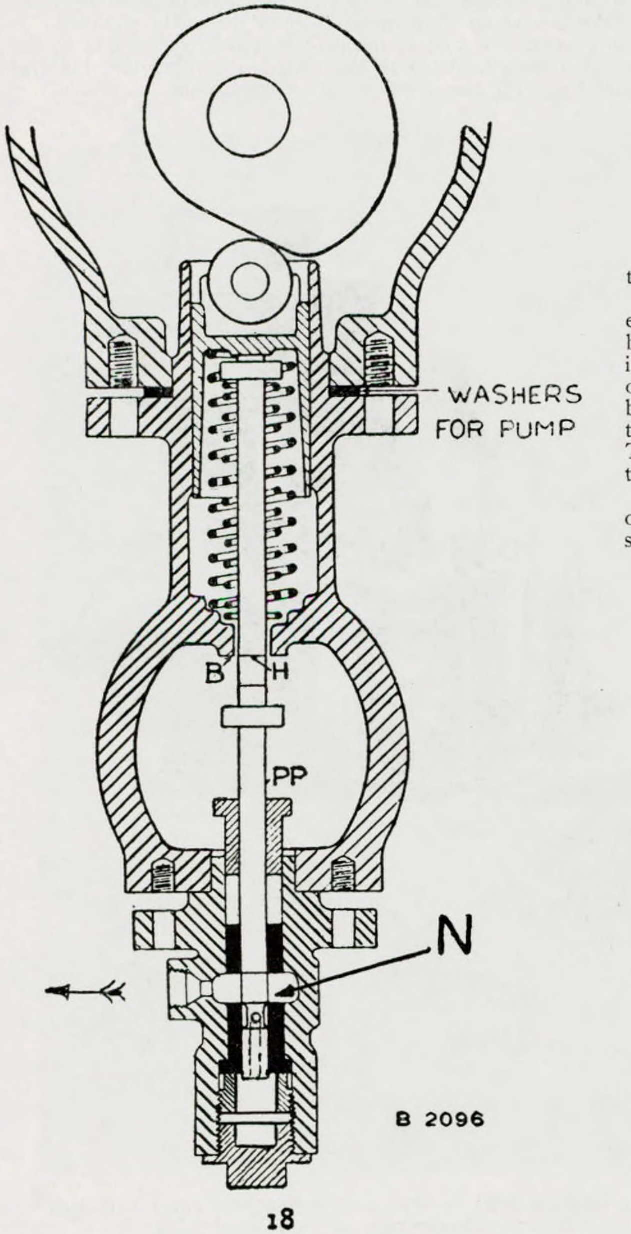


Fig. 8.—*Hornsby "R" type fuel pump, showing bypass recess in barrel (N).*

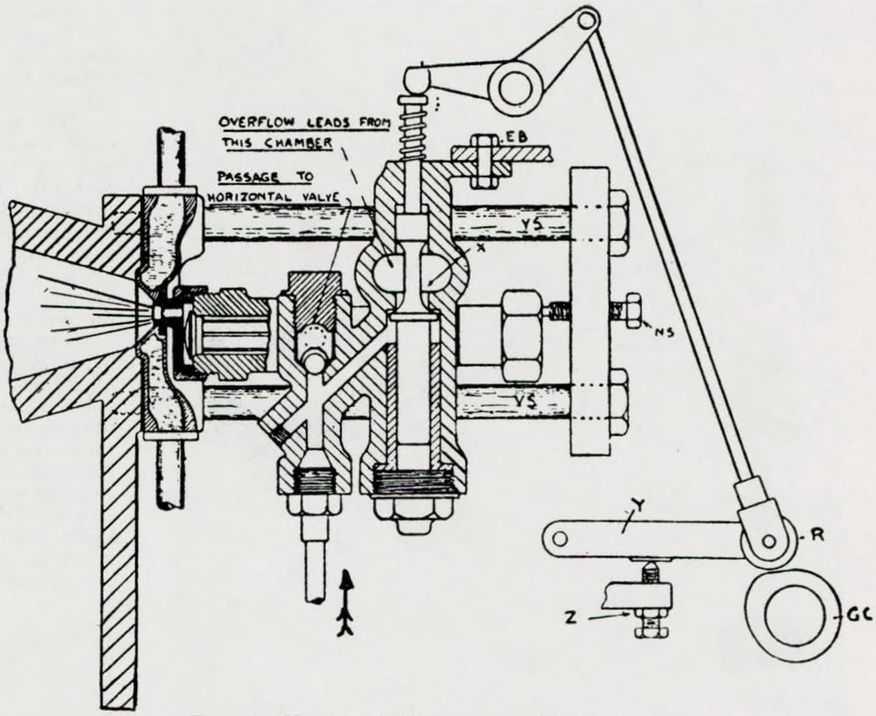


Fig. 9.—*Hornsby "R" type vaporizer valve box.*

This valve box was, in general, similar to that used on the Hornsby Akroyd engines, the principal differences being that the vertical control valve was of the balanced type, the nozzle had only a single hole, a non-return valve was fitted in the delivery pipe connection, and the spray pad was water cooled. The diameter of the hole in the nozzle varied from $\frac{51}{64}''$ to $\frac{3}{16}''$ on engines of from 35 to 170 b.h.p. and the amount of counterboring on the inside of this hole greatly affected the characteristics of the spray produced. For use with some fuels, such as Texas crude, a deflector in the counterbore was used to give a spiral motion to the spray. This type of valve box is illustrated in Fig. 9.

The vertical control valve was operated from a small quick lift cam, fitted on the camshaft, which could be moved along a spiral key by the governor, so varying the time of opening of the valve and resulting in an immediate fall

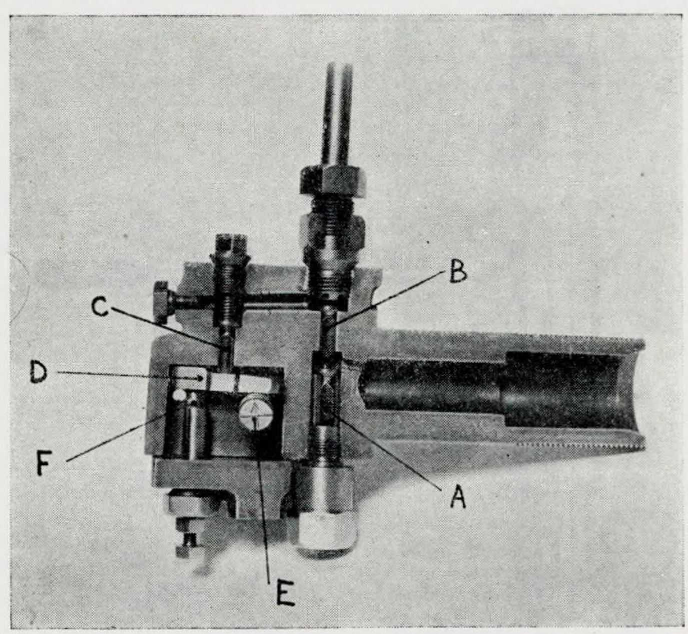


Fig. 10.—*Ruston "O" type fuel pump.*
"A" suction valve; "B" delivery valve; "C" overflow or bypass valve; "D" lifter bar; "E" eccentric operated by governor; "F" adjustable fulcrum.

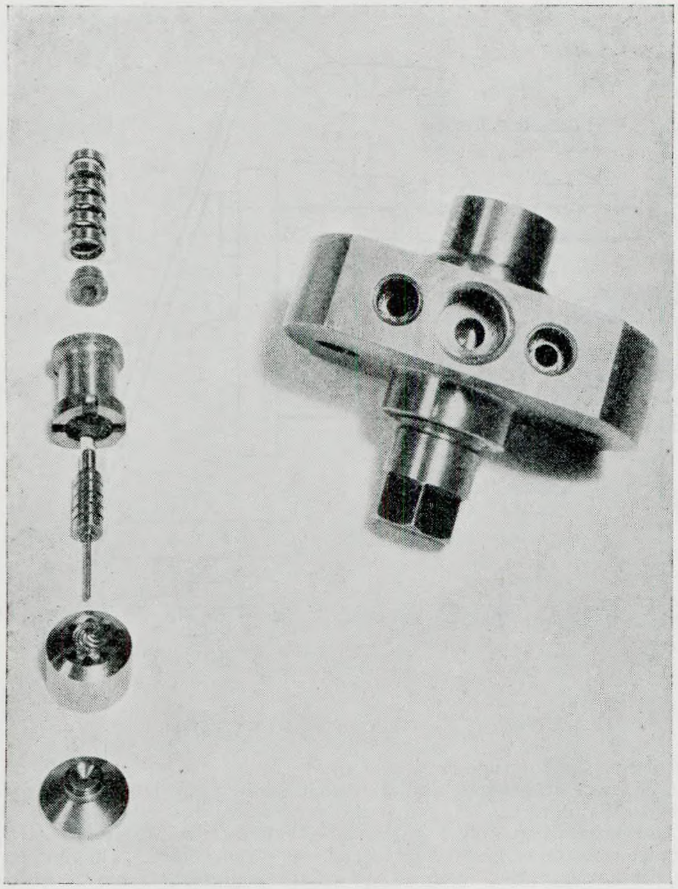


FIG. 11.—*Ruston "O" type atomizer. On the left are spring, spring cap, valve guide, needle valve, cone (note spiral grooves), and nozzle; on the right is the complete unit.*

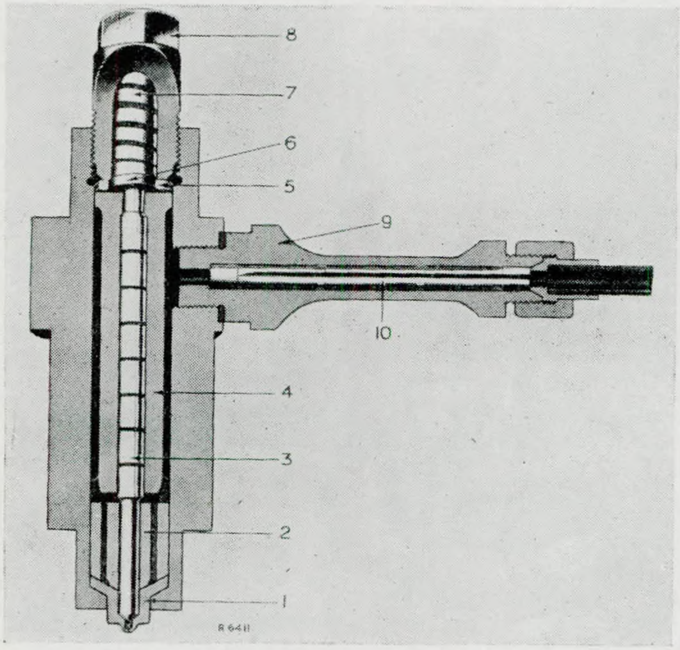


FIG. 12.—*Ruston high compression engine atomizer.*

1, nozzle; 2, cone; 3, needle valve; 4, valve guide; 5, joint ring; 6, spring cap; 7, spring; 8, spring plug; 9, filter body; 10, filter.

of pressure in the valve box.

From the above it will be realized that the "water hammer" effect, due to the sudden stoppage of the fuel pump bypass, was utilized to produce the atomization of the fuel instead of high fuel pressure forcing the fuel through fine jets.

The fuel pump of the Ruston "O" type medium compression engines was placed in a horizontal position at the end of the camshaft and was operated by a quick lift cam fitted with a hardened toe piece, the lift being varied to suit the size of engine. Originally the pump bodies were of bronze, but forged steel was found more reliable under pressure. The section through the pump in Fig. 10 shows the mitre type valves and the bore for the hardened steel plunger, fitted with U leather packings, which was made in two sections with a hardwood plug interposed, with the idea of reducing the metallic blow on the gear.

For regulating the amount of fuel delivered, an overflow or bypass valve was arranged so that it could be raised more or less off its seat by a lifter bar, which rested at one end on an adjustable fulcrum and at the other end on an eccentric which could be oscillated by the governor. The movement of this valve was very small and when running on "no load" a lift of less than ·010" was sufficient to release all the excess fuel. There was practically no reaction on the governor and by varying the angular position of the eccentric, the governing characteristics could be easily modified. A slight disadvantage was that as the load decreased the timing of the injection was retarded, owing to the time lag in obtaining the fuel release pressure with the overflow valve more open.

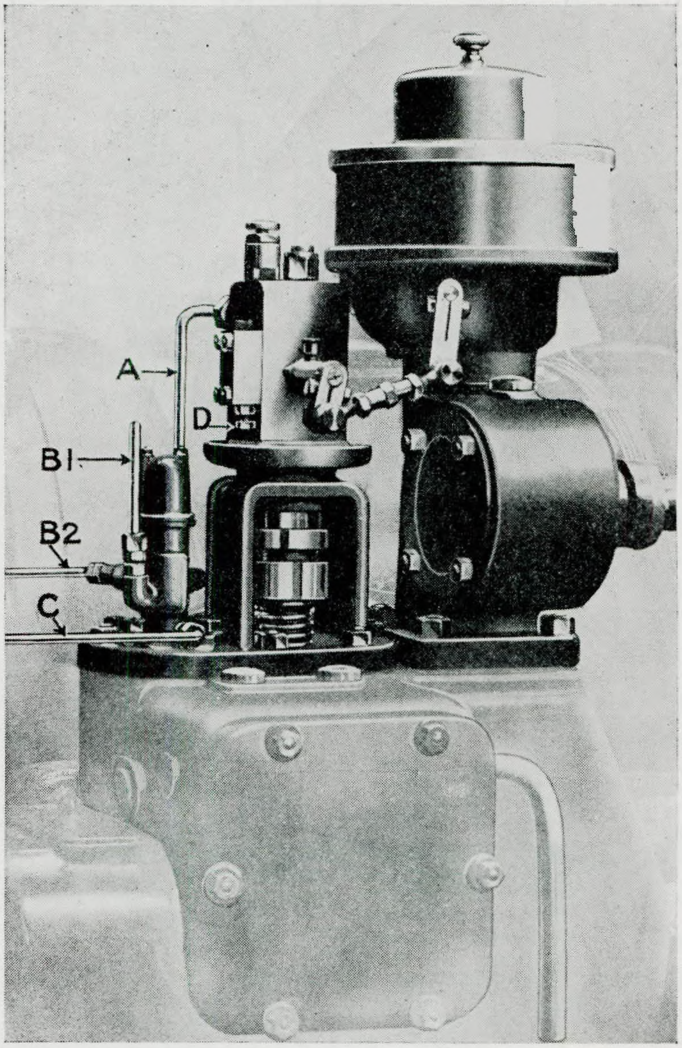


FIG. 13.—*Ruston high compression engine fuel pump and distributor, with governor on right hand side.*

"A" delivery pipe from pump to distributor; "B1" and "B2" delivery pipes from distributor to injectors; "C" pipe for leading distributor leakage back to fuel tank.

Both the method of governing and the construction of the fuel injector, or "atomizer" in the Lincoln works nomenclature, were in accordance with Patent No. 20582, obtained by Mr. F. Livens, the Company's chief engineer. This atomizer was perhaps the first to make use of a differential needle valve of which details together with a complete unit are shown in Fig. 11. The body was of forged steel, arranged for water cooling because it was subjected to the heat from the combustion chamber. The nozzle had a single hole, which varied in size from $\frac{3}{64}''$ to $\frac{3}{32}''$ in diameter for engines of from 15 to 100 b.h.p. Next to the nozzle was the "cone" which had spiral grooves on the end fitting into the nozzle. These spiral grooves, which gave a whirling action to the spray, were cut by a very ingenious machining operation on a specially modified lathe. The lower end of the needle valve, only $\frac{1}{32}''$ larger in diameter than the hole in the nozzle, was guided by the cone and the larger upper end fitted into the needle valve guide. This portion was relatively short, so that in order to keep leakage at a minimum without having a lapped fit between the valve and guide, a valve seating was formed at the top of the needle valve which came up against a seat in the guide when the valve was lifted off its seat in the nozzle by the fuel pressure, and so sealed the way of escape of the fuel. The needle valve was loaded to lift at the required pressure by a short stiff spring resting on the top, the plug securing the spring being drilled to allow any fuel leakage to be returned to the fuel tank. All the fuel pipes were of solid drawn copper with flat ended union nipples formed out of the actual pipe by means of suitable dies. These atomizers contributed in no small way to the success of this type of engine, with which fuel consumptions of less than ·5lb. per b.h.p. were obtained on crude and residual fuels in 1910, and similar types were gradually adopted by other manufacturers.

STAGE III.

The fuel pumps of the first Ruston high compression engines were the same as those used on the "O" type medium compression engine and the atomizers were of similar design, but, as they passed through the cool cylinder head cover, no water jacketing was required, although the length was increased. The single hole nozzle was replaced by one having a slot which gave a fan shaped spray in order that it should not strike the valves of the type of combustion chamber used. Previously no great stress was laid on the atomizer release pressures, but now these pressures, ranging from 1,200 to 1,500lb. per sq. in., became more important. To obtain this increase in pressure whilst retaining the original type of spring, the diameter of the small end of the needle valve was increased and the lengthened atomizer body enabled a longer needle valve and guide to be used, which contributed to keeping leakage at a low amount even with the increased fuel pressure. Fig. 12 is a sectional arrangement of this type of atomizer.

When the general engine design was modified in accordance with the policy of continual improvement, the fuel pump was moved from its position at the end of the camshaft and arranged vertically above the camshaft in a very accessible position, as shown in Fig. 13. The pump body was formed from a block of steel, ball valves replaced mitre valves, and later a lapped plunger was fitted in place of the packed type plunger, the plunger itself being solid and not in two sections. Eventually the slot type atomizer nozzle was superseded by a nozzle having three holes of ·009″ diameter and upwards arranged in a line, so that they sprayed between the valves. This facilitated manufacture whilst at the same time it gave slightly reduced fuel consumption.

The production of multicylindered vertical engines began to increase, bringing with it the problem of equal fuel distribution between cylinders at varying loads. Initially, separate pumps were employed for each cylinder with a specially arranged float chamber fitted to each pump, which enabled the engine attendant to check at intervals the amount of fuel delivered to each cylinder over the same period of time. Whilst this was satisfactory for the larger slow speed engines it was not automatic, and was discontinued as speeds increased.

In place of separate pumps a distributor was introduced which allowed the use of a single pump unit with one plunger (or two plungers in the case of 5 and 6 cylinder engines) and only one overflow valve to regulate the fuel supply for all cylinders. The distributor consisted of a ported, lapped plunger reciprocating in a sleeve, which had on one side a port connected with the delivery of the fuel pump, whilst on the opposite side was a series of ports arranged in pre-

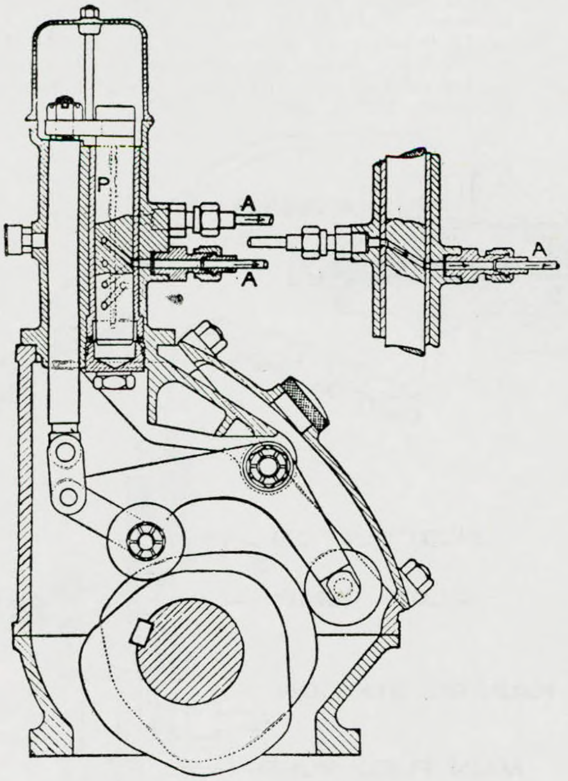


FIG. 14.—*Ruston distributor.*
"A" delivery pipes to individual injectors; "P" ported plunger.

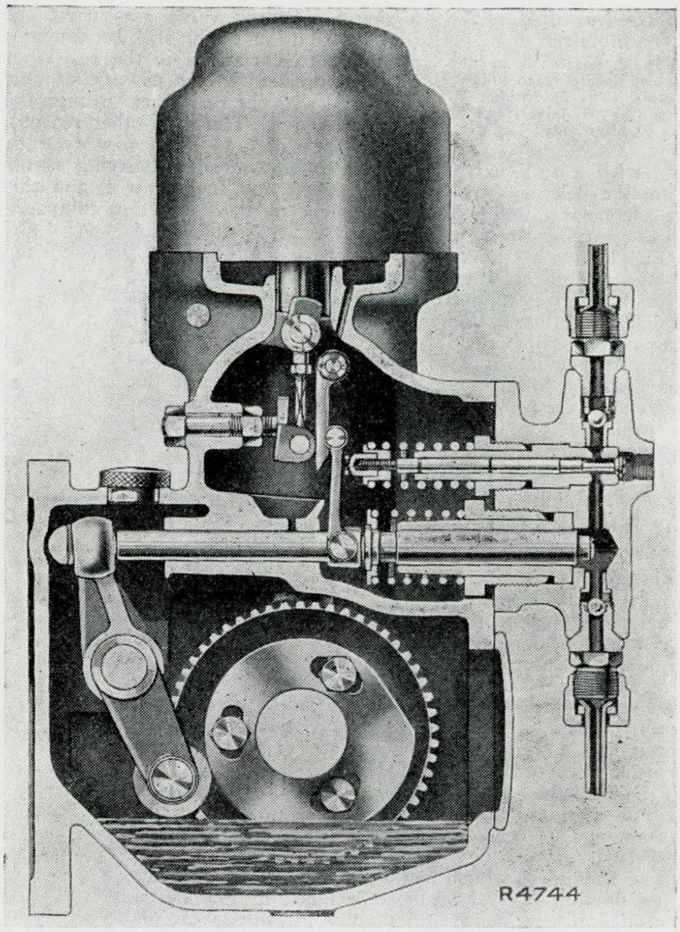


FIG. 15.—*Ruston spill valve fuel pump.*

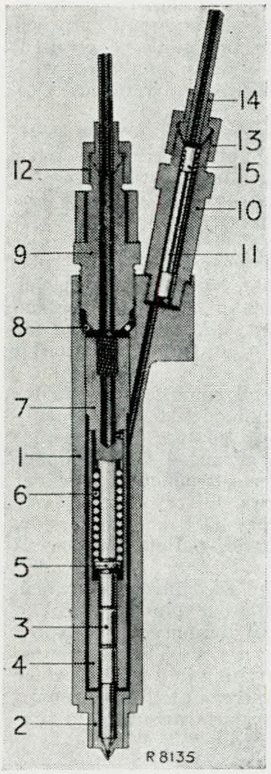


FIG. 16.—*Ruston Mark 37 atomizer.*

1, body; 2, nozzle; 3, needle valve; 4, needle valve guide; 5, spring cap; 6, spring; 7, spring stop; 8, joint ring; 9, plug; 10, filter body; 11, filter.

determined positions, each one connected to a different atomizer. The transverse ports in the plunger were so arranged that when one end of a particular port coincided with the delivery port from the fuel pump, the other end coincided with the port leading to the atomizer to which fuel was to be delivered. The plunger movement was controlled by a cam, or an eccentric in the case of two cylinder engines, the movement pausing as each set of ports coincided so that the fuel pump timing could be advanced or retarded without requiring adjustment to the distributor. To prevent any side thrust on the distributor plunger it was driven indirectly, and the lower end of the plunger was arranged as a pump to return any leakage to the fuel tank. A sectional view is given in Fig. 14 and an external view at the side of the fuel pump in Fig. 13.

The introduction of the distributor brought into prominence the need for keeping the volumetric capacity of the fuel pipes at a minimum and that they should be as rigid as possible. Smaller bore, thick walled steel pipes were then adopted as standard on all engines.

With the tendency towards increased engine speeds it was found that the limit for practical operation of an engine with a fuel pump in conjunction with a distributor was approximately 500 r.p.m., at which speed the pump of a four cylinder engine operated at 1,000 strokes per minute. It was also noted that, although a single overflow valve was used, the fuel distribution could still become uneven due to variations in the resistance of the atomizers to the passage of fuel compared with the resistance through the overflow valve. This, and other reasons, led to the adoption of a new type of pump with a spill valve, arranged to be opened at varying points during the delivery stroke of the pump, for fuel control, and this gave a constant timing of the commencement of injection compared with the varying timing of the overflow type of control.

Fig. 15 is a section through a typical pump of this type showing the lapped plunger, the balanced spill valve, to reduce the load required to open it, and the ball type suction and delivery valves. Various methods were adopted for opening the spill valve at the required time, but all mechanisms include a lever, one end of which reciprocates with the pump plunger whilst the position of the other end is varied by the governor through the medium of a wedge or eccentric, thus giving more or less initial clearance between the lever and spill valve stem.

It is interesting to note that Patent No. 20582, previously mentioned, covered the operation of the overflow valve as a time-spill valve and stated that this method of regulation was preferred because it gave a more regular fuel delivery pressure and consequently better atomization. The mechanism suggested was, however, more complicated than that required for the operation of a plain overflow valve, but simplicity was apparently considered at that time to be of first importance and this assumption was proved to be correct by the results obtained.

In most cases individual pump units, fixed in a common block, were used for each cylinder of the engine, but for multicylinder horizontal engines running at speeds of approximately 300 r.p.m. the combination of a spill valve pump with a distributor has been found to overcome the disadvantages of previous combinations and to give good distribution of fuel over long periods of running without requiring adjustment.

The atomizer, which had been little modified since its introduction in 1915, was re-designed in 1937 from the results of experience and to take advantage of improved methods of manufacture. All details were reduced in size, and due to greater accuracy of machining the seating in the needle valve guide could be omitted without resulting in excessive leakage, whilst being simpler to produce. This type of atomizer, known as the Mark 37, is illustrated in Fig. 16 which also shows the self-centering nozzle for facilitating assembly. A further slight variation was the introduction of nozzles with radial spray holes for use in a new range of engines with open combustion chambers.

When oils having high ignition temperatures, such as tar oils, are used as fuel, ignition, especially on light loads, is not always reliable and some form of pilot ignition is desirable. Previous to 1914 tests were made with a Hornsby "R" type engine running on tar oil, the light oil, for pilot ignition, being delivered by a separate pump through passages drilled in the valve box body into a small hole in the nozzle drilled just above the main spray hole.

One of the earliest Ruston high compression engines ran through the latter part of the 1914-1918 war period with creosote oil as fuel and without pilot injection, but for special conditions the device shown in Fig. 17 was adopted for these types of fuels. A small pump for the light oil, used for pilot ignition, was fitted; the plunger of this pump operated by the pressure in the main pump, the plunger stroke being regulated by hand to give the required amount of pilot fuel, which was constant for all loads. The main atomizer needle valve was hollow; the pilot fuel needle valve fitted inside the hollow portion, the fuel passing to it by various passages. This pilot needle valve was spring loaded, so that it lifted at a lower release pressure than the main needle valve, thereby allowing the pilot fuel to enter the cylinder slightly in advance of the main fuel, the angle of advance remaining constant even when the main injection timing was altered.

With the adoption of the open type combustion chamber, increased speeds and ratings, and the types of fuel oils now on the market, the tendency is for the adoption of individual fuel pumps arranged with the shortest possible delivery pipes from pump to atomizer; for this purpose the plunger controlled spill type of pump offers many advantages and has been adopted for the latest engines.

Due to the war the general adoption of further developments in the combustion chamber and fuel injection system has been unavoidably retarded, but when the time comes they will certainly play their part in the future progress of the heavy-oil engine.

The author's thanks are due to the directors of Messrs. Ruston and Hornsby, Ltd., for permission to publish this paper and for access to various records, also to past and present members of the staff for information on the earlier types of engines.

References have been made to:—

"Heavy-oil engines of the Akroyd type", by Prof. W. Robinson. Published by Blackie & Sons, 1931.

"Some Lincolnshire oil engines", by Mr. F. H. Livens, M.I.Mech.E. Paper given before the Institution of Mechanical Engineers at Lincoln, July 21st, 1920. "The Engineer", Vol. 1, 1891.

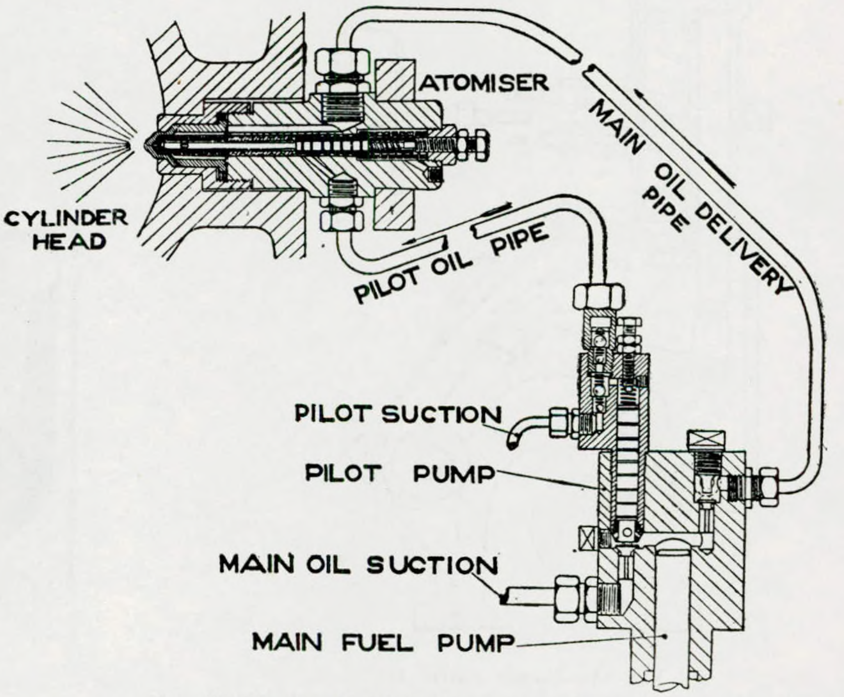
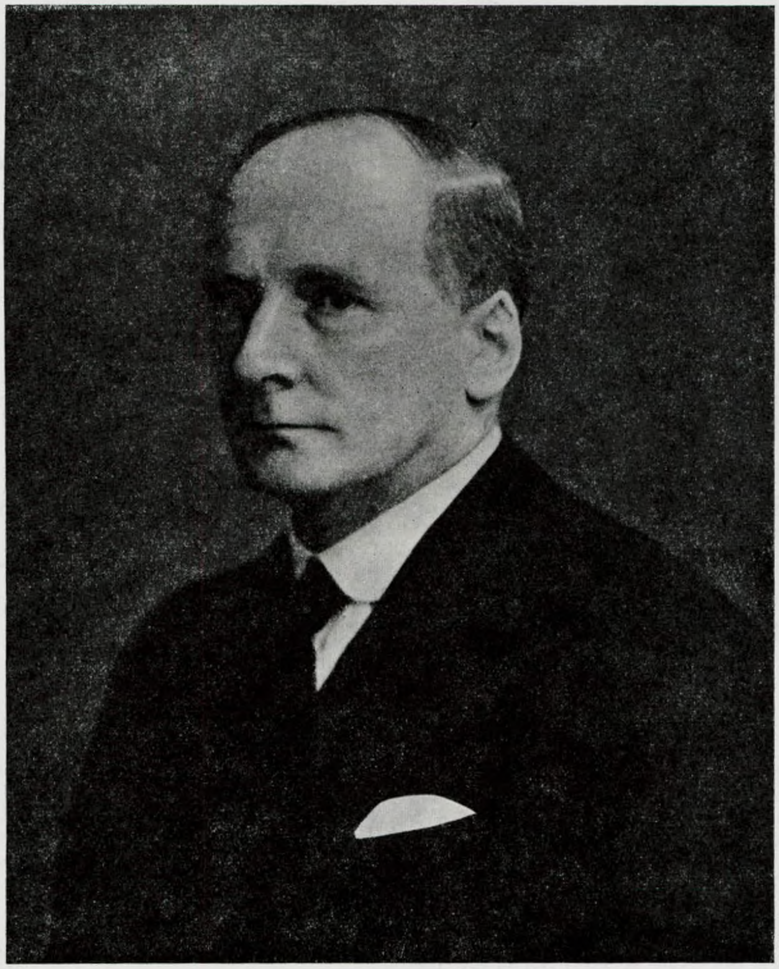


FIG. 17.—*Ruston pilot injection pump and atomizer.*

OBITUARY.

LORD CRAIGMYLE.

We regret to record the loss of an esteemed past-president of the Institute by the death of Lord Craigmyle. For a long while, indeed before and since he held the presidential office in 1936, he had been in poor health, and he died on Friday, September 29th, 1944, at Peel, Clovenfords, Selkirk, after a short illness. His presidential address to the Institute in 1936 revealed anew the fine qualities of mind and heart for which he was already known and admired throughout the shipping world, and his death at such a comparatively early age is deeply regrettable.



The Right Hon. Alexander Shaw, second Baron Craigmyle of Craigmyle, in the Peerage of the United Kingdom, was the eldest son of Thomas Shaw, first baron, the well-known Lord of Appeal and former Solicitor-General for Scotland, who died in 1937. He was born in 1883 and was educated at George Watson's College, Edinburgh, at Edinburgh University, and at Trinity College, Oxford, where he was President of the Union in 1905. Called to the Bar by the Inner Temple in 1908, he practised in the King's Bench Division and at the Parliamentary Bar. He was briefed in some notable Scottish inquiries, including the Rosyth Inquiry in 1911, the Glasgow Boundaries Bill in 1912, and the Water, Tramways, etc., inquiry in 1914. He unsuccessfully contested Midlothian as a Liberal candidate at a by-election in 1912, but three years later was returned as Liberal M.P. for Kilmarnock, which he represented till 1923. During his membership of the House of Commons he served in 1915 as Parliamentary Private Secretary to Sir John Simon (now Viscount Simon), who was then Home Secretary, and from 1917 to 1918 in the same capacity to Sir Albert Stanley, President of the Board of Trade.

As a director and later as chairman of the P. & O. Steam Navigation Company and British India Steam Navigation Company, Alexander Shaw became well known not only in this country but throughout the Empire. He was appointed a director at the beginning of 1920, and in 1927 deputy-chairman and managing director. After the death of the first Lord Inchcape in 1932 he was elected chairman. His task as head of the company during a critical period in British shipping was extremely difficult, but he did not spare himself and did an immense amount of important work. He was forthright and pointed in his warnings to the country generally, and to the Government in particular, about the urgent needs of British shipping in the early thirties; and his call was answered by the Government when proposals were published for helping tramp shipping financially. He spoke on the development of Japanese shipping at the expense of British tonnage in Eastern routes and strongly advocated a strengthening of the British shipping services in the Pacific. In 1939, six months before Hitler's armies invaded Poland, he urged that an abundance of shipping was vital to Great Britain's ability to survive a war which then seemed inevitable.

A year before he gave that warning, Lord Craigmyle, on medical advice, had resigned the chairmanship of the P. & O. Company and the British India Steam Navigation Company, but he retained his seat on the board and other directorships. Last year he resigned his directorship of the Bank of England. In 1927 he was president of the Chamber of Shipping of the United Kingdom; he was an honorary captain in the Royal Naval Reserve in 1935, and an honorary colonel in the R.A.M.C. in 1940. During the war of 1914-18 he held a commission in the Royal Marine Artillery and served throughout the Battle of the Somme in 1916. A High Sheriff of the County of London in 1931, Lord Craigmyle was also a Deputy-Lieutenant of Selkirkshire. He married in 1913 Lady Margaret Cargill Mackay, eldest daughter of the first Earl of Inchcape, and had one son and three daughters. The heir to the barony is the Hon. Donald Shaw, who was born in 1923.

Mr. D. K. BLAIR *(See portrait on page 194).*

News of the death on May 29th last at the age of 76 of our Vice-President in Wellington, New Zealand, Mr. D. K. Blair, has been received with regret.

Mr. Blair served an engineering apprenticeship first with Messrs. Kincaid McQueen & Company of Dunedin, and then with Messrs. William Cable & Company of Wellington. After eight years' sea service, chiefly with the Union S.S. Co. Ltd., and the Shaw, Savill & Albion Co. Ltd.. he was engaged for a year in dredge construction and repair work at Dunedin and Lyttelton. In 1899 he went into private practice as a consulting engineer, specialising in dredge design; for fifteen years he was Surveyor to the British Corporation Register of Shipping at Wellington and represented the American Bureau and Registro Italiano. In 1923, when he resigned his appointment as Surveyor to the British Corporation and the American Bureau, he was appointed non-exclusive surveyor to Lloyd's Register of Shipping at Wellington, a position which he held until July, 1936, when he resigned as a result of ill-health.

Mr. Blair first represented the Institute as Vice-President at Wellington in 1910, and then consecutively from 1923 until his death, during which time he rendered valuable service to the Council and numerous members with whom he came into touch.

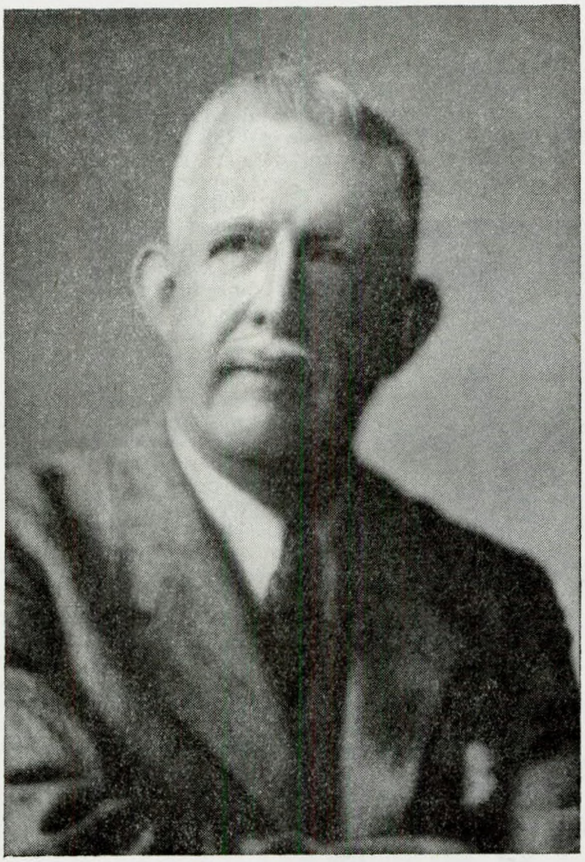
ADDITIONS TO THE LIBRARY.

Presented by the Publishers.

Heat Engines. A First Text-Book. By Dr. A. C. Walshaw. Second edition, 1944. London: Longmans, Green & Company, Ltd., 8s. 6d. net.

The book covers the work of Part I of the final B.Sc. and the Ordinary National Certificate examinations in this subject.

The general scheme of the book is good—it is divided into three parts. Part I (104 pages) deals with elementary heat and work quantities and describes a large number of different types of



The Late Mr. D. K. BLAIR *(See previous page).*

steam and internal combustion engines, including engine details such as governors and fuel injection systems. Part II (146 pages) deals with steam and the steam engine, including boilers, combustion and condensers, and Part III (124 pages) deals with thermodynamics and the internal combustion engine.

The book contains a large number of illustrations—many apparently reproduced from makers' catalogues—but they are far too small to be of much use to the student; for example, the diagram given for the description of a back pressure turbine together with the oil pressure governing system measures 2″×2″ only, also many diagrams have no letters for reference in the text.

The general sequence in which the work is arranged is not too good and in many cases reference has to be made to a subsequent section in the book, as for example, in the working out of a simple steam engine test, adiabatic heat drop and entropy are used but neither are defined till much later. Again, a perfect gas is defined as "one which obeys the characteristic equation PV=RmT" but the equation is not dealt with till several pages further on.

The Carnot cycle is not given until the section on internal combustion engines—it is not mentioned in the section on steam engines—and entropy is only dealt with in a supplement at the end of the book.

A few mistakes have also been noticed—some may be printer's errors. For example, in a specimen set of calculations for an internal combustion engine test, the fuel consumed is given as 170 cc. in 137·5 sec. and its specific gravity 0·733. The weight of fuel consumed per minute is given as $170\times60\times\frac{0{\cdot}733}{453{\cdot}6}=0{\cdot}120$lb.—the time has been left out. Again, on the same page, the heat equivalent of the b.h.p. is stated to be equal to 385 B.Th.U.—it should, of course, be 385 B.Th.U. per minute. In another place, in describing an internal combustion engine cycle referred to as the Atkinson cycle, it is stated that it has not yet been successfully used in practice, whereas in fact an engine working on this cycle was for many years used in a London water works.

Engineering Drawing, by Arthur Cryer, M.I.Mech.E. 5th Edition. Sir Isaac Pitman & Sons, Ltd., 1944, 156 pp., illus., 7s. 6d.

This book has been specially prepared for students in science classes, technical schools and colleges or for home study, and the very fact that it has reached a fifth edition suggests that it is still fulfilling a useful purpose.

The Author refuses to conform with the British Standards practice in connection with the all important matter of dimensioning drawings, inasmuch as that he persists in printing all vertical measurements so as to read horizontally. This practice must be puzzling to the beginner, because all the plates of examination papers supplied at the end follow the generally accepted method. It is true that he draws attention to this fact in his preface, but he cannot be excused for his careless fraction lines throughout.

It is also a pity that the method of indicating materials by different kinds of sectioning, long out of date, has persisted in this latest edition.

The book is 11″×8½″ and is filled with a great number of plates covering a wide field of mechanical engineering details graded to suit all students, but many of the drawings are very thin in outline and some plates are far too crowded, so that the result is most confusing and extremely difficult to read.

A special section on the Classification of Metals has been entirely rewritten and considerably amplified to include Heat Treatment, Defects in Raw Materials, Effect of Annealing and Normalizing, and Fatigue Failures of Components.

An appendix is added of selected examination papers taken from The Board of Education, The Union of Educational Institutions, The Northern Counties Technical Examinations Council, and The Union of Lancashire and Cheshire Institutes, including grades 1, 2 and 3.

The art of free-hand sketching is such an important qualification for the would be draughtsman, that the Author is to be congratulated upon his well selected 137 questions involving hand-sketching and calculations with which he finishes his book.

PERSONAL.

Lieut.(E.), L. L. Broad, M.B.E., R.N.R. (Associate Member), has been promoted to the rank of Lieut.-Com'r.(E.), R.N.R.

Mr. H. J. Grinyer, O.B.E. (Member), Commodore Chief Engineer of Royal Mail Lines, Ltd., retires on the 31st October, 1944, after over 41 years of service. He joined the Company in October, 1903 as a junior engineer and received his appointment as Chief Engineer in January, 1918. He was appointed Commodore Chief Engineer in September, 1943. His last vessel was the "Andes", in which he served for five years. Mr. Grinyer was awarded the O.B.E. (Civil Division) on the 12th June, 1941. Mr. N. L. Wright (Member) will succeed him as Commodore Chief Engineer, "Andes".

Lieut.(E.) P. Lawrie, R.N.R. (Member), has been promoted to the acting rank of Lieut.-Com'r.(E.), R.N.R.

Mr. E. Markham, Wh.Ex. (Member), has been elected to the board of directors of Peter Brotherhood, Limited.

MEMBERSHIP ELECTIONS.

Date of Election, 3rd October, 1944.

Members.
Frederic Leslie Bolt.
Charles Leslie Edwards.
R. W. Harding,
Lt. Com'r. (E.), R.N.R.
Edward Norman King, M.Sc.
Frederic Oldershaw Jerram Newell.
Alfred James Pover.
Frank Henderson Rose.
Joseph Small.
Jack Lewis Vandyck Temple.
Finn Waage,
Lieut., R.Nor.A.F.
David Williams.

Associate Members.
Joseph William Mainguy Barber-Starkey,
Lieut. (E.), R.C.N.
Austin Sandy Roberts.

Associates.
Jack Hinman,
D.S.M., E.R.A., R.N.
Harry Newman.

Graduate.
John William Rose.

Students.
Anthony Riley Hinson.
Donald James Macbride.

Transfer from Associate to Member.
Horace Ernest George Saffin,
Lieut.(E.), R.N.R.

Abstracts of the Technical Press

Neither The Institute of Marine Engineers nor The Institution of Naval Architects is responsible for the statements made or the opinions expressed in the following abstracts.

Totally-enclosed Marine Steam Reciprocators.

In a paper bearing the above title recently read at a meeting of the Students' Section of the N.-E. Coast Institution of Engineers and Shipbuilders by Mr. W. G. Brown, the author described several engines of the uniflow type. The thermal properties of the uniflow cycle were first set out in a patent granted to L. J. Todd in 1885, although the German engineer Dr. Stumpf is generally credited with the invention of the uniflow steam engine. After giving a short summary of the advantages of the uniflow principle and showing representative ideal and actual indicator diagrams from a uniflow engine, the author proceeded to give short descriptions of several designs of such prime movers, among them being that of a uniflow engine introduced by Alexander Stephen and Sons, Ltd., of Linthouse some years ago. It is to be regretted that only two installations incorporating this design of engine were constructed. A little known design of uniflow engine was evolved several years ago by Karl Schmidt, of Landsberg, who built a four-cylinder single-acting unit of this type developing 400 i.h.p. at 200 r.p.m. The cylinders had a bore of 470 mm. (18½in.) and piston stroke of 350 mm. (about 13¾in.) and the condenser shell was incorporated in the engine framing. For balancing reasons the cranks of adjacent cylinders were set at 180°, with the forward part turned through an angle of 90° relative to the other pair of cranks. The accompanying drawing (Fig. 1) shows the unusual arrangement of the guides and crossheads, the latter being circular in section and formed by extensions of the pistons which were considerably smaller in diameter than the working parts of these. The cranks were fitted with scoops for collecting oil from the sump for delivery to the crank pins, an arrangement of partial pressure lubrication which no doubt worked out well in practice. The steam inlet valves of this single-acting engine were placed centrally in the cylinder covers, the arrangement of the cam-operated bell-crank levers which operated the valves being shown in the right-hand drawing. Provision for varying the cut-off was made by mounting the levers eccentrically, there being several cut-off positions on a quadrant which could be brought into operation by the hand control lever shown. The camshaft was arranged to run at half the engine speed, and there were two sets of cam profiles to actuate each steam admission valve. Each cylinder had its own separate shut-off valve, so that steam could be shut off from any cylinder when required. Another uniflow engine described in the paper was a six-cylinder single-acting design developed by the Stumpf Uniflow Engine Company, Inc., of Syracuse, N.Y. Simplicity was the key-note of this engine, which was of the trunk-piston type and is illustrated in Fig. 2. The cylinders had a bore of 22in. and a piston stroke of 24in., and the engine was said to have developed 5,000 i.h.p. at 250 r.p.m. Each cylinder head carried a horizontal double-beat inlet valve operated by bell-crank levers from tapered cams mounted on a camshaft running at engine speed. Variations in cut-off and reversal of the engine were effected by longitudinal displacement of the camshaft, a hand-wheel operating the actuating worm gear and serving as main control. Access to the steam valves was obtained through hand holes provided with bolted-on covers without disturbing the valve-operating gear. The cylinders were bolted together at their exhaust belts in a manner reminiscent of marine Diesel-engine practice and intended to ensure longitudinal stiffness of the engine structure. The bedplate and columns were of cast steel and the cylinders were connected to the bedplate by means of long bolts passing through the columns. Forced lubrication was provided

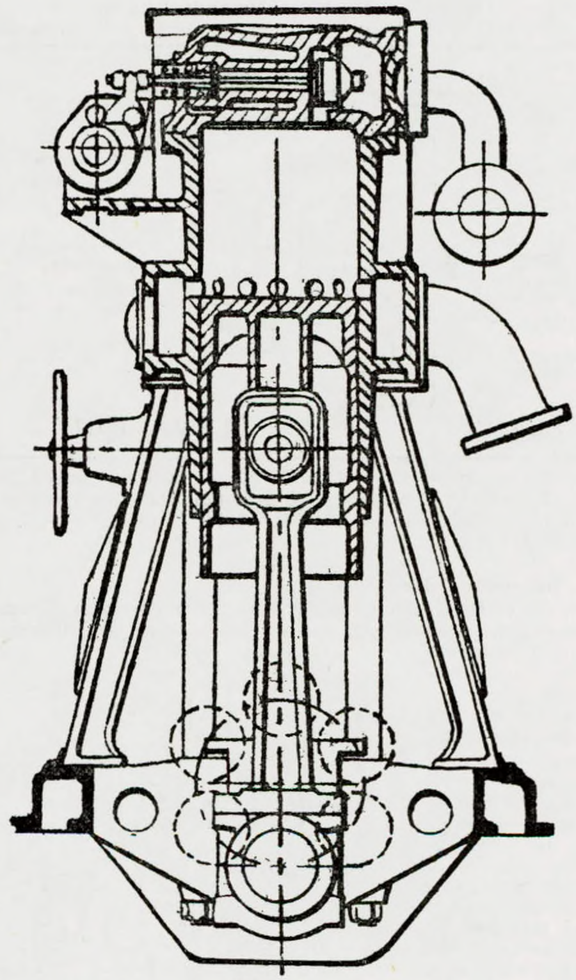


Fig. 2.

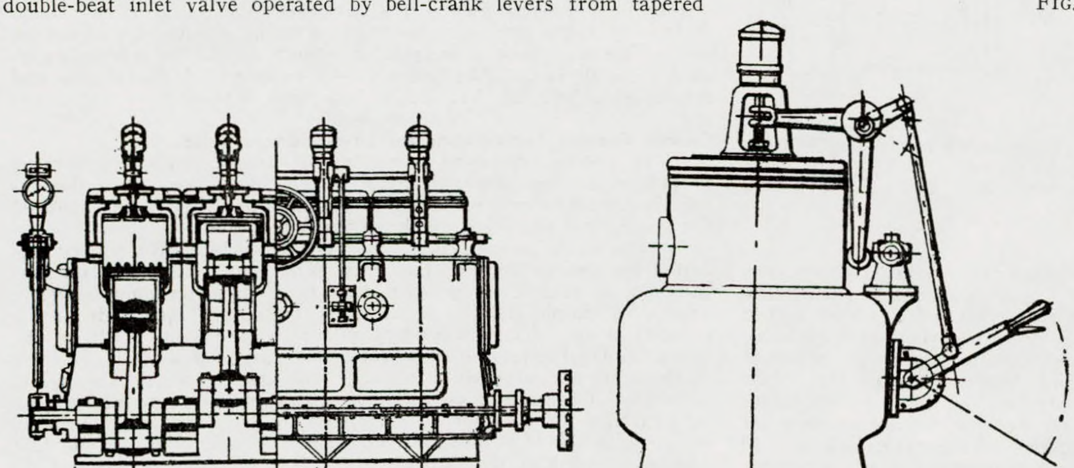
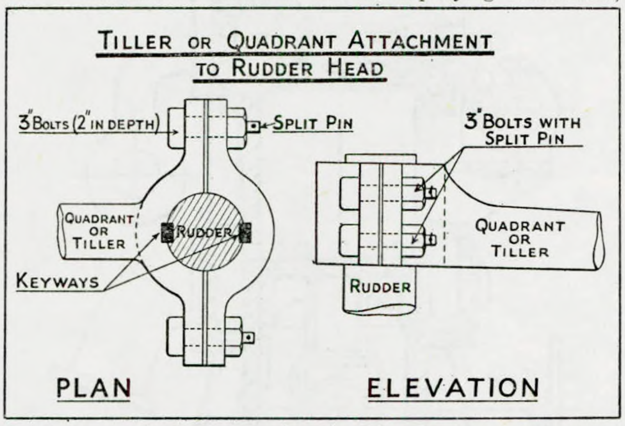


Fig. 1.

by an engine-driven pump, the crankcase being enclosed by light steel plates.—*"The Marine Engineer", Vol. 67, No. 804, July, 1944, pp. 279-280.*

Attachment of Quadrant to Rudder Head.

The tiller or quadrant is usually secured to the rudder head by shrinking, this operation being carried out aboard the ship after the rudder is in position. To ensure efficient attachment, it is the usual practice to allow a tolerance of 0·001in. for each 1in. diameter of rudder stock for shrinkage of the quadrant boss. If it becomes necessary to replace or remove a shrunk-on quadrant situated in a 'tween-deck compartment, the job involves a good deal of difficulty and expense. The writer therefore suggests that by adopting the method of attachment shown in the accompanying illustration, the



quadrant can easily be removed and replaced when required, with a considerable saving in repair costs, although the attachment to the rudder head is efficient in every way.—*J. A. Cromar, "The Shipping World", Vol. CXI, No. 2,668, 2nd August, 1944, p. 104.*

A.S.E.A. Generator Drive.

Two methods of driving generators from the main shafting of a marine engine, recently patented in this country, are illustrated in Fig. 3. In order to damp out the pulsations from a reciprocating engine, an electro-dynamic slip coupling is employed in conjunction wi.h a speed-increasing transmission. Double gearing is used in order to obtain a high speed ratio, and the coupling is arranged between the transmission and the generator. One part of the coupling has d.c. poles, while the other has a short-circuited a.c. winding. The upper diagram shows an arrangement in which the double gearing (*3*) is driven from the main shaft (*1*), and the second pinion drives the generator (*5*) through the coupling (*4*), constructed with d.c.-excited poles (*6*) and a short-circuited secondary winding (*7*). With the arrangement shown in the lower diagram, the generator (*5*) is located on the top of the thrust block (*2*). The parts are numbered alike with each arrangement.—*"The Motor Ship", Vol. XXV, No. 294, July, 1944, p. 134.*

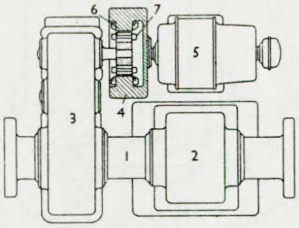
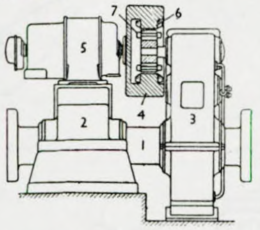


FIG. 3.



Marine Turbine Developments.

A proposal to improve the performance of marine steam turbines, put forward some time ago by Dr. Meijer, was to extract the moisture formed in the steam during expansion and to utilise higher initial pressures in preference to high initial superheat temperatures. He pointed out that, from a thermodynamical aspect, his proposal meant that a larger proportion of the heat content of the steam would be put in at the boiling temperature in the form of latent heat, and that higher pressures would increase the temperature of reception, thereby improving the efficiency of the cycle. If, say, 10 per cent. wetness is taken as the maximum permissible amount, there is no reason why this should be limited to the L.P. turbine; steam can be exhausted in the H.P. turbine until there is 10 per cent. of moisture when it is extracted by mechanical means, the process being repeated in the later stages of the expansion. Th moisture of condensation is returned to the feed system through suitably arranged feed heaters, with the result that a larger proportion of the latent heat of the steam is made available for power generation. Another idea for the utilisation of low-grade heat in preference to the employment of heat at boiler temperature, is the principle of stage feed heating. The gain on this account varies according to the arrangement of the feed heaters, each particular case being worked out individually, but, in principle, the optimum benefit is derived when each stage is heated by the same number of degrees, and the most efficient amount of feed heating per stage results when the degree of heating at each stage equals the difference between the temperatures of evaporation and condensate divided by one more part than the number of stages. For example, with a single feed heater, the degree of heating should be carried to half the difference between the initial condensate temperature and the temperature of evaporation in the boiler. For two-stage heating, the feed temperature should be raised two-thirds of this difference, equally, in each stage; for three stages, three-quarters of the difference, and so on. On this basis, the economy due to feed heating with steam bled from the turbine at one stage is a maximum of 4·5 per cent. when the feed temperature is raised to about 250° F. Two-stage heating to a temperature of 300° F. will produce an improvement of about 6·25 per cent., whilst the optimum feed temperatures with three- and four-stage heating are 325° and 350° F., the corresponding gain in efficiency amounting to about 7·0 and 7·5 per cent. respectively. Herein lies much of the benefit that results when steam turbine machinery is used with electrically-driven auxiliaries and the power for these is supplied by auxiliary Diesel-driven generators, since this makes it possible to make convenient use of stage-feed heating to the fullest extent. With steam for domestic services, such as accommodation heating and galley requirements, also bled from the turbine, it becomes possible to utilise the total heat of nearly 40 per cent. of the steam generated by the boilers, and the condenser losses are reduced accordingly. This consideration appears to bring the requirements for most efficient turbine design into conflict with the present trend of steam generation which favours the use of economisers as an alternative to air preheaters for recovering heat from the funnel gases in installations of moderate power. The fundamental idea of fitting economisers to the boilers is to add the sensible heat to the incoming feed on its way to the steam drum, and take full advantage of the considerable difference between the condensate temperature and that of the funnel gases. This can only be fully realised when the incoming feed is more or less at the condensate temperature. This trend in favour of economisers has been influenced by suspicions that the employment of feed heating makes the machinery harder to drive because additional steam has to be supplied to the regulating valve to make up for the steam taken from the turbine for heating the feed heaters. The saving due to stage feed heating is also diminished with reheating, and two different tendencies in design are again brought into conflict. The saving in fuel due to reheating when stage feed heating is carried out is approximately of 6·0 per cent. for all initial pressures above about 400lb./in.^{2}, but this economy increases to about 9·0 per cent. when feed heating is omitted at the higher pressures that become practicable when reheating is employed. A solution of these conflicting requirements can only be found in a compromise based on working experience, and the problems of feed heating in relation to the use of economisers and reheating in modern design call for a thorough investigation. The results of such an investigation may have a far-reaching effect on the future tendencies of turbine design.—*"The Journal of Commerce" (Shipbuilding and Engineering Edition), No. 36,329, 20th July, 1944, p. 1.*

Geared Turbine Installations for Low-powered Ships.

The greatest deterrent to the use of turbine machinery for the propulsion of low-powered cargo vessels has always been the relatively high first cost of such an installation. This has been realised for some time past, and much attention has therefore been devoted to developing a simple, cheap and reliable turbine unit particularly suited for use in ships of this type. One such unit is the Parsons Simplex, in which the gearing consists of a single train of gear-wheels in simple succession, a single high-speed pinion driving a primary wheel, and a secondary pinion on the same shaft as the latter driving the main gear-wheel on the propeller shaft. The teeth of the gears are arranged on a single helix and this provides a smooth drive since there can be no fore-and-aft movement of the gears. The two turbines of the unit are arranged to drive the single primary pinion with the H.P. turbine coupled at the after end and the L.P. turbine coupled at the forward end. The primary pinion and the intermediate shaft each have their own thrust block to take up the end thrust of the teeth, that of the teeth of the main gear-wheel being arranged in opposition to the propeller thrust in order to reduce the size of the main thrust bearing. The pinion and turbine rotors run in their own bearings, but the pinion shaft is coupled to the turbine shafts by expansion couplings to avoid bending stress in the event of the bearings getting out of alignment. The turbines, condenser and thrust block are incorporated in the construction of the gear case, so that the complete assembly can be installed in the ship as a single unit and the alignment will remain undisturbed by any straining of the hull. A unit of this type for an output of 2,000 s.h.p. at a propeller speed of 80 r.p.m. was built and exhaustive shop trials were carried out with steam at a pressure of 270lb./in.^{2} and temperature of 750° F., the resultant steam consumption being 8·75lb./s.h.p.-hr. The unit was subsequently fitted in a cargo ship and most excellent results were reported. The Turbloc unit, developed by Brown Boveri with the same object, has single helical gearing, but separate pinions are provided for the H.P. and L.P. turbines to enable them to run at the most suitable speeds for efficiency. The H.P. turbine runs at about 6,500 r.p.m., whilst the speed of the L.P. is about 4,800 r.p.m. The centre line of the H.P. turbine is placed at the same level as the horizontal centre plane of the gearing, while the L.P. turbine is placed high enough to allow of the condenser being fitted below. The casings of both turbines are flanged on to the gear-case and the tail end of the H.P. turbine slides over the latter. The turbine pinions are coupled direct to their respective rotors and mesh with a common first-reduction gear-wheel. The tooth thrust of the pinions serves to balance the steam thrust of the turbines, so that no dummy pistons are required. Any small thrust differences are taken up by the segmental adjusting blocks of the turbines. A single astern turbine is incorporated in the L.P. turbine casing, and the distribution of output between the H.P. and L.P. turbines when running ahead is arranged to be 45 per cent. and 55 per cent. respectively of the total power, so that the L.P. pinion is sufficiently large for astern running without risk of overloading. The economical operation of the auxiliary machinery in low-powered geared turbine installations is a problem for which various solutions have been put forward by designers. With the Parsons Simplex turbine unit certain of the auxiliaries are arranged in a group for driving by the main engine at full power and by a separate engine when manœuvring. The circulating pump, condensate pump, forced-lubrication pump, and the bilge and sanitary pumps are driven by a chain and friction clutch from the main shaft at full power and through another friction clutch by the auxiliary engine under other conditions. The feed pump and F.D. fans have their own separate drives to ensure independence of control. With the Turbloc unit provision is made for driving some of the auxiliaries from the gearing. The circulating pump, which runs at 600 r.p.m., is coupled to the intermediate shaft of the latter, and can be supplemented by the ballast pump when manœuvring. The condensate pump is coupled to the pinion shaft of the L.P. turbine, and its operation under all conditions is assured by the provision of an injector. A dynamo of sufficient capacity for meeting all the normal power requirements of the ship at sea is driven by a special pinion meshing with the main gear-wheel, and this pinion also drives a forced-lubrication pump of the rotary type. A steam-driven oil pump is provided for stand-by purposes and for use when starting up. The harbour requirements of cargo vessels equipped with low-powered geared turbine machinery can be met in the most economical manner by the provision of a Diesel-driven generator and motor-driven deck auxiliaries, as such an arrangement makes it possible to shut down the steam machinery and thus eliminate stand-by losses. Reserve power could be furnished by a turbo-generator which would also be available for the provision of auxiliary power at sea, but these auxiliaries of small output are relatively inefficient at reduced loads. The auxiliary turbine could, however, be arranged to run with bled steam at sea with an automatically-operated relay valve to run on full boiler pressure while manœuvring. The fuller development of these possibilities opens out the prospect of cargo ship machinery operating with fuel consumption rates of 0·85lb. of coal, or 0·6lb. of oil per s.h.p.-hr., which would constitute a substantial improvement on those of the present day.—*"The Journal of Commerce" (Shipbuilding and Engineering Edition), No. 36,323, 13th July, 1944, p. 1.*

Number and Size of Ships' Propellers.

The question of what is the best number of propellers to fit to a ship is one of some complexity, since no general rules can be laid down; specific considerations of design have an important influence on the matter. In very large vessels the determining factor is the limiting amount of power which can be transmitted through a single shaft. This figure is usually considered to be 40,000 s.h.p. for large ships, but the power output of the engine units available also enters into the case. For instance, in large passenger motorships the number of screws is generally determined by the maximum output of each propelling unit, whereas in cargo vessels a single screw is employed as far as possible, owing to the fact that from the propulsion point of view better results are obtained with a large slow-running propeller than with smaller fast-running twin screws. In addition, the adoption of a single screw simplifies the construction of the ship's stern, since the A-brackets and shaft bossings, which have an appreciable effect on the resistance to propulsion and are required for twin screws, are eliminated. Moreover, the E.R. arrangement is simplified, and the steering of a single-screw ship is more efficient than that of a twin-screw vessel. Nevertheless, there is a case for the replacement of one large propeller by a large number of small screws, since a propeller works by producing suction on its forward face, and this interacts with the frictional wake of the hull. The best arrangement is that in which full effect is taken of this forward moving water. Dr. Baker indicated some time ago that, provided the resistance of the shaft supports could be kept low enough, a 15-knot ship could be propelled more efficiently by five small screws running at about 250 r.p.m., than by a large single propeller turning at 100 r.p.m. It is, however, unlikely that such a complicated arrangement will ever be adopted.—*"Fairplay", Vol. CLXIII, No. 3,194, 27th July, 1944, pp. 178-180.*

Astern Power of Ships.

In a letter to the Editor, Mr. Sterry B. Freeman, superintendent engineer of Holt's Blue Funnel Line, points out that on a number of occasions in his experience serious accidents have been avoided by the immediate use of astern power exerted at its maximum degree. In the case of all new motorships and turbine-driven vessels put in service by his company it has been the practice to carry out reversing trials on the occasion of the acceptance tests by putting the engines from full speed ahead to full speed astern at a time when the propelling machinery is turning at its highest rate of revolution with the ship at full speed. As a matter of convenient practice, the time is taken between the telegraph being put to "Full Astern" and the time at which the white water reaches the bridge amidships. The ship, of course, is stopped and has been moving astern for some moments before the water reaches that point, but a practical test of this nature enables those in charge of the vessel to gauge her behaviour in emergency. The time taken must necessarily vary with the type of machinery, the size of the ship, and the power developed by the main engines, but the results obtained showed that, in general, the oil engine is the most quickly reversed, the reciprocating steam engine next, and the geared turbine considerably the slowest. In the case of the modern 18-knot twin-screw Holt motorships, 475ft. by 66ft. by 30½ft. draught, equipped with d.a. 2-stroke engines developing a total of 12,000 b.h.p. at 110 r.p.m., starting air can be admitted to bring the engines to rest in 20 seconds, a further 20 seconds being taken to bring the revolutions up to 100 per minute and the ship being stopped completely in 1 minute 45 seconds. Reciprocating steam engines can be reversed just as quickly, but acceleration is slower because all the cylinders are not working at full pressure immediately. In the case of turbines, it is necessary to open the astern steam valve while the rotors are still turning in the ahead direction to check their revolutions and there is a time lag while the pressure builds and the inertia of the gearing is overcome and the direction of motion is reversed. If the ship is steaming at high speed, high torque is required to carry out this operation and, as it is difficult to measure the torque, it has been found convenient to specify the revolutions rather than the power required for astern movement. The turbine machinery in the ships belonging to the writer's company is designed to operate when going astern at 88 per cent. of the ahead rate of revolutions. For both steam and oil engines the same power is obtainable for going astern as ahead, when the effect of the drag of the ship and its wake has been overcome, since the pressure and the revolutions become the same as when going ahead. The writer declares that he has no knowledge of any B.o.T. regulation which requires the astern turbines to have a maximum output of 65 per cent. of the full ahead power, and points out that the specification for the M.W.T. standard type of turbine-driven ships calls for only 52 per cent. of the ahead power, no revolutions being specified.—*"The Engineer", Vol. CLXXVIII, No. 4,620, 28th July, 1944, p. 70.*

Diesel-electric Pioneer Vessel with Original Propulsion Motor.

In a letter to the Editor, Mr. W. J. Belsey, of the British Thomson-Houston Co., Ltd., points out that some of the statements which have appeared in the technical press concerning the performance of the Diesel-electric machinery of the United Fruit Company's m.s. "La Playa" (*see abstract on p. 71 of* TRANSACTIONS, *July, 1944*) are somewhat misleading. The only changes made in the electrical equipment of the ship were the replacement of the original generators by new ones designed to suit the new engines, which operate over a speed range of 450-750 r.p.m., whereas the original British ones and the Italian engines ran at a constant speed of 250 r.p.m. The propulsion motor is still the original direct-drive double-unit machine rated at 2,500 h.p. at 95 r.p.m., which has not been replaced by a geared motor. The new generators, supplied by the General Electric Company, of New York, are driven by 1,200-h.p. engines, whereas the original British engines were only rated at 825 h.p. per engine by the builders. The Italian engines installed in 1927 were rated at 1,000 h.p. per unit and were coupled to the original generators. The five generator sets now fitted only occupy the same space as the original four, and the maximum number in propulsion service at any one time is limited to any four with one in reserve. "La Playa" was the first Diesel-electric cargo vessel to cross the Atlantic just over 20 years ago, and she was also the first ship to have four Diesel-generator sets to provide power for propulsion. At that time there was practically no operational information available to help in the design of suitable control gear for this type of service, and although considerable changes have taken place in the method of control as a result of experience gained under sea conditions, the B.T.H. Co. have the satisfaction of knowing that after all these years the original design and quality of workmanship put into the propulsion motor, switches and control gear have warranted their retention as originally fitted.—*"The Journal of Commerce" (Shipbuilding and Engineering Edition), No. 36,287, 1st June, 1944, p. 12.*

Stone McAllister Twin-screw Single-engined Propulsion System.

The above-named system of propulsion is intended mainly for shallow-draught vessels and depends for its success as a propeller-cum-rudder on the rotation through 350° of the fin in which the propeller mechanism is contained and on which the propeller is mounted. A twin-screw installation on the Stone McAllister system comprises two independent swivelling propellers driven by a single engine. The latter may be a high-speed steam unit or any standard type of Diesel engine, and drives a shaft which enters a casing at the stern of the ship, where it is geared, by means of bevel gears, to two short vertical lengths of shafting each of which terminates at the bottom end in a pair of bevel gears which, in turn, drive the propeller shaft. The housing for the horizontal and vertical shafting can be turned to the desired angle by means of a worm and worm-wheel driven by an electric motor, all the mechanism being duplicated when it is necessary to provide twin-screw propulsion equipment. The motors are controlled from a panel on the bridge, and the position of each propeller is shown there on a special indicator. Thus, for getting away from a pier or jetty one propeller can be set at right angles, while the other screw revolves ahead. The revolutions of the main engine are regulated by the engine controls, which remain independent of the rotational adjustment of the propellers.—*"Lloyd's List and Shipping Gazette", No. 40,433, 28th June, 1944, pp. 12-13.*

Mobile Power Plants

It is stated that the Westinghouse Electrical and Manufacturing Co., East Pittsburgh, Pa., have built ten 5,000-kW. mobile power plants for service in areas devasted by the enemy, when they are re-occupied by the forces of the Allied Nations. Each power plant is made up of a series of railway cars, one of which contains a turbo-generator set, two contain the boilers, each with a 12-ft. chimney and mechanical stoker, two more are air-cooled condenser cars for dealing with the turbine exhaust, and one contains auxiliary machinery, such as boiler feed pumps, air compressors, etc. There is also a tank car for treated boiler water and another with bunks and living accommodation for the personnel of the mobile power station. The trains will be able to generate power in almost any kind of weather, the equipment having been designed to operate at temperatures ranging from 40° F. to 95° F. The tank cars are fitted with steam heating pipes to prevent the feed-water supply from freezing. A tall wooden bunker will be erected alongside the boiler cars to supply coal to the hoppers of their mechanical stokers. The boilers have an evaporative capacity of 80,000lb./hr. and are designed to burn the poor type of coal found in certain parts of Europe. These mobile power-plant trains will enter the reconquered areas on the heels of the advancing Allied armies and will be able to provide electricity for war production, as well as for military needs and civilian rehabilitation, within a matter of hours, whereas it would take anything from nine months to two years to rebuild a power station destroyed by a retreating enemy. The trains will also be available for temporary service in new and undeveloped industrial areas until such time as permanent generating stations can be constructed. It is claimed that the mobile power stations will make it possible to establish war factories beyond the reach of enemy bombers, and to save materials and manpower that would otherwise have to be expended on the building of power transmission lines. After the war, the equipment in the trains can be removed and erected on permanent foundations in new power houses, or the trains could be kept in readiness for emergency service in districts affected by floods, etc. In addition to these 5,000-kW. trains the Westinghouse Co. are producing 24 mobile power stations of three cars each, capable of generating 1,000 kW. and meeting the needs of a single large factory or those of a small community.—*"Electrical Review", Vol. CXXXIV, No. 3,465, 21st April, 1944, p. 568.*

Machinery Arrangement of Victory Ships.

The arrangement of the turbines, auxiliary machinery and boilers in the AP2 and AP3 types of Victory ships is almost identical with that originally adopted for the Maritime Commission's C-3 type cargo liners, except for the fact that the latter have multiple-stage feed heaters, whereas the Victory ships have only one feed heater supplied with steam bled from a single point on the main steam system. Again, practically all the auxiliaries in the C-3 ships are motor driven, whereas in the Victory ships an important part of the auxiliary machinery is steam driven. The combined boiler and engine room in the latter type of vessel is 51ft. long, with the two boilers located fore and aft on either side of a central firing aisles at the forward end. The main turbines and D.R. gear are arranged along the centre line, towards the after end of the engine room, with the auxiliary machinery in the P. and S. wings. The distribution of the various auxiliaries, etc., is as follows: On E.R. floor level—O.F. pumping and heating equipment against forward bulkhead between boilers; main condenser pump (2) between boilers and turbines; main feed pumps (2), auxiliary feed pump, evaporating and distiller unit, refrigerating plant, auxiliary circulating pump, auxiliary condensers (2), lubricating-oil purifier and heater on S. side; O.F. transfer pump, general service pump, ballast pump, main circulating pump, F. and B. pumps (2), F.L. pumps (2), oil cooler and sanitary pump on P. side. On auxiliary machinery flats—F.D. fan, main switchboard turbo-generators and auxiliary air injector on S. side; F.D. fan, air compressors (2) and air reservoir, main air ejector, workshop machinery, ready-use storerooms and oil storage tanks, hot-water heater, washing-and drinking-water pumps on P. side. The two boilers, designed by the Babcock and Wilcox Co., and the Combustion Engineering Co. are of the sectional-header, single-pass type with interdeck superheaters and economisers and water-cooled side walls for the furnaces. The boilers operate with forced draught and are each fired with four double-front oil burners in the AP3 type ships and with three such burners in the AP2 vessels. The boilers of the latter are 12 sections wide, whereas those of the former have a width of 16 sections. The working pressure of the steam at the superheater outlet in 465lb./in.² with a total temperature of 750° F. Each boiler is fed by a separate steam-driven vertical simplex type feed pump through a Hammel-Dahl or Copes thermostat automatic feed regulator. The boiler feed system is of the closed type ,arranged for a single-stage feed heater, and the feed water enters the boilers at a temperature of 240° F. The auxiliary feed pump is a horizontal 4-stage centrifugal turbine-driven unit. The evaporator-distiller unit has an output capacity of 25 tons of fresh water per day. The 8500-s.h.p. turbines of the AP3 type ships comprise an 8-stage H.P. unit designed to run at 6,159 r.p.m. and an 8-stage L.P. unit running at 3,509 r.p.m., connected through flexible couplings to a double-reduction gear. The turbines develop their normal output of 8,500 s.h.p. when supplied with steam at a pressure of 440lb./in.² and temperature of 740° F. and exhausting at 28½in. vacuum to the two-pass condenser which is slung below the L.P. turbine exhaust nozzle. The speed of the propeller under these conditions is 85 r.p.m. The 2-stage astern turbine incorporated in the exhaust end of the L.P. turbine is designed to develop between 2,000 and 3,000 s.h.p. at 50 r.p.m. The turbines of the AP2 type ships are similar in design, but slightly smaller. They develop their normal output of 6,000 s.h.p. when running at about 5,500 r.p.m. (H.P. unit) and 4,000 r.p.m. (L.P. unit) respectively, the corresponding speed of the propeller being 100 r.p.m. The main and auxiliary circulating pumps are motor driven, whilst the ballast, F. and B., general service and O.F. transfer pumps are steam driven. These five pumps are identical units of the vertical duplex type. The remaining auxiliaries are all motor driven. —*A. C. Rohn, "Marine Engineering and Shipping Review", Vol. XLIX, No. 4, April, 1944, pp. 181-193.*

Cargo-handling Equipment and Deck Machinery of Victory Ships.

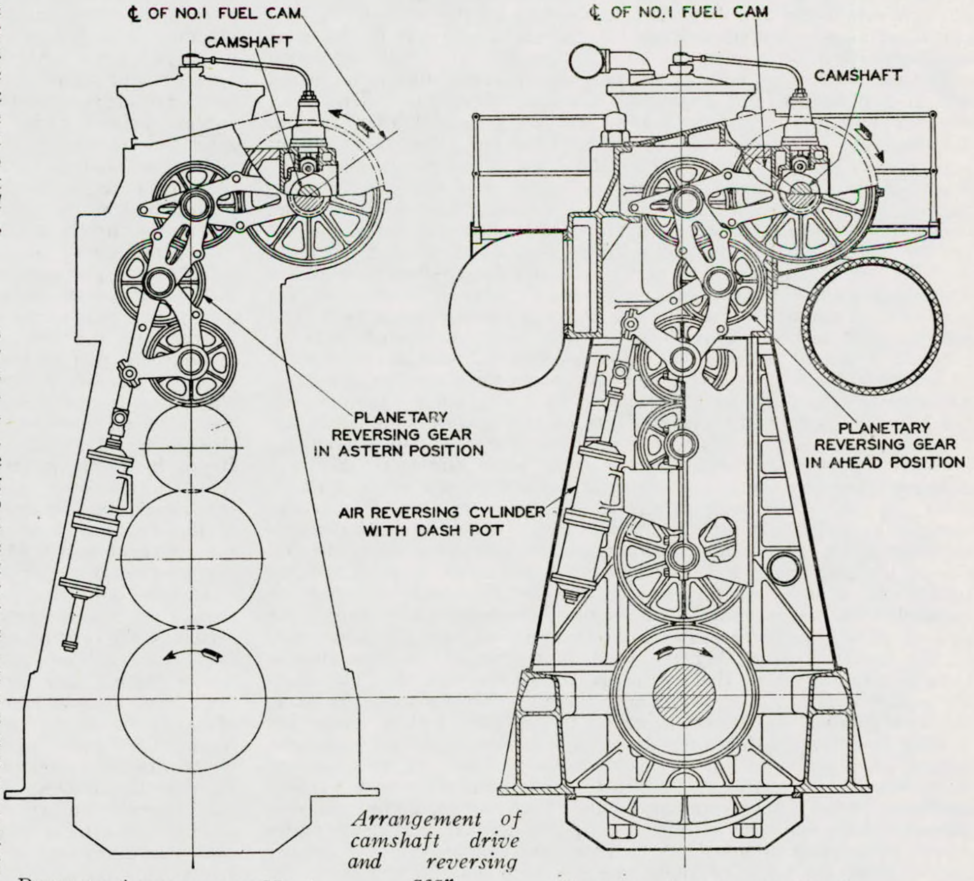
The five cargo hatches of the Victory ships are served by fourteen 5-ton derricks, in addition to which a 30-ton derrick is available for No. 3 hatch and a 50-ton derrick for No. 4 hatch. The cargo winches are of the motor-driven type with the control gear, resistors and brake enclosed in a common watertight casing and mounted on a common bedplate. Each winch is driven by a 50-h.p. watertight enclosed motor. There are 10 single-drum single-speed winches for the 5-ton derricks and four single-drum two-speed winches for the heavy-duty derricks. All the winches are operated through pedestal controllers conveniently located near the hatchways. The anchor windlass on the forecastle deck is of the motor-driven horizontal-shaft type and an electric warping capstan is fitted on the main deck aft with its motor on the deck below. The steering gear is of the Rapson slide electro-hydraulic, double-ram type with telemotor control from three positions. A separate motor-driven variable-displacement high-pressure hydraulic pump is used to operate each ram, but the latter can be worked by either pump independently of each other, if required. A change-over valve for this purpose is fitted in the steering-gear compartment. A hand-operated pump is also fitted for rudder braking or emergency steering. This pump is likewise used for filling and draining the hydraulic system. The steering gear is capable of moving the rudder from hard-over to hard-over (70°) in 30 seconds when the ship is going ahead at a speed of 17·78 knots, and in not more than 60 seconds when the vessel is going astern at 10·6 knots. Either ram will operate the rudder at normal rates up to and including 50 per cent. of the maximum ahead speed of the ship. The refrigerating plant consists of a duplex unit comprising two separate twin-cylinder s.a. vertical motor-driven Freon compressors, each with its condenser, receiver, etc., all mounted on a common structural steel base and installed on the S. side of the main engine room. The refrigerated compartments for ship's provisions are located on the second deck amidships and are cooled by a combination of unit air coolers and cold brine pipe coils.—*"Marine Engineering and Shipping Review", Vol. XLIX, No. 4, April, 1944, pp. 169-174 and 202-208.*

Air Compressors for Victory Ships.

Each Victory ship has two Ingersoll-Rand, Model 15B, Type 40 V-design air compressors. They are two-stage air-cooled machines with one 4-in. H.P. cylinder and two 5-in. L.P. cylinders arranged radially around a single crank of a design which permits the use of a short, rigid crankshaft. The stroke is 4in. The main bearings are of the heavy-duty tapered-roller type and the connecting rods are forged. The cylinders and bearings are lubricated by a uniform splash system, known as the "constant level" lubrication system, in which the cranks dip into a trough in which the oil is automatically maintained at a constant level, regardless of the oil level in the crankcase sump. A simple pumping arrangement raises the oil to the trough. Each compressor has a delivery capacity of 60 cu. ft. of free air per minute at a pressure of 125lb./in.^{2} when running at 870 r.p.m.., and is driven by means of a V-belt by a direct-connected marine type motor equipped with a hydro-pneumatic automatic starting and stopping device. The compressor is started up automatically when the oil pressure in the control device falls to 90lb./in.^{2} and stops automatically when it reaches 125lb./in.^{2}.—*"Marine Engineering and Shipping Review", Vol. XLIX, No. 5, May, 1944, p. 204.*

The 6,000-b.h.p. Nordberg Two-stroke Engine.

The 6,000-b.h.p. Nordberg Diesel engines to be installed in some of the new Victory ships are by far the largest direct-drive units for marine propulsion yet built by the Nordberg Manufacturing Co. for the U.S. Maritime Commission, as those of the 6,000-b.h.p. C-2 and 8,500-b.h.p. C-3 motorships were arranged for indirect drive. The propelling machinery of those vessels comprised two 3,000-b.h.p. units in the case of the C-2 class and four 2,225-b.h.p. units in the case of the C-3 class, driving the single propeller shaft through mechanical gearing and electric or hydraulic slip couplings, whereas the new 6,000-b.h.p. engines to be installed in the Victory ships are designed for direct drive. The new engine develops its rated power at 160 r.p.m. with a b.m.e.p. of 62lb./in.^{2} and a piston speed of 1,066ft./min. There are nine cylinders with a diameter of 29in. (about 735 mm.) and a piston stroke of 40in. (about 405 mm.). The length of the engine is 39ft. 9in., and the height above the crankshaft 18ft. 2in., the total height measured from the bottom of the crankcase being 22ft. 5in. Although the general design of the engine is of the crosshead type similar to that of the smaller Nordberg engines, the camshaft is of the overhead type instead of being arranged at the level of the bottom of the cylinders. The camshaft is driven from the engine crankshaft by means of a train of seven gears, the arrangement of which is shown in the accompanying sectional drawings. Reversing is effected by an alteration of the angular relationship between the camshaft and the crankshaft through the four-gear reversing mechanism incorporated in the camshaft gear train shown in the sectional drawings. The vertical fuel pumps, the plungers of which are actuated from the cams on the camshaft, are a development of the Bosch design. They are the largest of their type made in the U.S., and each pump is located in front of the cylinder which it supplies. A single lever on the port side of the engine regulates the starting, fuel control, reversing and stopping of the engine through a mechanical-pneumatic system with suitable interlocking gear. The forged crankshaft is made up of two sections, one with five cranks and the other with four. The crankpins and journals are 20in. in diameter and the total weight of the crankshaft is 35·6 tons. The main and crankhead bearings are removable steel-backed shells lined with centrifugally-cast anti-friction metal, whilst the crosshead bearings are copper-based alloy bushings. The engine governor is of the hydraulic type. The fuel pumps are connected to a regulating shaft and rack-and-lever assembly, the rack being graduated to indicate the engine load at any position of the lever. The cylinder blocks are mounted on A-frames and bolted together to form an entablature. Suitable holes in the A-frames are provided for the tie rods, which are anchored below and on either side of each main-bearing housing in the bedplate. They extend through each leg of the A-frame and the cylinder to form a rigid assembly, being tightened up by means of a hydraulic jack to ensure uniform stress. Scavenging air is admitted through automatic valves, the inlet ports in the cylinder walls being opposite those for the discharge of the exhaust gases. Lubricating oil is introduced at seven points on the periphery of the liner and near the upper end of each liner by a seven-feed lubricator for each cylinder, a separate pump unit being used for each feed. The lubricators are driven from a lay-shaft timed to deliver lubricating oil to each piston at a predetermined point in its stroke. A wiper ring assembly attached to the bottom of each cylinder consists of a casting containing two pairs of internal-expanding wiper rings; these fit the skirt of the piston and wipe off excess oil, returning it to the



Arrangement of camshaft drive and reversing gear.

Running Astern with No. 1 Piston on Top Centre.

Running Ahead with No. 1 Piston on Top Centre.

crankcase, while carbon particles and other foreign matter drain into a recess in the casting and thence into a header leading to the sludge tank in the E.R. bilges, from whence it is discharged overboard. The wiper rings are arranged so that the upper pair wipes the piston on its down stroke and the power pair on the up stroke. The top of the scavenging-air trunk is finished with floor plates which serve as the upper platform. Two motor-driven centrifugal blowers discharge scavenge air through separate connections to the scavenging-air trunk, which contains automatic plate valves. The oil-cooled pistons are in two sections, and lubricating oil is supplied to the upper one, as well as to all the working parts of the engine through a large header located in the crankcase, with leads to the bearings, camshaft drive and reversing gear. The oil from the bearings, gear and piston heads returns to the sump, from which it is delivered by a motor-driven pump through a cooler and filter to the header in the crankcase. The first engine of this type to be completed underwent exhaustive shop trials which included a 360-hour run at 160 r.p.m., a 48-hour run at 165 r.p.m. and a two-hour run at 172 r.p.m., the power developing during these tests being 6,000, 6,450 and 7,300 b.h.p. respectively. The tests were carried out with low-grade fuel oil of 18,345 B.Th.U./lb. calorific value, and the average fuel consumption was 0·344lb./b.h.p.-hr. despite the fact that the motor-driven scavenging-air blower requires about 7 per cent. of the power delivered by the engine for its drive, which normally absorbs 430 b.h.p. Subsequent tests with fuel oil of 19,000 B.Th.U. calorific value showed an average consumption of 0·332lb./b.h.p.-hr. When operating with low-grade fuel, no changes were made in the fuel-injection equipment, and an examination of the fuel nozzles and pistons after the 17-day continuous run showed that these components had remained unusually clean. The cylinder liner and piston ring wear was imperceptible and all rings were free.—*"The Motor Ship", Vol. XXV, No. 295, August, 1944, pp. 140-143.*

The Latest Tosi Two-stroke Engines.

It is reported, from a German source, that an extensive range of s.a. two-stroke Diesel engines for marine propulsion is now being produced by the Franco Tosi concern, Legnano, and that the design of these engines is an improvement on that of the firm's original s.a. two-stroke unit introduced just before the war (*for description see abstract on p. 117 of* TRANSACTIONS, *June, 1939*). The chief difference between the two designs is that in the earlier one the crankcase is not separated from the cylinders, whereas in the later one there are diaphragm plates with glands through which the piston rods pass. Other features of the new design are a slightly increased weight and height, and a greater structural flexibility. The latest engines are made with from four to ten cylinders of 460 to 750 mm. diameter, and a piston stroke of 640 to 1,250 mm., the power output per cylinder varying from 160 to 600 b.h.p. for running speeds of from 200 to 110 r.p.m. The b.m.e.p. in no case exceeds 63lb./in.^{2} at the rated output of the engine and the maximum piston stroke under such conditions is approximately 900ft./min. The steel tie-bolt system for taking the combustion loads is adopted, so that the main castings are not subjected to any tensile stress. Cast-steel rings are fitted between the cylinders and the covers in order to eliminate corrosion at the contact surfaces. The cylinder-liner exhaust ports are water-cooled and the upper part of the liner is formed with an external spiral to improve the cooling effect. There are two rows of scavenging-air ports, the upper row being supplied through a set of automatically-operated plate valves, so that after the bottom row has been covered by the piston rising on the compression stroke air continues to enter the cylinder until approximately full scavenging pressure has been attained. Each row of ports directs the air in a different direction. Each crankpin is forged in one piece with its webs, the latter then being shrunk on the main journals. The crankshaft is undrilled, oil for the main bearings being supplied through separate pipes, while the gudgeon pins are lubricated from the top end of the connecting rod, to which oil is delivered through rocking tubes. In engines with oil-cooled pistons the cooling system is isolated from the lubricating-oil supply, but those which have their pistons cooled by fresh water are far more economical to operate, as the builders claim that the total lubricating-oil consumption is then only one-third of that when oil is used throughout. The cooling pipe system is the same for both methods. The pistons are made in three sections, the crown being of forged steel with a flange for bolting it to the piston rod, the centre section being of cast iron with a bronze ring, while the bottom section, secured to a second flange on the piston rod, is allowed to expand and slide on the centre portion. Three different arrangements of scavenging pumps are employed. With one type of engine each cylinder has a separate pump driven by an arm attached to the crosshead, whilst with the second arrangement one pump is made to serve each pair of cylinders. In the third and more usual arrangement, there are two d.a. pumps in tandem, driven from an extension of the forward end of the main crankshaft. Two groups of fuel-injection pumps are provided, the suction and delivery valves being operated automatically. A regulating valve is connected to the recess between the suction and delivery valves, a lever varying the lift so that the commencement of injection alters according to the engine speed.—*"The Motor Ship" Vol. XXV, No. 294, July, 1944, pp. 114-115.*

A 1,200-b.h.p. Sirron Two-stroke Engine.

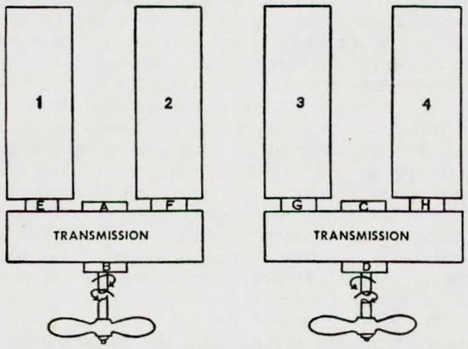
The Newberry Diesel Co., Ltd., makers of Sirron oil engines, have hitherto specialised in the production of units of moderate power, developing up to 100 b.h.p. per cylinder and intended for the propulsion of small craft of various types. However, the firm now construct Diesel engines of substantially higher power, the largest being a 6-cylr. s.a. two-stroke unit of the trunk-piston type developing over 200 b.h.p. per cylinder and having a rated output of 1,200 b.h.p. at 250 r.p.m. The corresponding b.m.e.p. is 64lb./in.^{2} (equivalent to a mean indicated pressure of 70lb./in.^{2}), but this can be increased to 70lb./in.^{2}, if required, thereby giving the engine a continuous service output of about 1,350 b.h.p. The cylinders have a diameter of 16in. (407 mm.) with a piston stroke of 25½in. (648 mm.) and scavenging is effected on the loop principle adopted in all the engines made by this firm. The total weight of the unit is 70 tons and the o.a. length about 24ft. 8in., the height from the bedplate being 15ft. 6in. The framework of the engine is designed to permit free expansion of the Meehanite cylinder liners. The separate square cylinder covers, which are of alloy steel, bolted together to form a continuous beam, are attached to the bottom of the bedplate by long through bolts. The alloy steel piston heads, with cast-steel skirts, are cooled by lubricating oil delivered through rocking pipes inside the crank chamber. Each cylinder head is in two sections, the lower one, which is in contact with the combustion chamber, being sea-water cooled. The water passes from the cylinder jacket through a pipe to the cylinder head, and is given a swirling motion by means of four nozzles, which, it is claimed, prevents any likelihood of corrosion. The engine drives all the auxiliaries required for its operation when the ship is at sea. The two-piston vertical type scavenge pump, which is 36in. in diameter, is driven from a crank at the forward end of the engine, and delivers scavenging air at a pressure of 2lb./in^2. into the engine cylinders through Circoflex automatic valves. The scavenging-air ports are designed to give the air entering the cylinder a rotary tangential motion which ensures satisfactory combustion. The fuel consumption of the engine is stated to be about 0·38lb./b.h.p.-hr. At the back of the engine are two gear-type F.L. rotary pumps, one of which draws the lubricating oil from the sump and delivers it to a tank in the engine room, whilst the other forces the oil under pressure through the bearings and pistons, after first passing it through a filter. The circuits for the bearings and piston-cooling system are entirely separate, although the oil in them is at the same pressure. The cooling water for the cylinder jackets and heads is supplied by two horizontal piston-type circulating pumps driven from the forward end of the engine crankshaft. The camshaft is chain-driven from the centre of the engine and actuates the plungers of the fuel pumps and starting-air valves, as well as a special pump for the hydraulic governor and a booster fuel pump which raises the fuel pressure to about 30lb./in.^{2} before delivery to the Bryce fuel pumps. The latter are vertical and arranged so that each pump is opposite the cylinder it supplies. For reversal, instead of employing the more usual method of having an ahead and an astern cam for each valve, only a single cam is utilised, the camshaft itself being moved through an angle of about 30° relative to the crankshaft when reversing. The engine is fitted with a Bryce hydraulic governor of improved design which controls the speed over a wide range. The power available from the governor for regulating the fuel-injection pumps is the same at any speed of the engine, and when the control lever is set at the desired speed, the governor will hold the engine regardless of any changes of load due to emergence of the propeller in rough weather or any other cause. Should the load on the engine be reduced, the governor checks the speed immediately it starts to rise, as opposed to the action of the type of governor which only comes into operation after full speed has been exceeded. This, it is claimed, should make it possible to run the new Sirron engine at higher speeds in rough weather than with manual control or a governor of the conventional type. Manœuvring is carried out by means of two hand-wheels and a lever. One wheel operates the air and fuel admission mechanism, whilst the other operates the reversing gear. The lever serves to regulate the amount of fuel which either the control mechanism or the hydraulic governor can supply. The reversing gear comprises a worm on the hand-wheel shaft engaging with a quadrant connected with the sun wheel of a train of epicyclic gears. The chain wheel for driving the camshaft is attached to the casing carrying the star wheels of the train of gears, so that when the quadrant is rotated the camshaft also turns in relation to the crank wheel, through the desired angle to bring the reverse side of the fuel and air-starting cam noses into the correct position for running in the reverse direction. The holes in the locking rack of the reversing hand-wheel are slightly elongated to permit a small movement of the latter when the control gear is in the running position. This enables the fuel-injection timing to be varied while the engine is running.—*"The Motor Ship", Vol. XXV, No. 294, July, 1944, pp. 106-110.*

Jacket Temperatures.

The determination of the temperature of the cooling medium being circulated through the cylinder jackets is particularly important in the case of a Diesel engine of a ship operating in tropical waters as well as in temperate or cold climates. It may often happen, of course, that the temperature of the sea water during a single voyage will vary considerably with every change of latitude in which the vessel is sailing. Although in modern engines sea water seldom forms the jacket-cooling medium—either fresh water or lubricating oil being used for this purpose—it is circulated through the heat exchangers or coolers into which the fresh water or oil is passed after it has been warmed during its passage through the cylinder jackets, so that the temperature of the sea water does indirectly control the temperature of the jackets. It often happens, more especially after the engine has been in service for a lengthy period, that the various thermometer pockets of the cooling system become dirty on the outside surface and scaled up on the internal surface, as the result of which the temperature recorded by the thermometers may be considerably lower than that of the cooling medium itself; in consequence of this, the engine may be running at a temperature far higher than is desirable. It is, therefore, essential that all thermometer pockets should be kept thoroughly clean, both externally and internally, so that a correct record of the temperature is obtained. This applies not only to the jacket-cooling system, but to every position at which a thermometer is installed.—*"Shipbuilding and Shipping Record", Vol. LXIII, No. 23, 8th June, 1944, p. 531.*

Chain Drive in American Motorships.

The accompanying diagram shows the unusual arrangement of the propelling machinery in the 170-ft. motorships built or building for the U.S. Government by Higgins Industries Inc., of New Orleans, who have several hundred of these craft in hand. They are twin-screw ships of all-welded construction with four 500-b.h.p. Diesel engines of the non-reversing type, all handed the same way, and arranged to drive the two propellers in pairs through chain transmission and Airflex couplings, in the manner indicated in the diagram. The transmission comprises a roller chain arrangement for ahead and astern drive, operated by Air-o-matic clutches.—*"The Motor Ship", Vol. XXV, No. 294, July, 1944, p. 129.*



Machinery lay-out for 170-ft. ships 1, 2, 3, 4. —Non-reversing Diesel engine A, B, C, D.— Air-O-Matic operating clutch E, F, G, H.— Airflex disconnecting coupling.

Balancing Arrangements for Doxford Engines.

Methods of balancing four-cylinder and six-cylinder Doxford engines having centrally arranged scavenging air pumps driven by an extra crank on the main shaft are illustrated in Fig. 1. The strokes of the upper and lower pistons are in inverse proportion to the reciprocating weights, so that the primary vertical forces are balanced. The secondary vertical forces and couples are balanced by a suitable crank sequence. When a single-plunger scavenging pump is fitted at the centre of the engine, unbalanced primary and secondary forces are introduced. The reciprocating weights of all the lower or upper pistons are modified accordingly. Half are increased and the other half decreased, all by the same amount. The position of the scavenging crank is arranged so that the unbalanced primary vertical and horizontal forces and couples for the complete engine remain at zero, while the unbalanced secondary forces and couples are reduced to unimportant values. The lower pistons of one group of cranks are reduced in weight equally and the amounts are such that, taking into account their phase relationship, they are equivalent to half the weight of the scavenging pump assembly. The remaining lower pistons are increased in weight by the same amounts. Referring to the diagram showing a four-cylinder engine, the firing order of which is 1, 3, 4, 2, the pistons (*24, 25, 26, 27*) have their weight modified as indicated. The reciprocating weight of the scavenging pump (*20*) is balanced by reducing the weights of two of the lower pistons and increasing the weight of the other two. For this purpose the crank (*22*) of the scavenging pump is set at a position (S P) midway between the centre cranks of Nos. 3 and 4 cylinders. The reciprocating weights of the pistons (*26, 27*) are reduced by providing thinner skirts. The pistons (*24, 25*) have their weights increased by the same amount. Owing to the phase displacement of the cranks, the weight which has to be added to or subtracted from the pistons is $\frac{\sqrt{2}}{4}=0{\cdot}353$ of the reciprocating weight of the scavenging plunger assembly, assuming the stroke to be the same as that of the lower pistons. So that only one kind of spare piston need be carried, all the four pistons (*24, 25, 26, 27*) are identical and the masses (*28, 29*) are detachable. In the case of a six-cylinder engine the crank sequence is 1, 4, 2, 6, 3, 5, and the scavenging pump crank (*32*) is in the same angular position as crank No. 5. The pistons of one group (*3, 5, 1*) therefore have their weight reduced and those of the other group (*4, 2, 6*) have their weight increased by the same amount. The weight subtracted from each of the first group and that added to each of the second is equal to one-quarter of the reciprocating weight of the scavenging pump assembly (*31*) when the stroke is the same as that of the lower pistons. The working parts of all cylinders remain duplicates, while the modifications, being distributed over a number of cylinders, keep the weights within a practicable range and the lifting gear does not require to be substantially increased in its capacity. The individual out-of-balance forces are smaller than with previous methods of balancing the scavenging pump, so that there is a reduction of bending stresses in the engine structure.—*"The Motor Ship", Vol. XXV, No. 294, July, 1944, p. 134.*

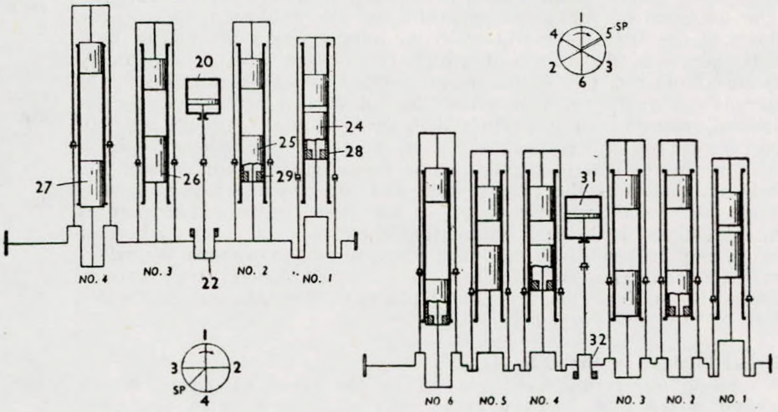


FIG. 1.

Dynamite to the Rescue.

A highly unconventional and ingenious method of extricating the ends of broken-off drills from the crankshafts of I.C. engines has been successfully developed by Mr. N. Sorenson, superintendent of the automotive crankshaft division of the Ohio Crankshaft Company, the well-known American firm specialising in the forging and finishing of crankshafts of every kind and size. One of the final operations in the manufacture of force-lubricated crankshafts for oil and petrol engines is the drilling of holes for the passage of lubricant to the bearing surfaces—a tricky and skilful job. In this operation the breaking of drills is a common occurrence and prior to the introduction of the present method of removing the broken ends of the drills from the holes, many thousands of pounds' worth of valuable material and work were lost every year by the firm through the impossibility of removing deeply broken-in drills from crankshafts of all sizes. According to an article in a recent issue of *Diesel Progress,* the idea of using dynamite for this purpose was first tried out by Mr. Sorenson about ten years ago, since when it has saved his firm many thousands of dollars a year. For instance, in one recent month 93 shafts were "dynamited" and later put into service in perfect condition after broken-in drills had been removed from them, their value being over $42,000. In another month 133 smaller shafts, valued at $29,000, were similarly treated. Where the drill has broken in a hole some distance below the surface of the journal or pin, its removal by means of dynamite is somewhat simpler than where it has broken off flush with the bearing surface. A very small quantity of dynamite (rather less than a thimbleful) is placed in the hole, after which a 6-in. fuse is inserted into a shoulder-free cap of smaller diameter and dropped into the hole on top of the charge. When the fuse is ignited a heavy plank or steel shield is placed over the bearing to be dynamited—the shaft may be placed on the ground or on blocks of timber—some such guard as the plank being advisable to stop the flight of the broken drill. The first charge does not always remove the drill, which sometimes breaks up into two or more pieces. In view of the high cost of a crankshaft almost any number of "blasting" operations are justifiable, especially if the shaft is a large one. On one occasion it was found necessary to blow no fewer than 72 charges to remove the end of a big broken-in drill from the crankshaft of a large Diesel engine. The treated shafts have never been known to suffer any damage from this mild dynamiting, as the action of the explosive is comparable to that which occurs when a shell is expelled from the barrel of a gun. The pressure of the gases generated by the explosion follows the flutes of the drill to the bottom of the hole, where a reversal of flow takes place as the result of which the broken drill is vigorously ejected from the hole with a ringing metal-striking-metal noise. On completion of the operation the affected part is always closely inspected, magnifluxed and returned to the stock line. Where the drill has broken off flush, much the same procedure is followed, except that in this case a putty dam some 1½in. high is built around the hole and into this the charge, fuse and cap are inserted as before. With drill breakages of this type it may take two or more charges to release the drill. It is stated that this unconventional method of extracting broken drills has been employed by motor-car manufacturers in America and England, and that it should prove equally useful to marine Diesel engine builders.—*"The Marine Engineer", Vol. 67, No. 804, July, 1944, pp. 296-297.*

Diesel Engines in the U.S. Navy.

Some interesting facts concerning the trend of Diesel engine design in the U.S. Navy were recently given in a paper read at a meeting of the American Society of Automotive Engineers by Mr. E. C. Magdeburger, head of the U.S. Navy Department's Bureau of Ships. After pointing out that the Diesel engine only reached its maximum usefulness when adopted by the automotive industry under pressure of war because it could be produced rapidly and cheaply on assembly lines, the author stated that 47 per cent. of all the Diesel engines in the U.S. Navy were of only 4¼-in. cylinder bore, developing 33⅓ h.p. per cylinder at 2,100 r.p.m., when the unit was a 2-stroke engine and 25 h.p. per cylinder at 2,600 r.p.m. when it operated on the 4-stroke cycle. Apart from the 4-stroke engines with natural aspiration for standard ships' boats, the vast majority of the small Diesel engines are of the 2-stroke or supercharged 4-stroke type because it has been considered preferable to "freeze" the original designs of such engines instead of attempting to derive advantages from their modernisation. A 4¼-in. bore by 5-in. stroke cylinder size has been adopted in the U.S. Navy for engines from 16 to 800 h.p. and in units of from one to 24 cylinders. Mass production has made it necessary to have a larger number of cylinders in such engines than would otherwise have been thought desirable, but this course has had to be adopted in order to secure the desired range of engine outputs. Both spur and bevel gears have been successfully employed for the transmission of the crankshaft torque. The author expressed the view that the cost of present-day fuel-injection equipment is excessive, and some simpler means of solving this problem are definitely called for. He considered that high fuel consumptions at higher speeds can hardly be explained by speed alone, and apparently reflect the lack of combustion research. The ballistic effect of exhaust as an aid or even the principal means of inducing supercharging has not yet been thoroughly appreciated despite the efforts of Büchi, Kadenacy and others. Recent test results with a Büchi turbo-supercharged engine seem to indicate that his insistence on uncooled exhaust pipes between the exhaust valves and the supercharger to retain the temperature of the exhaust gases is not the correct explanation of his excellent results, since they were duplicated by a water-cooled exhaust header provided with gas-tight passages for each pair of non-interfering cylinders. A greater utilisation of the kinetic energy of the gases passing through the exhaust valves or ports at the moment of their opening would increase the charging or supercharging effect into the cylinders and reduce the power needed for the mechanically-driven blower, or even if there was no blower and a similar intake manifold was provided. Referring to the development of new techniques due to the shortage of materials and man-power, the author said that the reclamation of worn and damaged machinery parts by welding, metal spraying and electro-plating is practised on a large scale in the U.S. Navy, and that further research is still in progress. Objections to porous chromium-plating of cylinder liners having been overcome, the problem of suitable wearing surface can be permanently divorced from that of the structural strength required. A steel liner with its better cooling and easier lubrication can therefore be employed, if chromium-plated. Large Government and private facilities for the mass production of chromium-plated cylinder liners are now available, but steel crankshafts of the desired degree of soundness and tolerance, are a bottle-neck. The Ford Motor Company have, however, produced a large cast-steel crankshaft for experimental purposes, while crankshafts welded from small drop-forged component parts have also been successfully produced and installed. At present, said the author, the most widely used cast shafts are made of "Proferall" and "Meehanite".—*"The Shipping World", Vol. CXI, No. 2,664, 5th July, 1944, pp. 9 and 11.*

Diesel-electric Ship with V.P. Propeller.

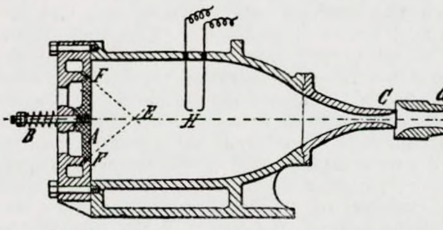
The twin-screw motorship "Suecia" of the Johnson Line, Stockholm, the first large ocean-going vessel to be equipped with Kamewa reversible-blade propellers, recently arrived at Buenos Aires, on her maiden voyage from Gothenburg, in Red Cross service. She is reported to have made a very fast passage and the performance of her v.p. propellers proved to be highly satisfactory. This fact has encouraged a firm of naval architects and marine engineers in this country to include a Kamewa v.p. propeller in a design for a medium-sized cargo ship with Diesel-electric machinery and alternating-current transmission. The vessel in question is 340 ft. b.p., with a beam of 46ft., a depth to upper deck of 28ft. and a d.w. capacity of 4,300 tons, the designed speed being 14½ knots. The ship is of the shelter-deck type, with five cargo holds and the main machinery compartment (which is only some 45ft. in length) is located between Nos. 3 and 4 holds, whilst the propulsion motor and propeller control gear with its oil pumps, are arranged in a separate compartment in No. 5 hold. The propelling-machinery lay-out shows three 8-cylr. two-stroke engines of the Sulzer trunk-piston type, each developing 1,500 b.h.p. and running at a constant speed of 300 r.p.m. Each engine is directly coupled to a 1,119-kW. 30-cycle, 2,000-volt alternator. The three alternators supply current to a dual-type propulsion motor of 4,000 s.h.p. which runs at 120 r.p.m., in addition to the auxiliary power, totalling 120 kW., required for excitation, E.R. pumps and fan motors, etc. An ample margin of power is also provided for losses in transmission. There are also two auxiliary Diesel-generator sets, each comprising an a.c./d.c. motor generator of 240 kW. driven through a hydraulic or magnetic clutch by a 320-b.h.p. Diesel engine. At sea, the whole of the current required for auxiliary and domestic purposes is furnished by the main generators, the motor generators being disconnected from their engines and supplying direct current to the ship's auxiliary system. If required, however, one of the Diesel motor-generator sets can take over part of the main-propulsion load, as, *e.g.*, when one main engine is shut down and additional power is required. In port, the a.c. synchronous motors of the motor-generator sets become alternators when driven by the auxiliary Diesel engines. The use of a v.p. propeller overcomes the main difficulty associated with a.c. propulsion, *viz.*, variation of engine speed with ship's speed. The main power units may operate continuously at full speed, the voltage and frequency remain constant and any astern running or variations in speed that may be called for are effected by means of the propeller. If one or more generators are cut out, the propeller is adjusted accordingly to maintain constant speed. The entire control of the ship is carried out by regulation of the v.p. propeller blades direct from the bridge. All the manœuvring and reversing gear on the engines can be dispensed with, and it is estimated that a speed of 10·25 knots would be maintained with one engine operating at full load, 12·75 knots with two engines at full load and 14·6 knots with all three in service and maintaining their full output. This wide variation of ship's speed is obtainable with the engines operating at their lowest specific fuel consumption, whilst the efficiency of the v.p. propeller would remain practically constant at from one-third to full load, when running at constant speed. The E.R. staff required by this ship would consist of three engineers, one electrician and four motormen or greasers.—*"The Motor Ship", Vol. XXV, No. 293, June, 1944, pp. 93 and 98-99.*

Joshua Hendy Iron Works Manufacture Diesel Engines.

The well-known Pacific Coast Joshua Hendy Iron Works, one of the largest makers of steam engines for Liberty ships and other vessels in the U.S., have now begun to build marine Diesel engines. Known as the Hendy Series-50 model, the first units to be put on the market are 6-cylr. direct-reversing four-stroke engines with a normal rating of 500 b.h.p. at 500 r.p.m. The cylinders have a bore of 12in. (305 mm.), the piston stroke is 15in. (381 mm.) and the b.m.e.p. at the rated output is stated to be 77·5lb./in.^{2}. The cylinder firing compression is 425lb./in.^{2}. The fuel consumption at full load is 0·38lb./b.h.p.-hr., which goes up to 0·42lb./b.h.p. when running at half load. Both the engine bed and cylinder block are of welded steel construction. The circulating water does not come into contact with the cylinder block, being confined to the removable cylinder liners by means of separate jackets for each of the latter. The duel inlet and exhaust valves in the Meehanite cast-iron cylinder heads are operated by an overhead camshaft, and unit type Bendix fuel pumps and injectors are provided for each cylinder. Reversing is effected by axial displacement of the camshaft by means of a pneumatic cylinder directly in line with the latter and controlled by a single manœuvring lever which performs the following functions: (*a*) moves camshaft; (*b*) locks camshaft in new position; (*c*) opens main air-starting valve; (*d*) bleeds starting-air header; and (*e*) controls the fuel. The various functions are carried out in their correct sequence as the lever is moved from the central "Stop" position to "Forward" or "Reverse", a series of control valves and locking pins arranged about a single cam, plus an interlock to the fuel control shaft and main air-starting valve being fitted. A manual emergency manœuvring wheel at the end of the engine is available for controlling the operation of the engine in the event of a failure of the pneumatic system. In addition to the single manœuvring lever, a "speeder" lever operates in conjunction with the governor spring to provide variable speed control of the engine. The maximum speed is always limited by the governor, but the "speeder" control enables the r.p.m. at lower speeds to be regulated with a high degree of accuracy. Each cylinder is provided with a starting-air valve controlled by a pilot valve which is operated by the camshaft. Forced lubrication is employed, with an oil-scavenging pump which delivers oil from the crankcase sump to an external reservoir, from which the oil is drawn by a separate pressure pump and passed into a header connected to the various bearings and to the oil-cooled cast Meehanite pistons. Fresh-water cooling is used for the cylinder jackets and heads as well as for the exhaust manifolds, in conjunction with a tube type heat exchanger cooled with salt water. The reversible type centrifugal pumps for circulating the fresh and salt cooling water are driven by the crankshaft. The total weight of this 500-h.p. engine is 30,000lb. exclusive of gearing, which is only fitted if a lower propeller speed is required. The o.a. length of the engine is 13ft. 7in., its width is 3ft. 8in., its height from the centre of the crankshaft is 6ft. and its depth below the latter is 1ft. 11in. The Series-50 Hendy engines are designed for ship propulsion, either direct or with mechanical gearing or electrical transmission, but they are equally suitable for marine auxiliary service, in which case the reversing mechanism is not fitted. Similar engines with four and eight cylinders are also to be constructed.—*"The Log", Vol. 39, No. 3, March, 1944, pp. 110-112.*

Engines of Flying Bombs.

From the description of the flying bombs which recently appeared in the Press, it would seem that the propelling jet is produced by a device that has been known for many years and that was originally proposed for use in a gas turbine. It is extremely simple, but highly inefficient; the petrol consumption of the flying bombs is known to be over a gallon per mile. It is almost certain that the compressed air stored in the two spherical chambers in the flying-bomb fuselage is mainly used to drive the motors of the gyroscopes which control the ailerons and rudder; but a proportion of it is also utilised to elevate the petrol to the jets. The accompanying sketch appeared in H. H. Supplee's *Gas Turbines*, published in 1909, and it will be noted that the description reproduced below agrees very closely with that of the present-day flying-bomb unit. "In the case of the second group, the explosion turbines, the air compressor is eliminated or greatly simplified. The explosive mixture is formed in the same chamber in which it is ignited, being either at atmospheric pressure or slightly above, and by its expansion, consequent upon the explosion, it acts upon the turbine wheel. The principle of such a machine is shown. The explosion chamber is closed at the back by a valve *A* held to its seat by a light spring *B*, the chamber having an expanding nozzle opening at *C*. The gas enters at small openings, as at *E*, under the seat of the valve, and the air is admitted at *F*, the mixture being ignited electrically at *H*, and discharged through the nozzle *C* upon the buckets of the turbine wheel *T*. The discharged gases pass through an induced-current nozzle *G*, which acts to reduce the temperature of the issuing gases and lower the velocity of the jet as it acts upon the turbine wheel".—*"The Engineer", Vol. CLXXVIII, No. 4,623, 18th August, 1944, p. 130.*



Circulation in Marine Boilers.

Recent discussions on engines for marine purposes have shown that many engineers still prefer the Scotch boiler to the watertube. It is not generally recognised that a tank boiler can be made to give more steam with efficiency provided that the same circulation is arranged for as in the watertube boiler. The locomotive type of boiler probably produces more steam for its weight than any other boiler, but it cannot do this if fixed on a solid foundation. The reason for this is that on a locomotive the boiler is rocked and vibrated and the steam bubbles are wiped off the evaporating surface as fast as they are formed. In a Scotch marine boiler the steam forms on the heating surface, depositing scale as it forms, and it then bubbles up through the water. Many attempts have been made to produce a good circulation in tank boilers, but they have all been based on the assumption that an upward stream of water must be assured, whereas one can no more get an upward stream in a tank boiler without a downward stream than one can in a watertube boiler. The downward stream can readily be produced if large downcomers are fitted inside the boiler, near the boiler shell and at other suitable parts, where the water can rush down them and thus produce an upward flow over the heated surface. So far is this from being recognised that many boilermakers place heating tubes in the parts where the water should be allowed to flow downwards and thus destroy the circulation and reduce the capacity of the boiler for generating steam. Models show that the method is highly successful. The water rushes down the downcomers and the upward current of water brings the steam with it in minute bubbles which escape without priming.—*C. Turnbull, "The Engineer", Vol. CLXXVIII, No. 4,621, 4th August, 1944, p. 88.*

Chemical Removal of Soot in Oil-fired Boilers.

There are certain chemicals offered on the market which can be injected at frequent intervals into the combustion space of the boiler or sometimes mixed with the fuel and which have a tendency to lower the oxidation temperature of carbon. A considerable amount of research work connected with the removal of soot from boiler furnaces and flues by the use of various salts and compounds, was carried out by the U.S. Bureau of Mines some years ago. It was found that various chlorides and metals that gasify at low temperatures will lower the burning point of carbon in the form of soot. Sodium chloride (ordinary salt) will reduce the burning point of carbon to 969° F., whilst cupric chloride will bring it down to 623° F. Some of the preparations on the market are very good and can be used with effectiveness to clean out combustion spaces while at sea. The more expensive preparations which contain cupric chloride are, of course, far more effective than the cheaper ones containing common salt. Metallic zinc is also an effective oxidizer and is frequently used in these preparations. The author would, however, like to utter a word of warning in regard to the purchase of chemicals of this nature, when the buyer does not know what they contain. He has seen salesmen offering chemicals containing potassium nitrate mixed with sulphur and all kinds of combinations which have a tendency to create an explosive substance when mixed with soot, particularly at high temperatures, and cases have occurred when rather disastrous explosions have taken place. All salesmen handling untried products of this type are eager to display certificates from the Coast Guard or the Bureau of Marine Inspection and Navigation claiming that they have approved of their products. In point of fact, these certificates only state that approval has been granted to carry the product in a ship, in other words, as an item of cargo or among the ship's stores; the certificates do *not* indicate that the product in question has been approved for the particular purpose for which it is intended. This is, of course, misrepresentation, but it might happen that someone will buy chemicals that are dangerous to use as soot eradicators on the strength of these certificates.—*B. E. Meurk, "The Nautical Gazette", Vol. 134, No. 6, June, 1944, p. 64.*

Mechanical Stokers.

The provision of an efficient form of mechanical stoker for marine boilers of the Scotch cylindrical type on board coal-burning tramps and coasters is a far more difficult matter than that of designing and operating such a stoker for use with a watertube boiler with its large furnace front and big combustion space. Some of the difficulties to be surmounted were recently described in a paper on "Mechanical Stokers for Shell Type Boilers" read in Manchester at a meeting of the N.-W. Section of the Institute of Fuel by Dr. A. C. Dunningham and Mr. B. M. Thornton. The shell type of boiler includes the Scotch marine type as well as the Lancashire, Cornish and "economic" types of boilers used on land. The authors suggest that in the case of hand-fired coal-burning boilers the operating efficiency may be as low as 50 or 60 per cent., whereas the employment of a reliable design of mechanical stoker enables the obvious shortcomings of hand firing to be overcome, with a corresponding increase in operating efficiency. The available types of mechanical stoker for use with shell type boilers are classified by the authors under four headings, *viz.*, the chain-grate type, the coking type, the sprinkler type of the Underfeed type. The authors point out that while each of these stokers has proved suitable for handling some particular grade of coal, they all suffer to a smaller or greater degree from the disadvantage that they lack flexibility, *i.e.*, the ability to handle different grades of coal. This, of course, is particularly disadvantageous in the case of marine boilers which may have to be fired with the grade of fuel available at the port at which the ship may happen to be bunkering and which may vary very considerably. Suggestions are put forward in the paper for improving the flexibility of existing types of mechanical stokers, but what is required, the authors assert, is a "utility" stoker capable of burning as wide a range of coals as possible and also possessing great flexibility as regards output and the adjustment of such variable factors as grate speed, coal feed, secondary air supply and grit emission. Such a stoker is now in process of development and experiments with a one-third full size model are in progress. Further particulars of this and trial results should prove interesting.—*"Shipbuilding and Shipping Record", Vol. LXIV, No. 6, 10th August, 1944, p. 124.*

Converted Oil Tankers.

There is news from both Canada and the U.S., of certain ordinary cargo ships being converted for the carriage of oil cargoes. A number of similar conversions were effected towards the end of the 1914-18 war, when some of the Government standard ships had large tanks built into their Nos. 1, 2, 3 and 4 holds, resting on the inner-bottom plating, so that reconversion remained possible with a minimum of trouble. At the present time, several Liberty ships have been taken in hand for conversion, and the Canadian Government, who have already converted a standard cargo vessel of 10,000 tons d.w., are reported to be proceeding with the conversion of further vessels of this class. Early in the war, the old U.S. Shipping Board motorship "William Penn", one of the first vessels to be equipped with an American-built B. & W. s.a. 4-stroke air-injection oil engine, was bought by National Bulk Carriers, Inc. of New York, who gave a contract to the Welding Shipyards, Inc., of Norfolk, Va., for her conversion from a cargo ship to an oil tanker. She was a twin-screw vessel of 7,615 gross tons with two 6-cylr. engines developing a total of 3,700 b.h.p. It has not been stated whether this conversion included the removal of the propelling machinery from amidships to aft, but this does not appear to have been the case. A much more important conversion, from a technical aspect, was that of the cargo steamer "Amsco", one of three sister ships built for Italian owners on the Gulf coast during the 1914-18 war, but never taken over. She was completed as a three-island ship with the engines and boilers amidships, a large coal bunker forward of the engine room, two cargo holds forward of the machinery space and two aft, and a continuous double bottom extending from the fore peak to the after peak. The hull was 371ft. 9in. long b.p., with a 52-ft. beam and a depth of 27ft. 6in. The first step in conversion was the elimination of the double bottom by cutting away and removing the tank-top plating. This was followed by the construction of new bulkheads dividing the ship into the number of tanks required for transporting bulk petroleum. Six new transverse bulkheads and one longitudinal centre-line bulkhead were built, in addition to which summer tanks were constructed throughout the oil spaces. As completed, the new arrangement comprised 16 main cargo tanks, eight summer tanks, two pump-rooms, one fuel tank and an engine room. The new engine room was located aft, forward of the after peak, and just forward of it was a cross fuel bunker. Forward of this space was a pump-room, which also served as the conventional cofferdam between the machinery space and the cargo oil tanks. A small compartment for dry cargo was arranged abaft the fore peak and then came the forward pump-room. The cargo capacity of the converted vessel was 60,000 barrels (about 8,200 tons). The whole of the conversion work was carried out by welding, the existing riveted transverse bulkheads being made oiltight by welding the boundary bars and the heads of the rivets. In order to make the new E.R. casing, it was found necessary to remove a large part of the deck aft, and to compensate for this $\frac{7}{16}$-in. doubling plates were fitted over the remaining deck plates and to the shear strakes. The hull was completed by the provision of the necessary expansion trunks and hatches, deck structures, masts, etc. The original 2,000-h.p. triple-expansion engine was moved aft, where it was supplied with steam by two oil-fired Scotch boilers. Steam-driven cargo oil pumps of the reciprocating type were installed. It is stated that over 600 tons of steel were used in this extensive conversion work. The final result was a tanker of somewhat unconventional appearance, as the original midship structure was retained, the navigating bridge being at the forward end of the latter. Abaft the bridge was a gap where formerly the funnel and engine casing were located, a portion of the old casing being retained at the after end of the bridge deck in order to disturb the accommodation as little as possible. The new engine casing was a narrow box-like structure built over the "hole in the deck" already referred to.—*"The Journal of Commerce" (Shipbuilding and Engineering Edition), No. 36,210, 2nd March, 1944, pp. 6-7.*

The Victory Ship "China Victory".

After constructing 320 Liberty ships, including 30 Liberty-type tankers, the California Shipbuilding Corporation launched the first of five Victory ships under construction, on January 26th. The new vessel, named "China Victory", had been on the stocks only two months and is due for delivery at an early date. Although the new Victory ships are longer and of greater beam than the Liberty ships—the actual dimensions being 455ft. and 62ft. as compared with 441½ft. and 57ft.—and have three decks instead of two, the d.w. tonnage (10,500 tons) and cargo-carrying capacity (9,146 tons) of both types is the same.* The Victory type of vessel has considerably finer lines, as well as propelling machinery of very much greater power, to obtain a service speed of 5 to 6 knots in excess of that of the Liberty ships. The "China Victory" has a single propeller driven through D.R. gears by an H.P. and an L.P. turbine. The total weight of the turbines, condenser and gears is stated to be 125 tons, and the diameter of the main gear-wheel is 12ft. The rated output of the two turbines is 8,500 s.h.p., 50 per cent. of this power being developed in each of the two units. The H.P. turbine, which runs at 5,300 r.p.m., takes steam at a pressure of 440lb./in.^{2} and temperature of 740° F. from the two watertube boilers and exhausts at a pressure of 30lb./in.^{2} and temperature of 260° F. to the L.P. turbine, which runs at 4,400 r.p.m. Most of the auxiliary machinery is motor driven, as are the cargo winches. The total output of the vessel's turbo-generators is stated to be ten times that of the three 20-kW. dynamos installed in the Liberty ships. The equipment of the Victory ships includes an extensive system of mechanical ventilation. —*"The Nautical Gazette", Vol. 134, No. 2, February, 1944, pp. 38-39 and 55.*

*Note by Abstracter: *Some of the dimensions given in the abstract on p. 32 of the April, 1944* Transactions, *would appear to be incorrect.*

The Victory Ship Design.

The steam-driven Victory ships now in course of production are of two types—the AP2, with turbines of 6,000 s.h.p. and the AP3, with turbines of 8,500 s.h.p. A Diesel-driven type, known as the AP4, and another steam-driven type, to be known as the AP1, are also being developed. As originally designed, most of the Victory steamships were to have been equipped with a 5,500-h.p. reciprocating steam engine of the Lentz type operating in conjunction with an exhaust turbine, which would have given the vessels a service speed of about 15 knots, but the immensely increased output capacity of the U.S. firms engaged in the manufacture of marine turbines and gears made it possible for the Maritime Commission to utilise turbine propulsion for the great majority of the Victory ships, with the result that their service speed will be substantially higher. At the same time, the oil-fuel consumption of these new vessels (0·66lb./s.h.p.-hr. in the AP2 and 0·59lb./s.h.p.-hr. in the AP3 ships) is considerably lower than that of the 2,500-i.h.p. (2,300-s.h.p.) Liberty ships, in which the specific fuel consumption is 1·3 to 1·4lb./s.h.p.-hr. The hull of the Victory type of ship is of all-welded construction except that the stringer plates are secured to the sheer strakes by double-riveted angles. Experience with earlier all-welded ships has shown that when cracks develop in the deck plating there is a tendency for them to extend to the shell plating, and it is considered that a riveted connection between the two will prove an effective crack stopper by preventing any break in the deck plating from going beyond the deck edge. The watertight subdivision of the hull provides a one-compartment standard of safety as regards flooding. In the case of the forward and after peaks and adjoining cargo holds, a two-compartment standard is achieved. In the first Liberty ships to be built no W.T. door was provided in the bulkhead between the engine room and the shaft alley, and after the vessels had been placed in service, there were many complaints from the E.R. personnel on the subject of the resulting inconvenience. The Maritime Commission thereupon agreed—with great reluctance—to have a quick-closing W.T. door of relatively small size fitted in the after bulkhead of the engine room to facilitate communication with the shaft alley, and a similar door has been arranged in the Victory ships, although the Commission's views on the undesirability of having such doors remain unchanged. The transverse stability of the hull is claimed to be such, however, that with any single compartment flooded, an ample degree of metacentric height can be maintained in service. Up to the 1st April of this year, contracts for the building of 346 Victory ships had been placed with six yards, 48 keels had been laid, 18 ships launched and six completed. The average time for completion at the Oregon yard (which had, by that time, delivered five Victory ships) was 105·6 days. The building programme of the Maritime Commission provides for the placing of contracts for 1,150 more Victory ships before July 1st. —*J. L. Bates, "Marine Engineering and Shipping Review", Vol. XLIX, No. 4, April, 1944, pp. 154-159 and 216.*

General Particulars of the Victory Ships.

The U.S. Maritime Commission's Victory ship, which is replacing the Liberty ship as the standard type of war-time cargo vessel, is a full-scantling vessel with three cargo holds forward and two aft of the machinery space, a straight raked stem and cruiser stern. There is a forecastle extending over No. 1 hold, a midship deck-house and a small poop deck-house. The double bottom is arranged for the carriage of oil fuel and reserve feed water, and the O.F. deep tanks in Nos. 4 and 5 holds extend to the top of the shaft tunnel. The hull, which is transversely framed and completely welded except for the connection of the bulwark and main deck which is riveted to a continuous angle at the sheer strake, is divided into seven main W.T. compartments. The accommodation for the entire complement of the vessel is arranged in the steel-built, watertight, three-tier super-structure amidships. The principal details of the Victory ship, so far released for publication, are as follows:—

Length o.a.	455ft. 3in.
„ b.p.	436ft. 6in.
Beam, moulded	62ft.
Depth to main deck, moulded	38ft.
Summer load-line draught	28ft. 6in.
Corresponding displacement	15,200 tons.
Deadweight capacity	10,700 „
Block coefficient at design l.w.l.	0·674.
Prismatic coefficient	0·682.
Gross tonnage	7,612 tons.
Normal s.h.p. (AP2 ships)...	6,000.
„ „ (AP3 „)...	8,500.
Service speed (AP2)	15·5 knots.
„ „ (AP3)	16·5 „
Total capacity (bale) of cargo holds ...	453,210 cu. ft.
„ „ of refrigerated stores ...	4,600 „ „
„ „ „ oil-fuel tanks ...	2,883 tons.
Capacity of peak S.W. ballast tanks ...	140 „
„ „ distilled-water tanks ...	21 „
„ „ reserve feed tanks ...	178 „
„ „ drinking-water tanks ...	96 „
Normal complement (including spare) ...	62 officers and men.
Defence personnel	28 „ „ „

The d.w. tonnage, s.h.p. and service speed vary slightly according to the two types of machinery installed.—*"Marine Engineering and Shipping Review", Vol. XLIX, No. 4, April, 1944, pp. 160-164.*

Major Bottom Repairs to Norwegian Tanker.

An extensive repair job of unusual interest was recently completed at the Baltimore yard of the Bethlehem Steel Company, when the Norwegian motor tanker "Solfonn" (9,925 gross tons) was made seaworthy after having sustained serious bottom and internal damage as the result of running aground off the S. American coast last winter. The ship was first docked at Simonstown, South Africa, where a survey of the damage showed that the vessel was hogged about 21in. by the stern, due to two buckles in the hull plating, one at the midship section and another and more severe one at frame station 75. As facilities for adequate repairs were not available at Simonstown, it was decided to effect temporary repairs to the hull to enable the tanker to proceed to an American port for permanent repairs. Four longitudinal girders of ⅞-in. web plating and ⅞-in. face plating, riveted together with heavy 6-in. angles were shaped to fit the damaged shell plating and were then welded to each side of the latter. Plate brackets ½in. thick were worked midway between the frame spaces, three frame spaces apart, and welded to the shell plating. These brackets were connected internally to the webs of the longitudinal girders by 3½-in. angles. The strength of the vertical keel and side longitudinals was re-established as far as possible by means of plates, brackets and angles, welded and riveted. Approximately 600 tons of cement and reinforced concrete were also used to make the ship watertight and stable for the voyage to Baltimore. The tanker made the passage to that port under her own power and on arrival there was placed in the 20,000-ton floating dock at the Bethlehem yard, where it was found that the temporary repairs to some of the wing tanks executed at Simonstown had failed. After making good these defects, the ship was transferred to the large graving dock in the yard for the removal of the cement and reinforced concrete covering the interior of the ship's bottom. This varied in thickness from 3 to 4ft., and had to be removed before any of the steel work could be started. Recourse was had to blasting for this purpose, the dynamite charges being placed in holes spaced at 18-in. centres in the concrete, and great care being taken to avoid damage to the heating coils and hull structure during the blasting operations. The removal of the concrete took about six weeks, and it was then found that the damage to the bottom and to the bilge sections, both internally and externally, was so extensive, from stem to stern, that only certain areas of the temporary repairs could be removed and renewed at one time. The sections to be repaired were dealt with in three separate locations along the damaged bottom, each extending over a length of 45ft., special cribbing and shoring being used to keep the remains of the old damage in alignment while this work was proceeding. As each damaged section was removed and replaced with new material, a constant check for alignment was kept by transit readings to determine the cause for any shifting or settling of the hull on the cribbing and shoring. About 500 tons of shell plating and 750 tons of steel for internal work were used during the repair. The damage in way of the engine room was so extensive that it became necessary to remove the whole of the main and auxiliary machinery from the ship in order to obtain access to the damaged tank top, floors and frames. The main engine bedplate, which was made in two sections, one weighing 45 tons and the other 51 tons, was raised and chocked about 2ft. clear of the tank top while the latter was being repaired, about 50 tons of steel being expended for this purpose. The C.I. cargo pipe system was found to have suffered such serious damage as to necessitate its complete renewal. The cargo pumps had also to be overhauled and tested. The repairs outlined above were completed in four months, after which all the main and wing cargo tanks, forward deep tanks, D.B. compartments under the engine room, fuel tanks, forward and after peak tanks, pump-room and cofferdams were tested by water pressure before the ship was undocked. On completion of the test on the D.B. tanks, the main engine bedplate was replaced on the tank top, after which the main and auxiliary engines, E.R. pipes and fittings were installed in place, lined up and connected. On completion of this work the ship carried out a satisfactory basin trial.—*"Marine Engineering and Shipping Review", Vol. XLIX, No. 5, May, 1944, pp. 160-162.*

Second Curve in Plates by Controlled Heat and Beating.

According to an article which appeared in the *Engineering News-Record* of 27th January, 1944, an American shipyard on the Pacific coast has developed an improved method of producing the irregular curvature in the bilge plates which is frequently necessary along the longitudinal length of a ship's hull in addition to the transverse curve that is required in many of the plates. It is claimed that the new method of bending reduces the fabrication cost by 70 per cent. The plate is first given its required bend in the long direction on rolls, then by beating along its edges, it is "dished" without changing the radius of the previously rolled bend. An oxy-acetylene flame is used, the width of the heating along the plate regulating the amount of the "fore-and-aft" bend that the plate will have. The method can be used on galvanized steel as well as black plates, although it is necessary to exercise a certain amount of care in moving the heat before the galvanizing melts. If the torch is held 6in. from the work, however, the heat will penetrate the metal without damaging the external coating of zinc.—*"Mechanical World", Vol. 115, No. 2,994, 19th May, 1944, p. 562.*

Tanker Converted into Escort Aircraft Carrier.

The U.S. Maritime Commission's oil tanker "New Orleans", a vessel of 13,500 tons d.w. with a length of 552ft. and a speed of over 18 knots, which had been serving as a fleet oiler for the U.S. Navy, has now been converted into an escort aircraft carrier. As such, she is stated to be considerably larger than many of the "Woolworth carriers" or "baby flat-tops" as they are popularly termed in America, converted from dry cargo vessels. The work of converting the "New Orleans" was carried out by the Bethlehem Steel Company, and involved the removal of the tanker's superstructure and oiltight bulkheads in many of the cargo tanks, and the installation of the necessary equipment, including two aircraft lifts.—*"The Journal of Commerce" (Shipbuilding and Engineering Edition), No. 36,281, 25th May, 1944, p. 5.*

A 4,500-ton Diesel-electric Car Ferry.

A contract for the construction of a new ice-breaking car ferry was recently placed with Marine Industries, Ltd., of Sorel, Province Quebec. The vessel is to be delivered before the winter of 1945 and will be operated by the Canadian National Railways on behalf of the Dominion Government between Port Borden, Prince Edward Island, and Cape Tormentine, N.B. The o.a. length is to be 372ft. 6in., the maximum draught, 19ft. and the gross tonnage about 4,500 tons. There are to be five decks, one of which will be provided with rail tracks for 19 railway cars, whilst the automobile deck will accommodate about 60 motor-cars. The passenger accommodation will comprise a restaurant and various public rooms for a total of 950 passengers. The hull is to be of all-welded construction. The propelling machinery will consist of eight Diesel engines driving electric generators capable of producing 12,000 b.h.p. and supplying current to four propulsion motors connected to two forward and two after propellers. It is claimed that this arrangement permits flexibility of operation, as it is possible to concentrate the whole of the power upon any one propeller in an emergency. The forward propellers will improve the ice-breaking efficiency of the ship, as well as her manœuvrability. Bridge control of the propellers will be available, with a great variety of speed changes and distribution of power among the various propellers. The designed speed of the new ferry is stated to be 16½ knots.—*"Lloyd's List and Shipping Gazette", No. 40,392, 10th May, 1944, p. 7.*

The "Canadian" Ships.

The new 10,000-tons d.w. cargo steamers under construction in Canada at the present time are of a design similar to that of the "North Sands" type of which a considerable number have already been built in the Dominion *(for description see abstract on p. 104 of* TRANSACTIONS, *October, 1942)*. The hull structure of the new vessels, to be known as the "Canadian" ships, will differ little from that of the earlier ones, whilst the propelling machinery and boilers will be similar in all respects except for the fact that dual firing of the three Scotch boilers will be arranged for. The D.B. tanks, which served as water ballast tanks in the "North Sands" vessels, are to be made oiltight and will be completely piped for O.F. pumping and heating. The deep tank aft of the engine room, which was formerly used for water, will also be made oiltight. Two O.F. settling tanks, each 7ft. wide, 17ft. long and 20ft. deep, will be installed on the P. and S. sides of the ship forward of the boilers. The D.B. tanks will still be available for use as ballast tanks, when not filled with oil fuel. The cargo-handling equipment of the new ships is to be made up of six 5-ton and four 10-ton derricks, in addition to which there will be a 50-ton derrick on the fore mast and a 30-ton derrick on the main mast. It is reported that the hull form of the new vessels is such that a slight increase in the h.p. of the propelling machinery (from 2,500 to 3,200 i.h.p.) would make it possible to raise the service speed to 12½ knots with a reasonably economical fuel consumption.—*S. C. Mantrop, "Canadian Shipping and Marine Engineering News", Vol. 15, No. 10, May, 1944, pp. 30-31.*

Steel Tug Construction in New Zealand.

Five small sea-going Diesel-engined tugs recently launched from the yard of Steel Ships, Ltd., Auckland, N.Z., were the first of a series of 30 such craft ordered by the U.S. Government for service with the American Army and Navy. Built to a modified American design, these tugs, which are V-bottomed, are 75ft. in length, with a beam of 18ft. and a maximum draught (aft) of 8ft. 6in. The propelling machinery consists of a 6-cylr. Atlas Imperial oil engine of 320 h.p. which drives a single screw. The steel hulls of the tugs are built up of fabricated sections made by various firms in Auckland and assembled at the shipyard by expert welders. A 125-ft.-girder type steel jib with a lifting capacity of six tons is used to lift the sections into place on the building slip, and the completed hulls, weighing about 64 tons, are then lifted into the water by the floating crane "Mahua". When ready for service, the tugs have a tonnage of 115. The first of these craft to be completed, the "Coatesville", underwent successful sea trials in heavy weather and maintained an average speed of 9½ knots. The tugs are stated to be excellent seaboats and are well equipped for the duties for which they were designed. Comfortable living quarters are provided on board for a complement of four officers and six men. Eighty New Zealanders, including two young women machinists, are employed in the shipyard. The first two tugs were delivered at the end of June, and the remainder are due to be completed at the rate of two every month. They will all be given New Zealand place-names starting with the letter "C".—*"Fairplay", Vol. CLXII, No. 3,190, 29th June, 1944, pp. 908 and 910.*

Recent British and American Diesel-engine Colliers.

The increased cost of bunker coal was probably an important contributory factor to the decision made by a Middlesbrough firm to have their two new coastal colliers equipped with Diesel engines instead of the traditional reciprocating steam engines and coal-fired boilers. These new motor colliers are ships of 1,874 gross tons, 257ft. b.p., with a beam of 39ft., a moulded depth of 18ft. 8in., a maximum draught of 17ft. 6in. and a d.w. capacity of 2,665 tons. The grain capacity of the holds is 131,040 cu. ft. and the ballast tanks will hold 885 tons of water ballast. The propelling machinery consists of a 6-cylr. s.a. two-stroke Diesel engine, with attached scavenge pump, developing about 960 b.h.p. and giving the ship a service speed of 10½ knots in a fully-loaded condition. In contrast to this design, that of a new American coaster intended to carry coal and other bulk cargoes, is deserving of consideration. This vessel has a length of 250ft. b.p., a moulded breadth of 42ft. 6in., a depth of 25ft. 3in., a maximum draught of 21ft. 3in. and a d.w. capacity of 4,025 tons. There are three large cargo holds, the hatch openings for these being of exceptionally large size and having special steel hatch covers. A 30-ton Diesel-electric crane, running on rails laid fore and aft along the ship's sides, serves all three holds. The propelling machinery consists of a supercharged four-stroke direct-reversing Diesel engine developing 1,300 b.h.p. at 277 r.p.m. and designed to give the ship a speed of 11 knots in a fully-loaded condition.—*"The Shipping World", Vol. CX, No. 2,662, 21st June, 1944, p. 639.*

A Word for the War-built Ship.

Among the improvements in design advocated for the post-war cargo vessel is a proposal to provide a permanent centre-line gangway flanked on either side by cargo hatches, and the writer, who describes himself as a naval architect, points out that there are serious objections to such an arrangement. Experience with centre-line gangways on board tankers, he states, has resulted in the universal adoption of open sides, the support and strut angles being widely spaced so as to give ready access from side to side of the ship and the greatest possible visibility to all the pipes, electric wiring and other fittings carried under the platform and on support angles extended beyond it transversely. A primary consideration is to have all the flanged joints in the piping accessible for overhaul without the need for removing any plating, etc., and that would not be possible with close-plated sides. As regards the location of the living quarters for the officers and men, the berthing of the entire personnel amidships has advantages when the propelling machinery is amidships, but is open to a number of objections where the machinery is aft. The most popular design for a cargo ship with a water-line length of some 412ft., is the shelter-deck vessel with superimposed forecastle, which the writer considers to be superior to the "three-island" type of ship in rough weather, more especially in a head sea. He condemns a proposal to group all the electric cargo winches in two houses and to operate them by remote control, since this would necessitate tortuous leads and increased block friction.—*"The Shipping World", Vol. CX, No. 2,663, 28th June, 1944, pp. 657-658.*

3,500-ton American Coastal Vessels.

Over 200 ships of a special type for coastal and shallow-draught service have been ordered by the U.S. Maritime Commission from various Great Lakes and other shipyards. Known as the C1-M-AV1 class, these vessels are expected to be in service by the end of next year. They will be small enough to pass through the Welland Canal locks to the St. Lawrence River, and sufficiently shallow to operate either on the Great Lakes or between various American and European ports inaccessible to the larger types of cargo vessels. The new coasters have the external appearance of a small tanker, the propelling machinery and living quarters being arranged right aft. They have an o.a. length of 320ft., a beam of 50ft., a depth of 29ft., a draught of 18ft., and a d.w. capacity of 4,000 tons. The register is 3,500 gross tons and the designed service speed 12 knots. The majority of these vessels will have their single screws directly driven by Nordberg or Busch-Sulzer engines. The Nordberg two-stroke unit to be installed in this particular class of ship develops 1,700 b.h.p. at a normal speed of 180 r.p.m., but is capable of a 2-hr. 25 per cent. overload, when it delivers 2,125 b.h.p. at 194 r.p.m. The six cylinders have a diameter of 21½in. (545mm.) and a piston stroke of 29in. (736·5). The trunk-type pistons are oil-cooled, whilst the cylinder jackets are cooled by fresh water. The crankshaft-driven scavenge pump is located between Nos. 3 and 4 cylinders. The scavenging air is delivered through a horizontal trunk to disc-operated automatic valves which control the two separate rows of scavenging ports of each cylinder, the exhaust being discharged through ports on the opposite side of the latter. The fuel-injection valve is located centrally in the cylinder bore. The total weight of the engine, complete with all spares, is 118 tons, which is equivalent to 115lb./b.h.p. at normal rating. The general design is based on that of the 2,150-b.h.p. and 3,000-b.h.p. Nordberg engines installed in many ships of the Maritime Commission's C-1 and C-2 classes, in which, however, the engine speed was higher and the propeller was driven through gearing, whereas the new 1,700-b.h.p. engines are designed for direct drive.—*"The Motor Ship", Vol. XXV, No. 293, June, 1944, pp. 74-75.*

New Passenger and Cargo Motorship for Blue Funnel Line.

The latest addition to the fleet of Alfred Holt & Co., Blue Funnel Line, is the single-screw motorship "Telemachus", a vessel of some 13,000 tons d.w. capacity and with accommodation for 13 passengers in two- and three-berthed staterooms in the midships deckhouse. There are five large cargo holds and 'tween decks, No. 3 hold and three compartments in the 'tween deck above it being insulated for the carriage of refrigerated cargo. The lower hold has no brine pipes, being cooled by cold air circulation. There are also three deep tanks for special liquid cargoes. The cargo-handling equipment includes a 50-ton derrick at No. 2 hold and a 25-ton derrick at No. 5 hold. The winches and windlass are of the electric type, whilst the steering gear is electro-hydraulic actuated by telemotor. An emergency air engine is provided to work the steering-gear pump in the event of a failure of the electric current supply; the engine takes air through a reducing valve from the main reservoir. The propelling machinery consists of an 8-cylr. d.a. two-stroke Kincaid-Burmeister & Wain engine with fresh-water cooling for the cylinders and oil cooling for the pistons. A combination exhaust heat and oil-fired boiler of the Cochran type provides heating steam for domestic purposes and for the coils in the fuel tanks and deep tanks. No evaporators are installed, sufficient fresh water being carried in the D.B. and other tanks to meet all normal requirements. The whole of the E.R. auxiliary machinery is motor driven, current being furnished by four 220-kW. Allen generators directly coupled to 5-cylr. four-stroke Allen Diesel engines. There is also a 40-kW. emergency dynamo driven by a 4-cylr. Ruston & Hornsby engine.—*"The Journal of Commerce" (Shipbuilding and Engineering Edition), No. 36,287, 1st June, 1944, p. 2.*

New Twin-screw Doxford-engined Ship for the Prince Line.

The latest vessel to be added to the fleet of Furness, Withy & Co., Ltd.'s Prince Line is a twin-screw motor cargo liner of 9,485 gross tons with a d.w. capacity of 11,230 tons. She has a beam of 63ft. 2in. and a moulded depth of 41ft. 9in. to the upper deck. There are five cargo holds with upper and lower 'tween decks, the engine room being between Nos. 3 and 4 holds. Four deep tanks in No. 3 hold have a capacity of over 2,000 tons of liquid cargo, whilst the D.B. tanks can hold over 1,200 tons of fuel. The fore-peak and after-peak compartments can also be used as fuel tanks if required, and have a capacity of nearly 300 tons. The ship's fresh-water tanks have a normal capacity of about 208 tons. The cargo-handling equipment comprises 14 winches driven by 30-h.p. motors of a new design and serving 14 five-ton derricks, but four of these can be adapted to lift 10 tons and there are also two heavy-duty derricks, *viz.*, a 50-ton derrick at No. 2 hatch and a 40-ton one at No. 4 hatch. The anchor windlass forward and warping winch are also motor driven, whilst the steering gear is of the electro-hydraulic type with telemotor control. The propelling machinery consists of two four-cylinder Doxford engines of standard design with centrally arranged scavenging pumps, the exhaust from the starboard engine being passed through a Clarkson waste-heat boiler. The pistons and cylinder jackets of the main engines are cooled with distilled water circulated at a pressure of about 30lb./in.^{2}. The inlet temperature of the piston-cooling water is 153° F., whilst the outlet temperature is 165° F., that of the jacket-cooling water being 155° F. Rototherm circular thermometer gauges on the engines serve to indicate the temperature of the piston-cooling water. The total amount of water required for make-up purposes does not exceed 5 gall. per day. The engine-room auxiliaries, which include two 400-ton S.W. pumps and a 350-ton ballast pump, are nearly all motor driven, electric current being furnished by three d.c. 175-kW. Allen Diesel-generator sets which run at the unusually high speed of 550 r.p.m. The sets are, in consequence, somewhat smaller and lighter than slow-speed ones of equivalent output. These generators are stated to be giving highly satisfactory service, the normal routine being to run each unit continuously for 600 hours, after which the valves are removed and examined. A more complete overhaul is made at the end of 1,500 hours' running. Most of the E.R. pumps are of the vertical type, with the result that the total amount of space taken up by the auxiliary machinery is much reduced. There is ample room available on the P. side for the installation of a fourth Diesel-generator set if this should be required after the war, as a proposal to insulate a complete hold for the carriage of refrigerated cargo is under consideration. In addition to the Clarkson waste-heat boiler, there is an oil-fired Cochran boiler in the engine room, both units generating steam at a pressure of 120lb./in.^{2} for the operation of the 10-ton evaporator and distilling plant and for working the 20-cu. ft./min. emergency air compressor. A separate low-pressure oil-burning Wallsend unit is installed for the heating systems. Although primarily a cargo liner, the ship has excellent peace-time accommodation for 24 passengers in 12 double staterooms on the bridge deck. At the present time these are fitted up as 4-berth cabins. The well-appointed quarters of the ship's officers are located in a large midship deck-house on the upper deck, whilst the crew are berthed aft in the poop. The E.R. complement is made up of nine engineer officers, two electricians, three donkeymen and three greasers.—*"The Motor Ship", Vol. XXV, No. 293, June, 1944, pp. 78-87.*

Ship Repairs and Conversion Work under Reverse Lend-Lease.

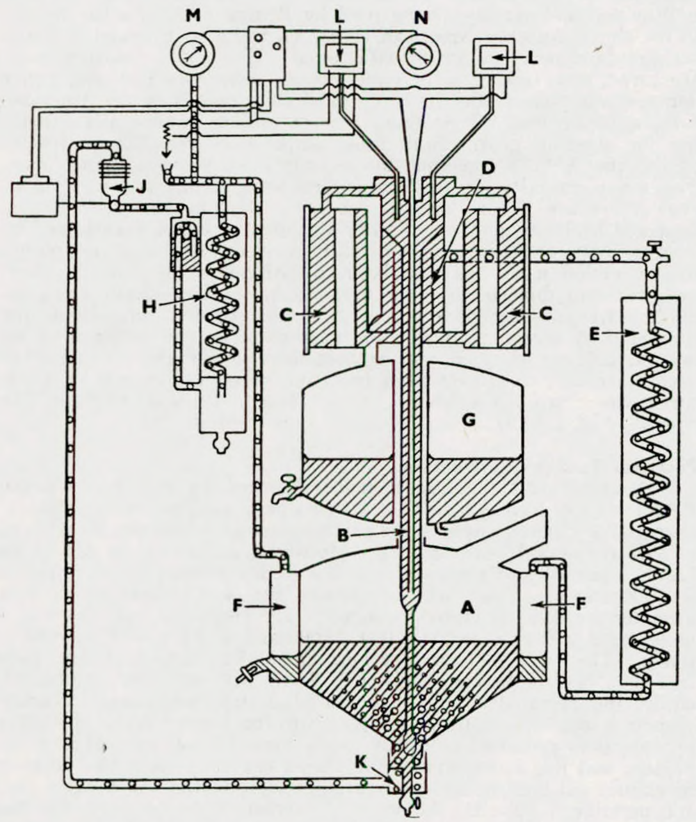
In the last two years the 50 or more British yards that repair American-operated tonnage as Reverse Lend-Lease have also been at work arming hundreds of vessels for the operations in Europe. Despite this vast war programme scores of jobs for the American ships have been completed. For example, an American ship which had the whole of her stern blown off by a torpedo in the Mediterranean ten months ago and could not be repaired in Malta or Gibraltar, was towed to this country. It was found that the propeller, rudder and rudder stock, tail shaft and stern tube were damaged beyond repair, so materials were rushed from the U.S. to England and are now being used by British workmen for repairs to the ship. Another American vessel, en route to England, suffered serious damage from an acoustic mine. Her shaft bearings were fractured, her rudder and rudder stock were wrecked and other damage was done to the hull. A third ship, owned by an American firm, went aground off Scotland, tearing off her rudder and damaging the steering gear. Both these ships were repaired in British yards, the M.W.T. meeting the expenses as Reverse Lend-Lease. For every casualty of this nature resulting from the war, however, there are dozens due to cracked plates, broken deck beams, damaged lifeboats, and many other varieties of damage sustained by vessels in the ordinary course of their service. An immense amount of conversion work has also been carried out by British shipyards on American tonnage diverted to Russian service. Such work includes strengthening of the bow to withstand ice formations, the provision of special pilings in the nose to offset the pressure of ice and the lagging of steam and exhaust lines to the winches and other deck machinery to protect them from the effects of the low temperatures which are experienced in the North Russian ports.—*"The Syren", Vol. CXCII, No. 2,500, 26th July, 1944, p. 201.*

Post-war Tanker Construction.

Practically all the largest tankers owned by the Anglo-Saxon Petroleum Co. have for some years past been equipped with pressure-charged Werkspoor engines, the performance of which has, in general, proved remarkably satisfactory. However, according to Mr. John Lamb, head of the company's technical department, it is probable that electric propulsion will be adopted for new tankers to be built after the war. Four classes of tankers are visualized, and these it is understood will be of 5,000, 9,000, 12,000 and 17,000 tons d.w. respectively. They will all have a service speed of at least 13 knots, fully loaded. The 17,000-ton ships will have turbo-electric machinery, whilst the remainder will have Diesel-electric machinery. Turbo-electric propulsion is to be adopted for the largest class of tanker because it is proposed to utilise heavy asphaltic oil as fuel in these vessels, and this is unsuitable for Diesel engines; hence the decision to employ oil-fired boilers and turbines, despite the far greater fuel consumption involved. Alternating current is to be used for the whole of the machinery in the engine room in all the new ships, whilst direct current will be utilised for the outside auxiliaries. Standard types and sizes of machinery units will be installed in all the vessels, the necessary differences in power being obtained by varying the numbers of the individual prime movers and alternators, the sizes of their respective components being the same throughout each category. Every unit will be readily replaceable, in order that all major overhauls may be carried out on shore, thereby avoiding delays during machinery refits. Diesel engines and alternators, for instance, will be removed complete and replaced by duplicate spare units. The main cargo pumps, also, will be lifted out of the pump-rooms and overhauled on shore, spare pumps being installed on board meanwhile, if required. All the Diesel and steam machinery will be of the stationary type and non-reversible.—*"The Motor Ship", Vol. XXV, No. 294, July, 1944, p. 113.*

An Automatic Lubricating-oil Re-refiner.

The present-day need for the conservation of supplies of lubricating oil is reflected by the widespread practice of filtering and purifying used oil for further use, but it may often be desirable to go farther than filtration by re-refining at the site of use, oils which will benefit from such a process. For this purpose, an entirely automatic, simple and compact plant known as the Vokes-Petco Automatic Re-refiner, has been developed and placed on the market. It is 5ft. 4in. in height, takes up a floor space of 2ft. 2in. by 2ft. 10in., and can be operated from any electrical supply between 110 and 250 volts, a.c. or d.c., the only connections required being a water supply, a drain and a 30-amp. power connection. The output of the plant is 8-9 gall. of re-refined lubricating oil from 10 gall. of used oil every two hours at a cost of only a few pence per gallon. The labour required to operate it can be entirely unskilled, as all that is necessary is to put 10 gall. of oil into the dirty-oil tank, after mixing with activated earth, and when the run is completed to remove the purified oil and impurities from their respective receivers. The oil is under treatment for about 1¾ hours, and the time required to carry out the above work is approximately a quarter of an hour. Temperature control throughout the operation is entirely automatic, and as it takes place under vacuum there is no risk of fire. Filtration of the oil is effected through ceramic plates which remove solid impurities, while liquid ones are distilled, condensed and retained by traps. The cycle of operations may be followed by reference to the accompanying diagram. Dirty oil, with which activating earth is mixed, is poured into the tank (A), from which it passes up the column (B) into the dual filter chambers (C). During the process of passing up the column (B), the mixture is heated electrically to at least 450° F. in



order to reduce its viscosity, and the earth and solid impurities, together with such acids, gums and sludge which may be present are then trapped in the filters (C), whilst the clear oil, which, however, still contains liquid impurities, passes to the fractionating chamber (D), where the remaining impurities separate out. Liquid impurities or diluent are condensed during their passage through the condenser (E) and are then stored in the tank (F) until the end of the operation, whilst the re-refined clear oil from the fractionating chamber is collected in the tank (G). Any gases present in the tank (F) are led off through an absorber (H), in order to protect the vacuum pump (J) from corrosion. Air issuing from this pump passes through a jet (K) in the bottom of the dirty-oil tank (A), so keeping the activated earth in suspension. On the electrical side are two thermostats (L) for temperature control, whilst other fittings include a vacuum gauge (M) and thermometer (N).—*"The Oil Engine", Vol. XII, No. 135, July, 1944, p. 81.*

Coal or Oil?

In a letter to the Editor of *The Times,* Sir Douglas Thomson, M.P., refers to the concern expressed by many people in this country regarding the effect on our national economy caused by the gradual change-over from coal to oil fuel of our merchant ships. The writer points out that all connected with the Merchant Navy have, since the beginning of the war, been subjected to a considerable amount of uninformed criticism on account of the alleged slow speed of our ships. The critics appear to overlook the fact that the fuel consumption of a vessel rises sharply with the speed, and that a ship will burn double the amount of fuel at 15 knots that she does at 12 knots. The carriage of cheap bulk cargoes such as grain, cement, coal, etc., at faster speeds involves higher freight rates, frequently without any benefit to the shipper, and it also means handling on board ship larger quantities of fuel. To carry, trim and fire quantities of coal in excess of 50 tons a day is a difficult matter in any ship and compares adversely with the ease of handling the same or a much greater amount of oil fuel. Thus the cry for higher speeds in peacetime is one contributory cause of the change-over to oil fuel.—*"The Times", No. 49,883, 15th June, 1944, p. 5.*

Oil and Water Emulsions and Sludge in Ships' Fuel Tanks.

In a paper entitled "Fuel Oil for Ship Operations" presented at a recent meeting of the Metropolitan Section of the American Society of Naval Architects and Marine Engineers by Mr. B. E. Meurk of the Isthmian Steamship Co., the author dealt at some length with the trouble that is sometimes caused by the formation of emulsions and sludge in ships' oil-fuel tanks, particularly when these are used intermittently for water ballast. He explained that there are actually two kinds of emulsions, *viz.,* oil-in-water and water-in-oil, in addition to combinations of both, known as dual or complex emulsions. The substance in a fuel tank which will act as an emulsifying agent is common dirt in the shape of iron oxide and solid or semi-solid hydrocarbons released the oxidization or chemical change of the oil fuel. The latter may absorb almost 50 per cent. of water in emulsion without any appreciable alteration in its general appearance. Some of the hard emulsions, which have the consistency of butter, may contain up to 85 per cent. of water and cause serious trouble in D.B. fuel tanks. They continue to build up, and therefore not only reduce the capacity of the tanks, but also clog the piping systems; and if by some chance they become sufficiently disintegrated to be dispersed with the good oil of the tanks, a considerable amount of fuel may have been rendered useless for combustion at a time when it is urgently needed. There have been instances when the chief engineer has suddenly discovered that the oil fuel on which he had been depending to take the ship to its destination has been so contaminated by dispersed emulsions resulting from violent pitching in a heavy storm, as to make it imperative to put into the nearest port to refuel. It is, therefore, essential to keep the sludge down to a minimum and to have exact information regarding the true conditions of the fuel tanks. The author mentioned the case of one of his company's vessels which had a small deep tank containing oil fuel. The chief engineer of the ship once had occasion to report that when he pumped oil from this tank into the settling tanks, the oil burners went out. When he tried mixing this oil with good fuel the fires would burn for a certain length of time and then go out again. In other words, the fuel from this particular tank would form a stratum in the settling tank in spite of the fact that it was kept circulating. It was eventually found that the fuel contained 40 per cent. of water in an oil-in-water emulsion. The author had previously observed that by using powdered napthalene crystals and sometimes mixing the fuel with sodium carbonate, it was possible to break certain water and oil emulsions. In this instance, the addition of powdered napthalene crystals proved satisfactory inasmuch as it became possible to burn the fuel; the emulsion was not broken, however, neither was the water drained off, but sufficient wet oil was dispersed uniformly in the settling tanks to give a mixture that would burn. The ship in question had Scotch boilers and the mixture which was burned contained 10 per cent. of water; had the boilers been of the watertube type with brick-lined furnaces, it would probably have been possible to burn a fuel with 20 per cent. of water. A 2-ft. layer of semi-solid sludge was left at the bottom of the tank, and as the vessel was urgently required for service, there was no time to clean it out. When the ship returned from her next voyage, it was found that sea water had leaked into the tank again and that the emulsion had increased so that the tank was almost full of a 15 per cent. oil and 85 per cent. water emulsion which could not be pumped or handled at all. In fact, when the ship was dry-docked, it proved necessary to cut a hole in the side plating to permit the emulsion to slide out into tubs at the bottom of the dock.—*"The Nautical Gazette", Vol. 134, No. 6, June, 1944, pp. 58, 63 and 64.*

Electrical Equipment for Victory Ships.

The power and lighting circuits of the Victory ships are on the 3-wire system, direct current at 230 volts being used for the various electric motors installed on board, whilst d.c. at 120 volts is employed for lighting purposes, etc. Current is supplied by two 300-kW. 240/120-volt d.c. geared turbo-generator sets on the starboard auxiliary machinery flat, where the main switchboard is likewise located. The generators of the 6,000-s.h.p. (AP2) ships are either shunt or compound wound, whilst those in the 8,500-s.h.p. (AP3) vessels are all compound wound. Under normal conditions, the entire ship's load, both at sea and in port, can be taken by a single generator. The alternating current required for certain services, such as the salinity indicators and tank level indicators, is furnished by a small motor-generator set. A 15-kW. Diesel-generator set for emergency service is installed in a special compartment at the after end of the boat-deck superstructure. An emergency switchboard fitted in this compartment is normally fed through an interconnecting bus feeder from the main switchboard. In the event of a sudden stoppage of the main generator in use, the emergency Diesel-driven dynamo is automatically started, and the emergency load, which consists of lighting and essential interior communication circuits, is automatically transferred to the emergency generator.—*"Marine Engineering and Shipping Review", Vol. XLIX, No. 4, April, 1944, p. 188.*