DOCKYARD MACHINERY—FORTY YEARS IN RETROSPECT

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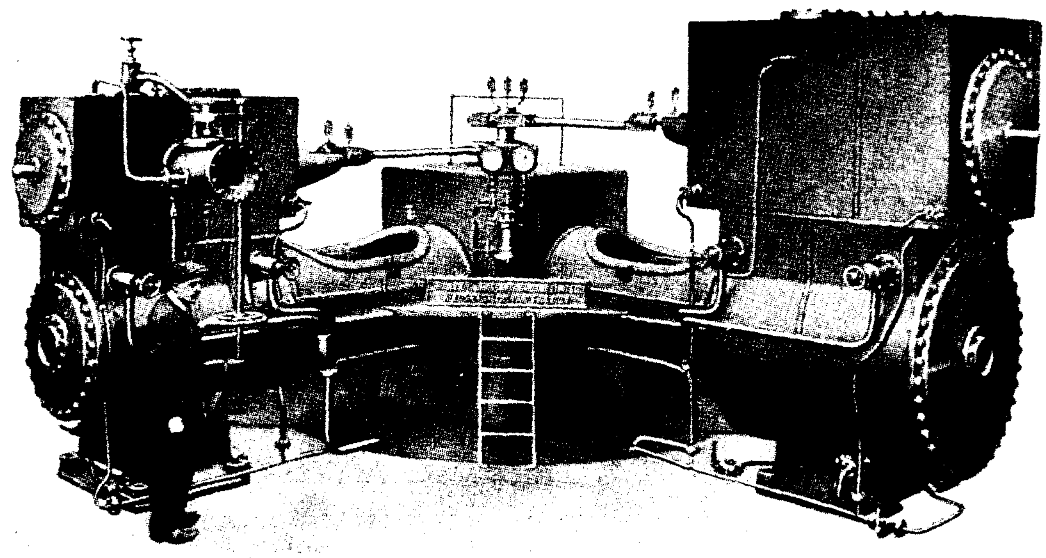
Many articles have appeared, in this and other engineering journals, indicating the revolutionary changes that have taken place in the design of hulls and machinery of naval vessels since the early years of the present century. No such attention, however, appears to have been drawn to the corresponding changes in the machinery in H.M. dockyards, the function of such machinery being to assist in the servicing and repair of these same craft.

This may be attributed to the fact that modernization of plant in dockyards has only progressed, more or less, in step with that in outside industry, including shipyards. The truth is that the Royal Dockyards, at least those in the south, had their origin centuries ago, and much of their machinery already had a history when the present century opened, so that the contrast between the old machinery and the new is rendered the more striking.



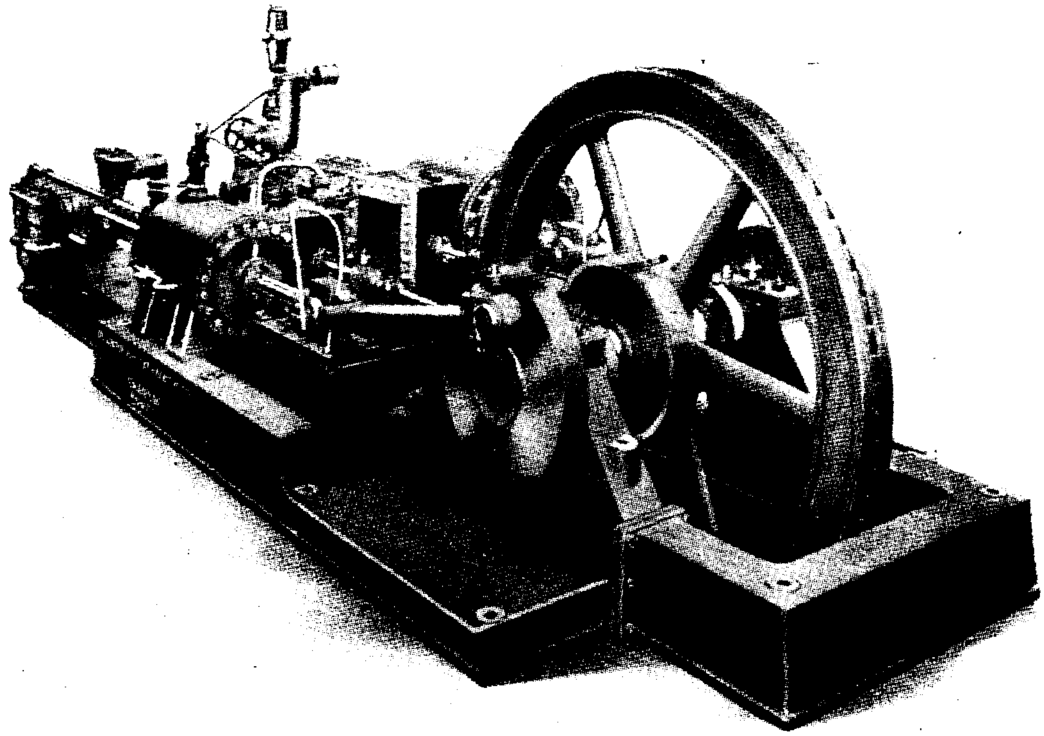
DOCK PUMPING ENGINE, 1912. CYLINDERS 26 IN AND 50 IN DIAMETER BY 27 IN STROKE.
NORTH PUMPING STATION, PORTSMOUTH
REPLACED BY MOTOR DRIVEN PUMPS IN 1943

Such a contrast is very apparent to the writer, who has had the not too common experience of being connected with what is known as ' Yard Machinery ' during all stages of his service with the Admiralty, for a total period of well over thirty years, and in many establishments. These included dockyards at Portsmouth, Chatham, Portland, Gibraltar, Malta and Hong Kong, as well as over ten years in Director of Dockyards' Department at Bath. During this period, experience on yard machinery, both from a drawing office and supervisory aspect, occupied almost the whole of the time served. The effect of such a career has been to produce an outlook that is far from parochial, and to create an interest in a most embracing subject, together with a feeling that this subject has never been given the publicity it deserves.

Before considering in detail the immense changes that have taken place in the design of the majority of items that comprise Yard Machinery since before the First World War, a broad outline of the responsibilities of the Yard Machinery sections in the dockyards will be presented.

So far as the Engineering Department is concerned, the Yard Machinery Section inside the dockyard is responsible for the running, as well as the maintenance, of the mechanical portion of all machinery used for general dockyard service, whether driven by electricity, steam, gasoline or Diesel engines, compressed air, hydraulic or any combination of these motive powers. Exceptions to this control are motor transport, in which lorries and passenger cars are manned and maintained by the Naval Store Department, and the electric generating station, for which the Electrical Engineering Department is responsible.

The main items of machinery included in the category of General Yard Services are enumerated below. The list is by no means complete, and in some dockyards, owing to geographical or other special features, there may be additional items. It should be noted that none of these services do any repairs to, or make any parts for, H.M. ships, although they are an aid to such productive work. They are therefore classed as indirect services and the costs of manning and maintenance charged as an oncost.



HORIZONTAL COMPOUND HYDRAULIC PUMPING ENGINE, 1900. CYLINDERS 20 IN AND 34½ IN DIAMETER BY 24 IN STROKE. CAMBER PUMP HOUSE, PORTSMOUTH
REPLACED BY MOTOR DRIVEN PUMPS IN 1931

Yard Machinery Section Responsibilities

Dock Pumping and Service Stations

The functions of these are :—

(*a*) Pumping out docks when ships are docked, and keeping them continuously drained of water leaking through the caissons and dock gates.
(*b*) Pumping salt, and sometimes fresh, water for fire purposes.
(*c*) Supply of compressed air and hydraulic power.
(*d*) Production of distilled water and oxygen gas.
(*e*) Decanting of refrigeration gases from commercial cylinders.
(*f*) Boiler houses for supplying steam for space heating of workshops and stores, and for process work.

Lifting Appliances

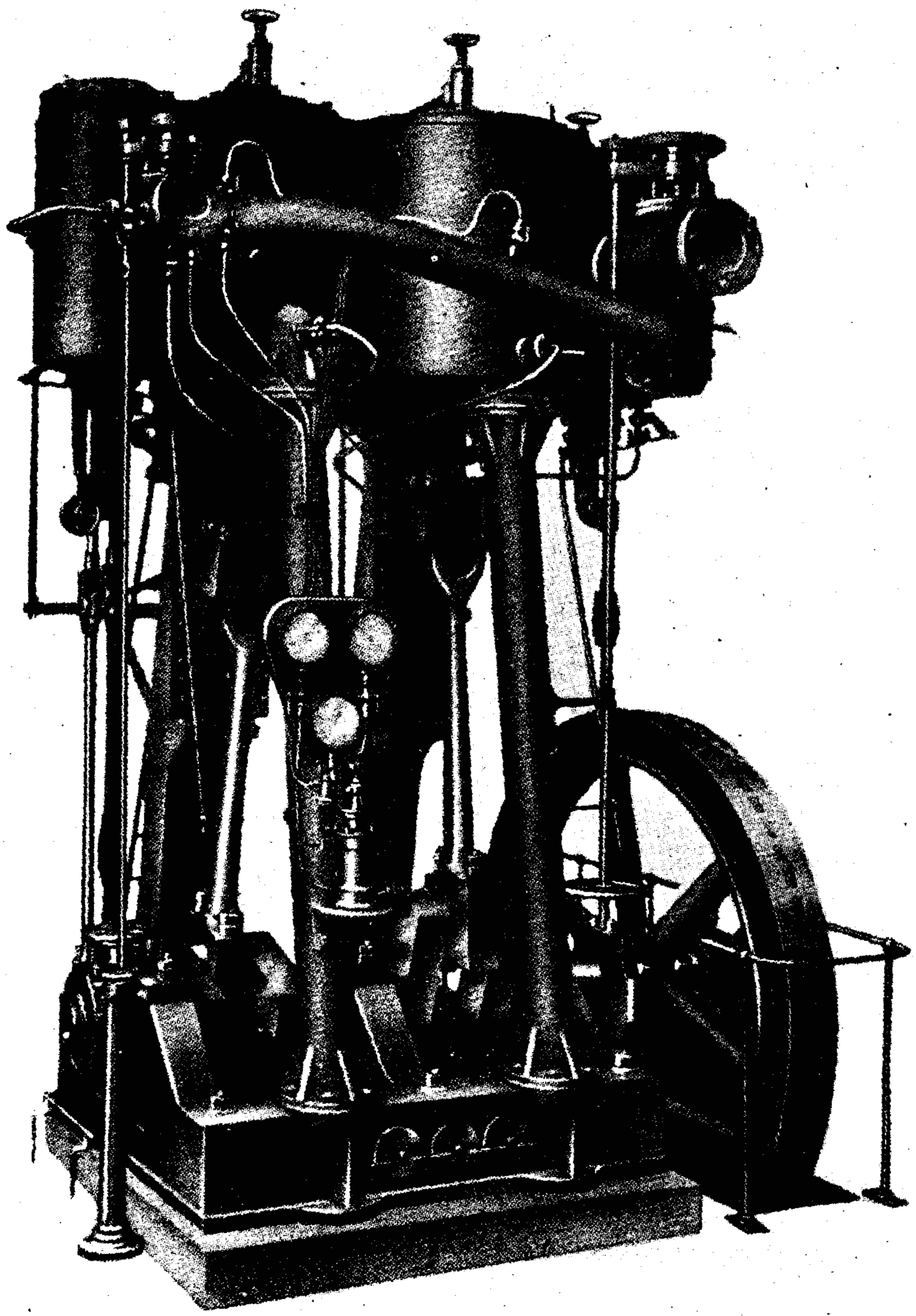
Consisting of all types of cranes, mobile and stationary, steam, electric, hydraulic, hand and I.C. engine driven.

Dock and Basin Machinery

This embraces all capstans for transporting ships, whether air, hydraulically or electrically driven ; dock caisson raising and hauling machinery, some of which is nearly eighty years old ; fairleads ; mechanical drives for the dock penstocks, or sluice valves in the filling or suction culverts.

Locomotives

This includes steam and Diesel locomotives, turntables and weighbridges.



Dock Drainage Pumping Engine, 1912. Cylinders 16 in and 31 in diameter by 24 in stroke. North Pumping Station, Portsmouth.
Replaced by motor driven pumps in 1939

Service Pipe Systems

Service pipe systems of steam, air and hydraulic pipes throughout the dockyard, amounting to several miles of piping, up to 12 inch bore, and hundreds of fittings. Installation and maintenance of steam and air services inside shops, stores and offices are also dealt with.

Installation

Installation of all new machinery, including machine tools, in all departments. Oversight of this work when performed by contract.

Other Miscellaneous Duties

These include the running and maintenance of portable I.C.E. welding sets and air compressors ; salvage machinery ; dockyard laundry ; custody and transport of main ledger machinery spares, and the preservation and packaging of stores. The maintenance of all machinery inside workshops, with a few exceptions, air hammers, hydraulic presses, weighing machines and all travellers and lifting appliances inside stores and workshops, is also included.

Outside Establishments

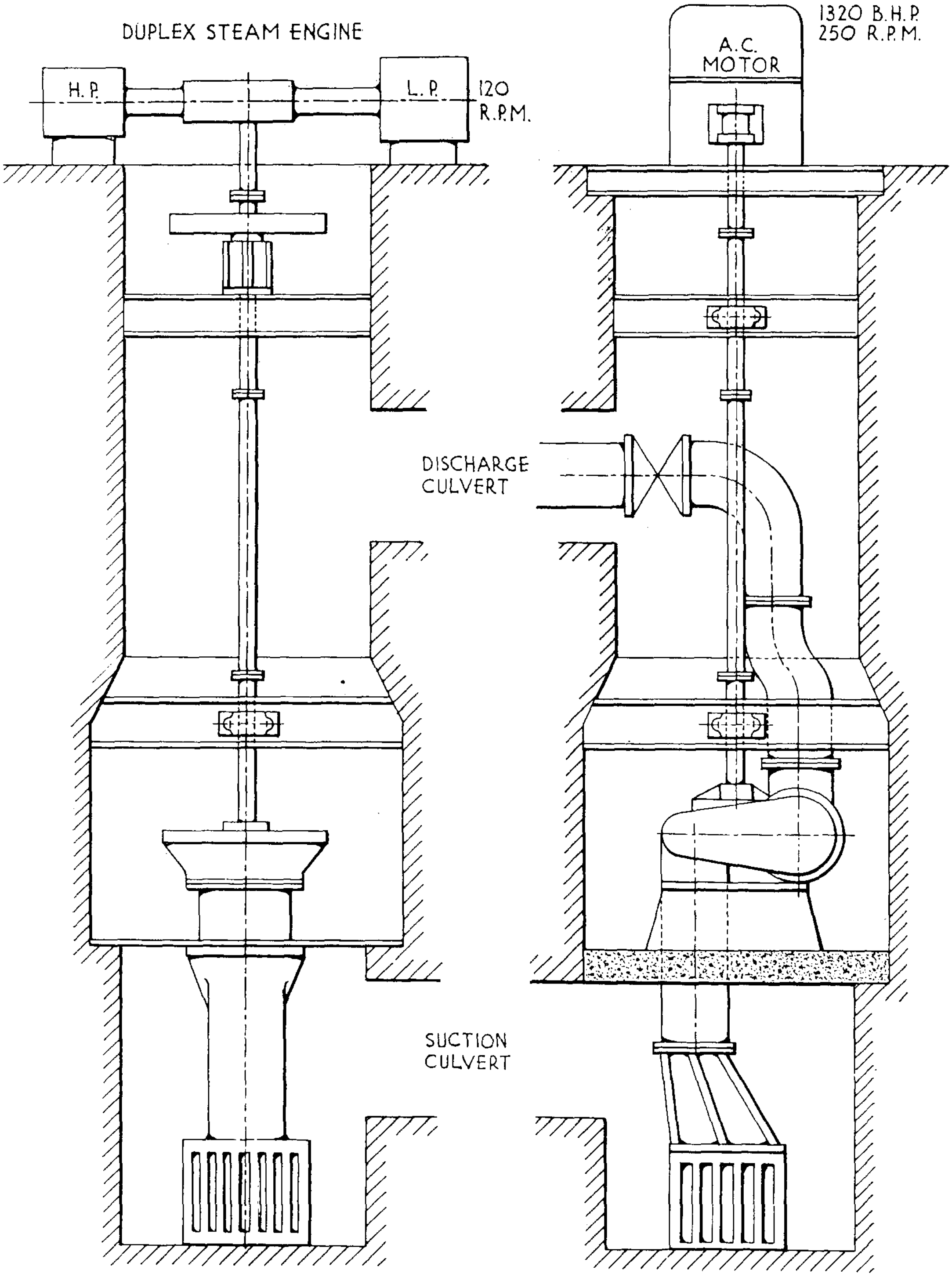
A somewhat smaller section deals with the installation of new machinery outside the dockyard, in civil and fleet establishments, fuel oil and air stations, etc., also repairs and maintenance of the machinery in these establishments which is considered beyond the capacity of the engineering staff of each establishment, if such is carried. Much of this maintenance work, especially in naval establishments, includes boilers and heating systems, culinary equipment of all types, refrigeration, ventilation, air conditioning, cranes, travellers and workshop equipment. Quite a lot of work is involved in carrying out tests on boilers, cranes, lifts and other appliances.

It will be seen from the above remarks that the duties of the Yard Machinery sections are fairly comprehensive. That more prominence is not given to this work in the dockyards is due to the fact that no fixed dates for completion of repairs, as for ships under repair, are circulated around the departments. In the ideal dockyard the plant should be maintained in such a way that it would seldom, if ever, require repair. Such a state is, of course, impracticable ; running repairs have normally to be carried out during working hours, between periods of use.

Having outlined the general scope and duties of Yard Machinery, it is now proposed to comment on the several changes that have taken place in its design and function during the last forty years ; or, in short, the evolution from the ' steam age ' to the ' electricity cum I.C.E. age,' also a brief summary of the advantages that have accrued from these changes. Where specific details are mentioned, it can be assumed that these relate to machinery at Portsmouth Dockyard.

Dock and Drainage Pumps

Dock and drainage pumps were all steam driven until the inter-war period, Main dock pumps, of which there were two in each pumping station, consisted of a rotating impeller, 9 or 10 feet in diameter, in a well somewhat deeper than the docks themselves. A culvert, or underground passage, at least 7 feet in diameter connected the well with the dock, through which the pump drew the water, nearly filling the well, from which it flowed by gravity to the sea or river,



STEAM DRIVEN
WET WELL DOCK PUMP,
9,000 TONS/HOUR : 1900–1928

MOTOR DRIVEN
DRY WELL DOCK PUMP,
22,000 tons/HOUR : 1930

through the upper discharge culvert. Each impeller was driven by a compound steam engine, having cylinders with circular guides at right angles in a horizontal plane. The vertical crankshaft, running at about 140 r.p.m. was connected to the impeller through a long shaft with lignum vitae bearings and thrust blocks, to support the weight of shaft and impeller. The engines varied from 400 to 700 i.h.p. with 155 lb/sq in pressure, and each pump discharged an average of 7,500 to 10,000 tons of water an hour. The drainage pumps, of which there were also two in each station, operated in separate wells connected with the drainage culverts. They were of the 3-barrel type, driven at 60 to 90 r.p.m. by a vertical compound engine. A clutch was arranged to marry the two pumps together, if it was required to drive them with one engine. Each dock and drainage pump engine exhausted to a combined surface condensing plant.

Since 1925, practically all the dockyard pumping stations have been electrified in stages, and the process is now nearing completion. The steam-driven dock pumps have been removed entirely, and replaced generally by electrically driven pumps of the ' dry well ' type. This means that the original wet well has been sealed off by a ' biscuit ' on which the pump sits in the dry.

The drainage pumps, in some cases, have remained intact, but the steam engine has been replaced by electric motor and gearing. In other cases, a smaller edition of the electric dock pump has replaced the original pump, in a much modified well.

These drastic changes which have been made in the engine rooms, which were once regarded as the show-places of the engineering departments, have many advantages, among which are greater efficiency, cleanliness and less maintenance costs. On the other hand, the romance seems to have departed, when one remembers the old pumping stations during docking operations. Those memories bring back the rhythmic beat of the engines, the hiss of steam, the smell of compound engine oil mixed with stale sea water, and the shouts of greasers running round with sweat rags and oil cans, imparting a thrill to the shift engineers, who had the feeling that they were ' doing things '. Nowadays, with electric drives, one merely listens to the monotonous hum of the motors, with very little visibly in motion, and only a few dials and lights flickering and winking on the switchboard. One feels that the people who are really ' doing things ' are at a remote generating station. Also, should the pumps stop or break down, it is seldom an engineer's job to diagnose the cause ; another department has to be brought in.

Other Pumping Station Services

These also have followed the inevitable conversion from steam to electric drive. Some of the deep well water pumps have had merely a motor and gearing to replace the steam engine, others have been changed completely from reciprocating to centrifugal pumps.

Air Compressors

Air compressors, apart from their conversion to electric drives, have not changed greatly in fundamental design. They still produce moderately dry air at 100 lb/ sq in pressure in two stages, but they are now more numerous and of higher capacity than formerly. They are not so centralized, and are arranged with automatic cut-outs to unload the compressor, when the mains pressure exceeds 100 lb/sq in.

Hydraulic Systems

Hydraulic systems for general yard services are now rapidly disappearing, one reason being that the prime movers are too slow to fit the tempo of modern conditions, and the long, buried lengths of pressure and return pipe, the former carrying 750 lb/sq in pressure, are very expensive to maintain in old age. There is also the added cost of gas for anti-frost precautions.

Self-contained hydraulic units inside shops, with single or twin accumulators, for operating presses, etc., are now general, operating at pressures of 1,500 lb/sq in, and, being electrically driven, are arranged to be entirely automatic.

Distilling Plants

Distilling plants in the earlier days consisted of those that were surplus from H.M. ships, varying from the Normandy and Kirkcaldy types to the later Caird & Rayner or Weir's. These generally included two evaporators and a distiller with drain cooler and combined steam pumps in each set. The output was about 3½ tons per hour from each plant using hard shore water, and the two or three sets installed had always one laid up for cleaning.

Sets working at a higher pressure, and having a much higher efficiency, producing water of a purity within the required limits, are now fitted. These sets are made in England, but on the French Prache and Bouillon principle, the weight of distilled water produced with steam at 120 lb/sq in pressure being at least three times the weight of steam used. A Kennicott water softener, using common salt like a giant domestic type, treats the raw feed water, and the two plants installed can be run together, producing about 14 tons per hour for extremely long periods, without requiring cleaning.

Oxygen Plants

A comparison of the earlier and later plants is as follows :—

Type	*Maker*	*Installed about*	*Primary Air Pressure*	*Length of Run*
High Pressure 'Jaubert'.	Société L'Oxylithe.	1920	2,100 lb/sq in initial. 1,420 lb/sq in working.	Varied, but often less than 1 week.
Low Pressure 'Claude'.	British Oxygen Company.	1934	360–400 lb/sq in.	No limit. Often 3 weeks continuously.

Both of these plants operate on the principle of liquefaction of dried and decarbonized air, from which the oxygen is allowed to boil off, and pass to a gasometer. After this it is pumped by a special compressor into cylinders, each cylinder holding 100 cubic feet of free oxygen at about 1,800 lb/sq in pressure. The earlier plant was continually breaking down, or freezing up, and could not be restarted until it was thawed out again. Similar plants were installed on H.M. ships for producing enriched air. The later plant has much more efficient, but complicated, arrangements for interchange of heat, and part of the cooling process is maintained by the cooling air driving an expansion engine; this, in turn, does work driving a dynamo coupled to an electrical resistance. There is no doubt that the low pressure plant has many advantages over the original plant, not the least of which are the shorter period to start production, and the greater purity of the oxygen produced. Even the nitrogen produced is of high purity, and could be collected if wanted.

Yard Boilers

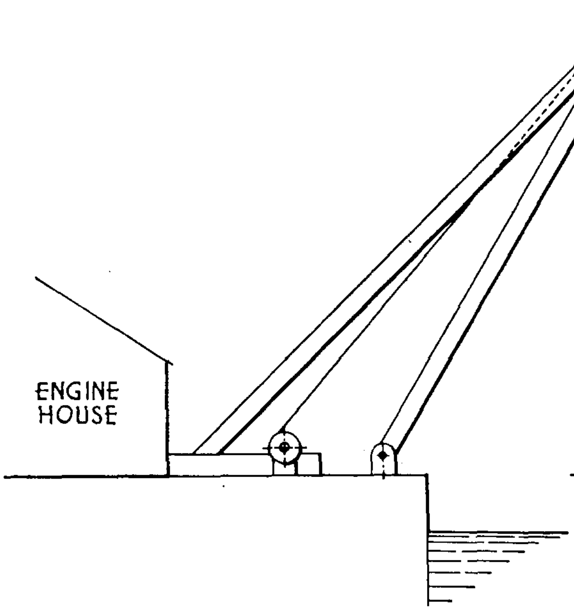
During the first decade of the century, the boiler houses of the dockyard were fairly numerous, since we were passing from the period when all workshop shafting was driven by vertical steam engines, to that of their replacement by electric motors, and subsequently to independent motor drives for all machine tools. In those days, all yard boilers, except those in generating stations, were of the fire tube type, either cylindrical, return or direct tube, and sometimes Lancashire or Cornish. Shop or store heating, when fitted, was by steam radiators, situated at floor level.

Since the electrification of the pumping stations previously described, most of the yard boilers have been utilized to provide steam for space heating and domestic purposes, also for shop process work, and occasionally testing of auxiliary machinery. The older boilers have been replaced by cylindrical boilers of the two or three pass economic types if designed for heating only, and in other cases oil fired water tube boilers, often those that have become redundant from cancelled ships' contracts. The tendency has also been to centralize the sources of steam supply, mainly at sites where the larger boiler houses originally existed. Another is toward oil firing in the larger boiler houses and mechanical stoking in the smaller ones, together with more instrumentation of steam production, CO_2 recording, draught and flue temperatures, all of which have improved the efficiency, cleanliness and quietude of the boiler houses. The systems of shop heating have also been changed to match different constructional, occupational and geographical conditions, and radiator systems have, in a number of cases, been replaced by or augmented with unit fan heaters, gilled lengths of piping or radiant heat panels.

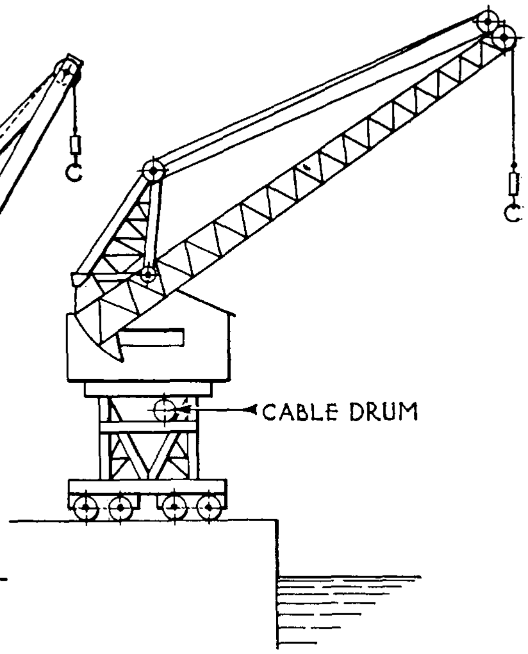
Lifting Appliances

Cranes, especially of the larger restricted travelling type, are probably the most conspicuous of the lifting appliances in any dockyard, and have been subjected to striking alterations in design and capabilities over the past forty years. Originally, one can recollect the steam operated fixed sheer legs, or arched Fairbairn cranes, acting as landmarks around dockyard basins, and often towering above the tallest brick chimneys. These old stalwarts, often with a past history of over half a century, had a useful range for lifting any item up to a 12 inch gun, but their disadvantage was that ships had to be moved each time that the load had to be plumbed, and most of their motions were extremely slow and ponderous. These appliances were rather scattered, and seldom was there more than one to each basin wall, and that was generally employed on a vessel undergoing a long refit.

Between the wars, the policy was to provide a much greater number of large cranes, having a limited travel on wide gauge rails. The normal preference has been for the portal type, to save space, and allow traffic to pass beneath the crane structure. The cranes have been arranged to serve the whole length of most graving docks, often on both sides, and to deal with the complete lengths of ships refitting in the basins. The more modern cranes are driven electrically from a feeding cable, or from a shoe on an underground conductor rail, and are more economical and versatile than the older steam types.



50 Ton Steam Sheer Legs : 1895–1936



10 Ton Electric Level Luffing Travelling Crane : 1952

Floating Cranes.—After experience with floating cranes taken over as reparations from Germany after the First World War, the value of this type of lifting appliance was appreciated, since it could itself travel not only to ships alongside, but to those anchored in the harbour, or away from port, when necessary. These floating ' mammoths ' have proved themselves so essential, especially in war time, that most large dockyards have at least one, if not more, and of capacities ranging from 5 to 150 tons.

Railway Gauge Travelling Cranes.—The tendency has been for these to become larger and much more stable, and several with Diesel or Diesel-electric drives now run around the dockyards.

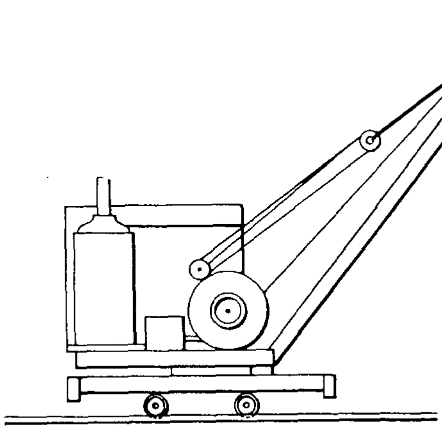
Mobile Cranes.—The main evolution during and since the Second World War has been the advent of the mobile cranes driven by I.C. engines for all motions, rendering them independent of railway lines, so that they can travel to almost any point inside or outside the dockyard by road. These cranes are of many types, shapes and sizes, and have proved invaluable, especially at remote sites and on airfields. As with another war-time lifting appliance, the fork lift truck, the mobile cranes manufactured in America, especially in the larger capacities of 10 tons and over, appear still to keep the lead, both in efficiency and design, over those cranes of British make.

Yard Locomotives

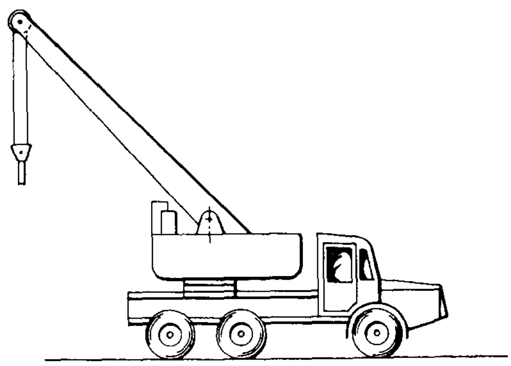
These are of the four wheeled shunting type, and have hardly changed at all except that steam locomotives are being replaced by Diesels as they wear out.

Fire Engines

These have changed from the manual or horse-drawn steam driven type to the fast motor driven vehicles. Fire appliances have been augmented by the more portable heavy mobile units, large and small trailer pumps, turntable escapes and fire floats.



5 Ton Steam Travelling Rail Crane : 1895–1915



10 Ton Mobile Crane, 20 m.p.h. Unladen : 1940

Capstans

Capstans, of which there are probably over a hundred at a large dockyard, have not changed much fundamentally in design, although hydraulically driven capstans, of which Chatham Yard once had the majority, have been generally replaced by electric types. Opinion, especially that of officers engaged in transporting vessels in and out of dockyard basins, varies as to the relative merits of air and electric capstans. Many favour the former as being more reliable on service, allowing the hawser attached to the ship being transported to render as necessary, when movements take place in windy weather.

Outside Establishments

Due to the dispersal policy for civil establishments, the increase in fleet shore training and research establishments, and the formation and expansion of the Fleet Air Arm, the number of establishments in which the engineering department of the dockyard has some responsibility for installation and maintenance of machinery items has increased considerably. As an example, the number of outside establishments dealt with by Portsmouth amounted to about a dozen in 1909, two dozen in 1920, and at the present time includes about 36 civil, 72 fleet and nearly a dozen air establishments. Further, due to improvements in welfare, modernization of culinary and laundry methods, and the increase in numbers and types of lifting appliances generally, the amount of assistance required from the dockyard for maintenance has correspondingly increased.

General Conclusions

The forty years under review can be summed up as a period in which one has had to take a final farewell of that good old faithful servant, the steam engine, and to welcome, in its place, the internal combustion engine and electric motor. These are necessary in a world in which the tempo of action has increased enormously, and at the same time, where manual labour is more expensive to employ. Machinery has certainly become more complicated, but its actual operation has become both simpler and safer.