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Transport and Handling of Coal.

PART II.

BY JOHN H. ANDERSON (Member).

Tuesday, March 4, 1919.

CHAIRMAN: MR. B. P. FIELDEN (Chairman of Council).

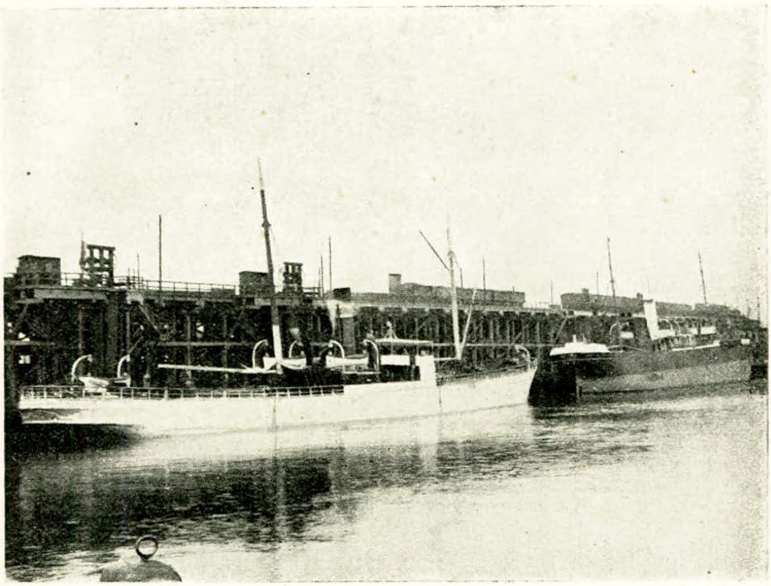
THE lecture this evening, although forming part of a series on "Coal from mine to consumer," is complete in itself, so far as the transport of coal is concerned. In the last lecture we saw in detail how this material is won from the bowels of the earth, how necessary it is for everyone of the miners to use great care for each other's safety. You saw that elaborate and expensive plant is installed, for the winning, washing and general preparation of this fuel for market, so much so, that practically everything in the way of coal that comes out of a modern mine—even to the sludge that is deposited from the water used for washing the material—is made use of. We will endeavour, in the time at our disposal, to show you the methods employed in Great Britain, for the handling of this material in bulk; incidentally, we shall trace some of the discharging schemes as used on the River Thames for a number of years past, showing present day plant where possible. We will see how this fuel is handled at other ports, and for comparison, Continental and American methods will be gone into. I would like you to follow these latter very closely. The writer has no object in view other than that of national economy, particularly in relation to the use of coal. Are we going the right way about this? We have the brain in this country; let us use it. Why are our engineers tied down in capital costs, for the erection of substantial machinery, when we, as practical men know that the question of a few pounds makes all the difference between doubt and positive running with a knowledge of doing the work you have plotted out. Again, look at the toys, comparatively speaking, that we shuffle from one end of the country to the other. I had a note from the States quite recently saying they were experimenting with 80 ton wagons, self-discharging bottom doors. Not British bottom door wagons, where the first quarter of the load has to be got out by poking it with a pinch bar, or knocking the side of the wagon in with a mallet, and the remaining three-fourths shovelled out, which is the case if we omit a few used by some of our people in the North of England.

A question may arise as regards the relation of transport of coal to that of economic use of coal. It is true that the transport of this material is only a section of our problem, but I suggest that it is one of the most important points and should be the one governing the location of our centralised super-power stations, stations that would receive the material direct from the receptacle loaded in the coal producing districts. These stations should also be in a position where plenty of water is available for condensing purposes. They should have a highly trained staff of men who would concentrate on the proper use of the fuel sent there after previous classification. If bituminous coal is used it should be in harmony with the supply of gas required, any surplus over this should be met with coal that would not pay to carbonise, such as the anthracites or some of the semi-bituminous coal that have practically no by-product yield, at any rate gasification and by-product recovery should be the first consideration. Raw bituminous coal should be abolished in towns for domestic use, small isolated plants would have benzol, tar oils, or anthracite coal as a substitute for bituminous coal for country districts. It requires no picture of mine to illustrate the general benefits that would be derived from this change, but I may mention that large gas works cart their coal to-day. The same thing can be said of power stations in this Metropolis of ours. Perhaps this coal has been transhipped a few times previously. In these days of engineering and scarcity of food I hardly see the necessity of growing so much human food for horses to consume. Neither can I see the reason for these same carts and horses using our streets as they now do, leaving their filth all over and making the place dangerous due to the mixture of slow and high-speed traffic. Dirt in houses would be reduced to a minimum, health would benefit thereby, and that coming trouble, the scarcity of domestic servants, would be got over, owing to the reduction of cleaning needed, which even then would easily be done mechanically, due to the encouragement given by low cost of power so that it would be an incentive for the introduction of this power, more so than in the past. Coal is the master key of all trades. No country is better situated than ours for its distribution economically. Let us examine our methods for this purpose, then, when we have received it, see that we set our machinery in motion whereby we get more than a tenth of its heat converted to power at the shaft, which is more than a great many of our manufacturing concerns are getting to-day. I have already warned you of German coal coming to this country and the reduction of our thicker seams, when the foreigner will reap the advantage; also of his methods how he obtained the by-products from us. Don't let us be caught napping with our transport designs. Let us utilise the latent talent of our own countrymen in these matters of transport. Regarding German science I would not give a fig for it for initial effort, but they are masters in the art of developing other peoples' brains. I suggest we get first in the field, particularly now that we have such a scope before us for the development of transport matters due to the new material we shall require for making up for the past four years.

DUNSTON STAITHES.

Very elaborate and expensive machinery is employed for the rapid handling of coal wagons for the purpose of loading coal vessels. Where the height for tipping this coal allows for its gravitation into the vessel's hold, no doubt this is one of the most economical methods to employ, unfortunately this system might create considerable breakage, however, it is one of our oldest methods and is carried out to a considerable extent on the River Tyne. This view shows Dunston Staithes, and is representative of several other staithes on this busy coal river. For this system of loading it is necessary to have bottom door wagons, and in this district they use wagons of from four to

40 tons capacity. It is several years since I took this photograph, since then electrically driven belts have been added to this staithe, so that much larger vessels may be loaded even at high tide.



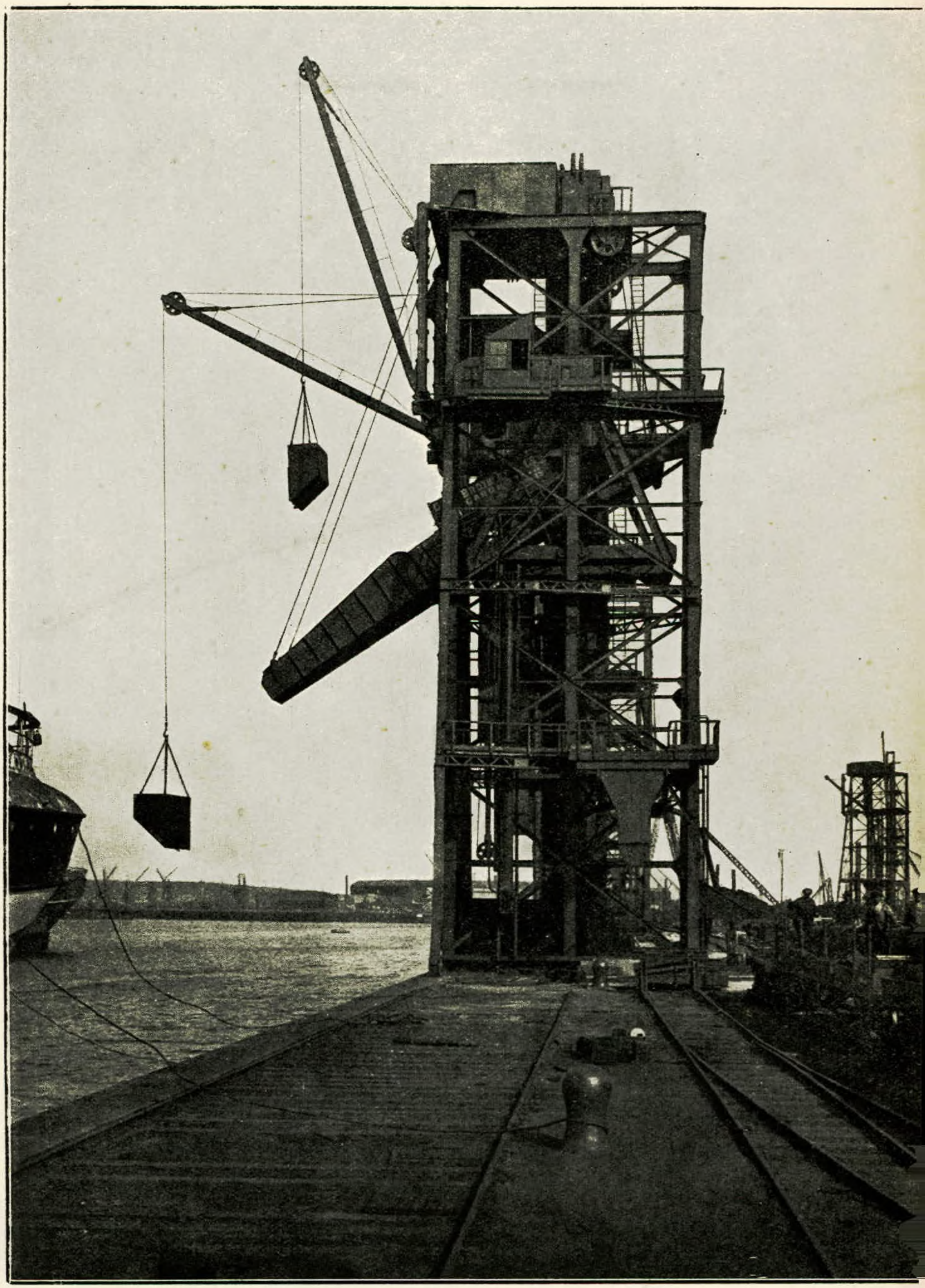
101.—Dunston Staithes.

COAL HOISTS.

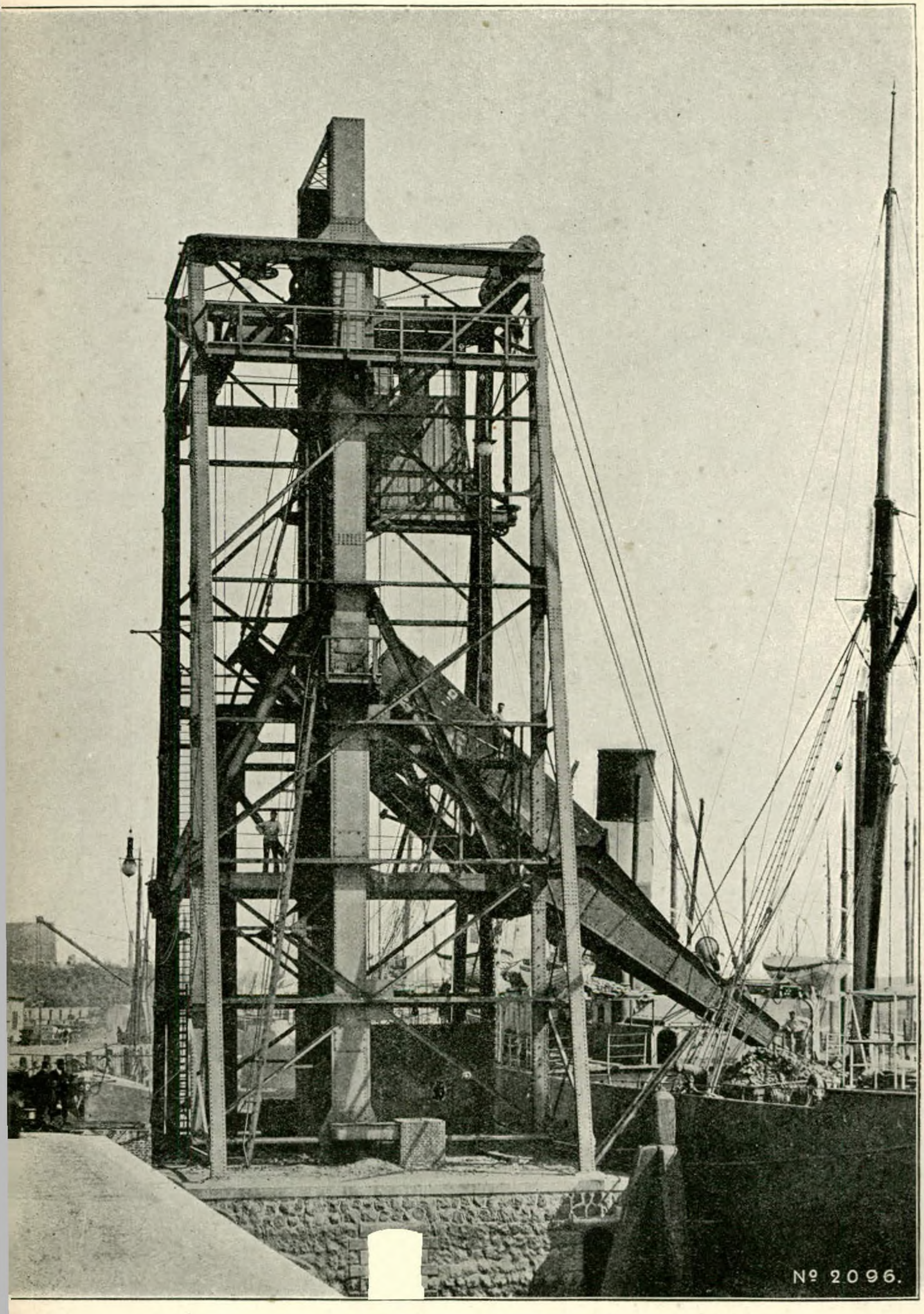
Fixed Hydraulic Coal Hoist (Sir W. G. Armstrong, Whitworth).

In most cases coal hoists are worked by hydraulic power, and they may be either movable or fixed. This view shows one of five hoists (three fixed and two movable) all of 30 tons lifting power and having a lift of sixty feet. Each hoist is fitted with five-ton anti-breakage crane and a three-ton small coal crane, built during 1915 for the Barry Railway Co. The capacities for an up-to-date hydraulic hoist of course depends on conditions, but many hoists are quite capable of tipping 500 tons an hour into ships hold.

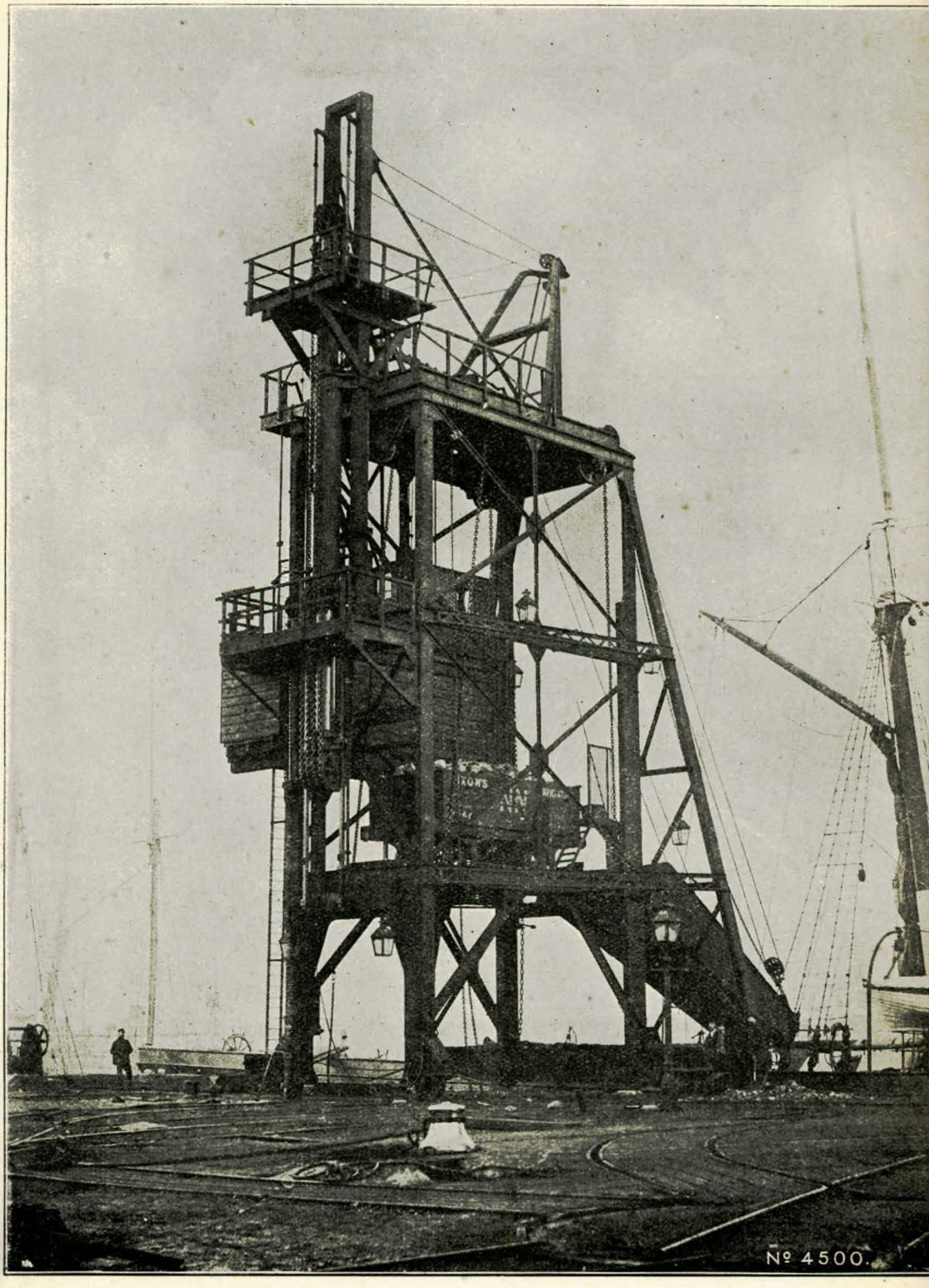
Direct Acting Coal Hoist (Armstrong, Whitworth).—This shows a hoist where the cradle is lifted by direct acting rams, placed on the sides of the hoist framing, the tipping motion



103.—Fixed hydraulic coal hoist, by Sir W. G. Armstrong, Whitworth & Co.



104.—Direct acting hydraulic coal ho'st, by Sir W. G. Armstr.ong, Whitworth & Co.



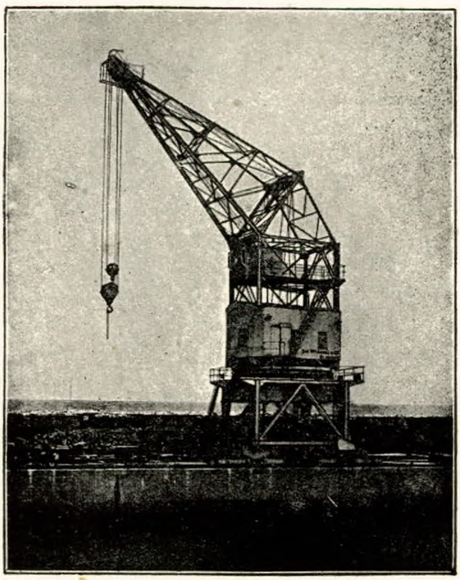
105.—Movable hydraulic coal hoist, by Sir W. G, Armstrong, Whitworth & Co.

106.—Lewis Hunter hydraulic coal crane, by Sir W. G. Armstrong, Whitworth & Co.

being effected by a ram and cylinder, also fixed to the side framing and attached to the tipping frame by chains or wire ropes.

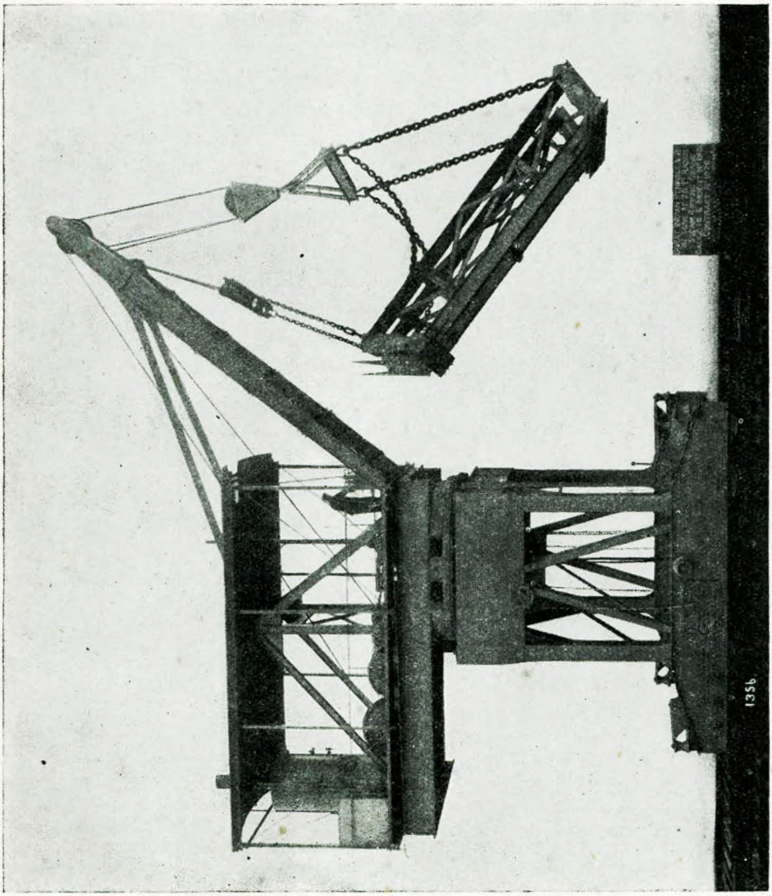
Movable Hydraulic Coal Hoist (Armstrong, Whitworth).—We now have a movable hoist before us capable of dealing with a gross load of 32 tons. Two or more powers may be provided so that economies may be effected when tipping the lighter wagons.

Lewis Hunter Hydraulic Coaling Crane (Armstrong, Whitworth).—This is a smaller capacity machine of 23 tons lift, but this system differs somewhat from the last methods. In this instance the wagons are tipped into a receptacle in the pit shown, the crane being used to elevate these boxes and lower them down into the vessel's hold, opening and releasing the coal when there. The idea is to prevent or reduce the breakage of pieces of coal which fall from a height. This system is that known as the Lewis Hunter method, and these machines were erected during 1912 for the Cardiff Railway Company, Queen Alexandra Dock.



1008A.—32-ton electric coaling crane, Sir Wm. Arrol & Co., Ltd.

Thirty-two ton Electric Coaling Crane (Sir Wm. Arrol & Co).—This view shows one of Arrol's build of cranes erected on the Clyde for the Clyde Trustees. It is designed to handle a maximum load of 32 tons at a radius of 47ft., and has a total



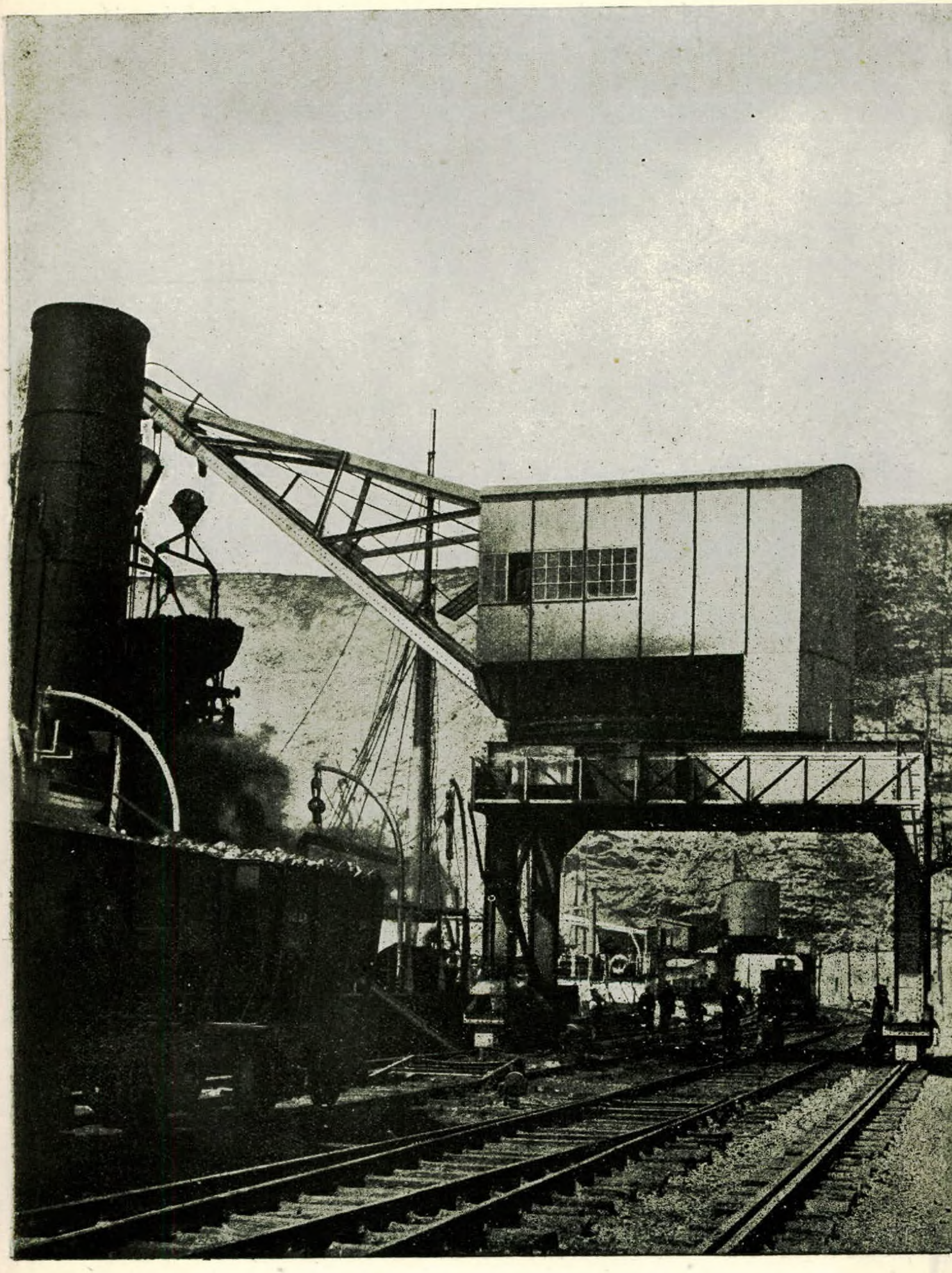
107A.—Ransome & Rapier steam tipping crane.

height of lift of 100ft. Not only is this crane intended for elevating wagons of coal, but it may also be used for general dock service. The crane will handle twenty 32 ton loads per hour, or a larger number of smaller wagons. The wagons are lifted on a special cradle by the main block, and they are tipped by the auxiliary block, which is shown at the top of the jib on the screen.

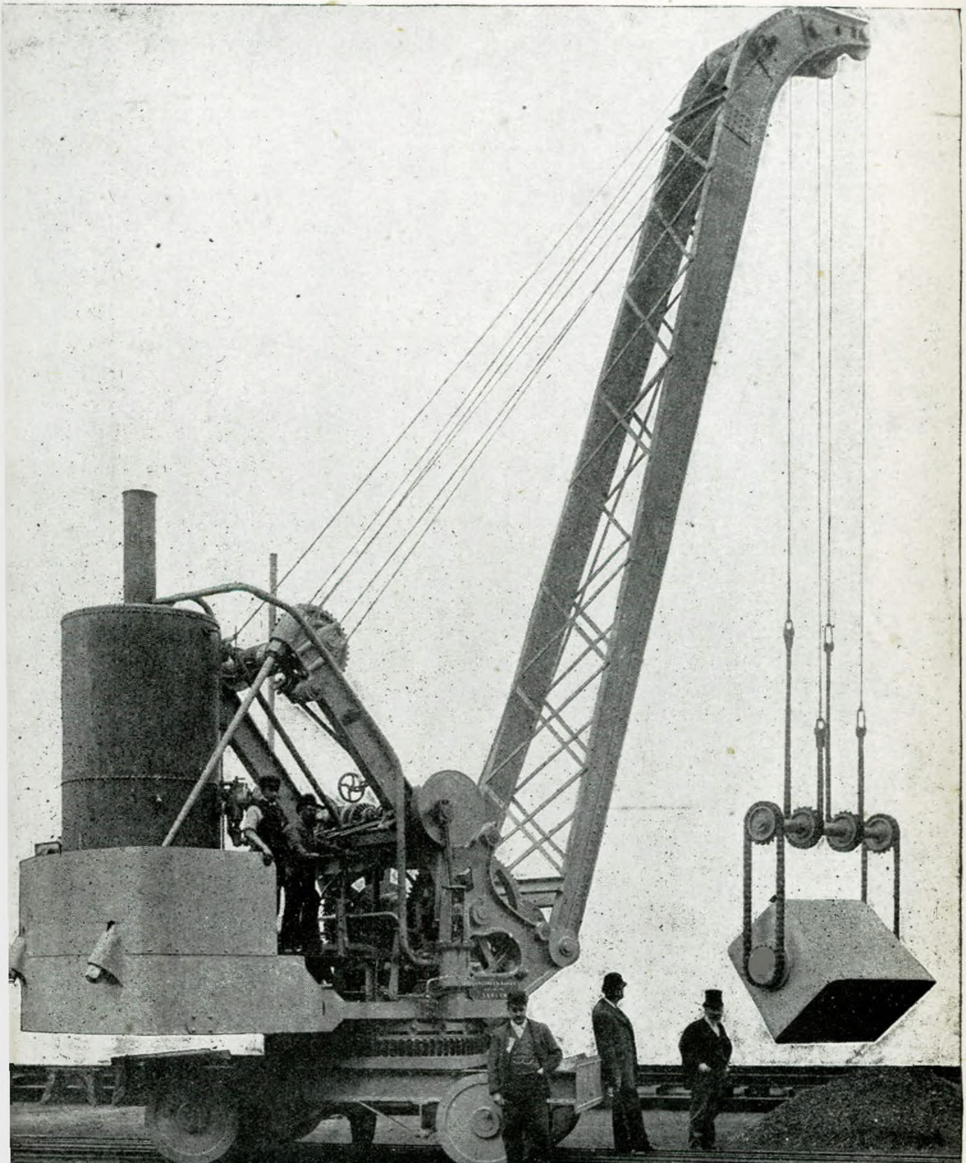
Ransome and Rapier Steam Tipping Crane.—Many similar cranes of this type are used to tip wagons of coal into vessels. This particular one was erected for the Great Indian Peninsular Railway at Bhusaval, and is now used to elevate and tip wagons of coal into storage. The wagons of a weight up to 30 tons are elevated in a special frame as seen, then when high enough for tipping the auxilliary gear raises one end while at the same time the end door is opened. The following details of time for the various operations will enable one to calculate the time for a complete cycle of operations for other work:—

	Seconds.
Lowering the cradle level after tilting to send discharged wagon off and attaching the hauling rope to a loaded wagon	5
Hauling loaded wagon 30ft. at 3ft. per second	12
Unclutching the rope from wagon and lost time	5
Lifting ramps on cradle 2ft.	8
Securing ties	5
Lifting 15ft. at $\frac{1}{3}$ft. per second	45
Slewing $\frac{1}{4}$ revolution	15
Lifting end of cradle 10ft. for tipping at 2/3ft. per sec.	15
Coal running out	5
Slewing back and levelling cradle	15
Lowering cradle to ground	20
Unhooking ties	5
Tilting cradle to send discharged wagon off	5
Wagon running off	5
Total	165

Babcock and Wilcox Electric Coaling Crane.—This machine was erected for the Cia Ferrocarril de Langres, Spain, and is of 30 ton capacity for lifting and tipping end door wagons. In this instance the wagon is hauled on to a lifting frame by an electrically driven winch, it is now lifted and slewed round over the vessel's hold, then one end elevated meanwhile opening the end door thus releasing the contents. The crane is of the type known as a portal crane, being built on a superstructure allowing free passage of two sets of wagons underneath. The



107B.—Babcock & Wilcox electric coaling crane.



108.—Stoney's tipping crane.

guage of the crane wheels being eight metres, and the radius of the crane being 12 metres, the whole of the operations being done electrically.

Stoney's Tipping Crane.—Stoney's Tipping Crane is a useful machine for handling material in special steel boxes. These boxes are fitted at each end with a trunnion, arranged to hang in the loops of two sprocket chains from the lifting bar of the crane. The boxes revolve in either direction so that the contents may be tipped either side. Several of these cranes have been at work on the Manchester Ship Canal. 312 boxes, each holding six tons of material have been lifted 25 feet, swung round, tipped, and the boxes replaced in their original position, in a working day of $9\frac{1}{2}$ hours.

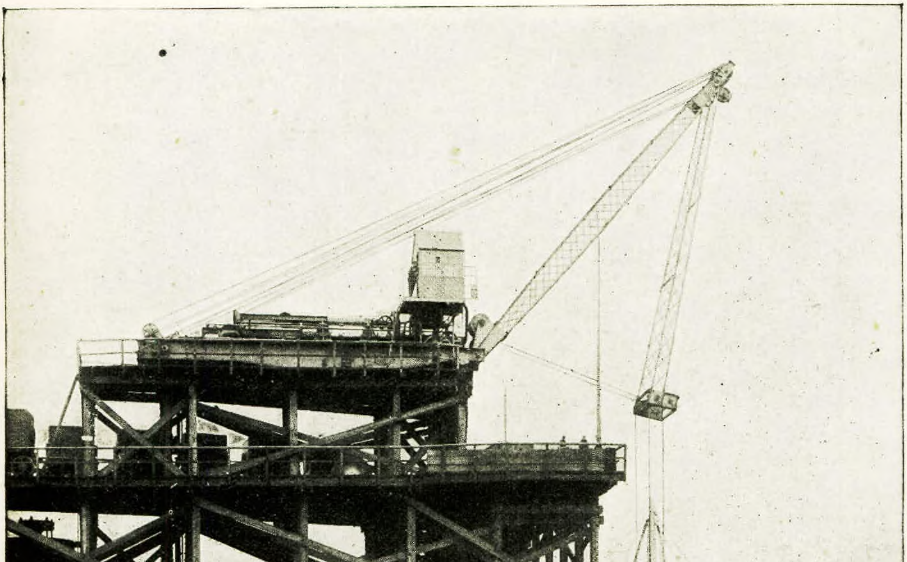
Rapier's Coaling Crane.—This plant was erected to deliver coal from a high level into vessels at a low level without breaking the coal, and with a minimum of power. The view shows the apparatus at work at the coaling berth of the Wallsend & Hebburn Colliery Co., on the River Tyne. This is an application of the Stoney Tipping Crane, but in this instance the power used is hydraulic. The boxes hold five tons of coal, and are delivered from the pit on underframes running on the rails direct from the colliery. The principle of this plant is that it is simply a device for storing the energy of the weight of the descending coal, this power being used for the return of the empty box and the replacing of it on the underframe ready to go back to the colliery. 45 to 50 tubs can be handled in an hour. Small auxiliary steam pumps are provided for supplying any extra power required and for making any losses good.

Special Hoist, Goole Docks (Armstrong, Whitworth).—This shows a special hoist for transhipping coal, brought from the collieries to Goole Docks in Bartholomew's Compartment Barges, which are formed into a train, towed down the canals into the dock, and are then floated over the cradle of the hoist. The last hoist built has a lifting power of 57 tons, the compartment boats being lifted bodily out of the water, elevated to the desired height and turned right over, thus discharging its contents through a shoot into the vessel. A similar hoist, but mounted on a pontoon, and capable of being towed from one part of the dock to the other to suit the requirements of the traffic, has recently been provided.

Fraser and Chalmers' Belt Shipping Plant at Durban.—During recent years the shipping of coal by belt, either for bunkers or cargo, has developed to a considerable extent. This plant at Durban started during 1917, and is capable of shipping over a 1,000 tons per hour if the belts are kept full. With these large belts there is not the difficulties of feeding similar to the smaller belts, one need not worry about lumps blocking up shoots and similar places. I believe there is a great future for this type of loading of bulk material.

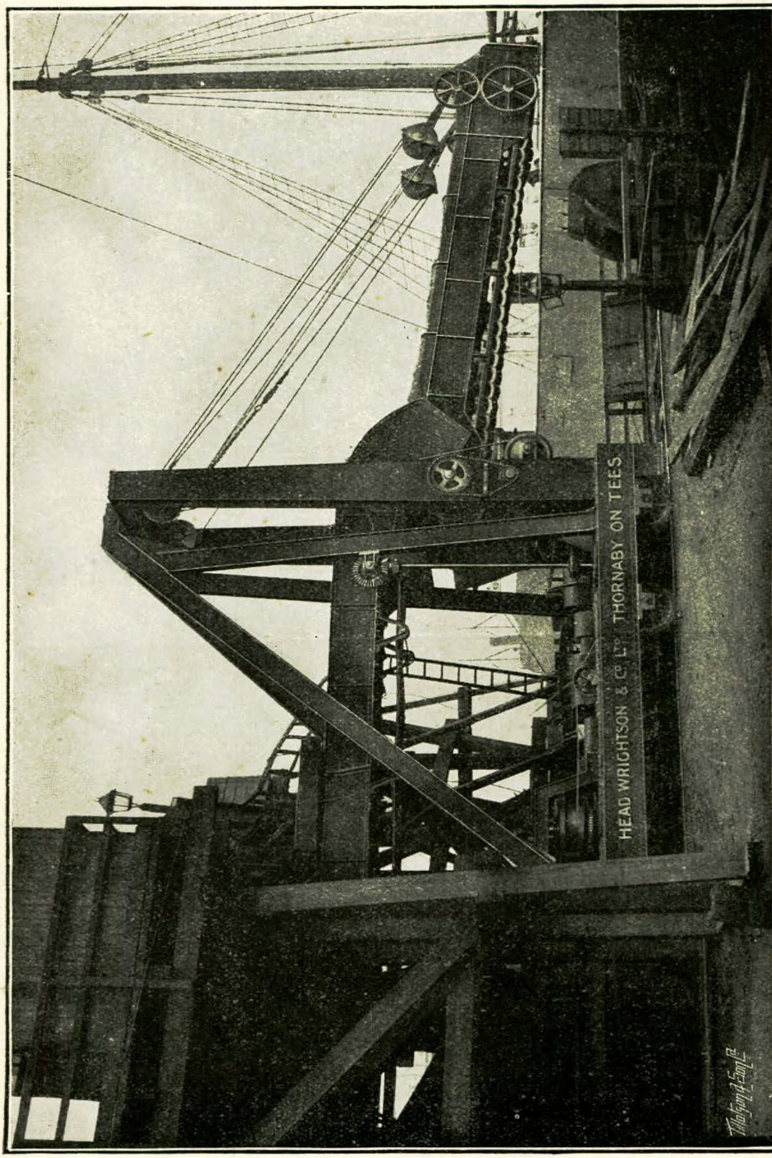
At Durban the coal is brought from the mines in trucks, aggregating a maximum weight of 70 tons, these are stored in the sidings till required for shipment, when they are run down to a tippler and there discharged, the coal being fed on to a belt, conveyed to the place where the loading apparatus may be on the wharf, where the coal is transferred to another belt and thereby to the vessel being loaded. The speed can be regulated to a nicety, depending on the requirements aboard, so as to suit the trimming if any has to be done.

Wrightson Patent Coal Shipper at Northumberland Dock.— This machine was designed to accomplish the rapid and economical coaling of vessels with a minimum breakage of coal, and has been in use since 1899. With a regular supply of trucks for tipping, one of these units can easily deliver 400 tons per hour, in fact this can be increased by increasing the speed of the belts. The coal is first discharged into a hopper immediately below the wagon. From this hopper the coal is fed to the first belt which moves under the mouth of the hopper and from which it takes a regular layer of coal, carrying it along in a horizontal or a slightly rising path to the side of the wharf, here the coal is transferred to a second belt called the "jib belt." This belt is fitted on a frame with a hinged centre at the shore end so that by means of elevating tackle this "jib" can be raised to the necessary height to allow for the various vessels loading and also for tidal effects. In addition to this vertical adjustment this jib has a slewing motion whereby the delivery end may be slewed either fore or aft, so that the coal may be placed to any point of the hatch opening, thus reducing the amount of hand trimming. A vertical belt enclosed in a trunk is suspended at the end of the jib belt, this is provided with trays working on hinges, these trays on turning over the top drum form a series of large boxes, each of which are filled in turn and gradually lowered to the bottom of the trunk. This point of delivery is usually at the cone of previously delivered coal in the hold, so that a continuous delivery of coal is placed aboard of the vessel with the minimum of fall, consequently least

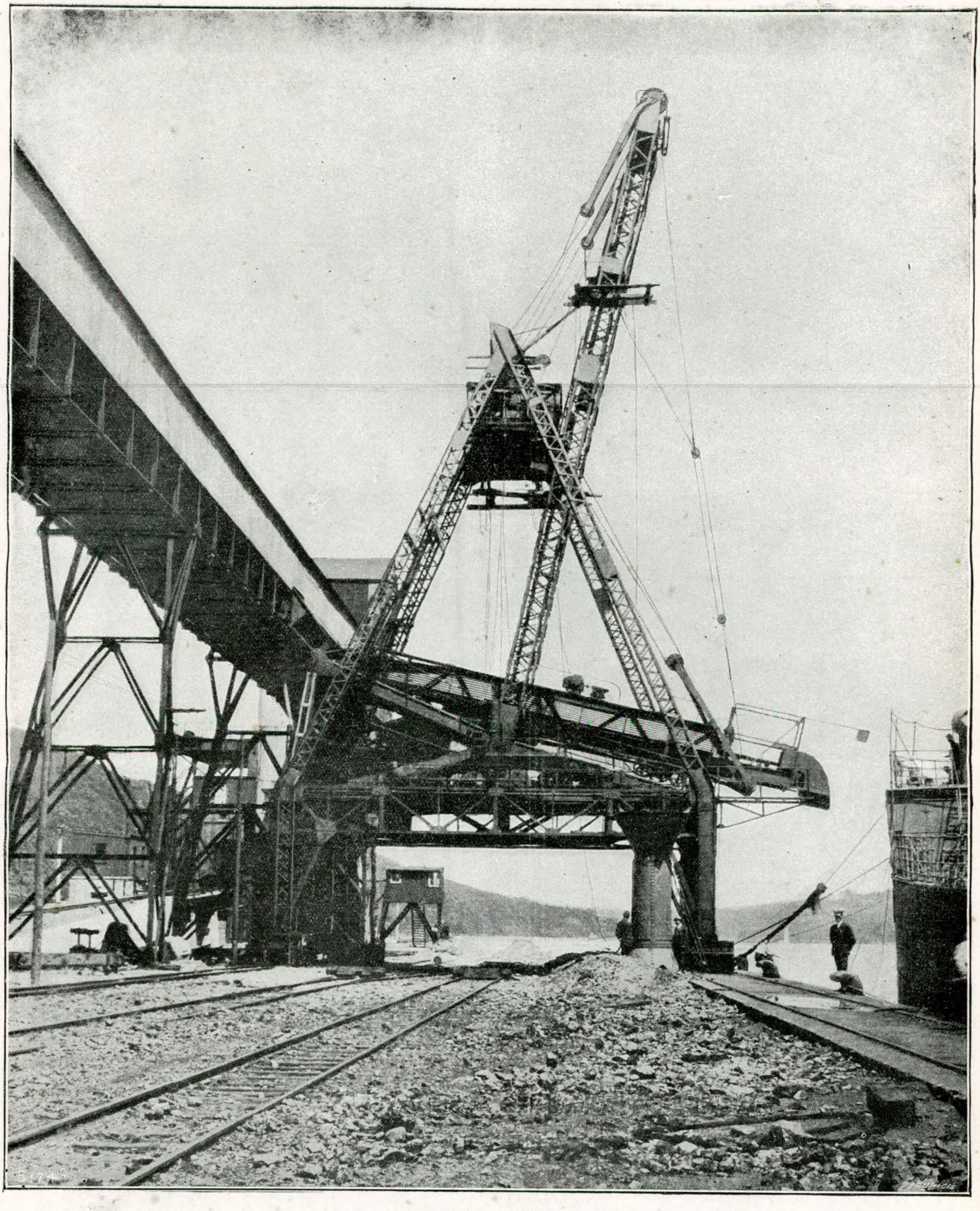


109.—Rapier's coaling crane.

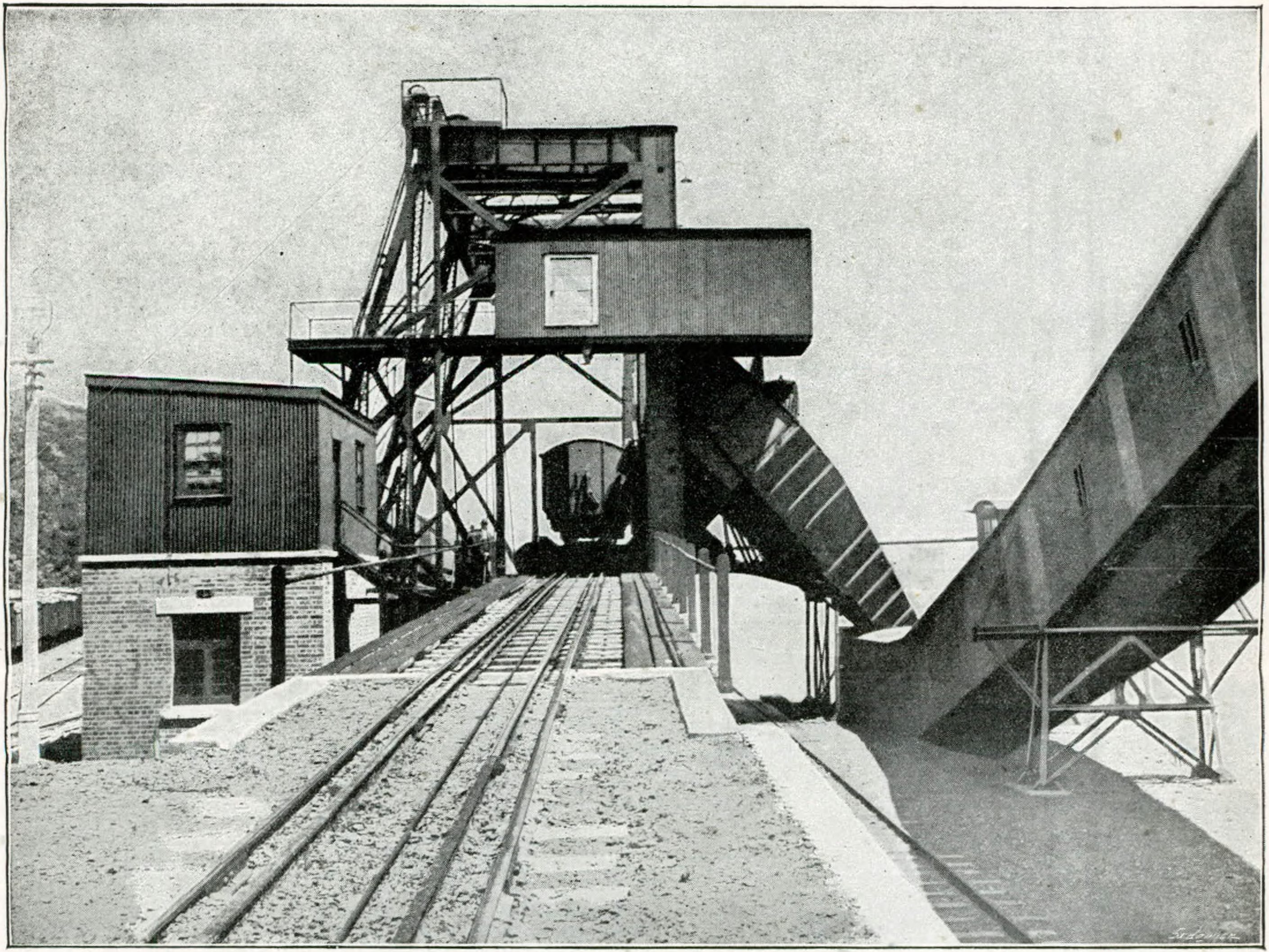
110.—Special hoist, Goole Docks. Armstrong Whitworth.



653.—Wrightson's patent coal shipper at Northumberland Dock.



Ax.—Fraser & Chalmers' belt coal shipping plant, Durban.

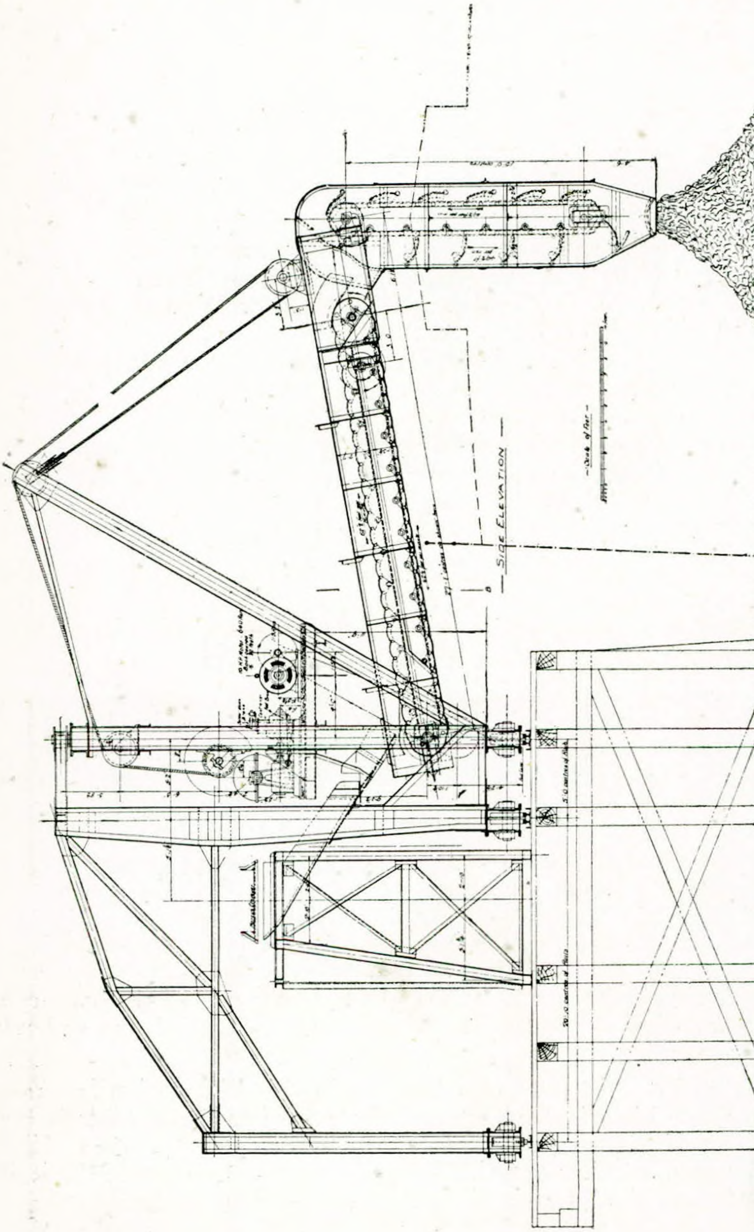


Bx.—Fraser & Chalmers' belt coal shipping plant, Durban

breakage. The weight of the descending coal greatly assists the power required, the coal cannot fall as this tray belt is entirely controlled by the machinery. If this anti-breakage device is not required the trunk can be removed and the shipping of material carried out by delivery direct from the end of jib belt. The construction of this trunk together with the trays is similar to that of the Grimsby plant, for which see diagram.

Coal Shipping Plant at Grimsby for the Great Central Railway Co.—This plant was designed so that a vessel once moored alongside the wharf need not be shifted until the coaling is completed. This machine is a much later build than that of Northumberland Dock previously described. Built during 1917, they are mounted on rails, so that they can travel along the pier parallel to the ship being loaded. In this plant the construction of the jib belt and anti-breakage trunk with trays is the same as the Northumberland Dock machine, the method of delivering the coal from the trucks is greatly different. Under the deck of the pier approach two hoppers are formed, into which the contents of bottom hopper wagons are discharged, in addition, end door wagons are dealt with by means of two electrically operated wagon tips. The coal from these hoppers is conveyed by flexible plate belts to raised gantries on which the conveyors are arranged, and from which the coal is delivered down shoots to the inclined belts communicating with the respective trunks or anti-breakage fillers in the ships hold. The loading belt and anti-breakage gear are carried by a post and jib to which is also attached the platform and house containing the gearing, and the whole of this arrangement can be swung round to right angles with the rest of the main framing. This facilitates the removal of the trunk when not required, in fact a recess is made on the staithe where this trunk may be deposited when not required. The capacity of this system of loading is somewhat governed by the supply of coal to the hoppers, and also to the type of vessel being loaded, but given a constant supply of large capacity wagons and a fairly good self-trimming modern collier vessel, the speeds of the belts can be so adjusted that a delivery of 1,000 to 1,200 tons per hour per machine could easily be done.

Lambot Boat.—The boat shown in this illustration is likely to prove historical, although only a rowing boat. This is the pioneer instance where ferro-concrete was utilised for the building of a floating vessel. Built in France during 1849, it is known as the "Lambot" boat.

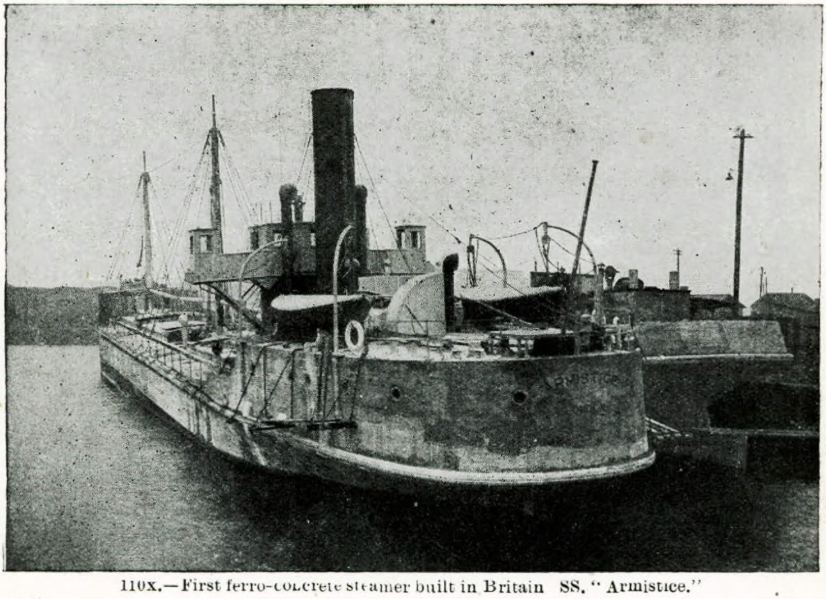


641.—Coal shipping plant at Grimsby.

S.S. Armistice (ferro-concrete steamer).—The S.S. *Armistice* is the first British built ferro-concrete steamer of over 1,000 tons dead weight. Launched on January 7th 1919, she has

110w.—First ferro-concrete boat—Lambot boat.

since been completely fitted and passed successfully through various trials. This vessel is 205ft. B.P., 32ft. beam, 19ft. 6ins. depth, 15ft. 9ins. draft when loaded with 1,150 tons of cargo, $7\frac{3}{4}$ knots, 400 H.P. engines.

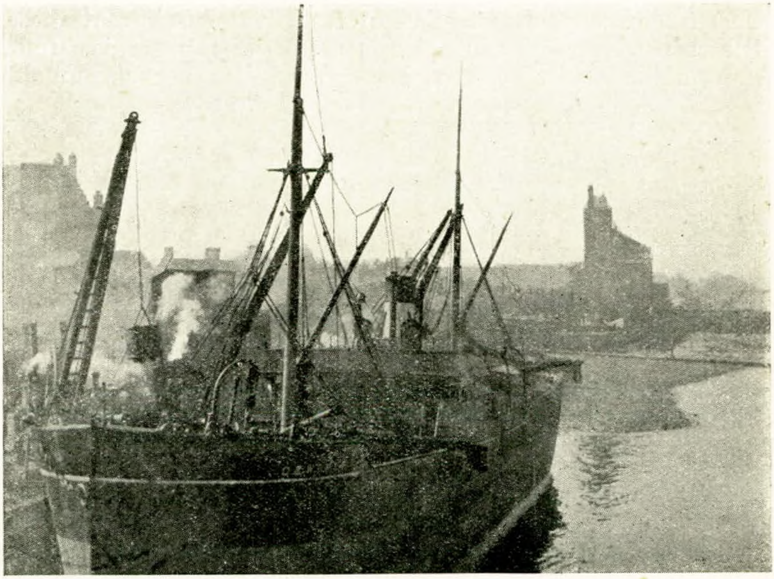


110x.—First ferro-concrete steamer built in Britain SS. "Armistice."

Although only a few weeks old, she has already passed through some very severe weather at sea. No doubt the building of ferro-concrete steamers was due to the effect of enemy submarine work. The life of the *Armistice* will be closely watched by many, embracing as it did the cream of the trade in its design, Messrs. Mouchel and Partners from the ferro-concrete point of view, and Messrs. Vickers, Ltd., from that of the naval architect, the actual erection being done by some of the oldest established ferro-concrete people in Great Britain, who made a yard to build these craft at Barrow-in-Furness.

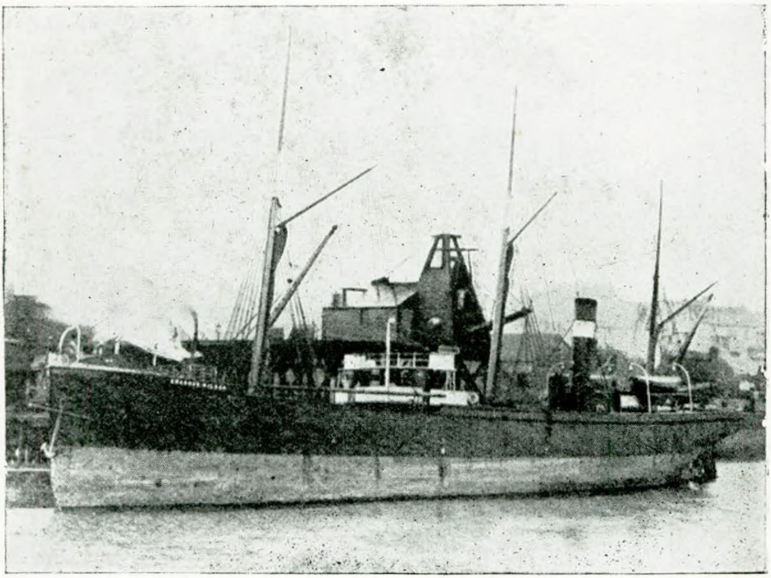
Whipping out Coal Cargo.—Not many years ago the principal trade to the Thames with coal arrived in brigs or "Geordies" as they were called. They carried from about 150 to 200 tons cargo. It used to be a picturesque sight to see those vessels with their various methods of getting to their destination. With the wind in certain directions these craft had quite a difficulty to negotiate some of the bends in the river, and at these times it was quite common to see hundreds of them battling against the elements to gain a turn ahead of another vessel. What a change with present-day methods, when we, in the Thames coal trade consider a lighter of 150 tons burden a small thing indeed. In many instances these "Geordies" were "jumped out," that is pulleys would be erected in the rigging over which a rope was placed and led down the hold, on this end of the rope a hook would be secured, which would be used to "hook on" a basket for elevating it out of the hold. The other end of the rope was reeved through a set of blocks, and from these blocks several tail ropes were suspended, one for each man employed at the jumping. The men stood on an elevated platform, and on being given the signal to lift the basket they jumped off the platform on to the deck, simultaneously the basket was brought out of the hold at a rapid rate, depending on the multiplying power used and no doubt also to the weight of the men. The basket would then be seized and swung round and tipped, the empty basket then being lowered into the hold by the simple process of the jumpers letting the slack out by getting once more on to the platform.

Later on steam vessels were employed. I mention this as it may be interesting from an historical point of view, from which aspect I will endeavour to show you the progress made to cope with the handling of these cargoes. The system of discharge known as "whipping" whereby the men elevated the coal in baskets by means of a crude winch, resembling a mangle roller with a crank at each end, fitted to two light side frames which were usually ballasted down with lumps of coal. This method of elevating was in use until quite recent times in the River Medway, and also for bunkering purposes in many of our London Docks.



116.—Chalk Farm berth, Erith, 1873.

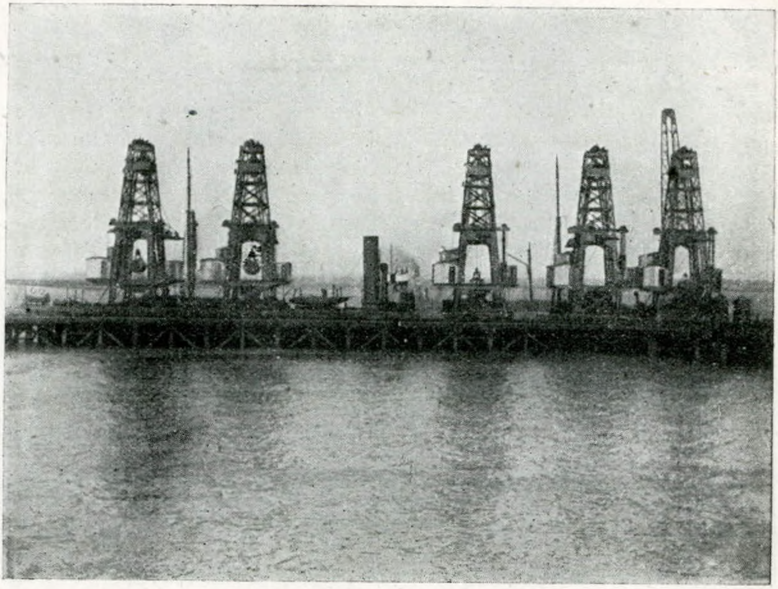
Chalk Farm Berth, Erith, 1873.—An advance is here seen whereby we see small steam cranes being used for discharging. This view was taken at Chalk Farm Berth, Erith during 1873. It may be interesting to inform you that these four little cranes, elevating ½ a ton of coal at a time worked until about 1908, when even then they were capable of discharging a steamer of 1,750 tons in 24 hours. This depot was used principally for house coal supply for the Kent trade. Here we see some more applications of machinery, whereby the elevating chain passes over the end of a jib. On the jib being drawn back vertically it conveys the tanks, containing ½ ton of coal, into the building, where it is emptied of its contents by a man releasing a side catch, allowing the tank to turn upside down. The jib is then lowered and the operation repeated. This vessel ran to this wharf continuously for nearly 20 years, and with the plant we just described, together with the assistance of another small steam crane, its cargo of 900 tons could be discharged in 24 hours. This plant worked till about 1902. In addition to these little wharves we have just seen, there were a further two wharves each depending on similar steam cranes and tanks for elevating the coal. All these plants are superseded by more modern plant, but it may be interesting to know that these little cranes have been made good use of during the past four years on work of "National Importance," thus even our old



117.—Front and Dock berth, Erith, 1873.

pensioners have been "doing their bit." The increasing demand for coal at this depot led to the conversion of what was a rather noted landing place for bygone pleasure steamers, and here we see three Gantry steam cranes, and one loco-type crane fitted with grabs of about a ton capacity. This plant was erected 1895-6. Here we see these cranes discharging a cargo of coal into wagons for general distribution.

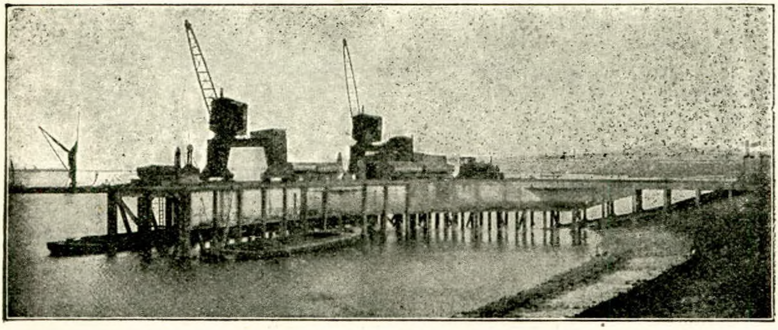
Erith Pier.—This plant, consisting of five electric transporter cranes, fitted with grabs, four cranes of which are at work discharging coal, the 5th one has the "jib up" otherwise not in



120.—Steam cranes, Erith Pier.

121.—Erith Pier.

use. A steamer of 2,500 tons has been discharged at this wharf in nine hours, five cranes being employed on that occasion. This plant is in operation at the present time, which together with another wharf alongside, also fitted up with modern electric cranes, have superseded all the older methods of coal working at Erith, and at the same time the capabilities of coal discharging has been increased many times. This plant is operated by Messrs. Wm. Cory & Son, Ltd.



122.—Belvedere Pier.

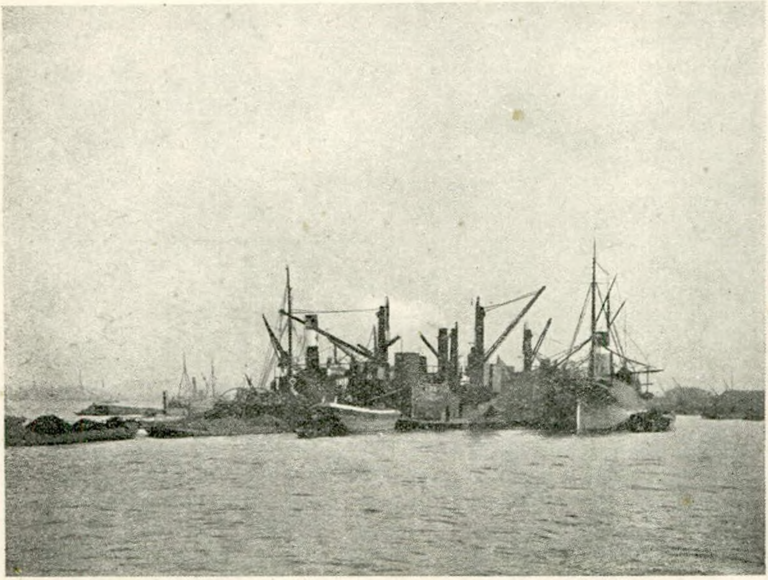
Belvedere Pier.—Here we see a little pier built of ferro-concrete on which are two Gantry cranes; you will easily recognise these cranes and judge where they came from, from previous views on the screen. Quite a lot of very interesting work regarding coal supply has been done by these cranes since 1914. These cranes are now replaced by more modern and larger cranes, however, they are still usefully employed at another wharf some distance away across the river. You will see that this jetty is built of ferro-concrete on the Henibique system; it is of T shape construction with an approach 136 ft. long, the angle of junction to pier being filled in by a curved portion making the maximum width diagonally at this curve 60 ft. across. The pier proper is 142 ft. long, and is the property of Messrs. Wm. Cory & Son, Ltd.

Atlas 1.—We now see a different type of discharging plant which you will notice is afloat and which for many years was quite a prominent feature at certain places on the Thames. This particular one known as Atlas No. 1 or Lower Derrick was moored in "Bugsby's Hole," Bugsby's Reach. Originally this vessel's hull was used for salvage purposes, later cranes were erected on its deck, and for many years much useful work was done here, until the plant was superseded by more modern appliances. The coal was elevated in tanks each holding about a ton of coal.

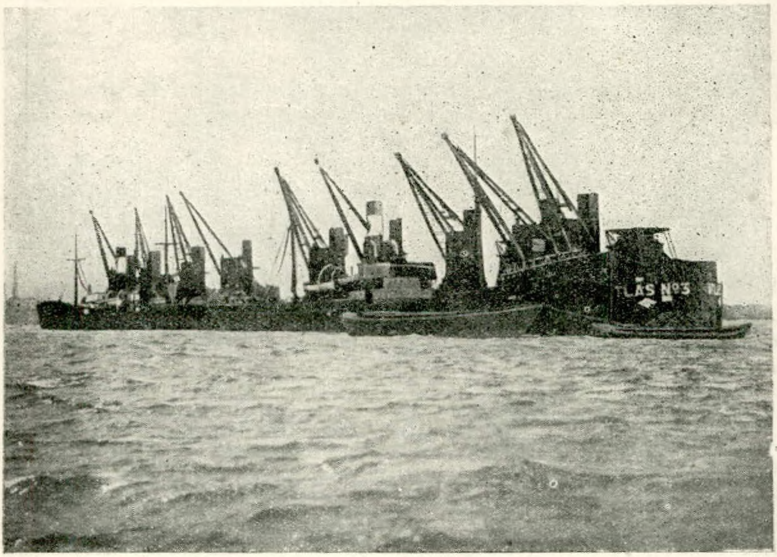
123.—Atlas I.

Atlas II.—This machine, similar in working methods as the last, but in this case built for the purpose of the coal trade, and known as Atlas II. or Upper Derrick. These machines, with tanks, have each discharged 25,000 tons in a week.

Atlas III.—A development of the last machines, we here see nine luffing cranes busily employed discharging two vessels alongside this floating structure, which was situated opposite Charlton. Two-ton grabs were employed at this station, and very good work in the way of speedy discharge was done with this machine. Unfortunately this plant was lost on going to the aid of one of our allies, who were in sore straits regarding their coal supply, their mines being overrun by the enemy, and of course they did not possess the discharging plant to cope with the coal sent them from this country. I am glad to say that it was possible to assist them with other apparatus of a

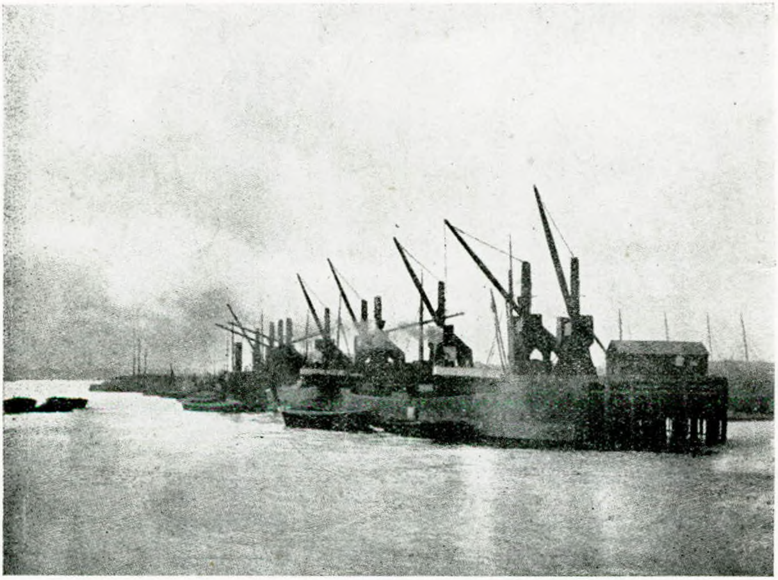


124.—Atlas II.



125.—Atlas III.

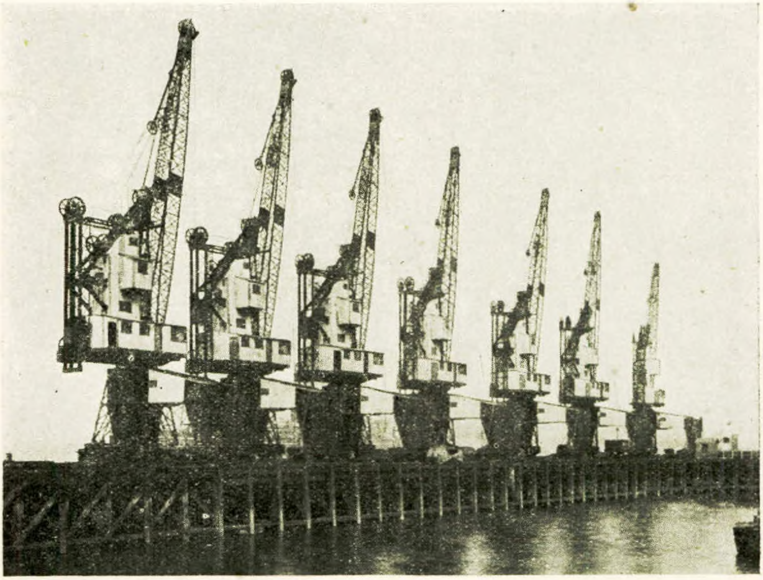
temporary nature, until more permanent plant was erected and working. All these derricks were the property of Messrs. W. Cory & Son, Ltd.



126.—Lambert's Jetty, now dismantled.

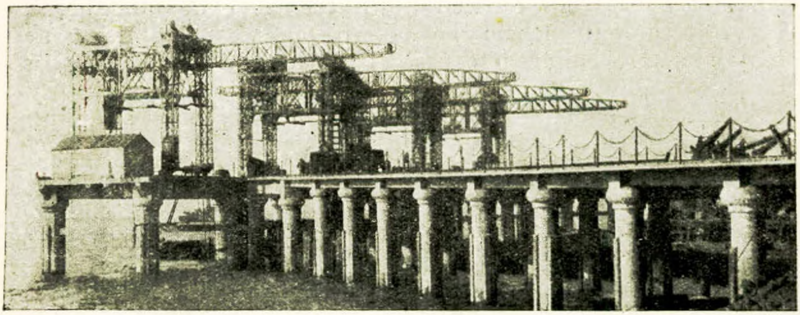
Lambert's Jetty.—Further down the river was Lambert's Jetty, at the entrance to the Albert Docks. These cranes at this time were believed to possess the longest jibs of any in London. A huge amount of coal was here discharged mainly for the demands of bunkers for some of the principal shipping companies. This plant is now dismantled and superseded by

Albert Dock Hoists.—The machines now before us are known as Albert Dock Hoists, probably this is the fastest coal discharging plant in Great Britain to-day. They are equipped with very long jibs so that the grabs—which grab four tons of coal—can be discharged over the outside of the steamer into barges placed there. The pier is also laid with rails so that wagons may also be loaded from the vessel. With six of these cranes a vessel of 5,000 tons was discharged in $8\frac{3}{4}$ hours, and no doubt this speed will be greatly increased when we get a run of our regular colliers again. This plant is also the property of Messrs. Wm. Cory & Son, Ltd.



127.—Albert Dock hoists.

Dagenham Dock.—This pier was built for Messrs. Williams and Sons in 1901, and was the first ferro-concrete structure built with Mouchel patent cylinders founded on ferro-



128.—Dagenham.

concrete piles. The absence of bracings with this method of construction is very noticeable. The pier is 780 ft. long by 35 ft. wide, and carries electric transporter cranes weighing 60 tons each crane, in addition to railway traffic for the purpose of wagon coal trade.

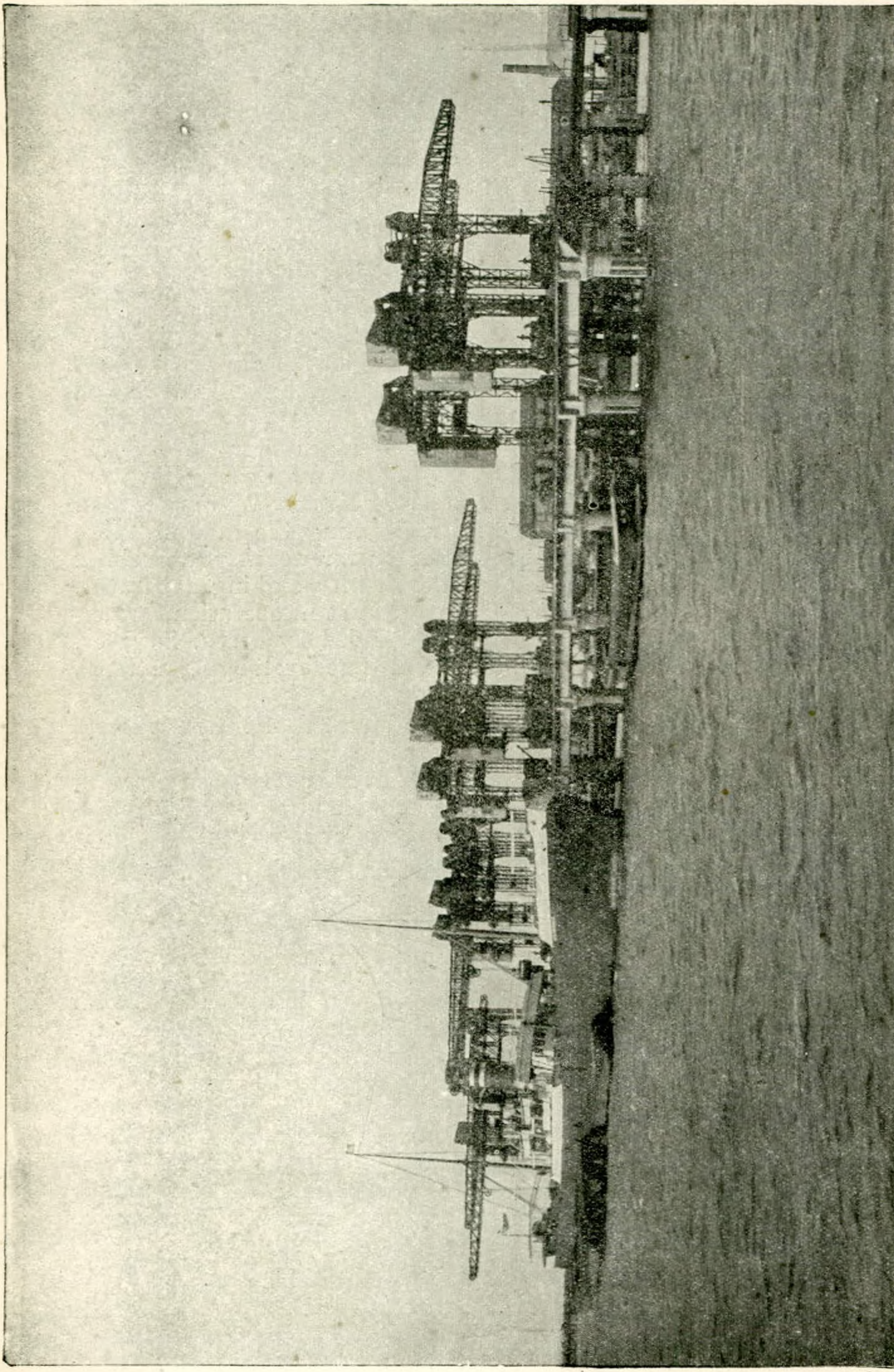
General view of eight patent Coal Transporters, Dagenham Dock, Essex.—Three-ton electric transporters.

Another view of Dagenham Dock Plant.—Perhaps this view will give a better idea of the pier and cranes. The colliers discharging are moored on the right-hand side of the view, where one of the sliding jibs is shewn with a grab partly traversed away from the pier.

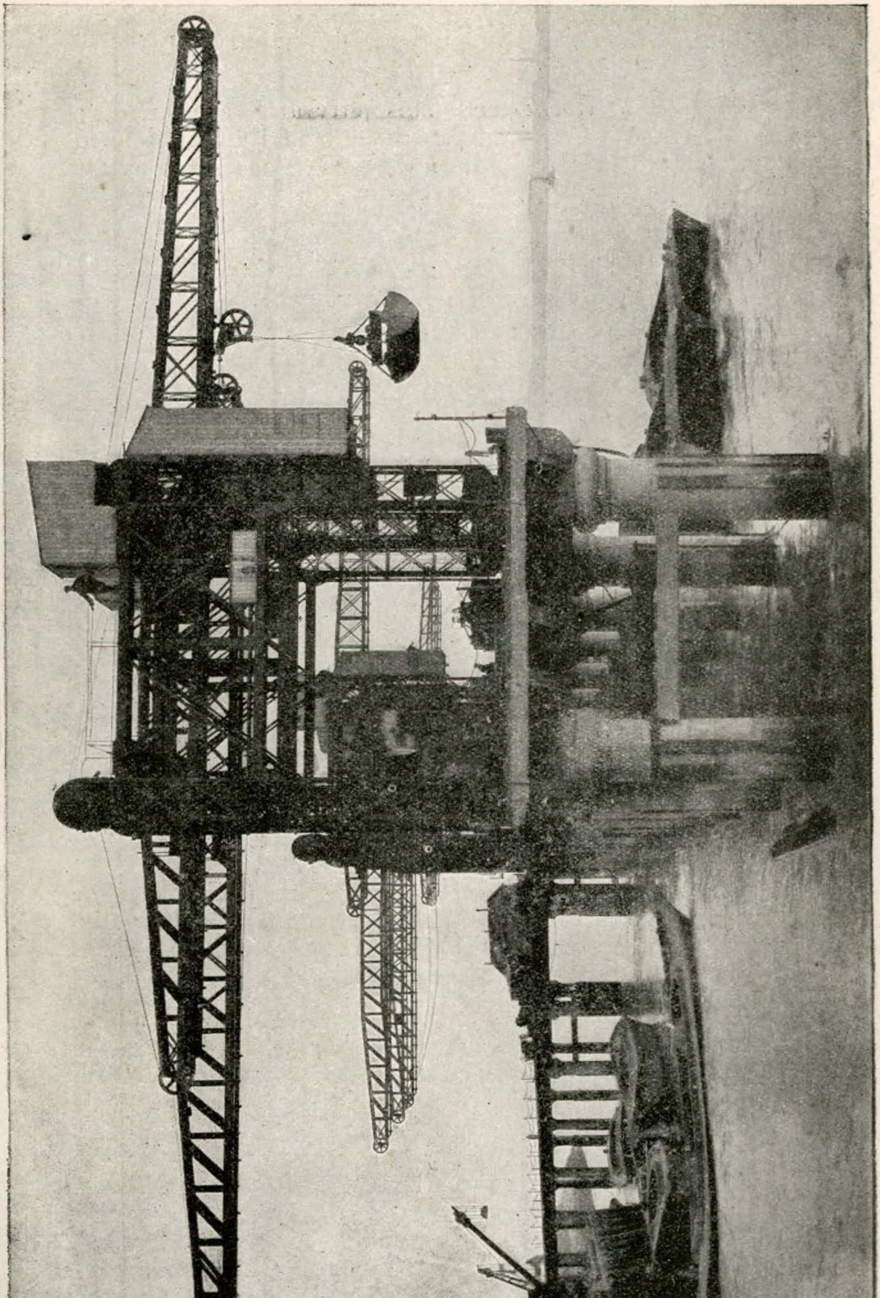
Harrison's, Tilbury Dock.—These cranes worked very successfully for a number of years in Tilbury Docks, and were operated by Messrs. Harrison, later by Messrs. W. Cory & Son. They were fitted with tanks for elevating the coal in. The jibs were fitted with hinged extension for working overside of steamer. The machines were fitted with weighing apparatus. For a number of years this plant was not in operation, principally due to tank work being superseded by grabs, however, they were quite an innovation in their time, built by Armstrong, Whitworth & Co.

Tilbury Coaling Co.—This plant, situated at the entrance to Tilbury Dock, is quite a modern and high-speed hydraulic discharging plant. The cranes are known as Musker Davison Cranes, the jibs being counterbalanced and operated by gearing, so that "luffing," that is raising or lowering the jib, is done without any suspending wires, chains or tie rods as most other luffing cranes are fitted with; this is the property of the Tilbury Coaling Company

Discharging Plant at Rotherhithe, S.E. for the S. Met. Gas Co.—This plant consists of 3 × 50 cwt. and 1 × 60 cwt. hydraulic single chain or Hone's grab cranes built for the South Metropolitan Gas Co., at their Rotherhithe Works, by Sir. W. G. Armstrong, Whitworth, Ltd. They are used to discharge colliers, by grabbing the coal from the hold of the vessel, then elevating and releasing the coal into the hoppers, shown at the back of the cranes. From a spout at the bottom of these hoppers, small wagons are loaded, and by this means the coal is distributed about the works to the place required. Barges may also be loaded from these hoppers, as immediately under the hopper spout there are holes in the pier with adjustable telescopic shoots leading to the barge underneath.

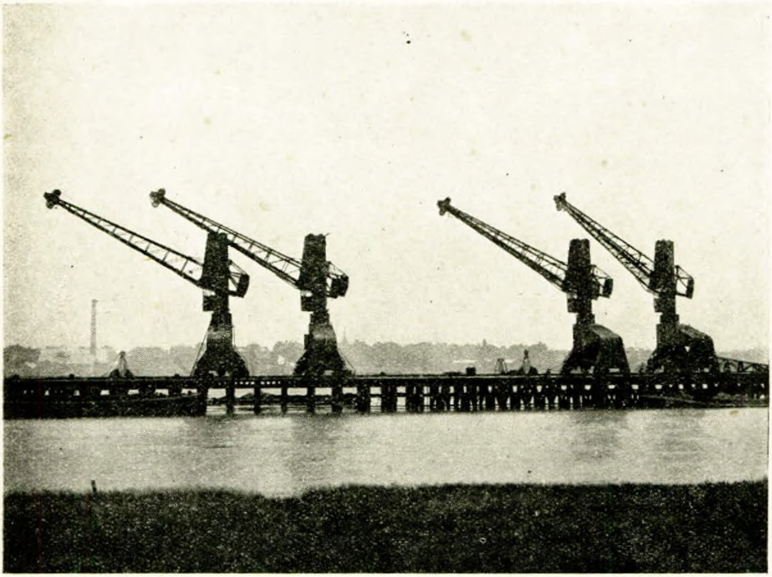


129.—General view of 8 patent coal transporters, Dagenham Dock.



129A.—Another view of Dagenham Dock pier and plant.

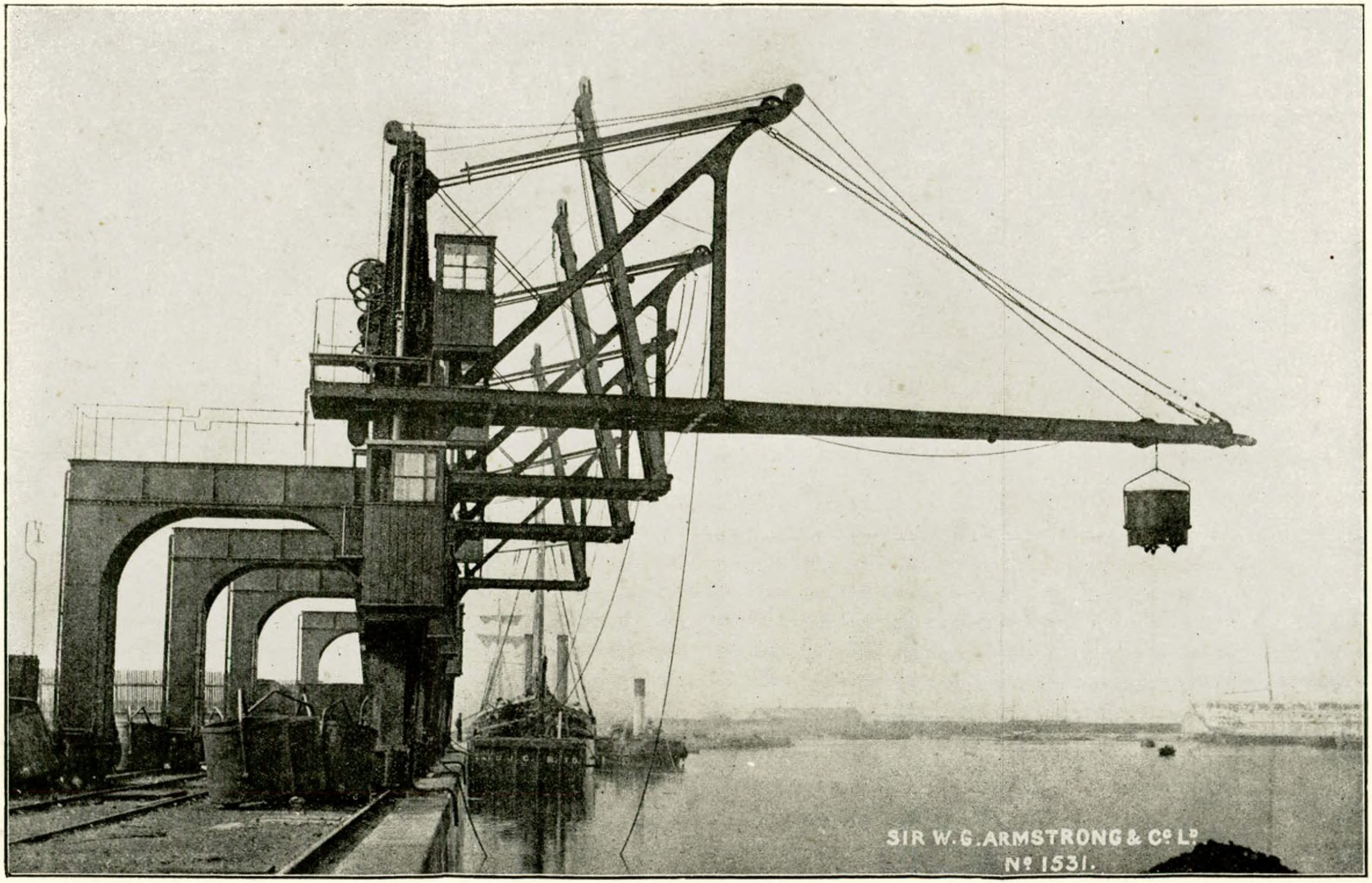
Coaling Jetty at Rochester.—This jetty at Rochester, operated by Messrs. W. Cory and Son, is built of Henibique ferro-concrete, and is 340 ft. long and connected to the shore by two



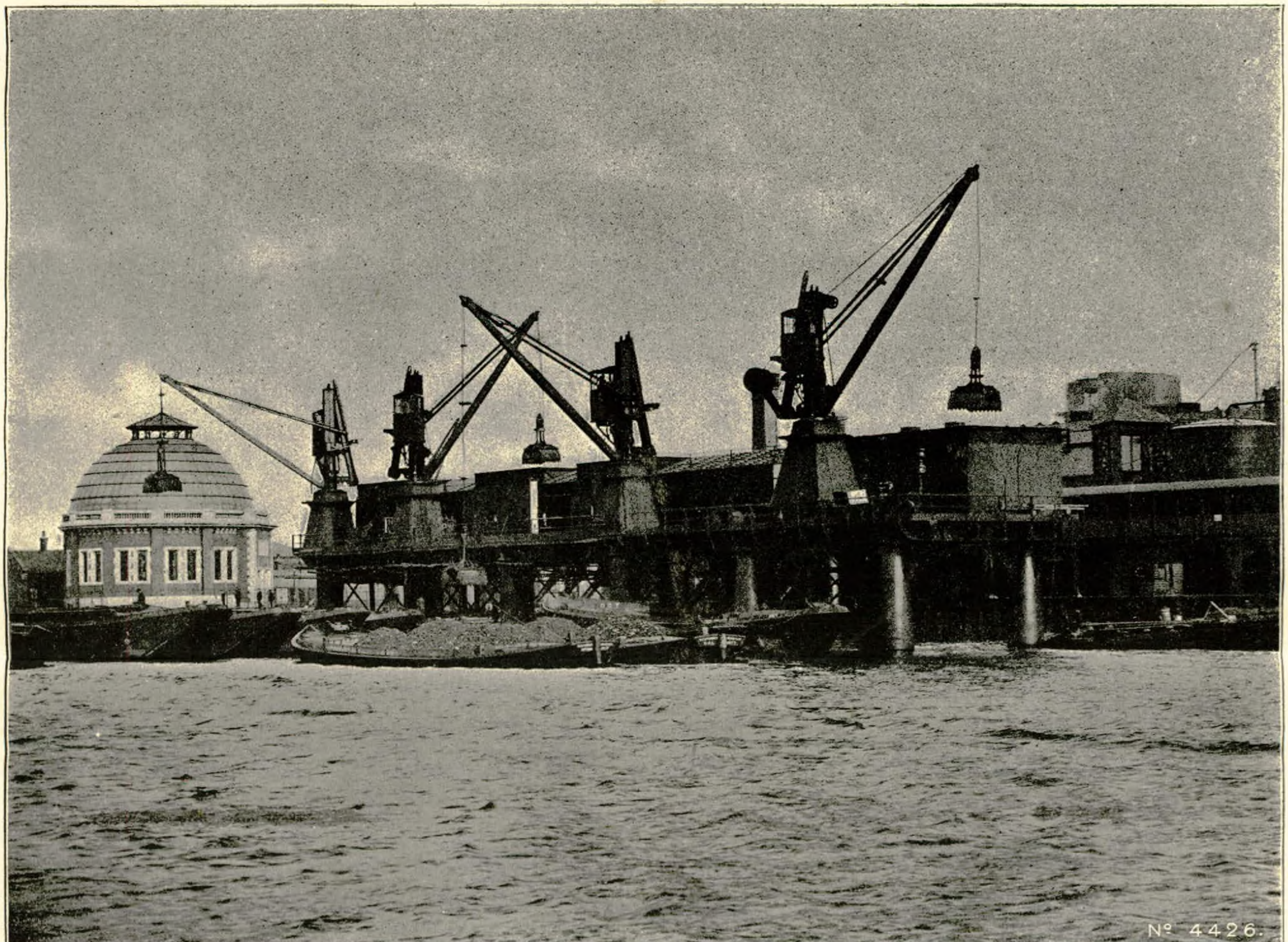
132.—Tilbury Coaling Company's plant, Tilbury Docks.

railway viaducts 180 ft. and 100 ft. long respectively. The jetty is equipped with four electric luffing cranes weighing 100 tons each. The coal being grabbed out of the vessels in grabs of three-ton capacity.

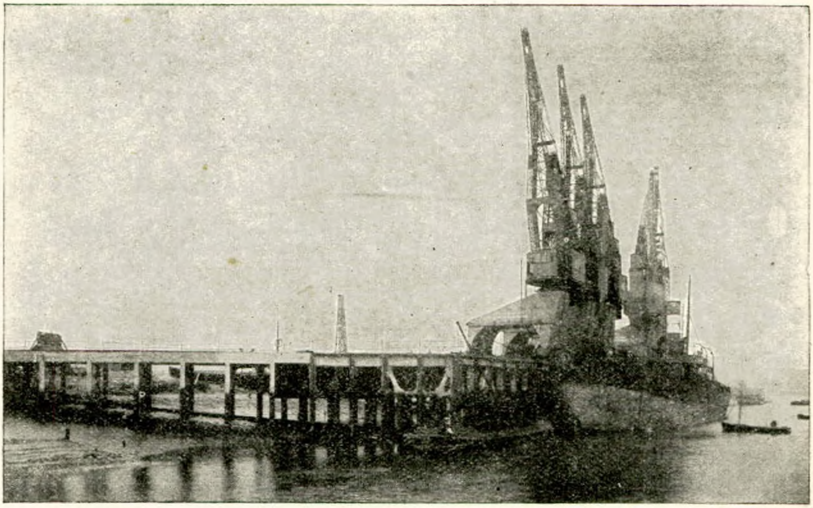
Coke Handling (*Armstrong, Whitworth*).—This shows a long range traversing bogie crane designed for stacking coke in the yard of a large gas works. The crane being equipped with a special form of box or bucket to release the load of coke. This view clearly shows the quantity of labour necessary to load this bucket. The bucket is emptied by the crane driver releasing the bottom. I think that a large light built grab would be of more advantage for this particular work. It certainly could be used for all the operations shown on screen, that is loading or emptying wagons or barges, and also for storing or reclaiming to or from heap.



130.—Harrison's coal discharging plant, Tilbury Docks.



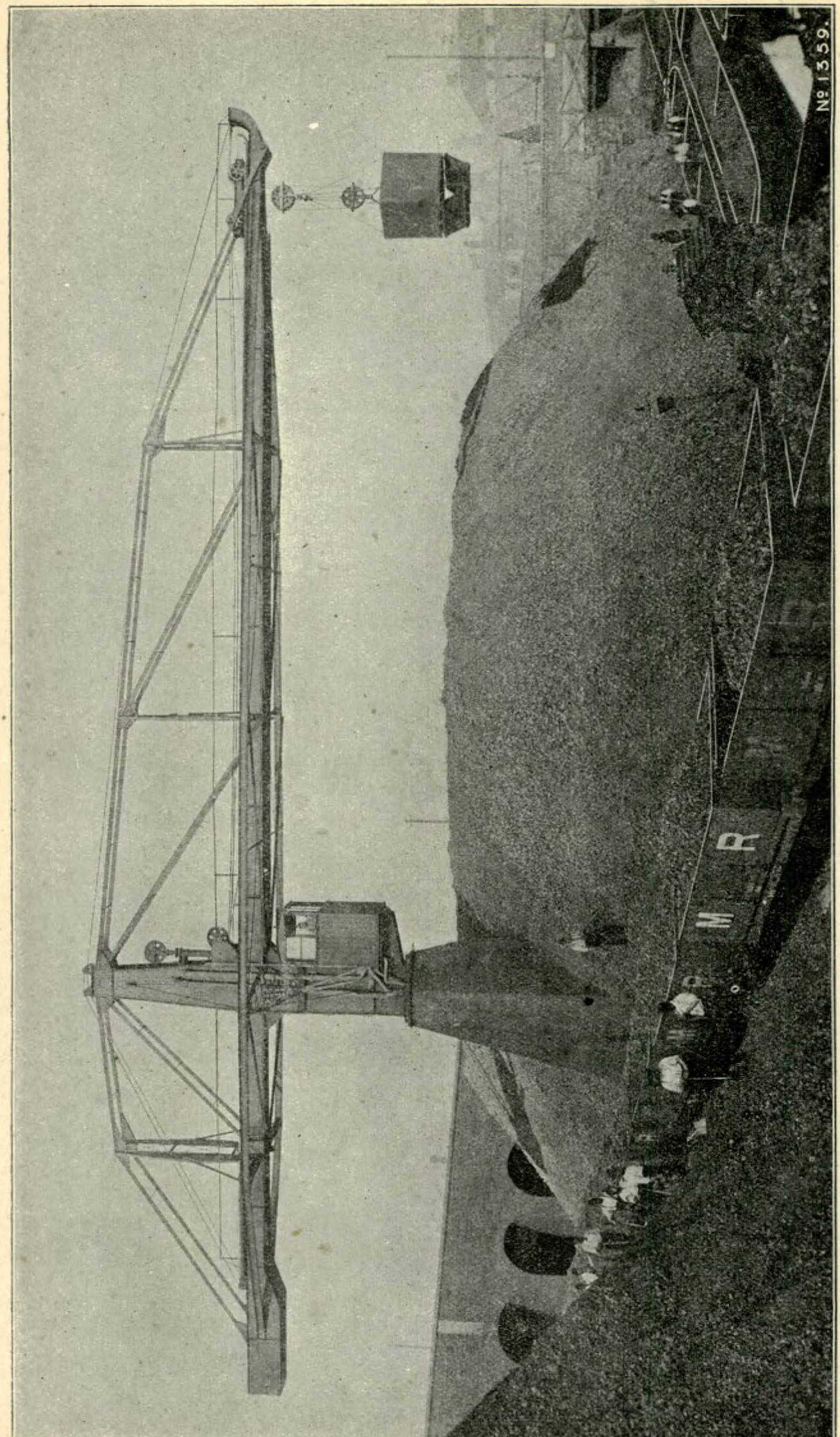
133.—Rotherithe discharging plant.



134.—Rochester discharging plant.

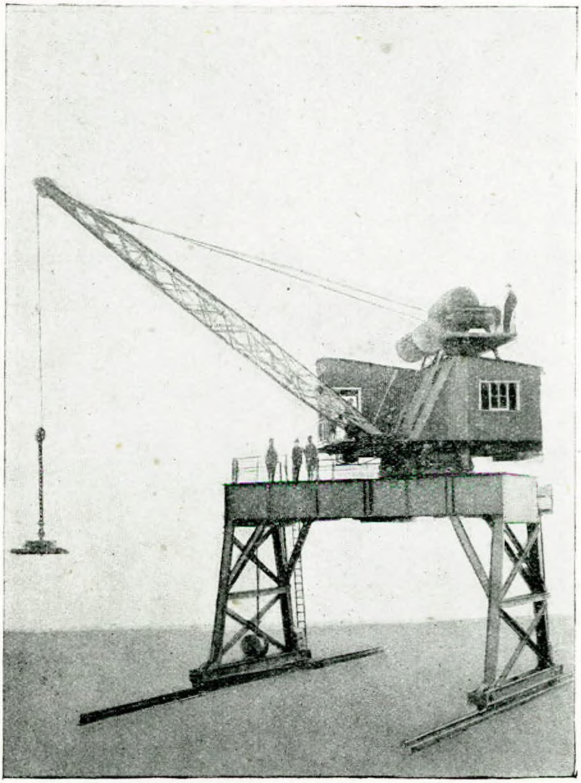
The Bowtell Patent Luffing Crane.—During recent years many kinds of level luffing cranes have come to the fore. This design is very simple, the method of keeping the load level being obtained by the automatic paying out or taking in of the lifting rope during the operation of luffing in or out, respectively. The crane frame and jib follow the design of the ordinary crane. The lifting rope passes from jib end pulley over a pulley at the heel of the jib, then around another pulley which moves along the front member of the crane frame, then back over another jib heel pulley, and then to barrel. The movable pulley is connected with the luffing gear in such a way that on luffing out this pulley moves away from the jib heel, thus compensating the rope that would otherwise have lowered the load, but in this instance keeps the load in a level line.

Another feature with this crane is the balanced jib, so that seeing the load does not rise or fall during luffing in or out, and that the jib being balanced, therefore very little power is required for this operation of luffing. This is an operation that is much used nowadays, owing to a great increase in the size of vessels it is necessary to at least plumb the centres of the hatches and in many instances in the coal trade it is also required to load into probably two barges wide outside of the



110A.—Coke handling.

vessel. Of course, without this luffing and with the large vessels, cranes built with the huge working radii would be prohibitive when numbers of units are required to be at work at



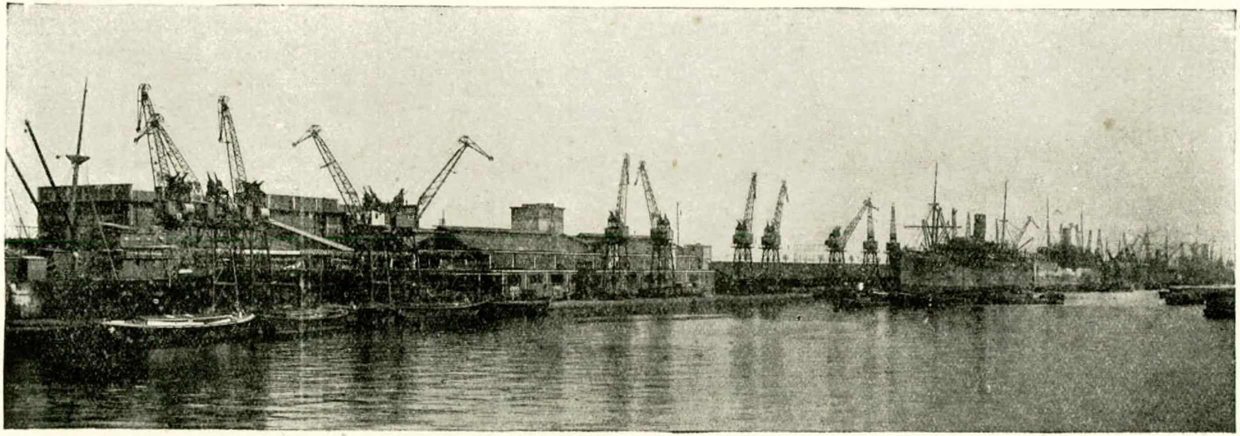
110B.—The "Bowtell" luffing crane.

the same time. The view shown is one of these cranes built by Messrs. Ransome & Rapier, and is for lifting five tons at 80 ft. per minute.

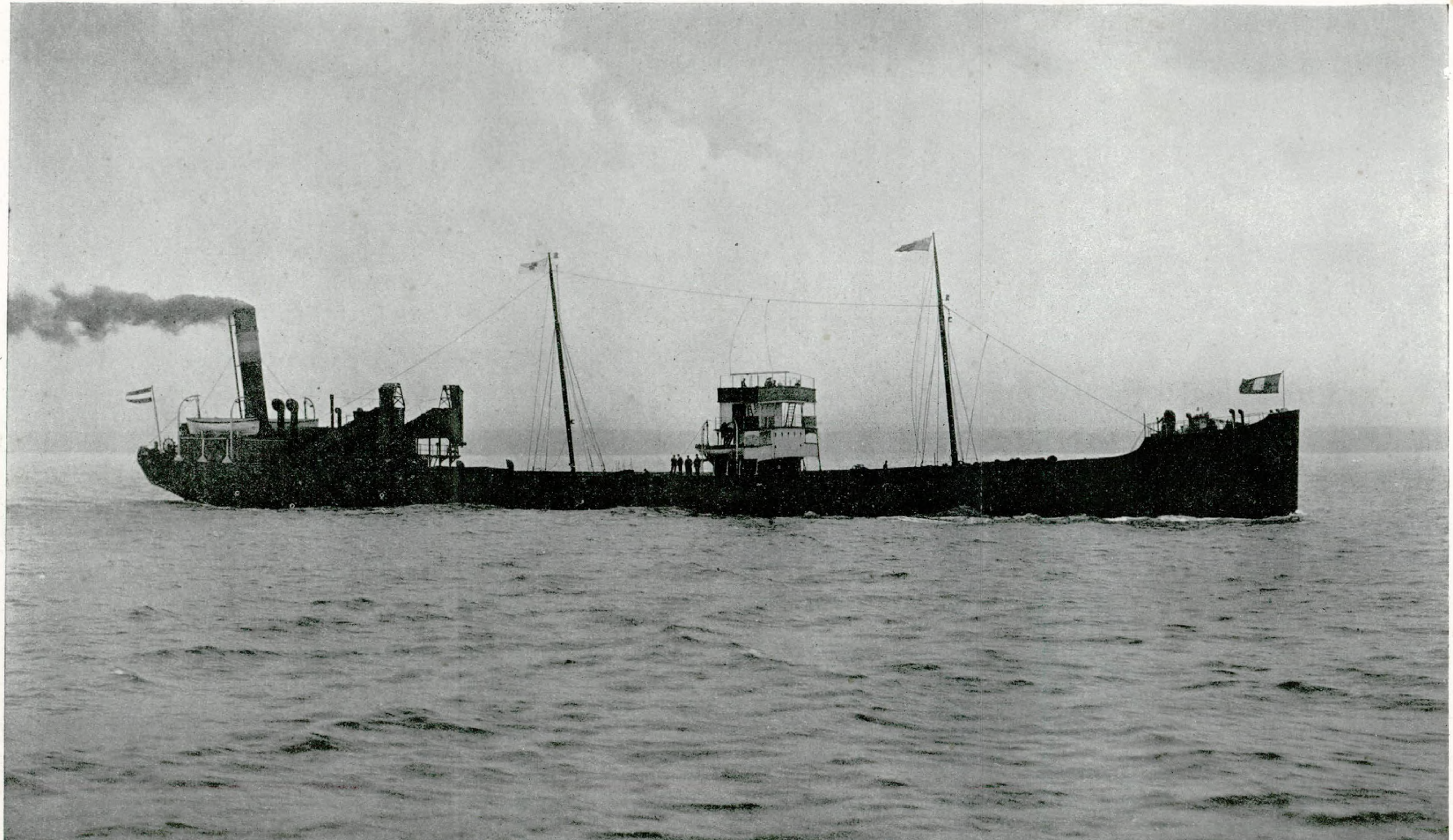
Slewing $1\frac{1}{2}$ revolutions per minute. Maximum radius, 42 ft. Minimum radius, 20 ft. Luffing level path, 150 ft. per min. Luffing 42 ft. to 20 ft., 8·8 secs. Luffing motor, $6\frac{1}{2}$ h.p.

These cranes are built with a maximum radius up to 105 ft.

Electric Portal Lever Balanced Luffing Cranes.—In the plant of the recent extensions of the Port of London Authority docks



110c.—Electric portal lever balanced luffing cranes.



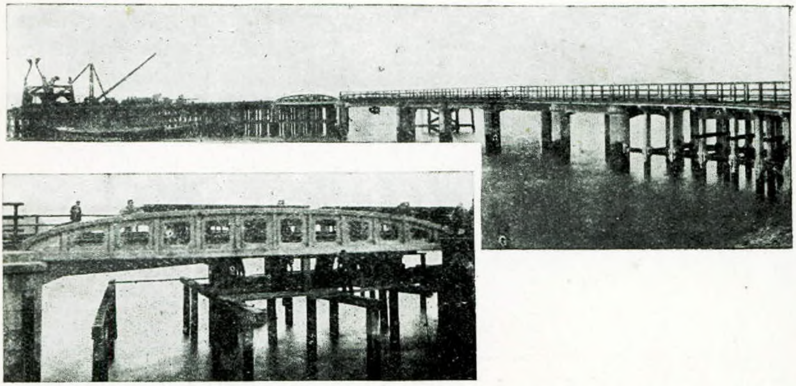
135.—Doxford's self-discharging collier, "Herman Sauber," steaming with cargo.

135A.—Doxford's self-discharging collier, "Herman Sauber," discharging 1,200 tons per hour.

at London and Tilbury many of these balanced and level luff cranes are fitted as seen in the illustration; electricity has been utilised as the operating power, so that in the near future some of the differences in working costs between these and the older portions of the docks which are equipped with hydraulic plant will be very interesting to close students in this line. This type of crane is suitable for grab work for the larger kinds of shipping discharging bulk material, and where a single chain grab can be applied as plenty of head room is given in the design so that chains could be coupled to the wire rope, thus when the grab was closed there would be no need to run the displaced chain over a wire rope pulley on the jib end. The view illustrated shows a few of the fifty-six balanced luff cranes supplied to the Port of London Authority by Messrs. Babcock & Wilcox.

Doxford's Self-discharging Colliers ("*Herman Sauber.*")—For a considerable time Messrs. Doxford have designed colliers and bunkering apparatus. The vessel now shown is the S.S. *Herman Sauber*, built for Messrs. Sauber Bros., Hamburg, and launched 29th February, 1912. One view shows this vessel steaming with cargo, while the other shows the vessel discharging into barges. She carries a cargo of 3,750 tons on an 18 ft. 9 in. draft, and is capable of discharging this coal by its own machinery at a rate of 1,200 tons per hour. These vessels may be built with as many bulkheads as required for dividing the cargo, or if necessary they may have one clear hold between fore peak and engine room bulkhead. The engines are aft as can be noted from the screen. As a loading vessel they are considered self trimmers. The hatches extending to 5 ft. from the sides of the ship. These hatches are continuous fore and aft, excepting where broken here and there to allow for tarpaulin fastenings and also the space for cabin accommodation. There are two conveyers under the holds which receive the coal as the doors are opened at the bottom of the hold. Access to these doors is given from a tunnel throughout the length of the conveyer belt under the holds. This belt takes the coal and discharges it on to another conveyer which elevates it to the desired height and from there through a shoot to craft alongside, or if necessary to any place ashore if auxilliary gear is there to receive the coal from the spout. These shoots can be adjusted for height to suit the craft loading, and they can be housed out of the road when vessel is discharged. Weighing machines automatically operated are installed.

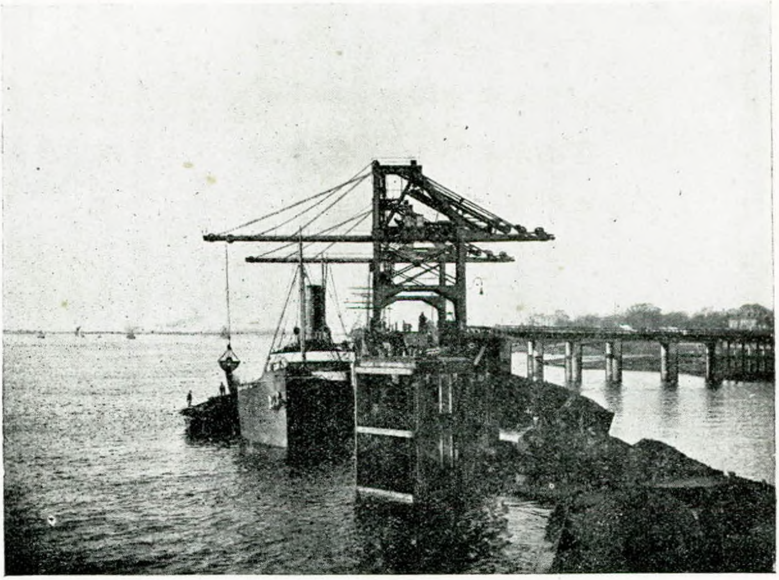
Purfleet Pier (*The Steamship Owners' Coal Association, Ltd.*). —This view shows the ferro-concrete pier at Purfleet as it was in 1903-4. The erection of the cranes has just commenced. The ferro-concrete bridge joining the pier approach with the



136.—Purfleet Pier, 1903, showing pier and cranes erection.

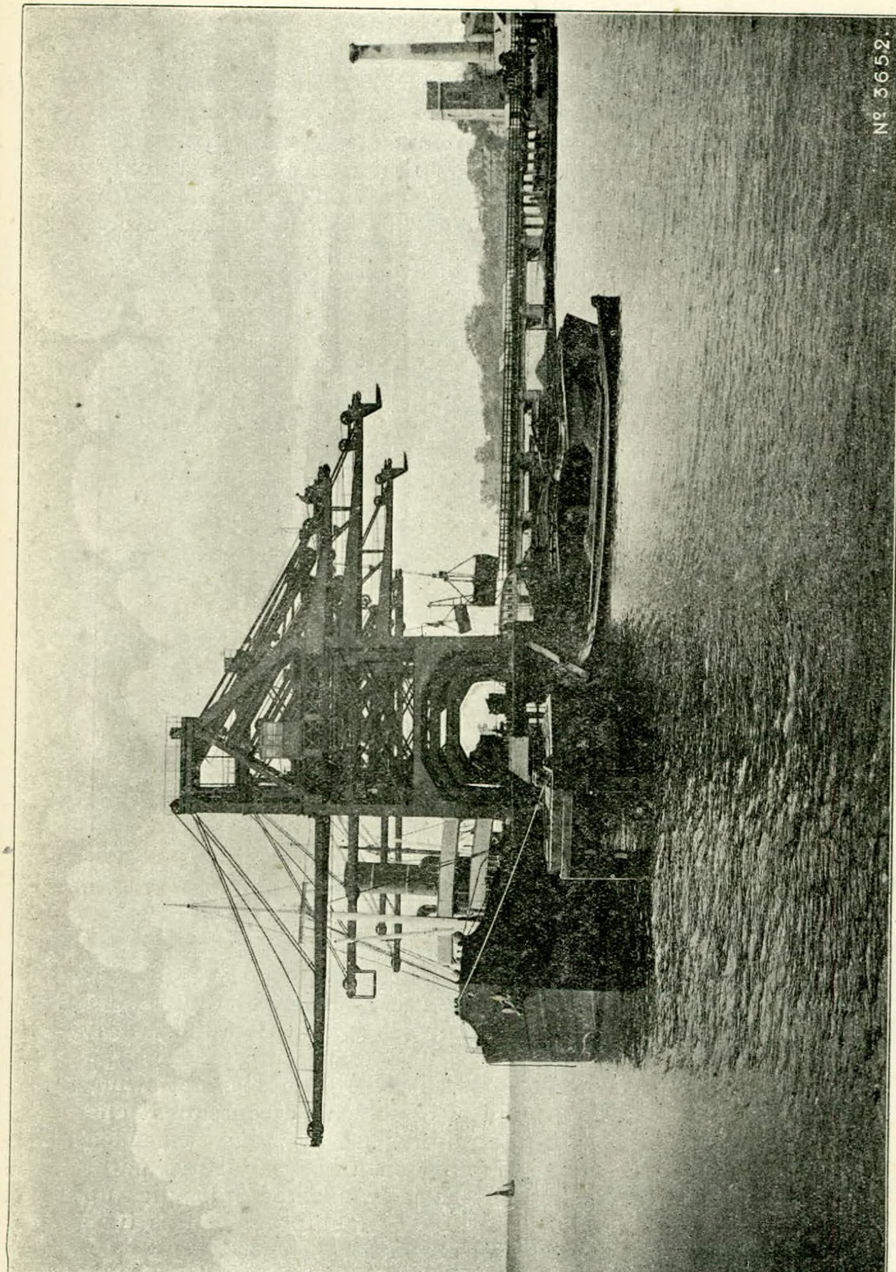
137.—Purfleet Pier, 1905, 2 cranes grab discharging inside pier.

pier proper is the first ferro-concrete bridge of its kind and span built in this country. The inset picture is an enlarged view of this bridge taken during the testing operations. This view shows the discharge of the first steamer at this wharf during 1905. You will see that at that time there were only two cranes erected; the power-house is seen on the right. Notice grab discharging inside. Grab discharging overside. Note weighing machine.



137A.—Purfleet Pier, 2 cranes grab discharging outside vessel.

By the end of the next year two additional cranes were erected and put to work, this plant was at that time the fastest discharging plant on the river. The cranes are of the type known as transporter cranes, that is, the grab does not swing round supported from the end of a jib with a consequent circular motion, but runs in a straight path by being suspended from a travelling carriage running on a horizontal rail path. These cranes weigh about 100 tons each, and the grabs pick up two tons of coal at each operation of grabbing. At this time the length of the pier proper was 250 ft.

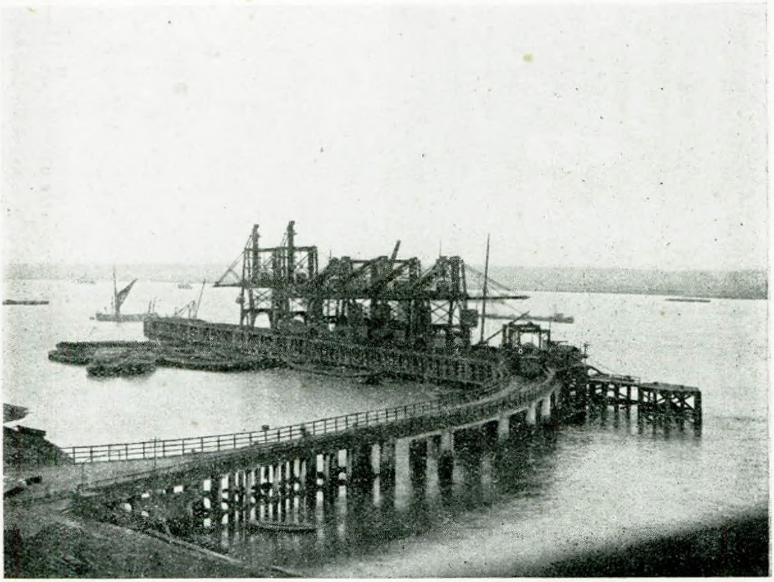


138.—Purfleet Pier, 1906, 4 cranes.

Vessels of the largest size in the coal trade are dealt with at this wharf, this one now alongside is of a carrying capacity of 10,500 tons, but this is exceptional. However, vessels of over 7,000 tons have traded here regularly, by this time six cranes are erected on the pier, and the wharf has been lengthened by the addition of a further 360 ft.

140.—Purfleet Pier, 1916, 6 cranes, 10,500-ton vessel alongside.

Perhaps this view may give a better idea of the general methods employed on loading barges or wagons from the vessel, the ship being outside and the barges inside the pier, while wagons are dealt with on the pier, on which there is a double set of railway metals. The tug passing outside, has just taken some loaded barges from the inside of the pier, and is now on its way to London. The rails on the pier approach are in connection with the sidings on the works, where several trains of wagons can be assembled foı their various destinations. The wagon tip, shown at the junction of the approach with the pier has been an extremely useful means of assisting London, in recent times, with its coal supply. Regarding speed of discharging colliers at this wharf, a vessel of 3,000 tons has been cleared in six hours, weighing the material en route to the barges at the back of the pier. The first crane before us has loaded a barge with 150 tons in an hour, weighing each grab of coal as it passed over the pier to the barge. The furthest away crane has loaded a 220-ton barge overside the ship, with-

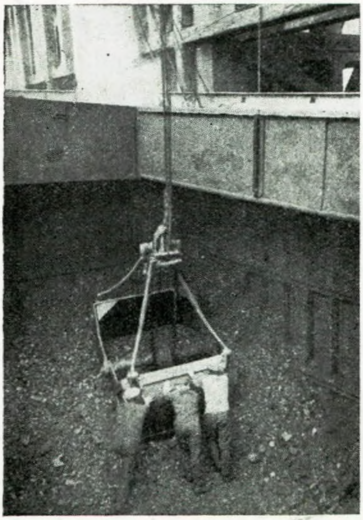


141.—Purfleet Pier, 1918, general view.

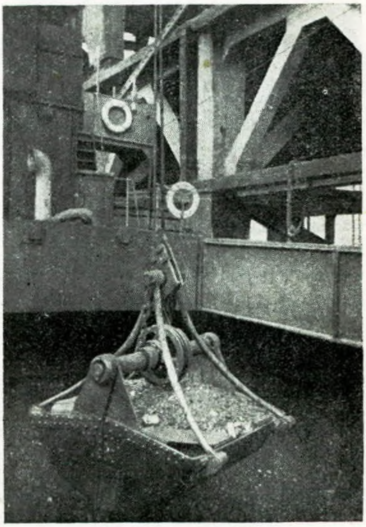
out weighing, in 20 minutes. The plant was built by Sir W. G. Armstrong, Whitworth & Co., and the grabs used are known as the Priestman Double Rope Grab.

Changing 700 *ton Barges.*—Some time ago we heard of the Tyne schooners trading to the Thames with cargoes of 150 tons of coal. This view shows the operation of "Changing barges," that is letting the loaded barge drift out of the loading position with the tide, while the empty barge swings alongside. These barges each carry 700 tons of coal, but the usual coal barge is from 100 to 300 ton capacity.

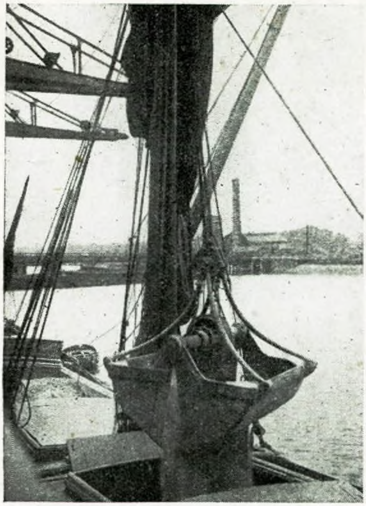
Discharging Flooded Holds.—These slides show the adaptability of grabs for overcoming difficulties. We have coped with several similar instances to this. This particular vessel had a draft of over 30 ft. aft, and also a heavy list. At low



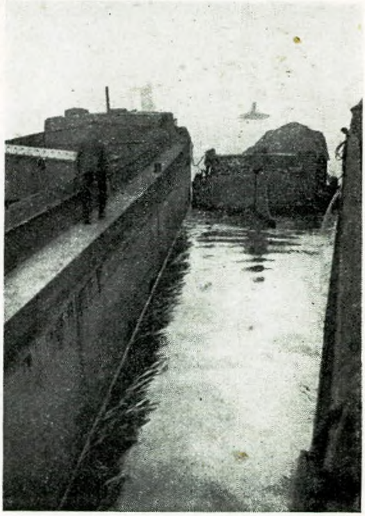
142.—Purfleet Pier, swinging the grab under the deck space.



143.—Purfleet Pier, loaded grab coming out of vessel's hold.

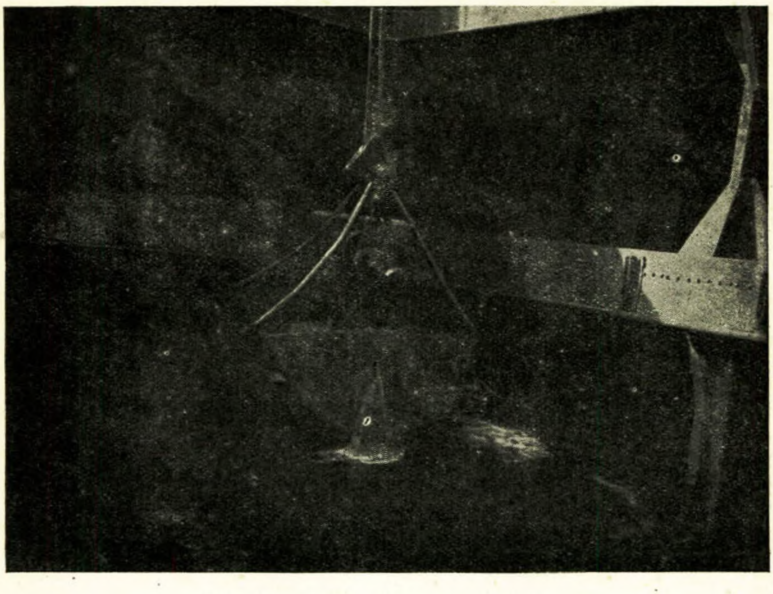


144.—Purfleet Pier, loading the forehold of a sailing barge with grabs.



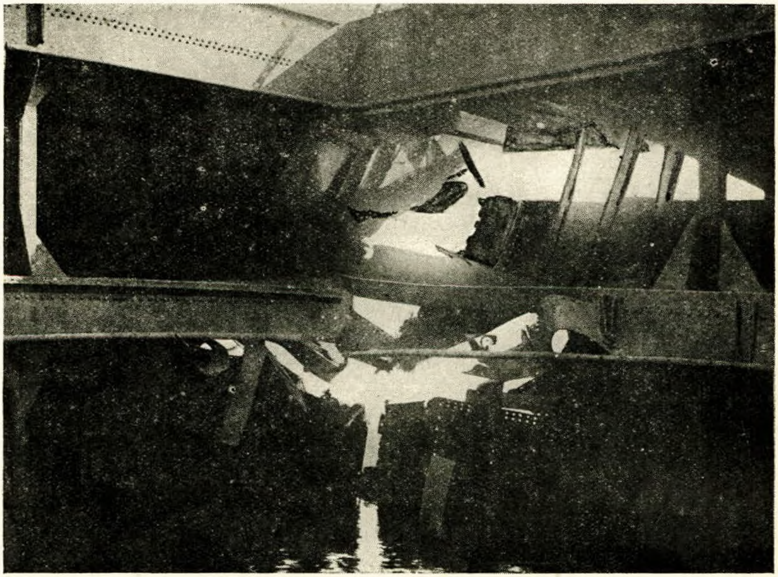
146.—Purfleet Pier, changing 700-ton barges.

146A.—Purfleet Pier, discharging flooded holds.



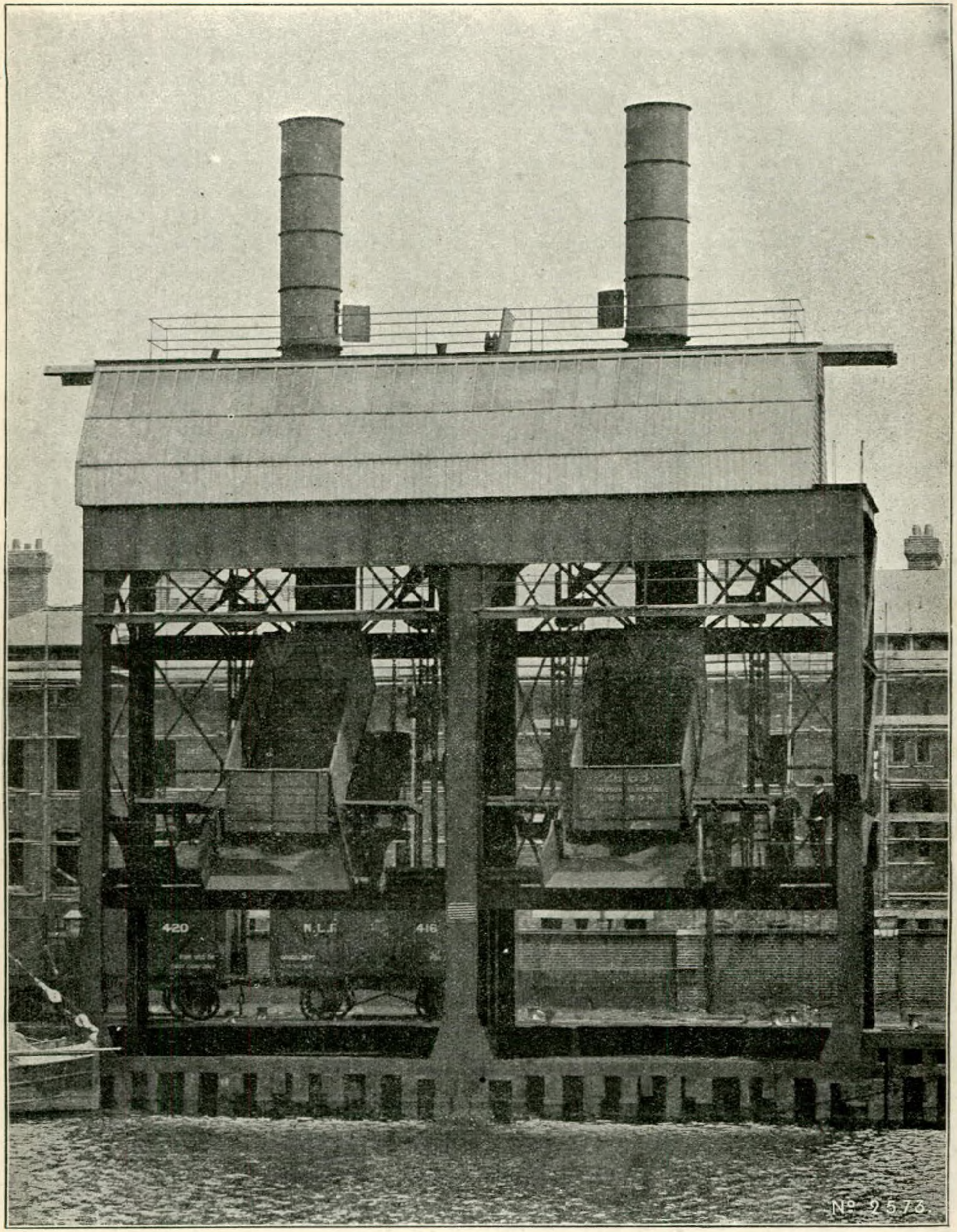
146B.—Purfleet Pier, discharging flooded holds.

water the depth of water alongside the pier is $17\frac{1}{2}$ ft., therefore it is an anxious time trying to neutralise the difference of draft between forward and aft, before the first low water after berthing the vessel alongside the pier. This view shown was the effect of torpedo explosion, and was in No. 4 hold. The 'tween deck beams were all bolted in, and under water, the consequence was that we had to use every endeavour to get the after end up so that we could get these beams unbolted or at least sufficient of them out to allow the grab to get to the cargo underneath.

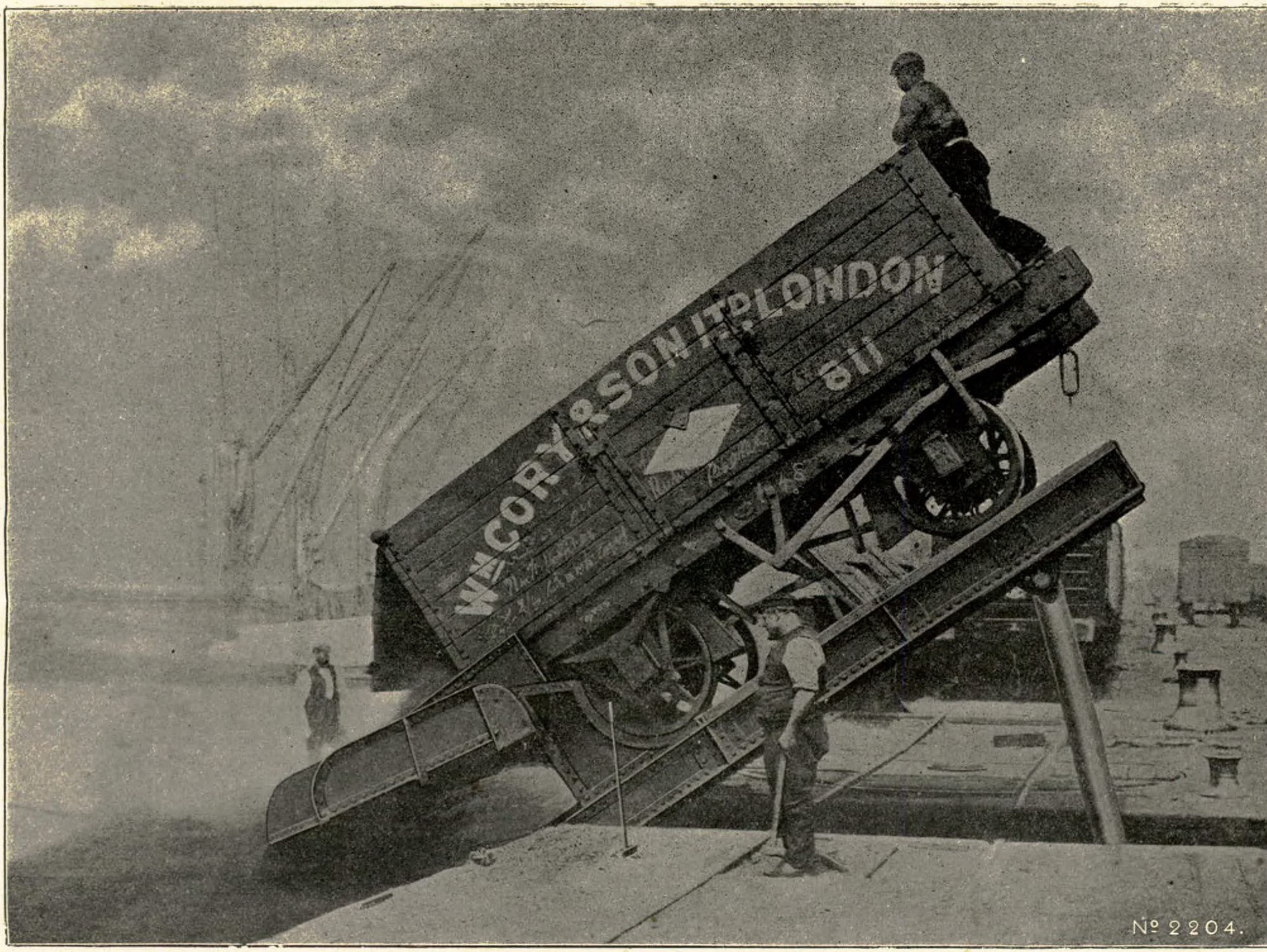


146C.—Purfleet Pier, discharging flooded holds.

The discharge of the forward end was not commenced till some time later. Two grabs were put to work at No. 3 hold, and after we got the 'tween deck beams out of No. 4 hold this hold also got away full swing. We were assisted by the judicious use of ballast tanks forward, so that the work went along quite smoothly. Practically all the coal was recovered from this vessel, although No. 4 hold had all to be dredged out from under water. The slides show, "Discharged to 'tween deck," "Discharging," and "Discharge finished." The bulkhead showed signs of the strain due to pressure of water when we

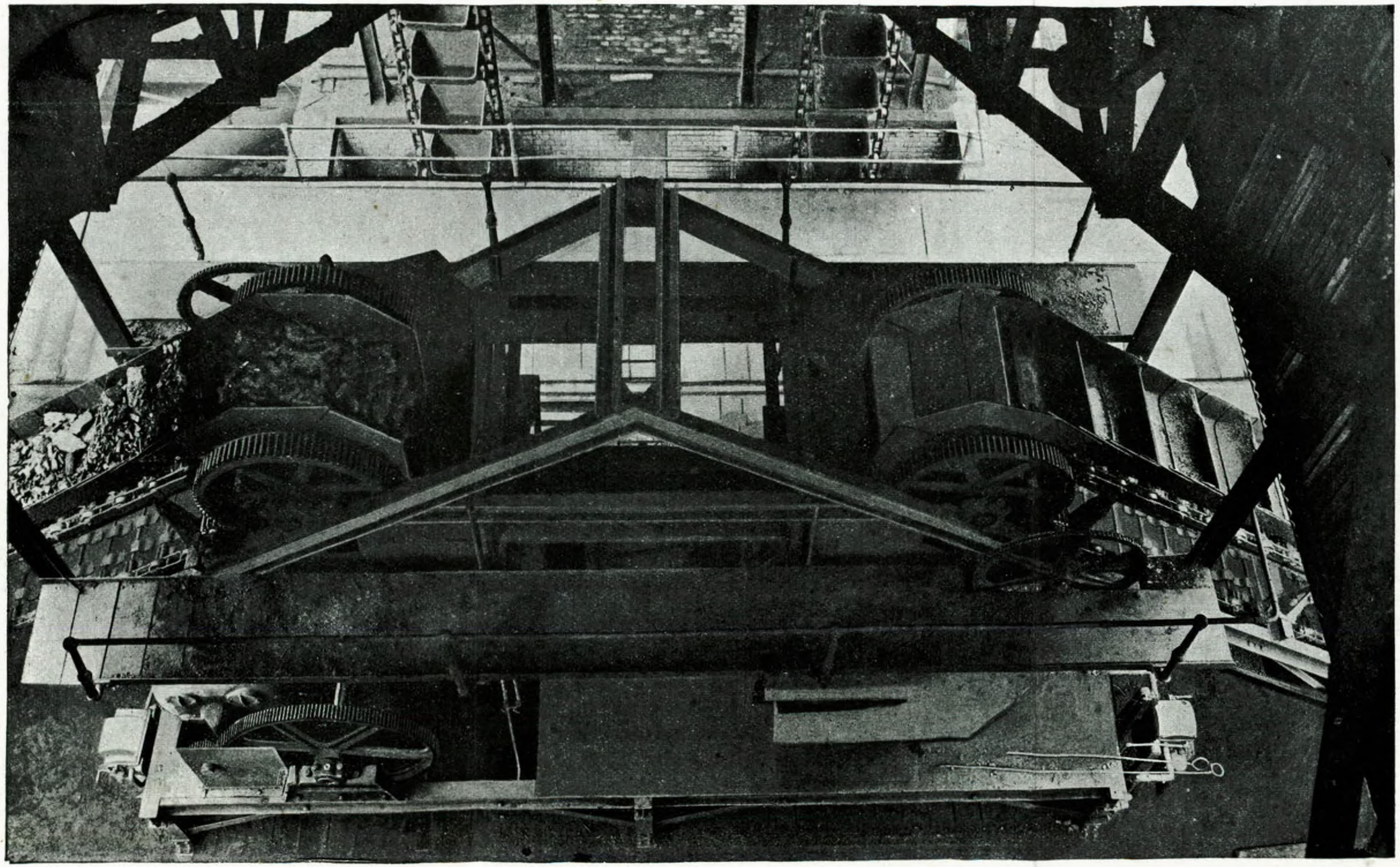


152.—Double wagon tip, Poplar Dock.



151.—Wagon tip, Brentford.

152A.—End door wagon tip and coal handling plant, Birmingham Corporation Gas Works, Saltley.



152B.—Upper terminals of the two tray conveyers, Birmingham Corporation Gas Works, Saltley.

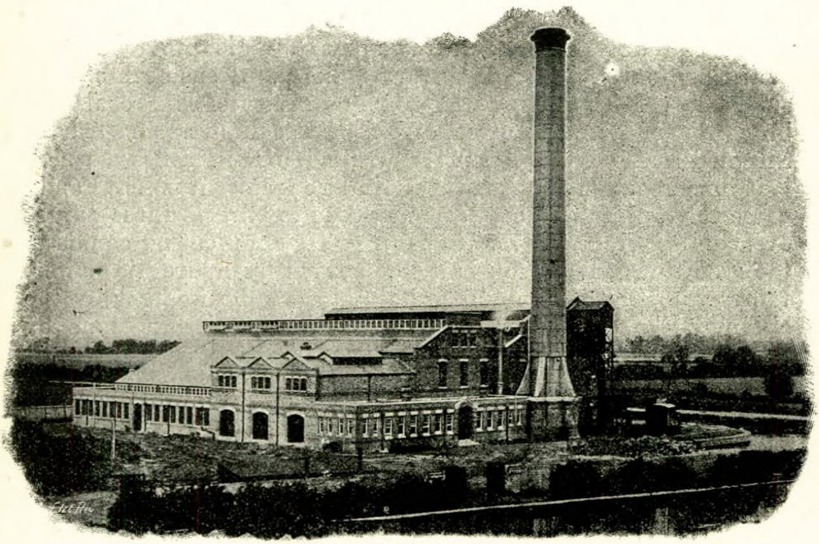
cleared No. 3 hold. This bulkhead was then shored up as an additional precaution to float the vessel away.

Wagon Tip, Brentford (Armstrong, Whitworth).—This shows a simple tip without any elevating range other than that for tilting up the wagon, so that the coal will run out when the end door of the wagon is opened. This tip is used to tip wagons direct from the colliery into barges on the Thames, principally for large Welsh coal.

Double Wagon Tip, Poplar Dock (Armstrong, Whitworth).—This view shows a twin or duplicate hoist for transferring coal or coke from wagons to barges. It is capable of dealing with either end door or side door wagons, and is provided with elevating as well as tipping gear. This plant has been of considerable service during the war, as much of our coal was brought to London direct from the collieries in trucks. Situated in Poplar Dock on the North London Railway, where it is in connection with all the main line traffic, it is in a handy place to transfer this coal from wagons to barges, these barges eventually going all over the river or communicating canals to their destination. The plant is operated by hydraulic power, the rams being on top and protected from the weather by the chimney-like casing around them. Side tipping is done by running the wagons along the rails parallel to the quay, elevating them and opening side door. End tipping is usually done by running wagons on a second set of rails parallel with quay, then when opposite the machine the wagon is turned on a table, taken forward and elevated, opening the end door, and tilting the wagon to the necessary angle for all the coal to run out.

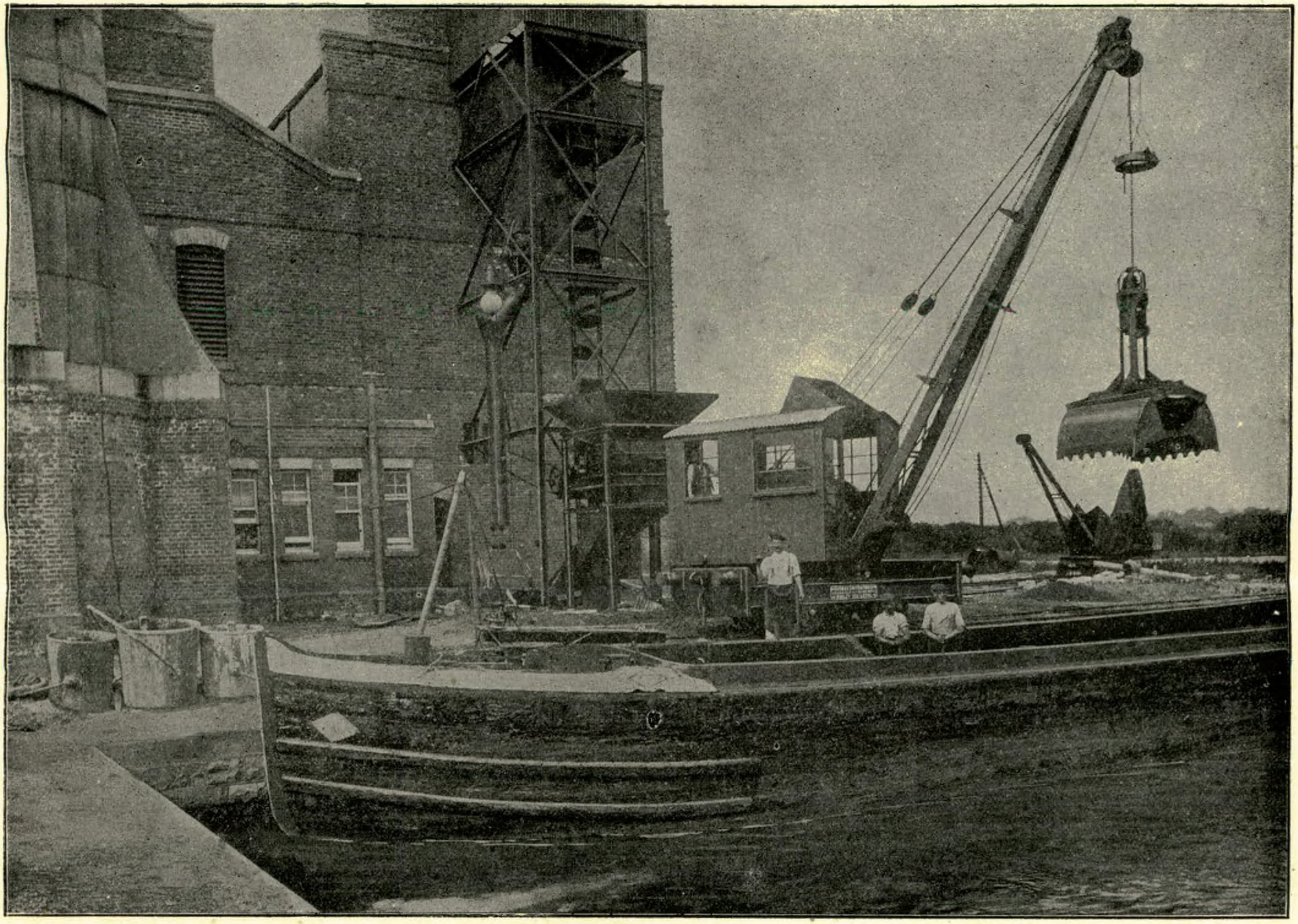
Upper Terminals of the two Tray Conveyers, Birmingham Corporation Gas Works.—The Birmingham Corporation Gas Works have led the way in this country whereby consideration is given to the manufacture of coke for foundry purposes as well as the making of gas, thus a step in the right direction as regards the more scientific utilisation of our coal. For years the writer has advocated this, and it is gratifying to hear that the scheme is a success.

At this place the coal is received in end door wagons and tipped by one of two tips as seen on the view, the coal goes into a hopper and fed to an inclined tray conveyer—one to each tip—these conveyers raise the coal to a common point of delivery as seen on the following illustration; this is high enough for the material to gravitate through coal breakers and afterwards disintegraters where the material is broken and reduced to a very small size, and then delivered in its pulverized state to a special feeding arrangement (patented by Babcock and Wilcox and Mr. Alexander Lennox) to a gravity bucket conveyer which elevates and conveys the coal to a series of bunkers. From the bottom of these bunkers the coal is delivered as required, by gravity, to a travelling charging and stamping machine, which in turn feeds the coke ovens installed at these progressive works. The coal handling apparatus is that of Messrs. Babcock and Wilcox construction, and each plant is capable of handling and treating 80 tons of coal per hour.



153.—North Metropolitan Electric Supply Co., Brimsdown.

The various appliances we have seen show most of the plants of any consequence that has been erected on the River Thames for coal discharging. This material is sent from these wharves in either barges or wagons to the various power stations, gas works, or depots for house coal distribution, the greater portion of this latter fuel arrives direct from the collieries in trucks, and in most cases filled into cwt. sacks and distributed by horse and cart to wherever required. The operations regarding the supply to some of our power houses are very interesting. The view before us shows quite a modern power station from the outside.



153A.—North Metropolitan Electric Supply Co., Brimsdown, conveyer and coal handling plant.

The next picture where you see the barge in a little dock is alongside the River Lea. This barge of coal has had many miles journey up the Thames, being towed by a steam tug, then pushed and pulled about through various lock gates into the canals by hand, or poking as it is termed. It is then towed by horses until it eventually reaches its present position. The coal is now grabbed out by the electric crane, elevated and released into the hopper where it is automatically weighed and released on to a feeding arrangement which fills each bucket with a measured quantity of coal. This endless chain of buckets which may be seen rising vertically to the top of the building, is then carried horizontally the full length of the building wherein at any place throughout its length it can tip its load by the setting of a trigger. The coal is stored in large hoppers the full length of the boiler house.

At the futher end the buckets are made to descend vertically and are again diverted horizontally under the fronts of the boilers, where, when required, they are made to do another duty, by gathering or receiving the ashes, eventually tipping these into the tank we see behind the elevator. From this tank the ashes can be discharged either into carts or barges by simply pulling a chain opening the door which allows the ashes to drop through the spout.

London and North Western Railway Co.'s Electric Generating Station and Coal Handling Plant, Stonebridge Park, London.—Gravity bucket and tipping tray conveyers, each of 40 tons capacity per hour, handling coal from coal store to boiler house bunkers, a distance of 1,180 feet; also suction ash plant for collection and removal of ashes.

View showing gravity bucket conveyers on the top of storage bunkers; also showing Babcock and Wilcox operating mechanism and tripping gear to empty buckets automatically. Manchester Corporation Electricity Works, Stuart Street, Manchester.

County Borough of Wallsall Power Station (Outside).—We here have another station alongside a canal the operations being similar to the last plant, but as the power house coaling plant is extended away from the building it may convey a better idea of the horizontal conveyer carrying the coal to the coal hoppers. Let us go inside and follow this coal to the furnace.

County Borough of Wallsall Boiler House (Inside).—Here we see overhead the bottoms of the storage bins, from which a spout is led to each of the boiler furnaces. By pulling a chain the quantity of coal required is released and runs down to the hopper over the furnace door. This coal for each boiler is again automatically weighed before it comes down this angular spout, so that it is quite an easy matter to tell whether any boiler is economical or not by taking into consideration the amount of water evaporated by a certain amount of a known coal. The final test of course being how much current is produced by a certain amount of fuel at a certain cost.

BOILER TRIAL.

REPORT

On the trial of a Water-tube (C.T. Marine) Boiler, made by Babcock and Wilcox, Ltd., working at County Borough of Wallsall Electric Power Station, Birchills; made on the 29th August, 1917.
By E. M. LACEY, ESQ., M.INST., C.E.

BOILER. Sheet 1.

GENERAL DESCRIPTION AND DIMENSIONS.

Type of Boiler.—Water-tube C.T.M., made by Babcock & Wilcox Ltd.
Makers' rating of the output of the Boiler.—25,000 lbs. of steam per hour.
Test.—Made at an output of 25,448 lbs. of steam per hour.
Object of the Trial.—To test normal evaporation capacity and efficiency.

GENERAL DESCRIPTION OF BOILER AND LEADING DIMENSIONS.

Ref No.

1 Marine steel cased boiler, with integral Superheater, superimposed economiser and steel chimney.

2 Method of starting and stopping the test. Flying start after boiler had been working several hours and conditions steady. Test finished with fire thickness, etc., same as at the start.

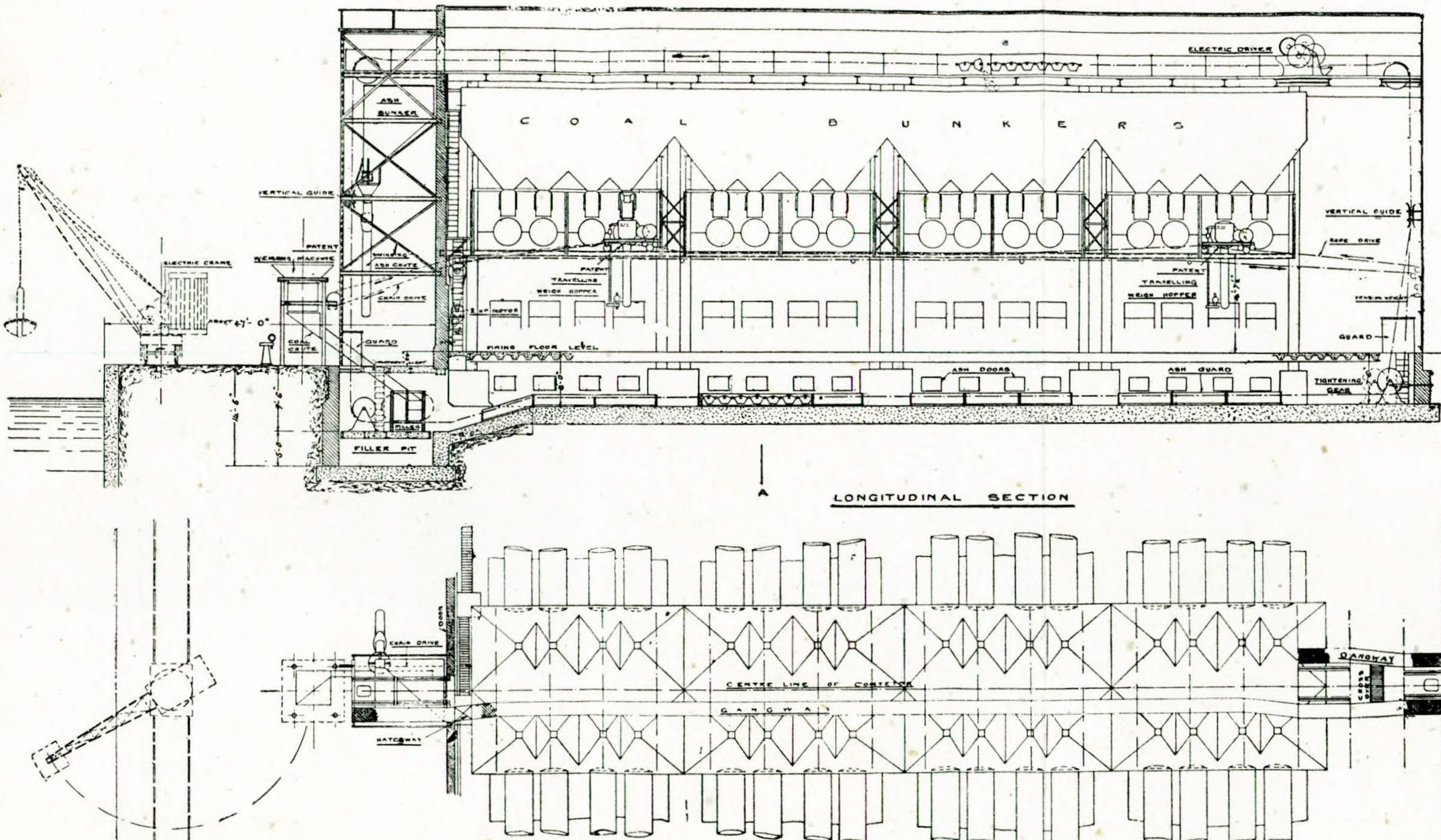
3 Method of stoking, and average thickness of fire mechanical chain-grate stoker; fire thickness, 5½ inches.

4 Production of draught. Cold air ejector.

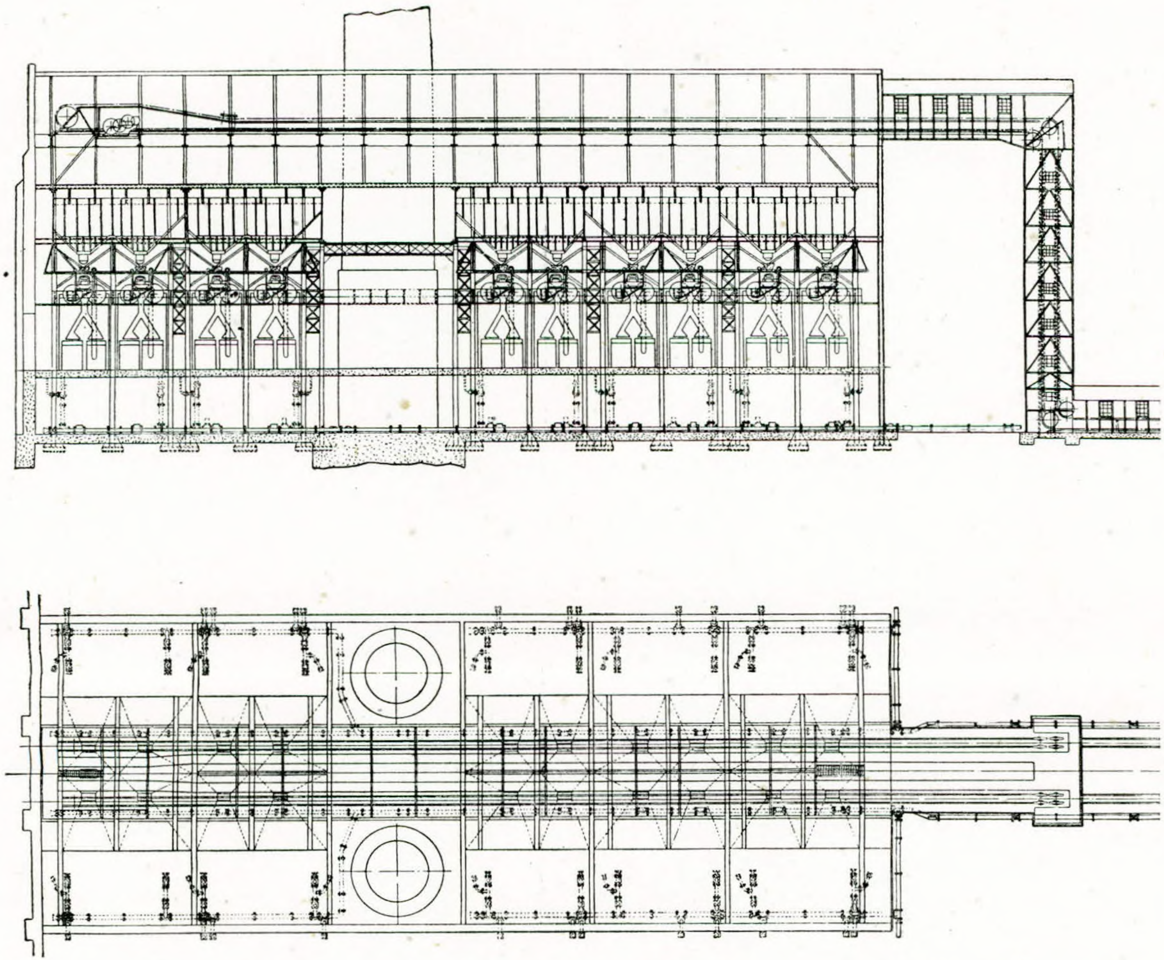
5	Chimney—height, 80 ft. Area at ..	bottom,	sq. ft.	—
		top,	sq. ft.	—
6	Total grate surface (excluding dead plate) ..		sq. ft.	140
7	Grate area occupied by air space between bars		sq. ft.	not measured
8	Total heating surface		sq. ft.	3970
9	Capacity of water space, at inches, in guage glasses		cu. ft.	—
10	Capacity of steam space, at inches, in guage glasses		cu. ft.	—
11	Area of water surface in boiler		sq. ft.	—
12	Duration of trial from 12.30 to 8.30, 8 hours.			

FUEL.

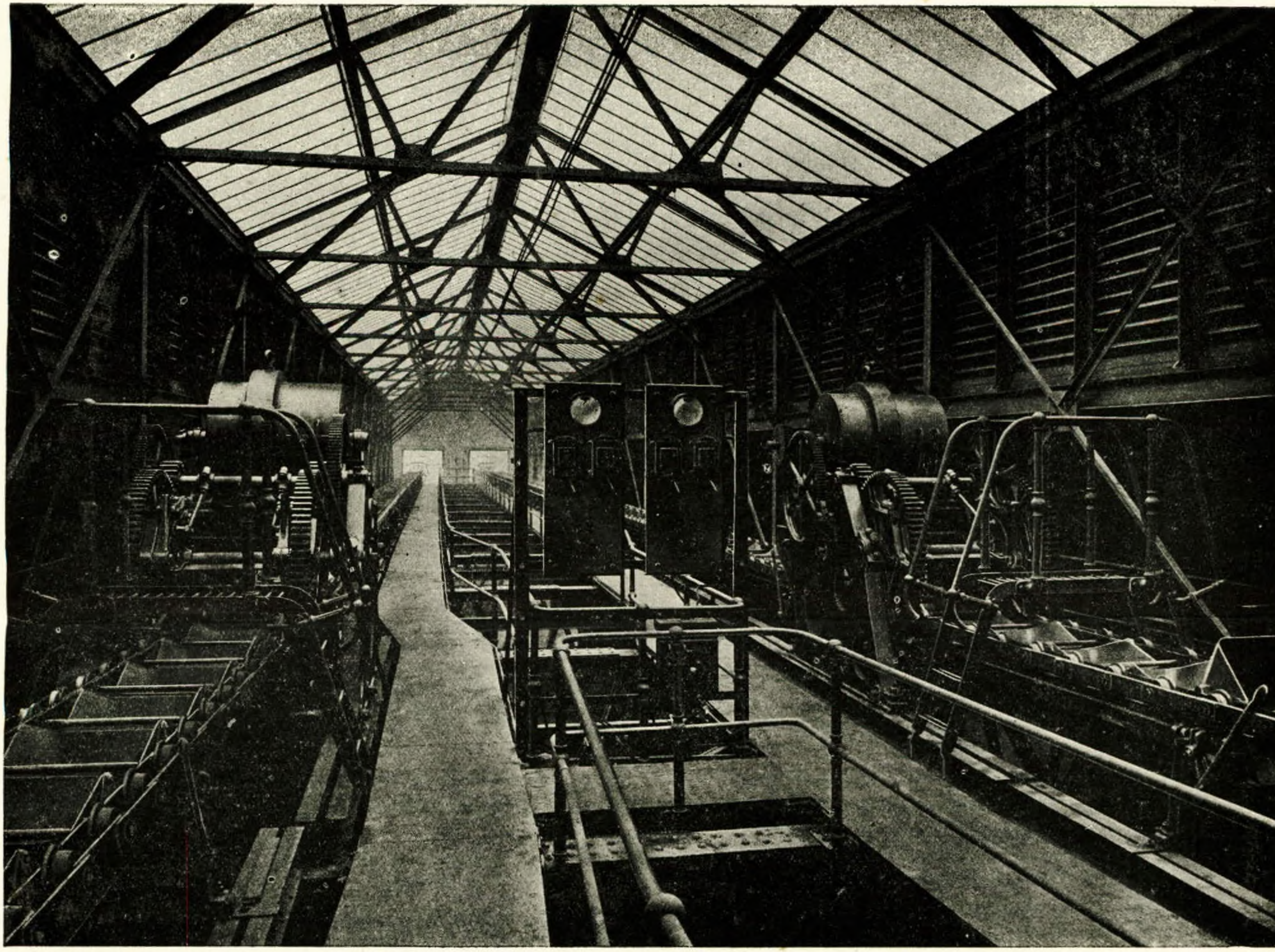
13	Short Description		Walsall wood.
14	Fired per hour	lbs.	3,680
15	Analysis by weight of fuel as fired:—		
	Carbon	per cent.	56·62
	Hydrogen	per cent.	4·13
	Sulphur	per cent.	2·10
	Ash	per cent.	9·35
	Oxygen and other matters ..	per cent.	13·48
16	Moisture in fuel as fired	per cent.	14·32
17	Calorific value of fuel as fired (lower value) B.T.U.	per lb.	10,411



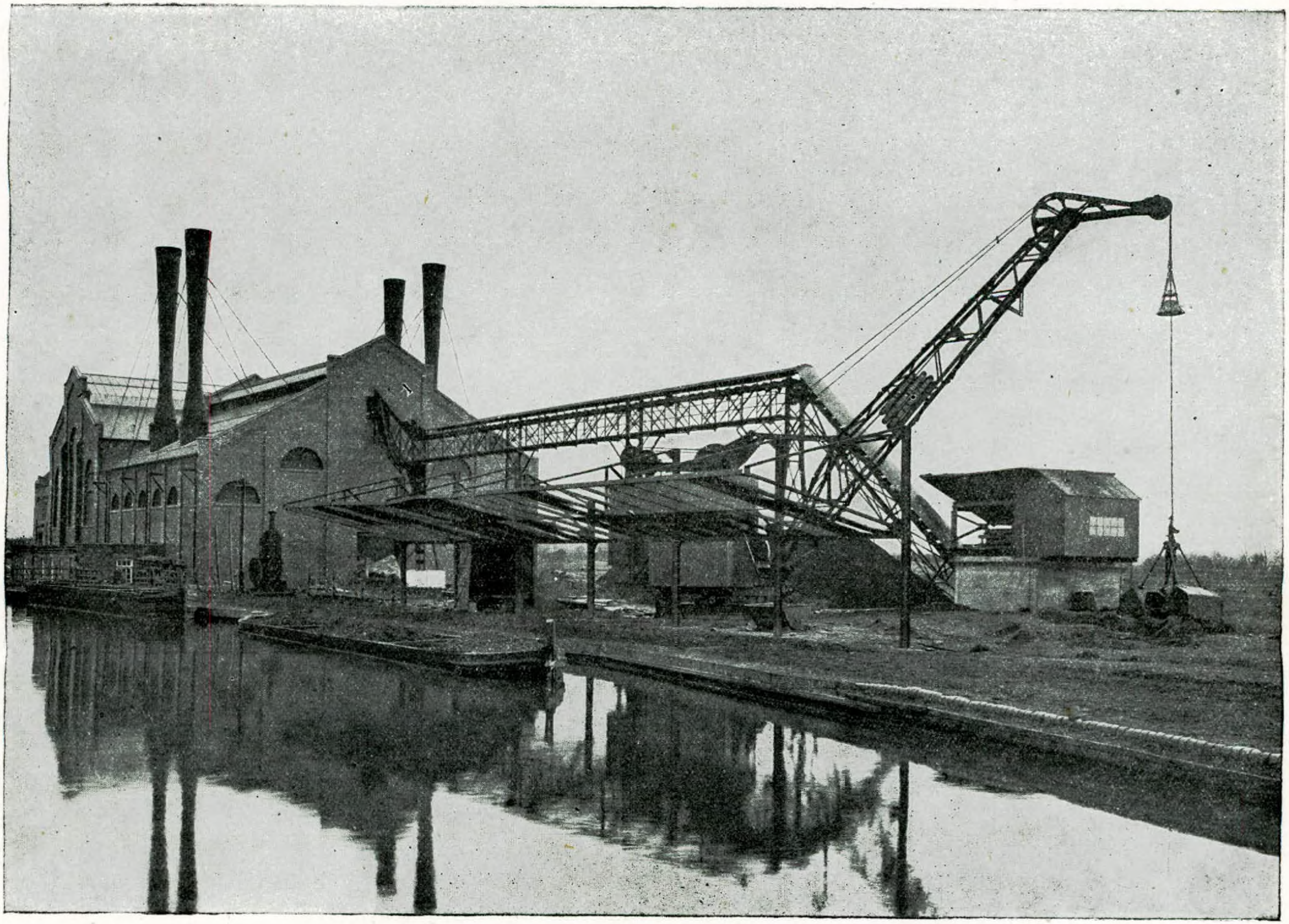
153B.—Two diagrams, North Metropolitan Electric Supply Co., Brimsdown.



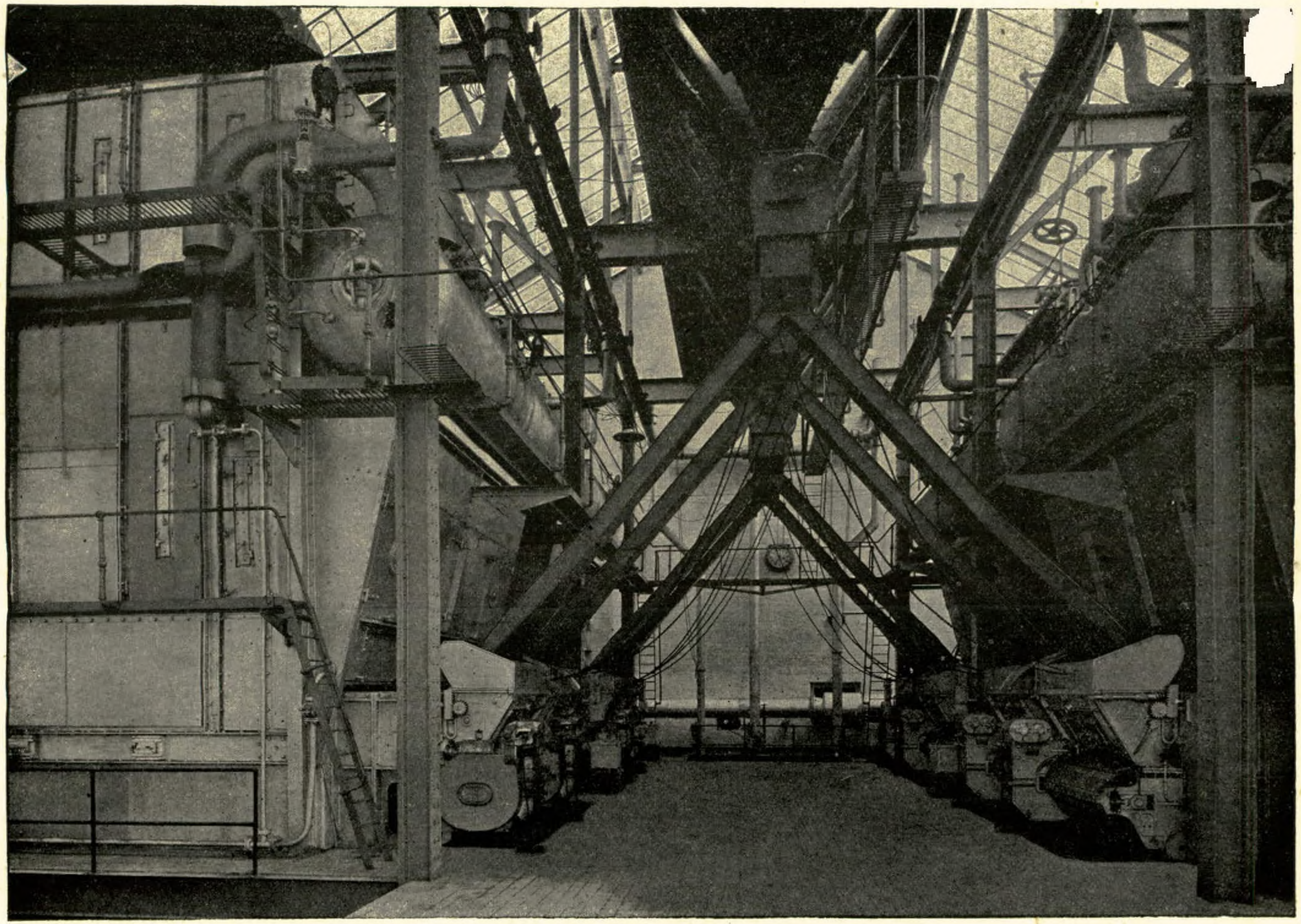
153C.—London and North Western Railway Co's. Electric Generating Station, Stonebridge Park, London.



153D.—Gravity bucket conveyers, top of storage bunkers, Manchester Corporation Electricity Works.



154.—County Borough of Wallsall, Electricity Works, Wallsall.



155.—County Borough of Wallsall, Electricity Works, inside view.

ASH & CLINKER

18	Total per hour		lbs. 281
19	Carbonaceous matter in ash per hour ..	lbs.	not measured
20	Calorific value of ash	per lb.	not measured

FLUE GASES

			By Volume		By Weight
21	Analysis of dry flue gases—				
	Carbonic Acid ..	per cent.	12·6	..	18·4
	Carbonic Oxide ..	per cent.	nil.	..	nil.
	Oxygen	per cent.	6·8	..	7·2
	Nitrogen (by difference) ..	per cent.	80 6	..	74.4
22	Average temperature leaving boiler flues		°F	..	613·
23	Mean specific heat of products of combustion B.T.U.			..	257·

AIR AND DRAUGHT

24	Temperature of outside air	°F ..	64·
25	Barometric pressure (Inches Mercury) ..	lbs. per sq .in.	not measured
26	Pressure in ash pit (forced draught) ..	inches in water,	open ashpit
27	Pressure over fire (forced draught) ..	inches in water,	open ashpit
28	Draught at gas exit from boiler	inches in water,	·55
29	Draught at base of chimney	inches in water,	·71
30	Weight of steam per hour used in producing draught in lbs.		not measured

BOILER. Sheet 2.

Data deduced from observations.

FEED WATER

Ref. No.	Particulars of Observations.	Abstract of Observations.	
31	From pump economiser of feed heater ..	lbs. per hour	25,448
32	Temperature of feed to Boiler	°F ..	202.

STEAM

33	Gauge pressure	lbs per sq. in.	180.
34	Absolute pressure	lbs. per sq. in. approx.	195
35	Total moisture in steam	per cent.	not measured
36	Temperature of saturation	Fahr.	380

BOILER. Sheet 3.

HEAT ACCOUNT AND DEDUCTIONS

Ref. No.	Heat Account (per lb. of fuel as fired)	B.Th.U	per cent.
37	Total heat value of 1 lb. of fuel as fired ..	10,411	100·0
38	Heat transfered to the water (Thermal Efficiency) ..	8,381	80·5
39	Heat carried away by products of combustion	1,246	12·0
40	Heat carried away by excess air	395	3·8
41	Heat lost by incomplete combustion ..	—	—
42	Heat lost by unburnt carbon in ash ..	Not measured	—
43	Loss per hour by radiation ..	Not measured	—
44	Balance of heat account, errors of observation and unmeasured losses such as those due to radiation, escape of unburnt hydro-carbons, superheating moisture in air, loss in hot ashes, &c.	389	3·7
	Total of lines 38 to 44, equal to line 37 ..	10,411	100·0

DEDUCTIONS

45	Heat transmitted per square foot of heating surface	B.Th.U.	—	6,588
46	Weight of fuel fired per square foot of grate per hour	lbs.	—	26·3
47	Water evaporated per pound of fuel as fired	lbs.	—	6·915
48	Equivalent evaporation from at 212 °F. per lb. of fuel as fired	lbs.	—	8.644
		including superheat.		
51	Air used per lb. of fuel as fired ..	lbs.	—	10·88
52	Air theoretically required per lb. of fuel as fired	lbs.	—	7·92
52a	Excess air used per lb. of fuel as fired ..	lbs.	—	2·96
49	Weight of feed from and at 212 °F. per square foot of heating surface per hour ..	lbs.	—	8·0
		including superheat effect.		
50	Velocity of steam across water surface feet per second			not measured
53	Ratio of air used to air theoretically needed	..		1·37
54	Weight of products of combustion per lb. of fuel as fired	..		8·83
55	Weight of gases per lb of fuel as fired ..	lbs.	—	11·79
56	Heat carried away by gases per lb. of fuel as fired	..		1,641

ECONOMISER AND SUPERHEATER. Sheet 1.

GENERAL DESCRIPTION AND DIMENSIONS.

General Description of Economiser and Arrangement of Flues, &c.

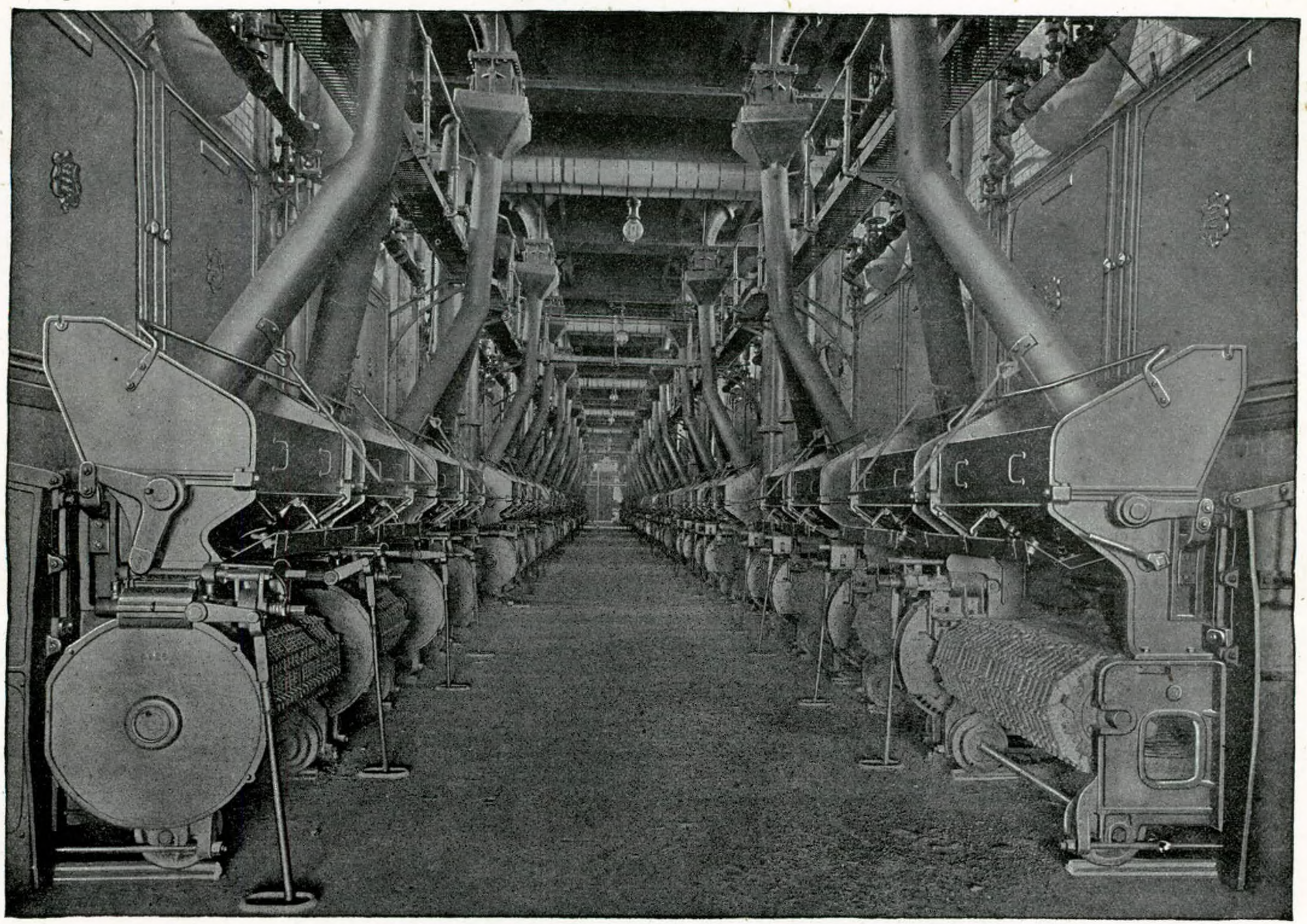
57	Horizontal steel tubes, three pass, on top of boiler		
58	Heating surface of economiser	sq. ft.	2,104

SUPERHEATER

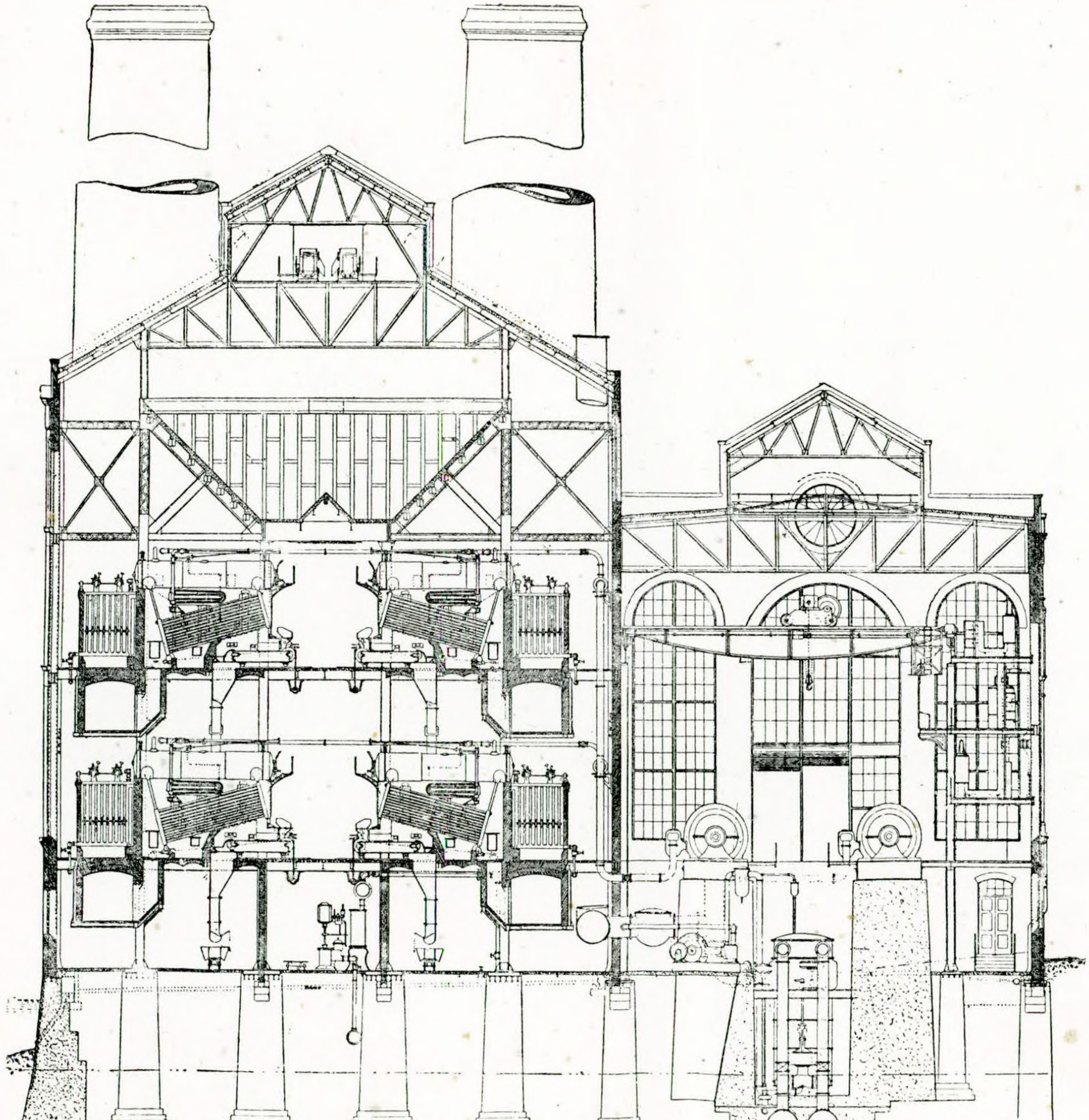
59	General description of superheater and of method of heating it		Integral
60	Heating surface	sq. ft.	1,468

DATA DEDUCED FROM OBSERVATIONS

	ECONOMISER. (Heating of Feed by Flue gases)		Abstract of Observations.		Remarks
61	Weight of feed watering economiser per hour		lbs.	—	25,548
62	Temperature of feed into		°F.	—	110
63	Temperature of feed out of		°F.	—	202
64	Temperature of flue gases into		°F.	—	613
65	Temperature of flue gases out of.. ..		°F.	—	372
			By		By
66	Analysis of dry flue gases leaving economiser—		Volume		Weight
	Carbonic Acid	per cent.	12·6	..	18·4
	Carbonic Oxide	per cent.	—	..	—
	Oxygen	per cent.	6·8	..	7·2
	Nitrogen (by difference) ..	per cent.	80·6	..	74·4
67	Mean specific heat of flue gases leaving economiser		B.T.U		25·6



156.—Underground Electric Railways, Lots Road, boiler-house.



157.—Underground Electric Railways, Lots Road, elevation of power house, with scale.

ECONOMISER AND SUPERHEATER. Sheet 1.

GENERAL DESCRIPTION AND DIMENSIONS.

SUPERHEATER

68	Weight of steam entering superheater per hour	lbs.	25,448
69	Steam pressure (absolute) into	lbs. per sq. in.	approx. 195
70	Moisture of steam into	per cent.	Not measured
71	Temperature of steam into	°F.	— 380
72	Temperature of steam out of ..	°F.	— 720
73	Temperature flue gases into	°F.	— 1,159
74	Temperature of flue gases out of °Fahr.	..	835
75	Analysis of dry flue gases leaving superheater—	By Volume	By Weight
	Carbonic Acid	per cent.	not measured
	Carbonic Oxide	per cent.	not measured
	Nitrogen (by difference) ..	per cent.	not measured
	Oxygen	per cent.	not measured
76	Mean specific heat of flue gases leaving superheater B.T.U.	not measured	

ECONOMISER AND SUPERHEATER. Sheet 2.

HEAT ACCOUNT AND DEDUCTIONS.

77 HEAT ACCOUNT (per lb. of dried fuel)—

ECONOMISER.

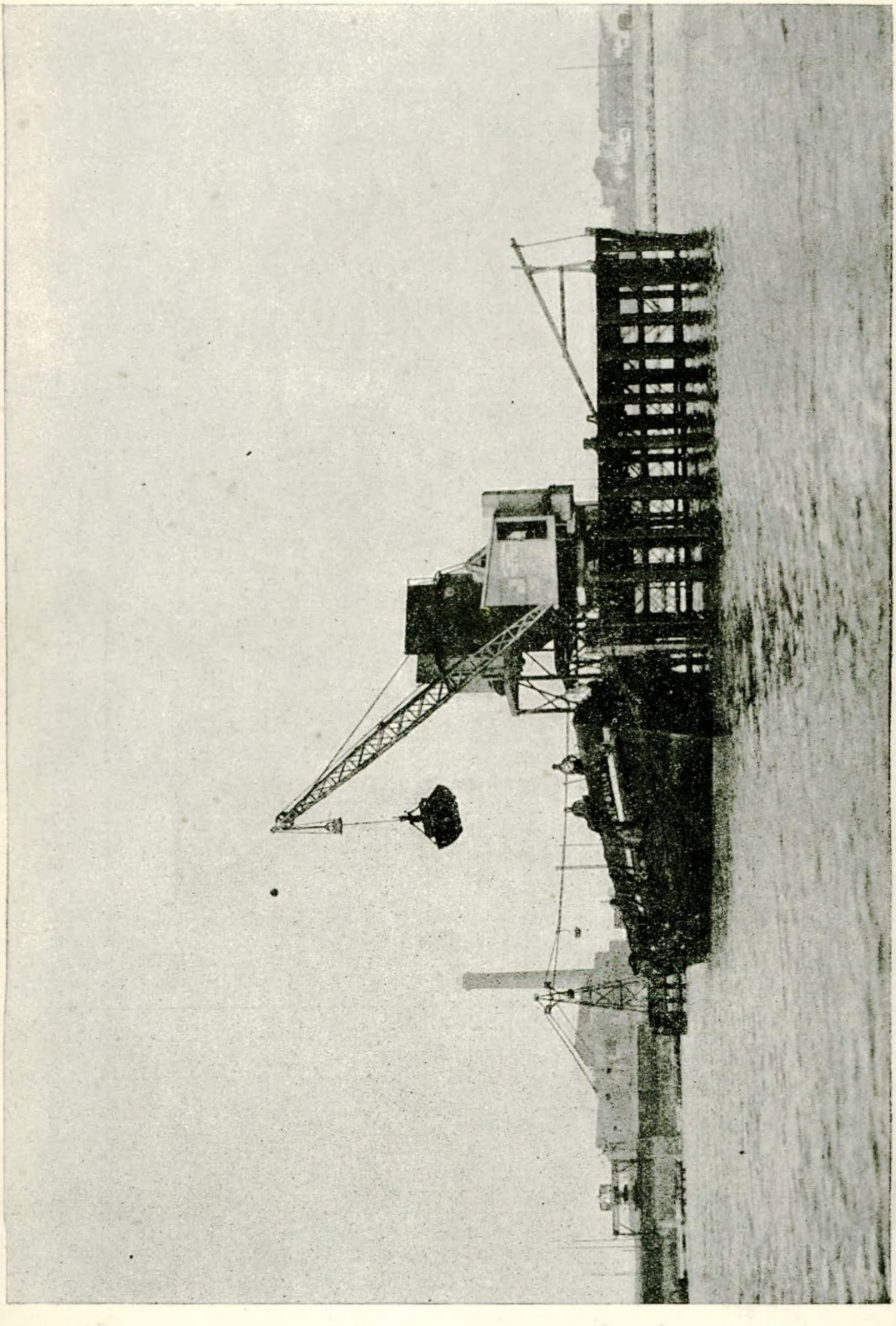
	Heat received from boiler flues, in gases and steam, per lb. of dried fuel (reckoned from air temperature) ..	B.TH.U. 1,641	per cent. 100·0
78	Heat transferred to the water (EFFICENCY OF ECONOMISER)	636	38 8
79	Heat carried off in the chimney gases ..	918	55 ·9
80	Balance of Heat Account, including errors of observation and difference of heat contained in brickwork at beginning and end of tests, &c.	87.	5·3
81	SUPERHEATER. Total of lines 78 to 80, equal to line 77 ·	1,641	100·0
	Heat received from flue gases and steam, per lb. of dried fuel (reckoned from air temp)	—	100·0
82	Heat transferred to steam (EFFICIENCY OF SUPERHEATER).	•	
83	Heat carried off in the chimney gases ..	Included in Boiler.	
84	Balance of Heat Account, including errors of observation, &c.	Included in Boiler.	
	Total of lines 82 to 94, equal to line 81 ..		100·0

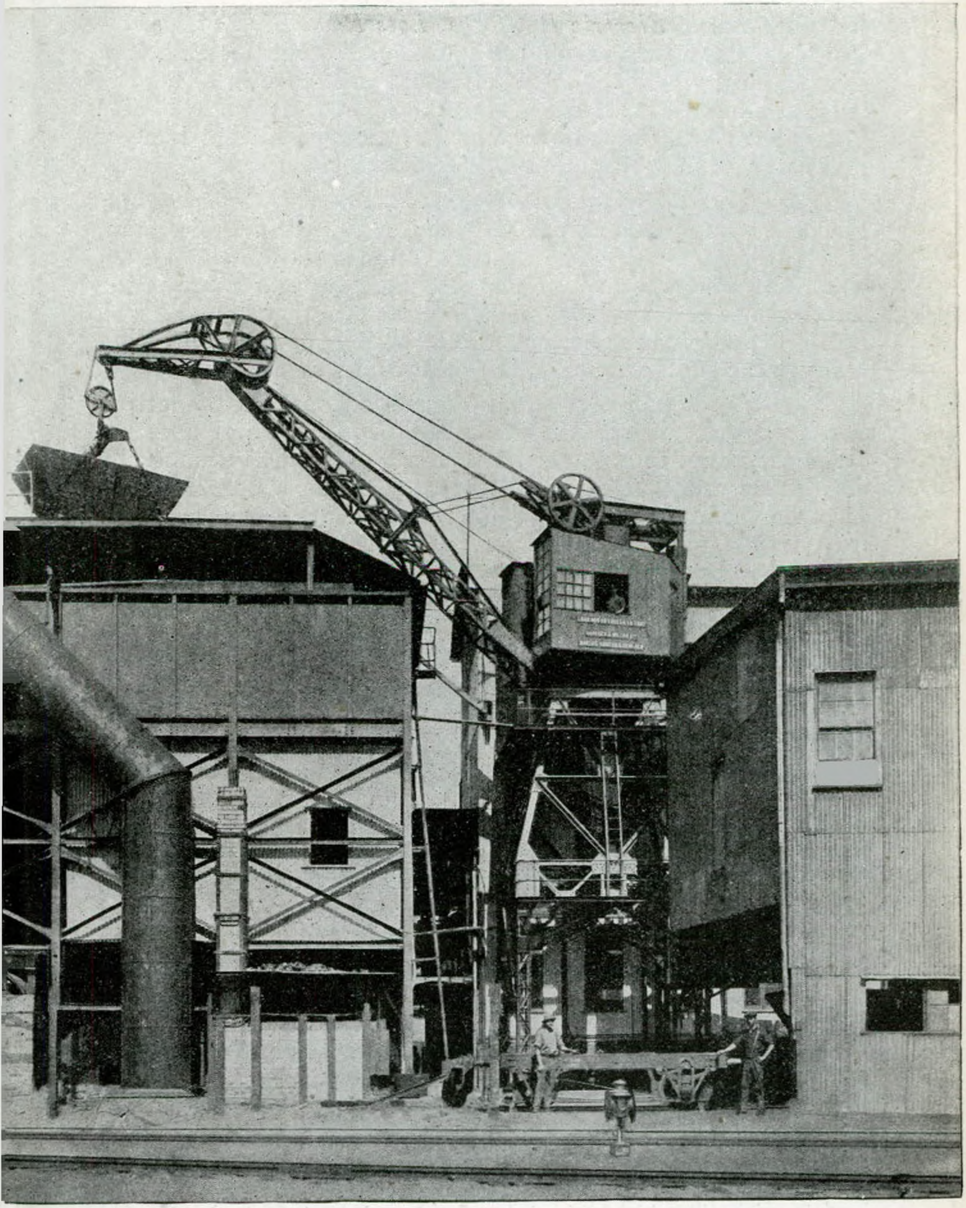
DEDUCTIONS.

85	Heat transmitted per square foot of heating surface of economiser per hour ..	B.TH.U.	-1,113
86	Heat transmitted per square foot of heating surface of superheater per hour ..	B.TH.U.	3,195
87	THERMAL EFFICIENCY of boiler and economiser combined	per cent.	86 6

FURTHER REMARKS.

At the completion of the normal load test, the output of the boiler was increased to a rate of 31,547 lbs. per hour, for a period of 38 minutes, at the end of which time the evaporation had to be reduced on account of the load on the station falling considerably.





157B.—10-ton lever balanced luffing crane for power station, Brisbane Tramways Co.

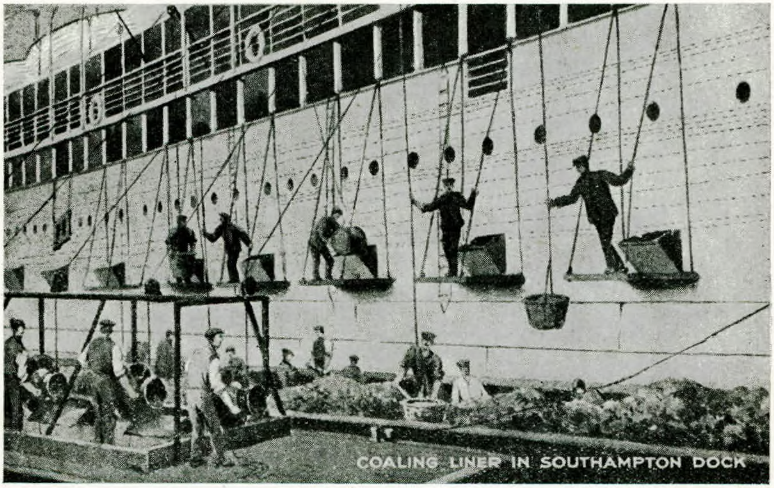
Underground Electric Railways, Lots Road Boiler House.—This gives you an idea of the inside of a large boiler house. Very careful records of each individual unit have to be kept in these stations. Coal being one of the principal costs. These plants have to be kept in the best of condition so that none of this valuable material is wasted if it can be avoided.

Underground Electric Railways, Lots Road, Elevation of Power House.—This elevation is shown to give you a general idea of this station. The overhead bunkers are clearly seen, with the conveyers on top, also a rather unique feature is the two floors of boiler rooms, one above the other, designed for 80 Babcock and Wilcox boilers. The position of the generating plant in the engine house on the right is also seen.

The Usina Electra, Monte Video.—This method of getting coal from craft is adopted where the depth of water does not allow the vessel to get near the shore. The coal is grabbed by an electric crane fitted with grab, erected on a dolphin some distance from the shore. The grab discharges its load into travelling skips that travel on an overhead wire, taking the material to the storage bunkers. The power house can be seen in the distance. The discharging crane is electrically operated and is of $2\frac{1}{2}$ ton capacity with a radius of 32 ft. 9 ins., built for the Usina Electrica, Monte Video.

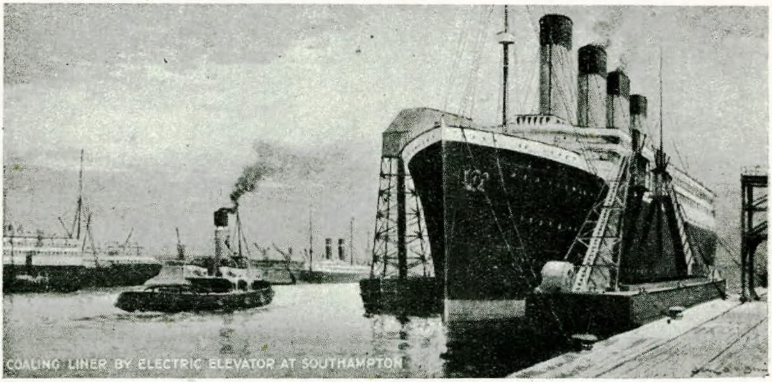
Ten ton Lever Balanced Luffing Crane for Power Station Coal Supplies for the Brisbane Tramways Co., Ltd.—Another method of dealing with the elevation of coal for power stations is that of the Brisbane Tramway Co., Ltd., where special wagons are elevated by a 10-ton electric crane. These wagons are equipped with bottom doors, which, when over the top of the coal storage hopper, are opened, thus releasing the material. This crane is fitted with the Babcock and Wilcox lever luffing and balanced jib apparatus, and as seen in the illustration the jib is extended to its maximum of 30 ft. discharging a wagon of coal into the top of the bunker.

Coaling Liner at Southampton by Electric Winch Barge.—Coaling by electric winch barge at Southampton is similar to other port winch barge work, with the exception of a few details of power application. Current is derived from the port authorities, so that there is not so much smoke flying about owing to the absence of boilers aboard the barge; also the electric barge is much smaller than the usual steam winch barge, thus, can get to more awkward places. This view shows side port bunkering with the aid of winch barges for elevating the baskets of coal. These baskets hold from $1\frac{1}{2}$ to 2 cwts of coal. There appears to be a great deal of labour employed by this basket work,



164.—Coaling liner at Southampton, by electric winch barge.

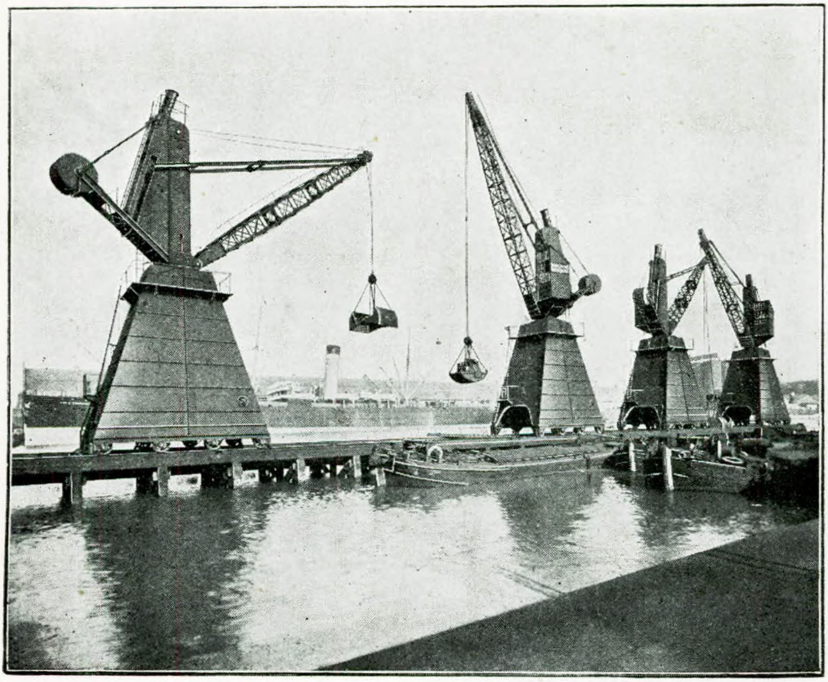
but there is much to be said in its favour particularly if you take the cosmopolitan types of steamers that go to the various docks into consideration, and in the aggregate probably there may not be so much labour with this system compared with mechanical bunkering as may appear, but as I say this depends



165.—Coaling liner at Southampton, by electric elevators.

on the class of vessel to be bunkered, the facilities for stowing the bunkers, the receipt of the coal from the colliery to the dock, and in many cases the quantity of coal required as bunkers.

This shows machine bunkering at Southampton, outside of the ship you will see a Clark's machine delivering into side ports, similar to inside machine which is one of Doxford's "The Portrush." Like Liverpool machines these are not self-propelling, but have to be towed about to where the ship lays, then when empty they are towed back to discharging wharf to be re-loaded. The machines are fitted with electro-motors, but no prime movers, as the current necessary to work these machines can be obtained practically within a few yards of any part of the dock. This is a point well worth copying by other dock authorities, not so much as making a profit from, but as a lead for mechanical bunkering, thus generally assisting the quicker dispatch of the vessels.



165A.—Rea's discharging plant at Liverpool Docks.

"Portrush" (Doxfords).—The "Portrush" is another of Messrs. Doxford's design, and works practically on the same principle as the discharging apparatus of the *Herman Sauber* previously described, excepting as this vessel is for bunkering it is designed to deliver the coal sufficiently high for side port work of large liners. The capacity of the machine is 725 tons on 10 ft. 9 in. draft, length 172 ft. 8 ins. × 27 ft. $10\frac{1}{2}$ ins. × 15 ft. The machine is fitted with a double set of conveyers and ele-

166.—Coaling at Liverpool by mechanical elevators.

vaters, delivering the coal through adjustable telescopic shoots to the side ports. The motive power is obtained from the shore and supplied through flexible cables to a 20 h.p. motor for each set of elevating gear. After the coal is taken from the hold of the machine and before it passes to the elevator, the coal goes through a sizing apparatus, breaking up the large pieces to a suitable size. The machine works very efficiently and can put 250 tons aboard in an hour. It has to be towed wherever wanted, but at Southampton where there are no lock gates to contend with this is not such a serious matter as at most other docks. This machine is the property of Messrs R. and J. H. Rea.

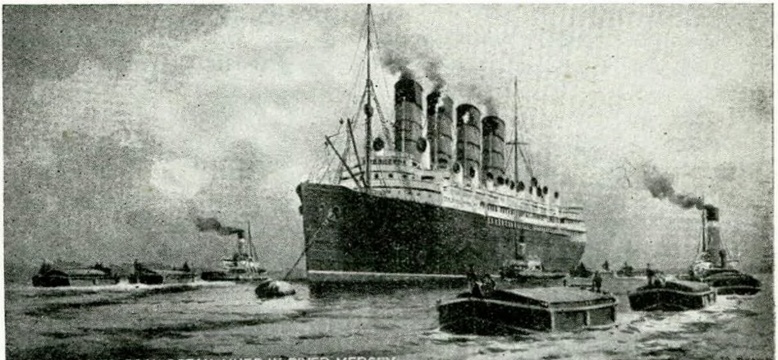
Rea's Discharging Plant, Liverpool.—Liverpool is favourably situated for the receipt of local coal from the coalfields by means of direct railway communication, therefore a large portion of the coal used is sent direct in wagons. However, there are kinds of coal, such as the Welsh coals shipped in the South Wales district when it is better to transport this material by sea, this of course necessitates discharging machinery to empty the colliers rapidly. The type of plant now under review is that known as the luffing jib cranes, and in this instance the power utilised is hydraulic. Built by the East Ferry Road Engineering Works, Co., London, the plant consists of four units of five ton self propelling cranes, fitted with the Priestman double rope grab capable of "grabbing" about $2\frac{1}{2}$ tons of coal at each operation. As the system of coal bunkering at Liverpool requires large barges—5 to 600 tons—and as the pier at this discharging wharf is not wide, you will see that when discharging operations are under way that these matters all tend to the rapid handling of the material. The actual working speeds with a full load of five tons, that is grab and coal, were as follows:—

Lifting, 203 ft. per minute. Luffing from 45 ft. to 20 ft., 10 seconds. Slewing half revolution, 20 seconds. Travelling on quay, 28 ft. per minute.

Messrs. Rea have made it a study in the Liverpool Docks to cope with the rapid bunkering of vessels of all descriptions. This discharging plant is situated in the Birkenhead Dock, Liverpool.

Coaling by Mechanical Elevators in Liverpool Docks.—This view shows rather a busy coaling scene, yet it is an every day occurrence at Liverpool, where they have carried out mechanical bunkering for some number of years. Here we see two of Campbell's machines grabbing coal from barges of 600 or 700 tons. The coal is elevated by grab and deposited into a hopper, which feeds a conveyer belt, this takes the coal to the point where it is required on deck. You will see that Messrs. Rea have thus added a conveyer to this type of machine, and at the same time they have done away with one of the jibs on which the grab traversed along on to the vessel where it discharged its coal. Quite a considerable amount of rocking motion goes on with this class of machine, due to the loaded grab out on the jib traversing into the centre then going back light. Sometimes this motion is aggravated by the cycle of operations synchronising with the roll of the machine, thus gathering a little more roll every time. This machine is not used for side port bunkering, and for overall coaling the average working is about 1,200 tons in 24 hours with a clear delivery. The bunkering on the other side of the screen shows the Clark's machines at work. The idea of these is that of an endless belt passing above the keel of the vessel, receiving the coal from the hold of machine, elevating it in swinging buckets to the top of the structure, tipping the buckets there into a receiver, which can distribute the coal down one or more telescopic spouts to the point required, the empty buckets travel down to the other end of the vessel and repeat the operation. The whole of the coal in the machine can be taken out without trimmers, as when the coal gets slow on going to the buckets a hydraulic ram lifts the bottom up on each side thus giving the coal a fall towards the conveyer buckets. They bunker at about 250 tons per hour. These machines are not self-propelling, they are efficient at their work, but rather awkward getting about the docks, as tugs have to be in attendance. They all offer a huge area for stormy weather affecting them, particularly the higher type of machine for overall bunkering, similar to the nearest machine of Clark's. The further machine is used for side-port bunkering. No matter what height the coal has to be delivered all of it must be elevated to the top then go down the spout. Although this is bad practice from an engineering point, and also as regards the breakage of fuel and its results are liable to create spontaneous ignition. Yet this has a decided advantage in the labour of bunkering as the coal has gained quite a considerable momentum, so much so that on many an occasion the coal can fill the bunkers right up to the top with practically little effort on the part of trimmers. The spouts delivering the coal like so much high pressure water from a fire hose.

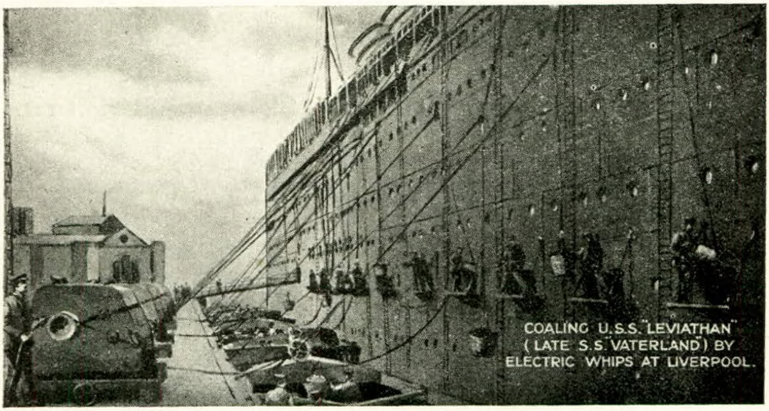
Liverpool bunkering differs somewhat from other places as the coal is mostly brought to the port in wagons. These wagons



188A.—Preparing to coal ocean liner in River Mersey.

are tipped into the bunkering machines (Clark's 1,100 tons) at night time. The other coaling barges are mostly of 600 to 700 ton capacity, and generally the shipping is of a large scale. All this facilitates mechanical bunkering.

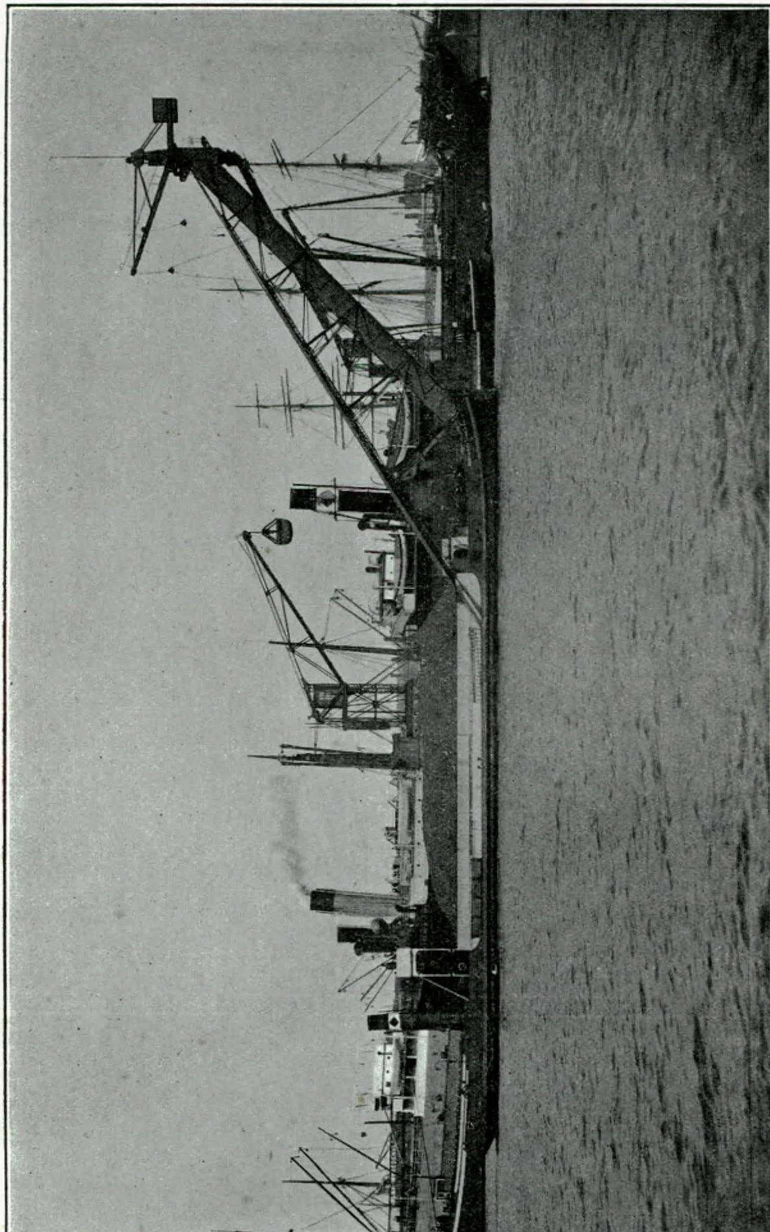
The next view illustrates this large type of shipping, while the following picture shows a recent application of whipping by an electric winch fitted on a portable truck, elevating coal from barges to vessels side ports by means of baskets. All this plant is the property of Messrs. Rea and Co., who cope with this class of work with the greatest dispatch.



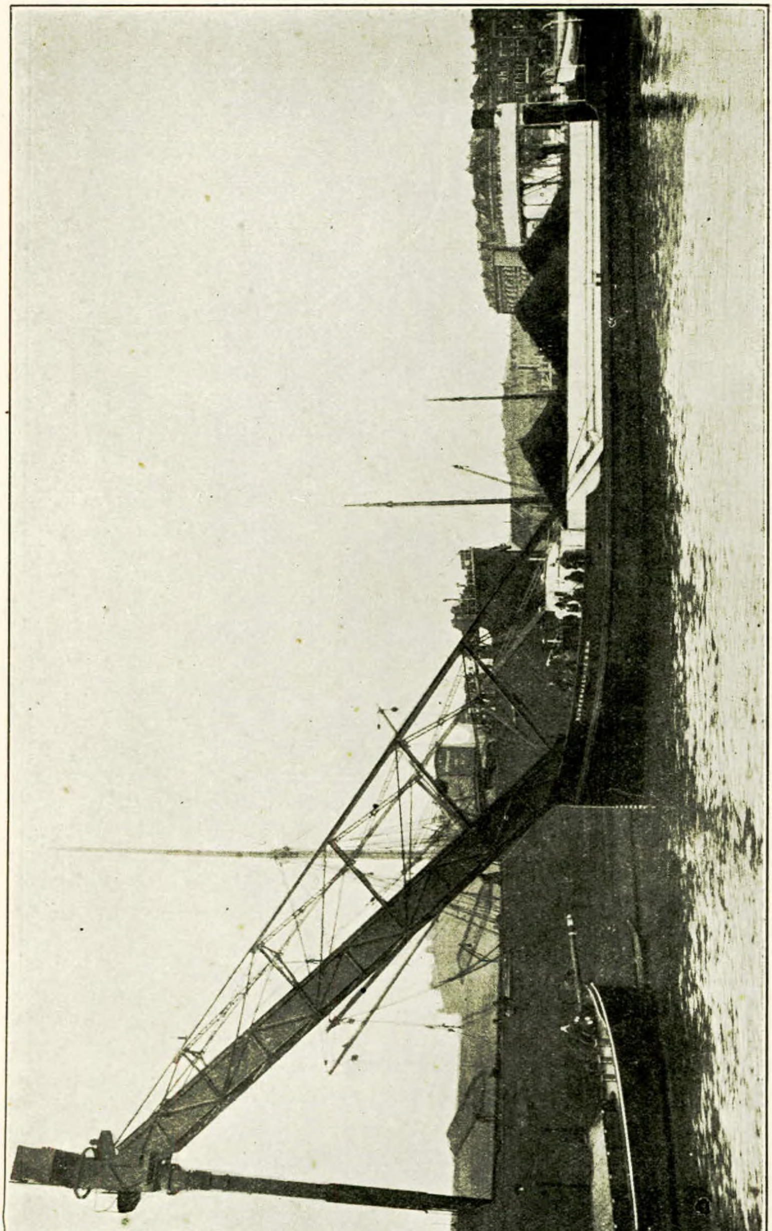
166B.—Coaling U.S.S. "Leviathan" by electric whips, at Liverpool.

A great deal of the success or failure of mechanical bunkering depends on local conditions, such as the quantities usually supplied to vessels, the type of steamers running to the port, and the facilities for loading the bunkering machine. Whatever may be the cause there is no getting away from the fact that we are a long way behind in this country in comparison to some of the Continental ports in this matter of rapid handling of bunkers by mechanical means. This adds considerably to the time some of our ships have to stay in port, because with many cargoes it is not possible to combine to two operations of either unloading or loading at the same time that coal is put aboard.

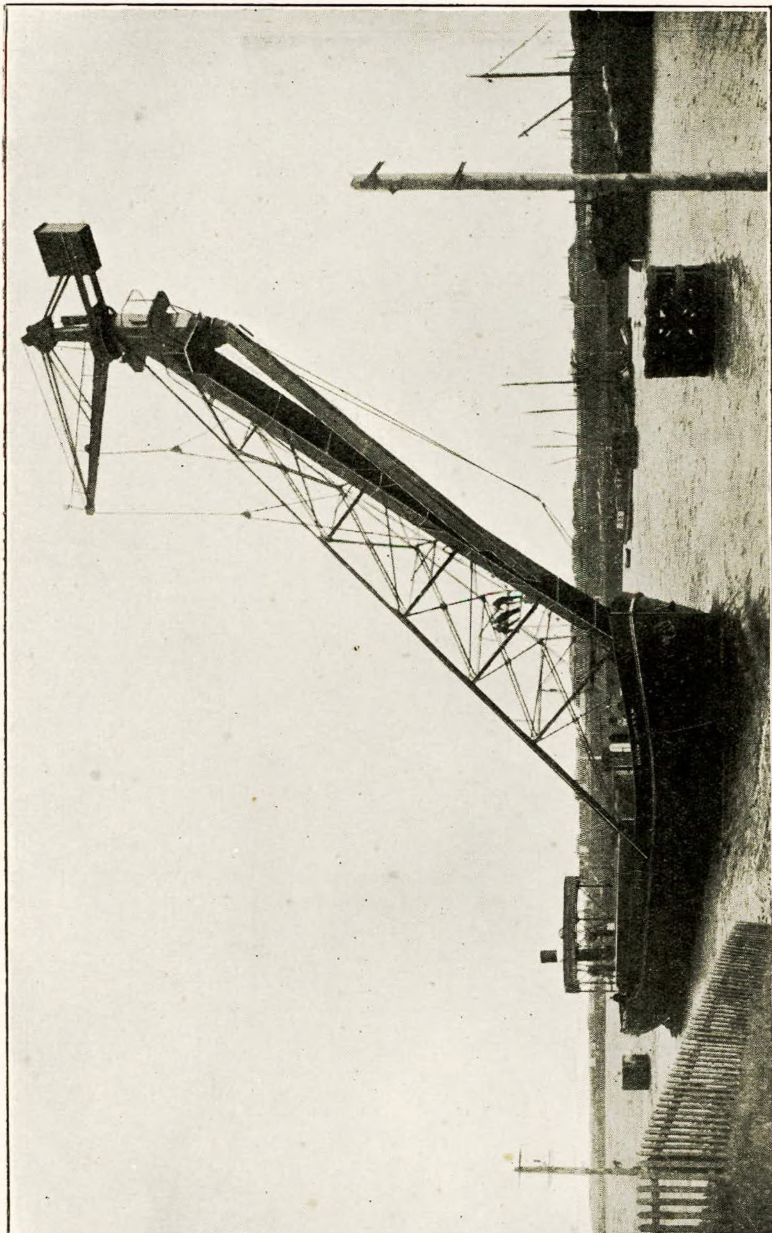
Again there is much to be said as regards the design of bunkers, or perhaps it would be better to say the lack of design in bunker space. It appears to the writer that in many ships



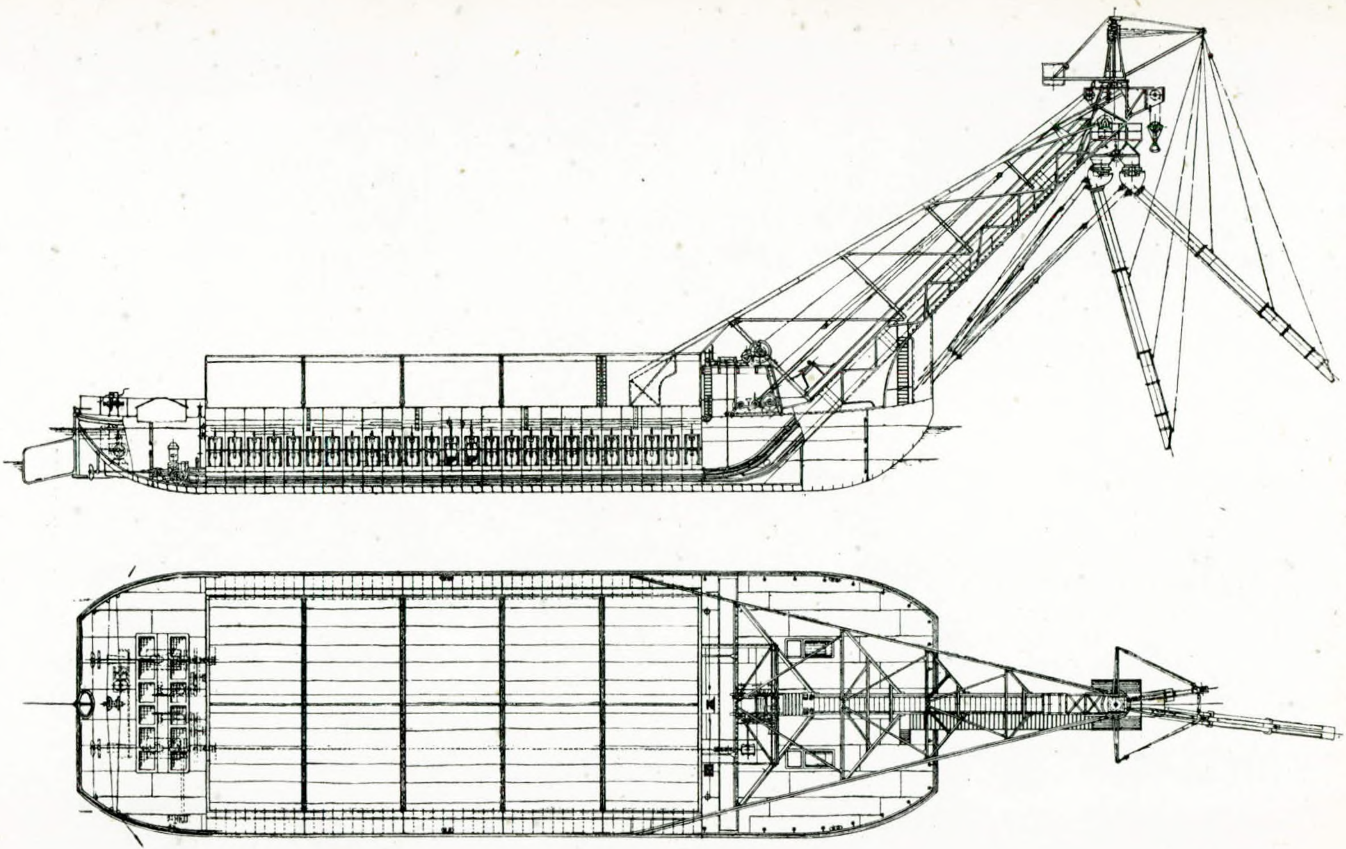
173.—Werf Conrad bunkering craft at work.



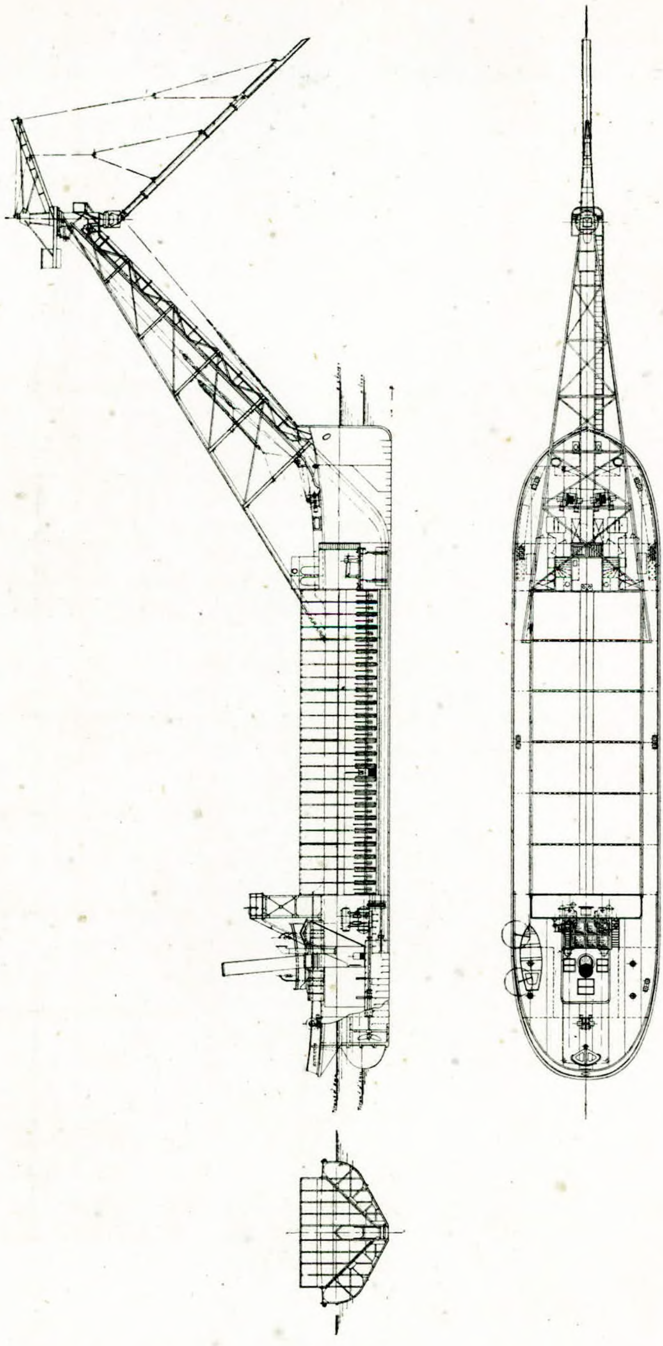
173A.—Werf Conrad bunkering craft loaded.



173B.—Werf Conrad bunkering craft empty.



173c.—Werf Conrad motor bunkering craft, diagram.



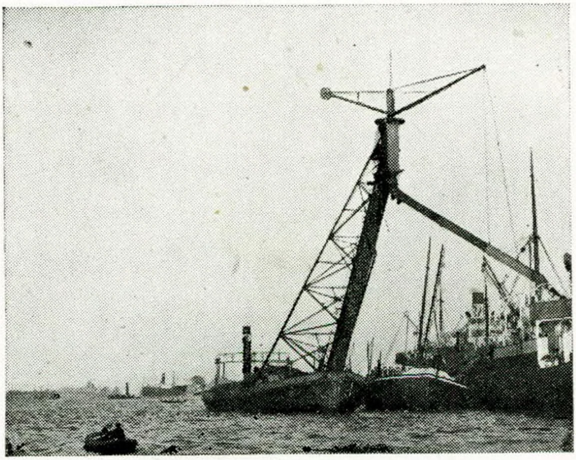
173D.—Werf Conrad steam driven bunkering craft, diagram.

any space amidships that cannot be used for anything else is utilised for stowing coal in. I suggest this simple detail of ships' bunkers is one of the principal things that will assist us to utilise a steamer in a more efficient manner, thus doing away with a lot of time spent in port so that the ship could be more usefully employed conveying cargoes to and fro' instead of occupying so much time with trimming operations by hand labour, probably shovelling most of the coal three or four times, breaking the fuel up and creating so much dust as to prohibit any other operation being done anywhere near.

All bunkers should be self-trimming, this covers the whole suggestion, then bunkering apparatus could be applied to load at any speed one likes, depending on how much one is prepared to expend in capital cost. However, machines are in existence capable of doing over a 1,000 tons per hour with a free run, this rate does not last for long excepting in the case of very few ships indeed, the machine having to be stopped for the hand trimming aboard the steamer being bunkered. The plant now under review is that known as the "Werf Conrad" Bunkering Craft, made by this firm at their shipbuilding works in Haarlem, Holland. These handy machines are built of a carrying capacity of about 800 tons, and are fitted with discharging apparatus to trim, elevate and deliver this cargo through a spout at a rate of 200 tons per hour, the holds are made self-trimming, whereby the coal goes to an endless conveyer throughout the length of the vessel. This conveyor rises up inside the steel casing shown in the views to a height of about 65 feet above the water line when the machine is loaded, and from this point the coal slides down an adjustable telescopic spout to the hatch opening or side ports of the steamer. Automatic weighing machines are installed which register the weight of the coal passing a certain place near the fore end of the vessel.

These machines are self-propelling, driven by a pair of engines with twin screws. One of these engines drives the elevating gear, the other may be used for this purpose if anything fails with the one connected. Other machines installed are driven by oil motor engines, the design of the bunkering being practically the same as the steam driven machines.

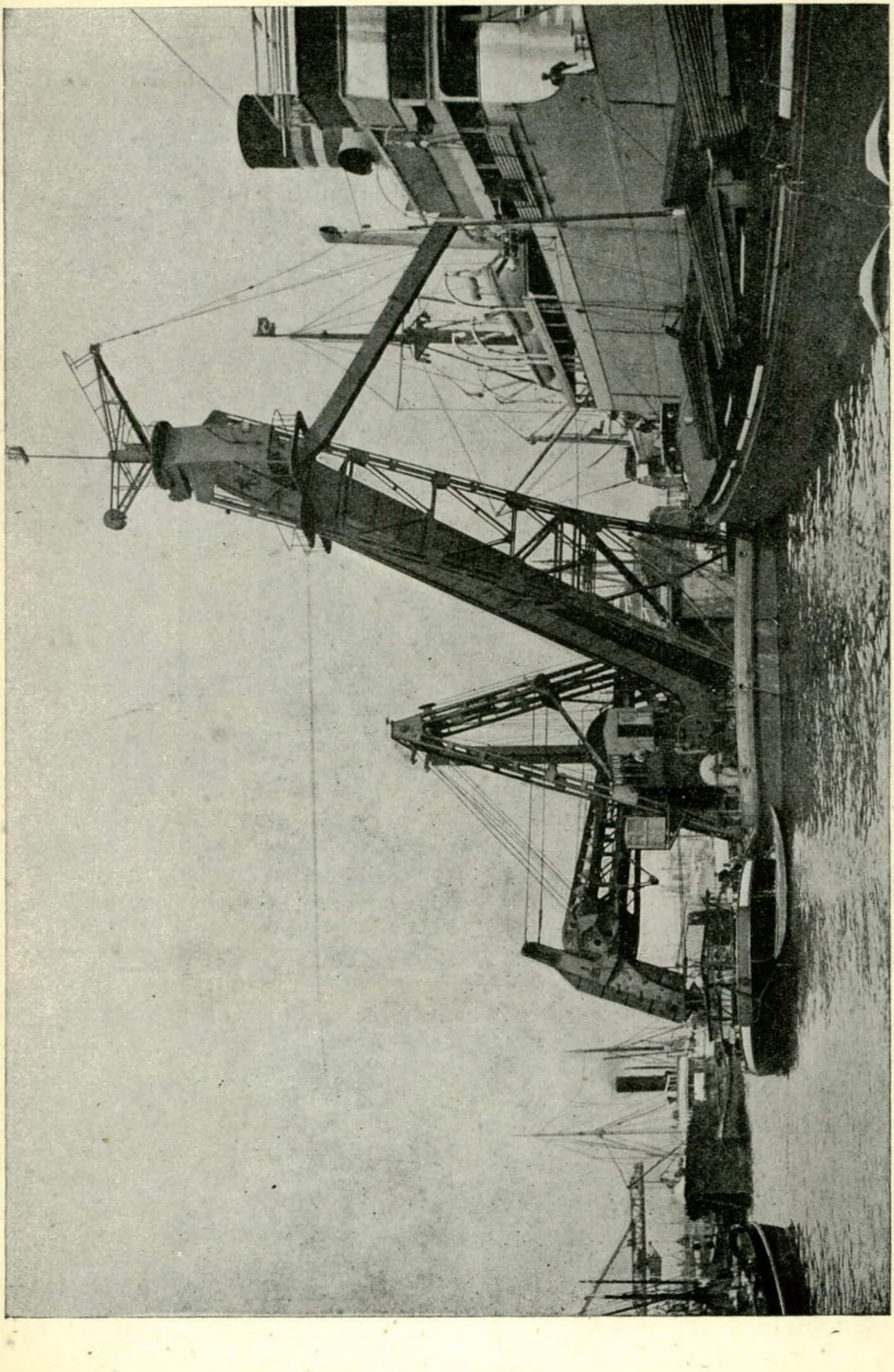
Werf Gusto Machines Bunkering the Starboard Bunkers from the Port side.—These vessels are usually divided into compartments, as shown, and the coal may be taken from any of these divisions by opening a sliding door, thus allowing the coal to fill the buckets of the conveyer, which runs in a tunnel above the ship's keel. Any doors may be opened, thus, if there are more than one kind of fuel aboard they may easily be mixed if desired. From experience the writer can definitely state that there is a lot to be gained by judicious blending of fuel, but to get the best results this operation must be done mechanically. The endless conveyer is driven by one of the twin engines



169.—Werf Gusto machines bunkering the starboard bunkers from the port side.

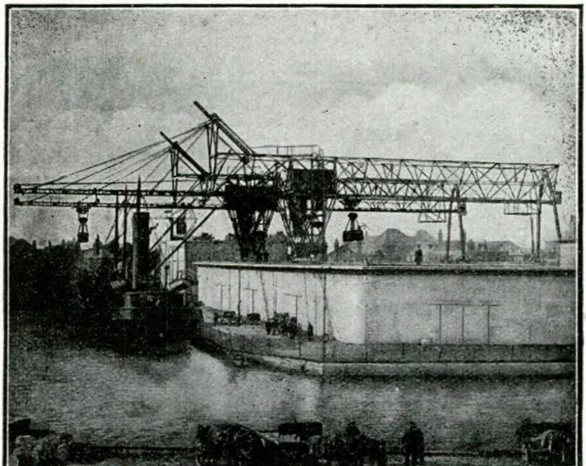
of the ship, and the coal may be weighed on this conveyer, if desired. The whole of the conveying apparatus is covered so that there is no spilling of coal, neither is there any dust. The coal is delivered from the conveyer at the top of the ladder into a receiver, and then slides down the telescopic shoot to the bunkers. The ladder of the older pattern machine could be raised or lowered by means of wire purchase, but I believe most of the new machines have a more rigid build, similar to the view shown. The shoots are made adjustable to any point, depending on the height of the machine, as for example in the illustration the machine is delivering coal to the starboard bunkers from the port side. No doubt you may see some advantage in this, particularly if a cargo barge happens to be working at a place where it may be necessary to work at the same time as receiving coal aboard. Machine capacity, 700 tons; discharge, 100 to 150 tons per hour.

"*Westfalen.*"—Mechanical bunkering is carried out extensively on the Continent, and the results of previous machines



paved the way for a vessel of a much higher discharging output. A similar machine to the one now under review, "The Holland," has quite a combination of coal deliveries. "The Westfalen" started working in the middle of 1912, and proved quite a success. In this vessel the idea of wagon delivery conveyer was abandoned, so that the scheme is less complicated than the "Holland" previously mentioned. Various details were improved as found by previous experience.

The machine is used purely for the discharge of barges by means of digging buckets, and elevating gear to raise this coal to the top of a telescopic shoot where it is delivered to the steamer being bunkered. At the trials the contract rate of 600 tons per hour was easily done, as a matter of fact the high figure of 1,052 tons per hour was reached. This type of machine may also be used to discharge coal from colliers either into barges or direct into larger vessels bunkers.



1004A.—Fraser and White's coal handling plant at Portsmouth.

Messrs. Fraser and White's Coal Handling Plant at Portsmouth.—This plant, built by Sir Wm. Arrol and Co., was erected at Portsmouth for Messrs. Fraser and White (1914). It is erected on the top of a reinforced concrete coal store, built on the Kahn system. The store has a capacity of 15,000 tons when fitted to a surcharge of 6 ft., it being approximately 240 ft. long by 90 ft. 6 in. wide at one end, and 97 ft. at the other. The track for the cranes to travel on is placed on the top of the walls, and the transported back frames are fitted with a compensating bearing so as to adjust itself to the rails which are not parallel by 6 ft. 6 ins. in the length of the store. The water side supporting framework is rigid with the transporter girder. The grabs are of the double rope type and may be transported in either direction either open or closed as desired.

Equipment:—

Hoisting motor,	65 H.P.,	600 revs. per minute	
Transporting ,,	30 ,,	,, ,, ,, ,,	
Travelling ,,	15 ,,	,, ,, ,, ,,	
Beam lift ,,	10 ,,	700 ,, ,, ,,	

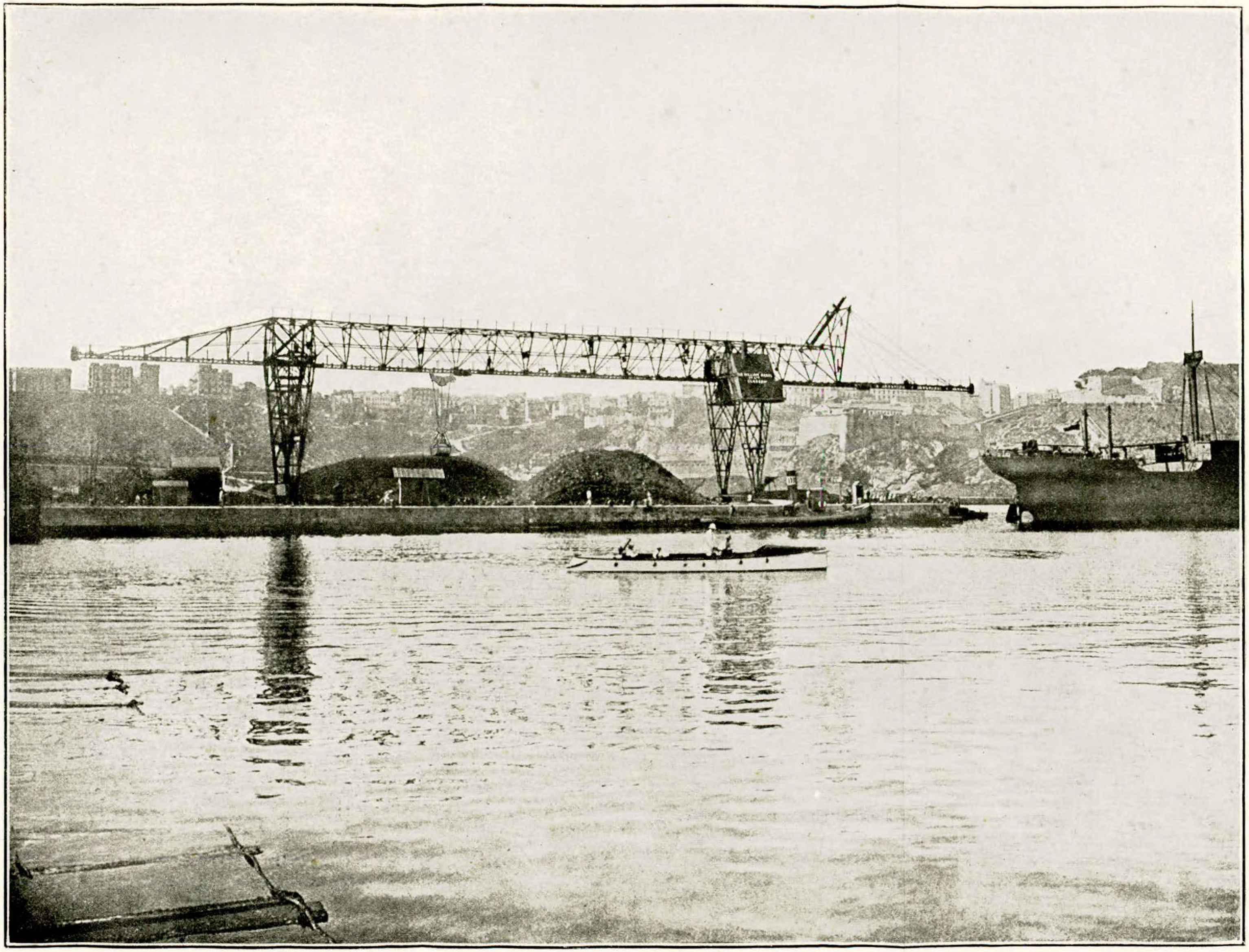
	Ft.	Ins.
Over reach from centre of front leg ...	88	0
Span of bridge between legs	93	6
Total transporting distance	173	0
Maximum gross load	3·7 tons	
Weight of coal lifted	1·25 ,,	

65 tons per hour from ship to middle of store.

Hoisting full grab ...	... 240 ft. per min.
Transporting full grab	... 900 ,, ,, ,,
Travelling along track...	... 40 to 50 ,, ,,

Coal Handling Plant at Oran, Algeria.—This plant constructed for the Oran Coal Co., by Messrs. Sir Wm. Arrol and Co., Ltd., of Glasgow, is used for the storage and supply of bunker coal. Vessels 582 ft. long with a mean draught of 25 ft. 9 ins. have already been bunkered there. This work of bunkering was done by Arab and Negro labour, when at times there was plenty of this labour available, yet at other times, particularly during harvesting operations, frequent delays were experienced owing to the Arabs leaving the district, thus making a scarcity of hands available for the work of coal handling.

Further than this, only a certain number of craft could be used without blocking the fairway, and as the traffic of the port increased, so also would the liability to create a stoppage occur; it was then recognised that some more efficient and quicker method of coal handling would be necessary, so that a greater use could be made of the craft, by having them loaded and emptied much more rapidly. All the work of discharging colliers, and the bunkering of liners, is done away from the quay wall, so that floating grab cranes were designed for this purpose. These cranes, of which there are several, were designed to work a double rope grab of the Temperley pattern



1032.—Coal handling plant at Oran, Algeria, Sir Wm. Arrol and Co.

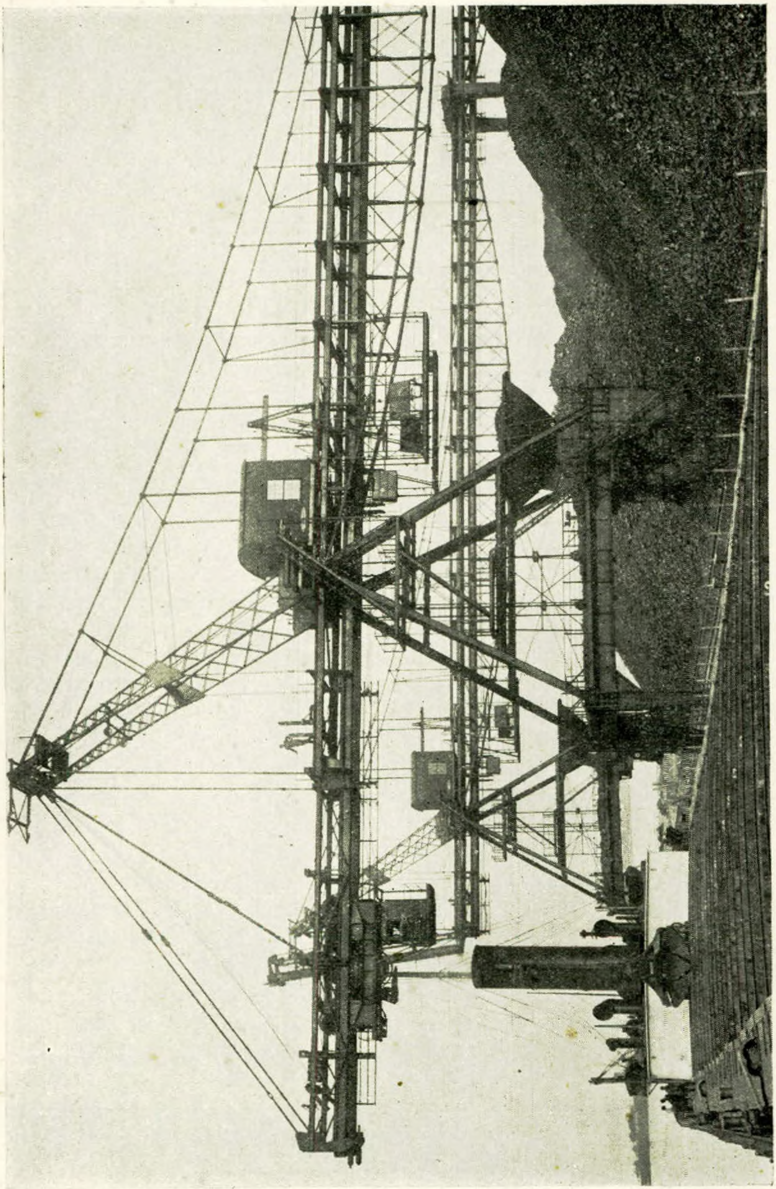
with a capacity of 30 cwt., and the motions of hoisting, slewing and derricking all being operated from the steam engine by means of gearing and clutches. In actual practice 74 tons of coal has been put aboard into bunkers by one crane, but this is generally too fast for trimming down below in vessel being bunkered.

Minimum radius, 36 ft. Maximum radius, 49 ft. Height from deck level to jib head sheave at max. rad., 59 ft. Engines, double cylinder, 11 in. × 12 in. stroke. Boiler, 5 ft. dia. × 10 ft. high. Pressure, 80 lbs. sq. in. Hoisting speed, 150 ft. per min. Slewing, two complete revolutions per minute.

As colliers cannot be discharged alongside the quay at Oran but into lighters, at times it is essential to store this surplus coal on the shore, therefore a specially constructed storage ground was built for this purpose, the masonry wall being built sufficiently strong on a good foundation for supporting machinery for discharging the craft contents from barge to shore or *vice versa.*

By far the greatest saving in time, labour and costs in the change from hand labour at this port so far as coal handling was concerned was at this operation of storing and refilling the coal from or to barges. Formerly 50 natives were required for this purpose, now it only requires one man and a boy to control the plant together with two or three men to trim the barges. In addition the material can be more promptly attended to, together with greater rapidity per unit. A much greater storage area can be efficiently made use of, which would have been impossible with hand labour. This has been accomplished by the erection of a grab transporter by Messrs. Arrol, of Glasgow, with a transporting range of 336 ft. 6 in., and fitted with a Temperley grab of a capacity of 30 cwts. During the official test of this machine 100 tons per hour from barge to store were handled, but ordinary working usually averages 80 tons per hour.

Span of bridge between centre of legs, 173 ft. 9 ins. (52·96 M).
Total transporting distance, 333 ft. 6 ins. (101·718 M).
Effective length of cantilever—waterside, 55 ft. (16·775 M).
,, ,, ,, —landside, 55 ft. 9 ins. (17·004 M).
Hoisting and travelling engine, 9 ins. × 12 ins.
Transporting and beam lifting engine, 8 ins. × 10 ins.
Maximum gross load, 4·25 tons.



176.—Pittsburg Coal Co., Duluth, U.S.A., Brownhoist Plant.

Contents of grab, 1·5 tons.
Hoisting full grab, about 200 ft. per min.
Transporting full grab, 1,000 ft. per min.
Travelling the complete installation along the track, 50 to 75 ft. per min.
Steam pressure, 100 lbs. sq. in. Vertical multitubular boiler.

Pittsburgh Coal Co., Duluth, Minn., U.S.A.—This is a view of the coal handling plant at Duluth, belonging to the Pittsburgh Coal Dock Co., a subsidiary of the Pittsburg Coal Co. This Company operates many coal mines in Pennsylvania, West Virginia, and Ohio, and they do an extensive retail business throughout the Eastern and Central section of the United States as well as Canada.

This view shows part of the recently equipped Brownhoist plant at Duluth consisting of three two-span bridges on the face of the dock and two one-span bridges at the rear. These latter two are fitted with screening apparatus. The coal is grabbed out of the vessels and put in store piled to a height of 40 ft., if necessary, which gives this dock a storage capacity of 825,000 tons (40 cub. ft. = 1 ton 2,000 lbs.). The coal is also loaded direct into cars of large capacity. This company's plant and storage is said to be the largest in the world. You will notice the large type of lake vessel that the coal is brought to the place in, the freedom of deck obstructions, and generally the whole tone is that of something very extensive. Most of the wagons you see here are self-discharging, and of high capacity.

The grabbing is very efficient. The average discharge from recent tests show 900 tons per hour, including the cleaning up of vessel's bottom. When working in free coal the plant can discharge 1,500 tons an hour from the ship to the storage. This you will see averages 500 tons per hour per crane in vessel. Each span is of 242 ft. and the double span bridges can be connected with the single span bridges, thus the coal can be traversed right across the storage ground a total distance of 726 ft. The length of the yard is 1,250 ft. The two span bridges have a cantilever jib of 78 ft. over the dock, and the single span have an extension of 35 ft.

The trolley from which the grab is suspended is designed to carry a load of 25,000 lb., to hoist the full load of the bucket 225 ft. per min., and to run along span at 1,200 ft. per min. Each bridge can propel itself along the dock at 60 ft. per min. when the grab is loaded. The grabs have a capacity of $5\frac{1}{2}$ tons, and are of the double rope type, but in practice, working in free coal the grab averages six tons of coal per operation. The dock end of the two-span bridges is carried on portal piers that are equipped with bins for loading coal into railcars. The centre and rear end of these bridges are carried on shear-legs, each shear-leg running on a single rail line. The shear-leg rails are supported on trestles made of steel girders carried on steel A frames. There is one single rail trestle and one double rail trestle, the former to carry the centre shear-leg and the latter to carry the rear shear-leg of the two-span and the shear-leg of the single span. These rails are 35 ft. high.

The operator travels with the trolley and in addition to the movements previously stated he can twist the grab round a quarter of a circle so as to clear narrow hatches, etc. By joining the single span on to the double span bridges as previously mentioned, you will see that not only can the coal be stored all over the yard, but it can also be picked up from wherever it is tipped. At the end of one of the single span bridges is fitted a screening plant as here shown. The grab delivers the coal from the ship or store into a 30-ton receiver from which it is fed into the screening plant. At the side of the main part of the pier is another bin with three compartments, each of 40 tons. Over this bin is a rotary screen which separates the coal into each of the three bins as each size passes through the aperture corresponding with the description of the coal, *i.e.*, stove, nut, screenings.

Beneath the 30-ton receiver is a shaker screen. This discharges the coal passing over it into a small hopper, and thence by pivoted scraper conveyer into wagons. The coal that passes through this shaker screen is discharged into a bin, and from there an elevator lifts it to the rotary screen, where it is divided into the three sizes into the 40-ton bins as previously stated. Each of these three bins is arranged with gates to control the discharge from same on to a horizontal belt conveyer. This belt is reversible so that its discharge can either go back to the storage pile or into wagons on the rail track, depending on the size required for market. There is also a further shoot from each of the 40-ton bins, each controlled with its own gate allowing any of these sizes of coal to discharge to the pivoted scraper conveyer and thence to wagons.

There is also an auxiliary shoot from the 30-ton receiver direct to the elevator supplying the coal to the rotary screen, so that any coal from the screenings pile may be re-screened over the rotary screen if desired. The 30-ton bin is fitted with a large gate operated by power shaker screen 5 ft. wide × 15 ft. long. Reciprocating motion through links and eccentrics from shaft, and belt driven from motor of 15 h.p. This motor gives power to operate gates of hopper. Different size screens can be fitted quite easily, as they are removable. The rotary screen is driven by a 20 h.p. motor and the elevator is also connected with this power. The belt conveyer has a 15 h.p. motor, and the scraper conveyer one of 10 h.p.

The plant can screen 200 tons of coal per hour that has passed through the shaker screen; this of course does not take into account the lump coal that passed over the shaker screen. The other machine is also fitted with a 30-ton receiver with control gate and shoot to load direct into rail cars, a screening bin and elevator for screenings; also shoots for unloading screened coal into cars. Beneath the screening shoot is a 50-ton bin to catch the screenings, and from this bin these screenings can be raised with a bucket elevator to a point high enough to be discharged by gravity to either the screenings pile or by belt conveyor to either of two tracks on the pier side of machine.

Duluth electrical equipment supplied by General Electric Company:—

440 volt., 3-phase, 25 cycle alternating current.

3 × 112 h.p. motors for moving the 3 × 2-span bridges.

1 × 112 h.p. motors for moving the single span with large screening plant.

1 × 50 h.p. motors for moving the other single span.

1 × 225 h.p. motors in each of the trolleys for hoisting.

2 × 112 h.p. motors in each trolley for trolley travel.

1 × 5 h.p. motor turntable to rotable grab 90°.

1 × 2 h.p. clutch motor in each trolley.

1 × 15 h.p. continuous running motor for elevator and conveyer with lesser screening plant.

Bridge travel motor operated by General Electric drum type controller.

Hoist motor operated by master operated magnetic controller.

Trolley travel motors on each trolley operated by master type controller.

Duluth plant test discharges:—

Steamer, *J. S. Ashley*; tonnage, 8,983 tons; lump coal, unloaded in 10 hrs. 15 mins.

Steamer, *J. E. Upson*; 8,747 tons; lump coal; 10 hrs. 55 mins.

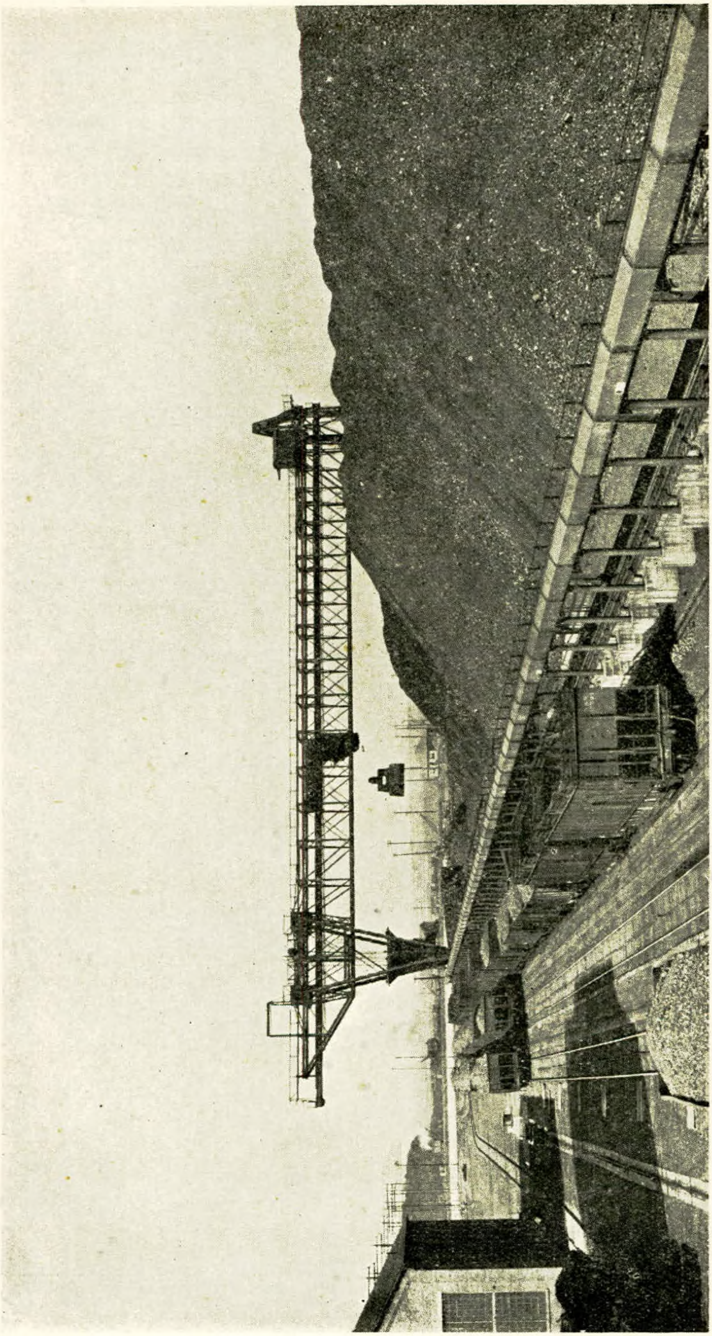
The grabs averaged six tons per cycle when working in free coal.

Astoria Light, Heat and Power Co., near New York City.—This bridge, built by the Brownhoist Company for the Astoria Power Co., near New York City, U.S.A., has a span of 250 ft. between supports, then in addition at both ends there is a cantilever extension each of 171 ft. It is fitted with a grab suspended from a trolley which travels at a 1,000 feet per minute, grab full laden can be elevated at 225 ft. per minute, and the whole bridge is capable of traversing along the yard at 75 feet per minute. This bridge is for the purpose of storing and reclaiming coal from the storage heap; where it is piled to a height of 40 ft. if necessary, but in general practice 30 ft. is the storing height. This view gives one a good idea of the large size units employed at many of the American yards. It clearly demonstrates the efficient penetration of the grab so that a full grab of material is obtained, this is the first and most necessary qualification for a grab, as thereby speed of tonnage per hour is kept up. This grab when open has a spread of 13 ft. 9 ins., with a width of 9 ft., and a height of 13 ft. 9 ins., and no doubt may set many of our British designers thinking when we mention that it grabs nine tons of coal per cycle of operation. (American ton = 2,000 lbs.).

View of a Coal Storage for the National Tube Co., Loraine, Ohio, U.S.A.—This plant is also equipped with a nine-ton grab, which handles the coal rapidly to and from stock pile. Here the height of coal heap is rather prominently seen, although it is difficult to compare with other things on the view as all their units are on a large scale. This plant was built by the Brownhoist Co.

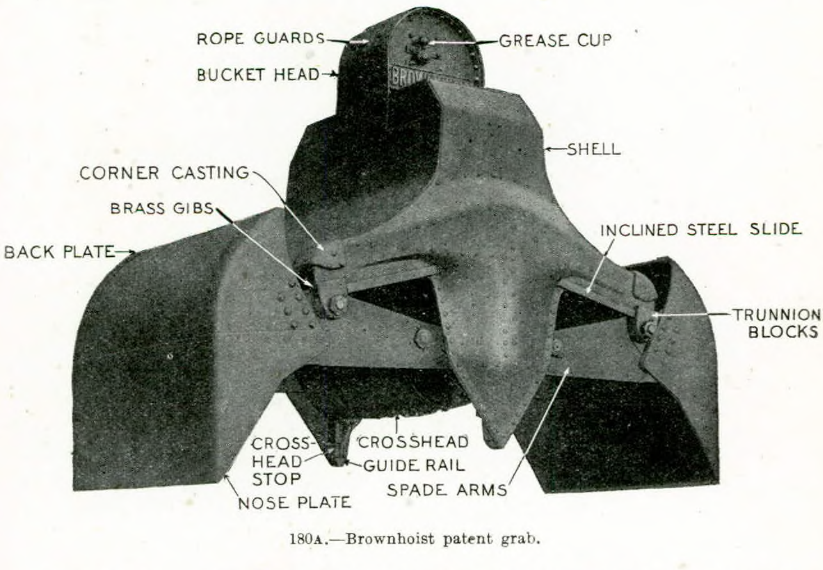
Brownhoist Patent Grab.—The Brownhoist grab is built on scientific lines, and is one of the best American grabs for coal working. It consists of two spades, spade arms, shell, crosshead inside the shell, and the bucket head. The shape of the spades is such that when placed on the coal the entire weight of the grab rests on the digging edges of the spades.

180.—Astoria Light, Heat and Power Co., 9-ton grab.



180*.—National Tube Co., Loraine, Ohio, U.S.A. 9-ton grab.

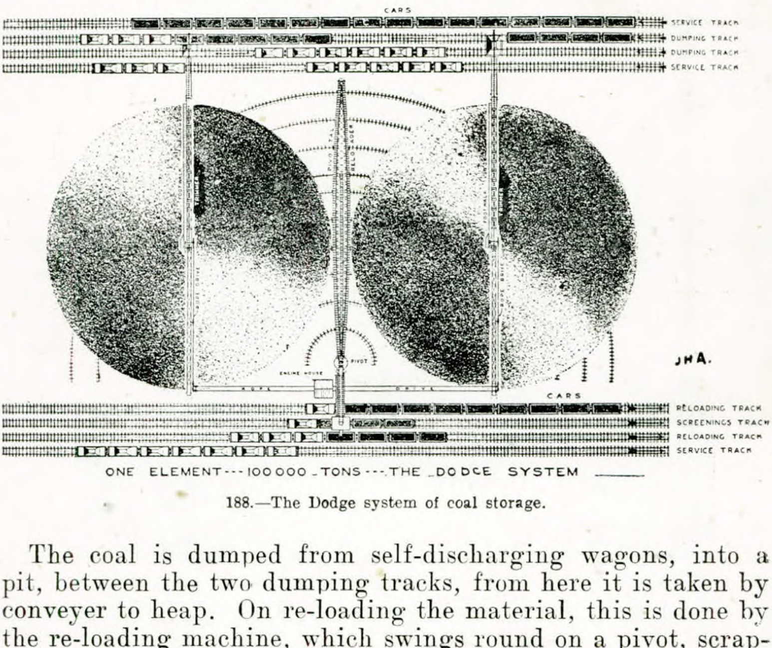
They believe on a wide spread of digging area with this type of grab, thus again ensuring a full load every time. Like most makes of grabs, these are designed for either the double rope system or the single rope method of operation. This of course depends on the kind of crane that the grab it attached to, but the author's experience of both kinds covering many years of high capacity work teaches him that for all round efficiency and freedom of accidents, providing the grab is operated by thoroughly good flattened strand non-spin wire ropes such as those we have proved in actual practice, there is nothing to approach the two-wire system of grab operation.



180A.—Brownhoist patent grab.

Grabs are not used to the extent they ought to be in this country, not only for coal but for almost any bulk material. But one must not run away with the idea that a particular design of grab is suitable for all purposes. Many things effect the efficiency, but broadly speaking no two bulk materials are alike, therefore each instance should be designed for the work it has to perform. Such things as weight of grab, shape, lengths of levers, multiplying powers, all have their peculiar effects on the grabbing operation, so that as I said before the design should be made by experienced people to suit the class of work to be done.

The Dodge System, one element 100,000 *tons Anthracite Coal Storage.*—This system of storage is a standard American method of storing and handling anthracite coal. The usual arrangement for storage in the open consists of two trimming machines, with a re-loading machine between them, this forming an element for the storage of 100,000 tons. A storage plant may consist of a number of these elements, which, as you may see from the plan before us, lends itself to easy extension by the addition of one or more elements.

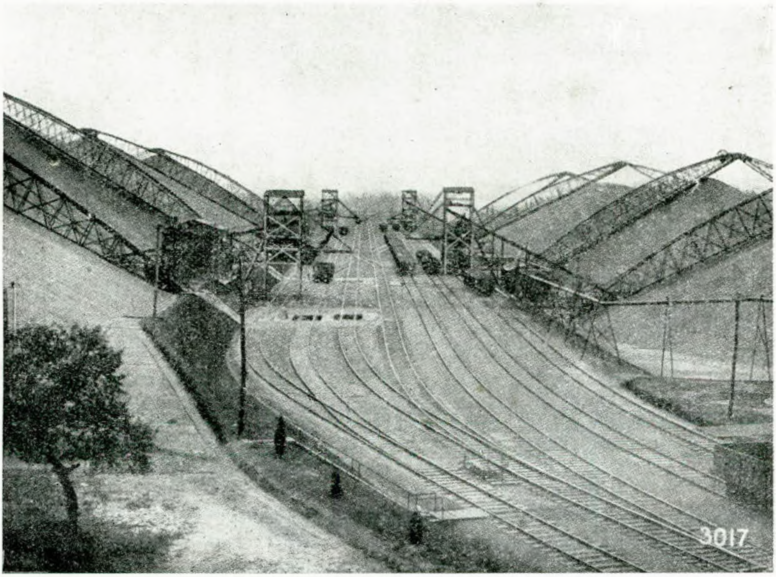


188.—The Dodge system of coal storage.

The coal is dumped from self-discharging wagons, into a pit, between the two dumping tracks, from here it is taken by conveyer to heap. On re-loading the material, this is done by the re-loading machine, which swings round on a pivot, scraping the coal throughout the area of the heap and at the bottom of same. This machine delivers the coal to a re-loading tower, which may also be constructed with screening arrangements, delivering the various screened sizes to different wagons on the sidings.

General View of 480,000 *ton Transfer Anthracite Coal, Philadelphia and Reading Coal and Iron Co., at Abrams, P.A.* One may here see the huge and systematic methods of storage as practiced generally in America. This is built at Abrams, P.A., for the Philadelphia and Reading Coal and Iron Co.

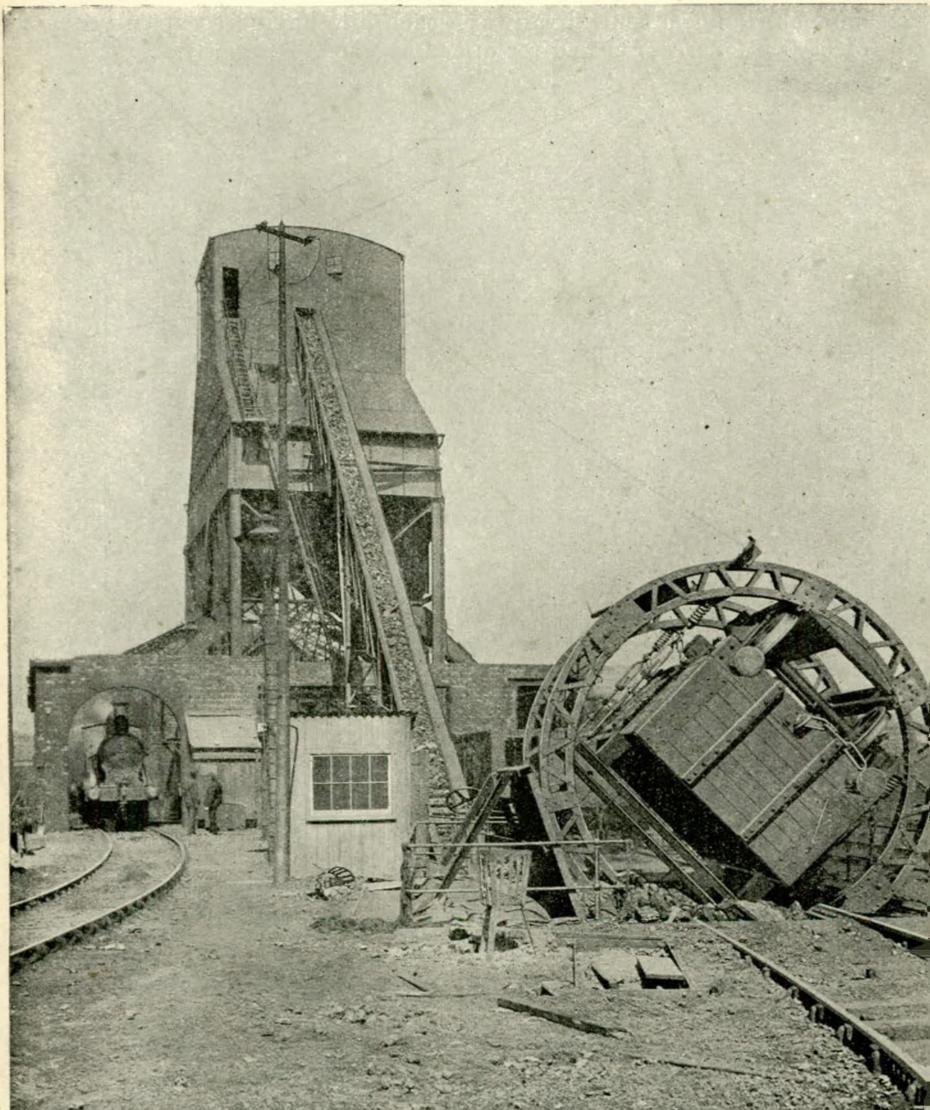
This large tonnage of coal is divided into eight piles—four on each side of a central railway—each pile having a capacity of 60,000 tons, stored and reclaimed by the "Dodge System."



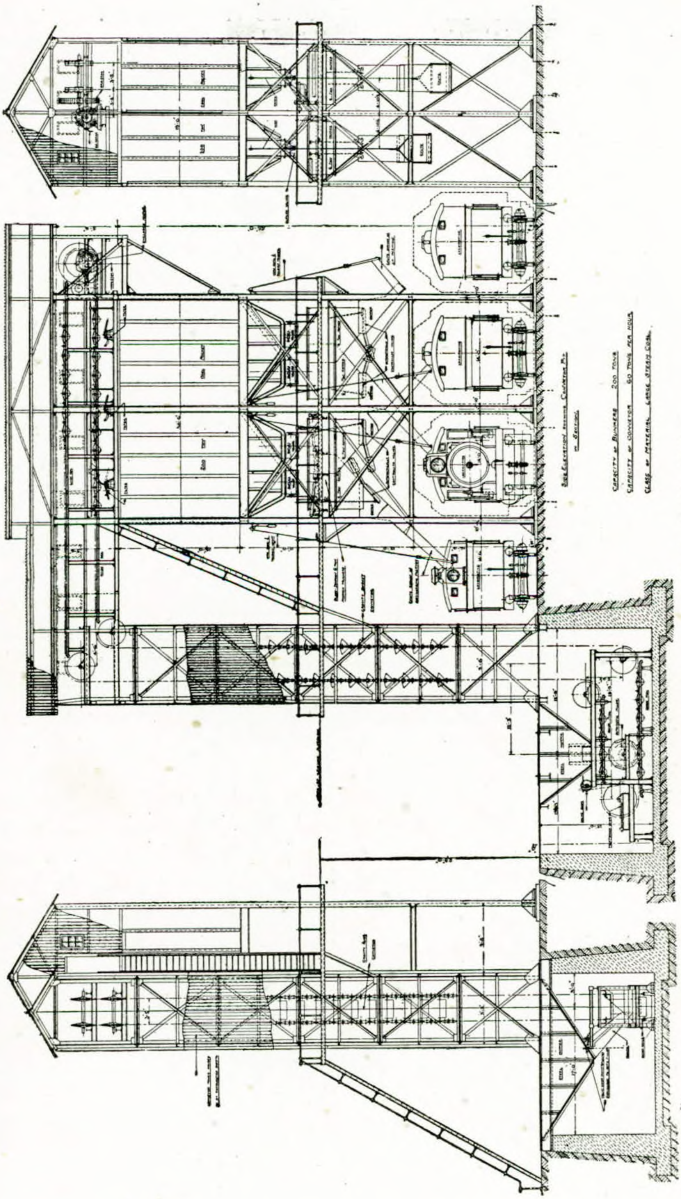
189.—General view of 480,000-ton coal storage and transfer.

The plant is capable of handling 1,800 tons per incline conveyer per day of 10 hours, thus they can store 14,400 tons per day of 10 hours. On re-loading, each re-loader can handle 2,500 tons, thus 10,000 tons may be handled from store to wagons per day of 10 hours. The discharging or dump pits are clearly seen, between the metals at the first machine before us.

Locomotive Coaling Plant at Crewe for the L. and N.W. Railway.—It is astonishing the number of depots in this country that stick to the old fashioned idea of coaling locomotives by means of baskets filled by hand and afterwards elevated by an extraordinary muscular effort of the men to get these on to the loco. tender. In America, practically all this work is done by machinery, such as a grab crane loading to the tender, or to a storage compartment where the coal gravitates down a spout to the locomotive.



189A.—Locomotive coaling plant at Crewe for the L. and N.W. Railway.



189B.—Locomotive coaling plant, South Africa.

Many of the collieries alongside the railways make a speciality of dealing with this class of trade, and in most cases the coal is delivered from the screens to a hopper, whereby the coal can be extracted by the simple process of opening a sliding door; several of these plants are equipped with weighing apparatus that record the weight of material put on to the locomotive. In this country probably the London and North Western Railway has led the way to a more scientific method than our older plan of basket work, and in the view shown we will see their coaling plant at Crewe.

Here the wagon is seen on a revolving frame which has practically capsized the coal out into the hopper underneath. From this hopper the coal is fed to a tipping tray conveyer, which elevates the material and distributes it to a series of hoppers, each having their spout which can be led to the locomotive tender. The locomotives may coal at either side of the bunker, and one can easily grasp the rapidity of this system compared with the older way. This plant was built by Messrs. Babcock and Wilcox.

Locomotive Coaling Station, South Africa.—This diagram illustrates one of several plants for the coaling of locomotives on South African Railways. As shown it can supply fuel to four locomotives simultaneously. All the coal is weighed, and each engine is debited with the quantity it takes away. The method of receiving the coal is by self-discharging hopper bottom trucks emptied into an underground hopper, from which the coal is elevated by means of a bucket elevator to the storage bunkers on top of the erection. The weighing is recorded on a six-ton hopper machine fitted with a counter and ticket stamping apparatus. These tickets are in duplicate, one is given to those on the loco. while the other is retained at the storage place. This plant was built by Messrs. Fraser and Chalmers, of Erith, and is typical of many others built by the same firm.

DISCUSSION—PART I.

Tuesday, February 25th, 1919.

Chairman: MR. A. BOYLE (Vice-President).

The CHAIRMAN: I think we should accord a hearty vote of thanks to the lecturer for his most interesting address and the excellent pictures which have been placed on the screen to illustrate it, thus adding to its usefulness.

Mr. J. H. ANDERSON: In thanking you for the reception given to the lecture, my difficulty has been that I have had so much to say and only a certain time to say it in. I was asked to give a series of lectures on "coal from mine to consumer," but I find that there is such a vast area to cover that I have to cram as much into one lecture as possible and that accounts for the time occupied this evening.

The Rev. J. H. HAYES: I am not a coal merchant, but I have been amazed and delighted at this evening's lecture. The remarks on the leaving of columns of coal as a support to the roof were especially interesting as it was as a result of this that we were able to burst the Chislehurst bubble. The caves at Chislehurst were reputed to be of immense antiquity and tales were told of the old Druid ceremonies that used to be carried on there, and there was also a well that was supposed to be almost prehistoric. Well, with other members of the Archæological Society I visited these caves and there we found columns of chalk left to support the roof just as the lecturer has described as found in the coal mines, and after examination we came to the conclusion that the supposed caves were a chalk mine which had had the original entrance blocked up by a fall of earth, and these columns and other evidence all pointed to the mine being of comparatively recent date. As to the ancient well, we actually found the man who had dug it (during 1860) on looking round the neighbourhood. Perhaps the lecturer will give us the reason why there is such a great difference in the price of coal at the pit-head and the price when delivered to us. I have been amazed at the processes which the coal goes through on its arrival at the top before it is ready to be sold; the picking out of the clays, slate, and brasses, the washings and so on. But if the last few loads that I have had delivered to me went through all these processes then all I can say is that they ought to have been put through them a second time. I think the coal must get very rough handling in the transport. The lecturer mentioned one process which he showed us on the slides as being illegal in this country, I should like to know why it is illegal here. Also he mentioned a case of the Americans paying royalties to an English inventor. I should like to know what we have to pay as royalty and how long this goes on. May I place the following questions before the meeting for the lecturer to consider and reply to:—

1. How many men can be brought up in a cage at one time from a shaft 1,000 yards deep?

2. How long does it take to wind them up from base to surface?

3. In the larger mines how long does it take to reach the cutting face from the shaft bottom?

4. Why is the use of the electric tractor engine illegal in England?

5. After what time do the royalties to the American patentee expire? And after what period do the British royalties expire? 15 years or 17?

6. If the coal is so carefully sorted, sifted and washed by over 30 processes how do you account for the fact that the "best" coal is frequently delivered fractured into small pieces, dusty, and adulterated?

7. Can you give a clear idea of the number of times the coal is tumbled about, shoveled, weighed, carted, put in bags, etc., before it is placed in the cellar?

Mr. ANDERSON: In reply to the questions in their order:—

1. This depends on the size of the cage, and the number of platforms on the cage, some pits will only elevate about half a ton, whereas others may have cages with two or more stages, each probably holding a couple of hutches. Thus, the area for men standing on will be much greater, consequently a larger number may go down or up at each operation, the smaller cage may just comfortably hold four men. Depth does not control the number of men.

2. I mentioned during the lecture and showed engines that were capable of winding at the rate of 2,000 feet per minute. On winding men this speed is somewhat reduced, generally to about half the working speed of the mineral. If Mr. Hayes wants to know how long it takes to get all the men to the bottom of the shaft, which I think is really what he requires, this of course depends on the number of shafts at the colliery, in addition to the previous remarks.

3. This again is a very comprehensive question, and depends a great deal on the distance to the working face. Where this is a long way from the shaft bottom the men take a ride on the bogies going to the face; however, many mines have a limited area to work on, and in this country the shafts are close together so that there are not many where there is a long way to walk underneath; this of course does not refer to coal seams wrought under the sea, which is the case at several places. I think the extreme distance in these instances is about three miles, but in time to come there is no doubt this distance will be greater for these mines.

4, 5 and 6. Answered in the general summing up which follows.

I cannot answer for adulteration.

7. This depends on the locality and method of receiving the coal from the coal fields, some instances it may mean a dozen or more handlings, all of which have a tendency to break the fuel and lose a certain portion in weight.

Mr. Anderson: The washing which the coal was given was not a question of washing actually, really this is a misnomer but refers to extracting foreign material from it by its difference of specific gravity in agitated water so that even if you get coal-dust it is still pure coal. The question of transport is indeed very important. I know a gas works, and the last speaker knows it too, where they get their coal from steamers, load it into barges, empty the barges into wagons, then empty the wagons by hand into horse vehicles, cart the stuff to the gas-works, all within about a mile. If you could convince this gasworks that getting the delivery as direct as possible is a great factor in their business, then you would have done a great deal toward the solution of the problem of cheaper gas. The difference was enormous. You got coal badly damaged in transport, and these added handlings is the reason why it costs you six shillings per thousand feet, but if you get the coal in a more direct manner the price might be brought as low as three shillings per thousand cubic feet. With regard to the haulage method I stated was illegal in this country, the reason for this, and a very good reason too in my opinion, is that the Government will not allow bare wires in the pit because the mines are gassy, however, I see no reason why battery tractors should not be used. As I have explained, in America most mines are very near the surface, and some are even above it, the coal being got out of the hill-side. These are well ventilated and drained so that the atmosphere is quite good and there is practically no fear of explosions and indeed you seldom hear of mine explosions over there. So electricity can be used with impunity, but here it is different. If you break contact you form an arc and you get such a temperature that the gases in the mine would ignite.

With regard to royalties I will be very frank. If I were the owner of the ground I would not like to see royalties done away with, but as a consumer I should like to see them abolished. The average royalty ran to about sixpence a ton.

The Rev. Mr. Hayes: I may explain I was not referring to ground royalties but to royalties paid on machinery.

Mr. Anderson: Well, I think the royalty system is only fair. If I invented a machine or had put up the money for the invention I should not think it right that another man should be allowed to make that machine without paying me something for it.

The Rev. Mr. Hayes: Yes, but do these royalties go on for ever or are they paid for a stipulated time only.

Mr. Anderson: I am not an authority on these questions, but I think that you may take it that the period usually is fourteen years.

A Member: I should like to ask why it is that they use open lamps in some of the Scotch mines, round Midlothian and Edinburgh, for example?

Mr. Anderson: They can use the open lamps in these mines because there is no gas in them. There are mines where they have huge furnaces which burn thousands and thousands of tons of coal simply for ventilation purposes. It depends largely on the kind of coal found in the mine and whether it is likely to give off gases or a lot of coal dust. Where there is no danger of gas you can use as much naked light as you like, providing the coal is not friable, thus making dust.

Mr. B. P. Fielden: I have been very interested indeed in the lecture, and am sorry that all our members could not be present, but they are spread all over the world, especially now, as a result of the war. I am sorry that the pictures cannot all be reproduced as well as the lecture so that our members could see them when they read the transactions. It seems to me that at a coal mine there is a lot of machinery on top and very little below. Is it not a fact that many mines are electrically lighted?

Mr. Anderson: Certainly the mines are electrically lighted and the appearance in many cases would astound you. The main road walls are whitewashed, and though I won't say that they look like drawing rooms, still the appearance is very different to the dark gloomy caverns most people imagine them to be.

Mr. Fielden: Cannot we get a better system of haulage than we have at present? They seem to use far more machinery in America than we do here, and surely this places us at a great disadvantage. Can you give us the cost of getting the coal per ton there and here and also give us the amount mined per man per hour there and here? If I am not mistaken they can get the coal much cheaper there than we do. I say this because I know that bunker coal is cheaper out there even taking wages into consideration.

Mr. ANDERSON: It is certainly a fact that mechanical means of mining are used far more in America than here and certainly this places us at a disadvantage. This is largely due to the miner himself, for there is a prejudice against the machines here very similar to that which was once felt against the spinning and weaving machines. This is a thing which must be got over for the good of the country and the introduction of mechanical methods would of course improve the conditions of labour if the men would but realise it. There is no necessity at all for some of our methods. It is quite right to say that the American miner produces more than the British miner. I cannot vouch for the absolute accuracy of the figures, but I think I am right in saying that the British miners output averages a little over one-third of the American. The output per annum per man is 613 tons in America and 260 for the Britisher during 1911. I will endeavour to get later figures. Of course you must remember first of all that the American ton is 2,000 pounds and the British ton 2,240 lbs. Then as we have seen, the American has far more machinery at his command and the seams are big and thus far more easily worked. Also they have not to wind the coal as we have, for as I have said the mines are for the most part very near the surface, and in some cases even above it. In some mines out there they have to have retarding means to prevent the coal from simply falling away on lowering it from the mine outlet to the screens. The most important reason is that of the difference of the thickness in the seams which I have referred to. Over here we have worked at our big seams and let stuff lie about and generally mined as if we thought that there was no possibility of the coal giving out, and the result is that now we have to work very narrow seams indeed, excepting some of the newer fields. A friend of mine told me that he was actually working on a seam only $13\frac{1}{2}$ inches thick. Taking into consideration the fact that we have so few mechanical appliances and that we are working against the force of gravity all the time, there is not much difficulty in understanding why there is the difference between the production of the American and the British miner. All the same, when the British miner goes out to America he is always sure of a job, the mines out there are only too anxious to get him, for it must be remembered that ninety per cent. of the miners in America are not men who have been born to the job, so to speak, as here, but men from farms and so on who have just drifted down into the mines from European countries.

Mr. Fielden: Then there is the difference in price between the pit head and the consumer, who gets all that money? Isn't somebody doing some pretty heavy profiteering there? Also I should like to know whether the amount paid in royalties is much more here than in America?

Mr. Anderson: I am indebted to Professor H. H. Stoek, of the University of Illinois for the following information as regards royalties in America. "Royalties vary from three cents to 25 cents for bituminous coal, dependent upon conditions. I presume as near an average as any would be from 10 to 15 cents, and within the past few years a custom has prevailed of a sliding scale in regard to royalty, a certain price being paid based on a certain sale price, and as the sale price increases, the royalty increases correspondingly. The current royalties for anthracite are much higher, but for recent leases 50 cents per ton, and in a few instances even higher."

With regard to the first question I can hardly undertake to answer that, but the next lecture will be on "Transport from the Mines to the Consumer," and it is very possible that we shall find the answer to that question of who gets the profits on the difference in cost at the pit head and actual cost of consumer. Certainly the profiteering was not taking place in the mines. You must bear in mind that the cost of working the coal is in advance of the pre-war figure, it is more an averaging of costs than anything else. I mean by that, that many mines are working to-day that certainly would not pay to work in pre-war days. As a matter of fact they don't pay to-day.

The added cost has more to do with the altered conditions of transport than anything else, owing to such a huge tonnage being sent by rail, some of which in pre-war days would cost 25/- per ton for rail rates alone, irrespective of winning and handling costs at the delivery and the price of coal to-day is artificial, it is quite a huge revenue gathering machine, part of which is spent—in my opinion—on unnecessary jurisdiction as regards its so-called control.

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DISCUSSION—PART II.

Tuesday, March 4th.

Chairman: MR. B. P. FIELDEN (Chairman of Council).

The CHAIRMAN: Possibly some members wish to ask questions on the previous lecture before we enter upon the discussion of what has been put before us this evening in so interesting a way by Mr. Anderson.

Mr. FARRER: We must thank Mr. Anderson for his most interesting lectures, and not only is he doing this good work of letting people here see the conditions under which coal is obtained, he has also done this at many places elsewhere. He has explained the conditions under which it is obtained, and its transport to the bunker. One fact he did not give us was the figure regarded as the reasonable output for a man hewing at the face. How many truck-loads does he turn out in a day's work. With regard to seams, most of us were under the misapprehension that seams only 16 inches in thickness were not profitable, and it has been put forward as a point in favour of Government working of the mines that these seams would be worked and not allowed to go to waste. I understand that it really does not pay private owners to work such seams if there are thicker seams available. We don't want to go into the thorny question of the price of labour, but I, and I am sure others here, would like to know the cost of hewing and bringing the coal to the top.

The CHAIRMAN: I put a similar question at our last meeting, since then literature has been handed to me and I have been reading the subject up a bit. The result of such reading is to make one feel somewhat downhearted. There seems to be a general tendency to a policy of restriction of output. The production per person employed in the coal trade in the United Kingdom in 1896 was 312 tons, in 1911, 211 tons; whereas the corresponding figures for the United States were 400 and 613 respectively. Why is coal cheaper in America than here? Is it that more is made out of it after it leaves the mine? The only people who were right in this question of coal supply were the Marine Engineers, at least from their point of view. Owing to the representations of Marine Engineers the Government is inquiring into the question of the transport of coal, and we can look forward to something being done now that we have the Coal Commission sitting. The whole question hinged on the problem of machinery. Machinery is more in use in America and this may account for the difference in price. In our own line we know that the bunkers are put anyhow in a ship, and vessels are not built from a bunkering standpoint We must have more and better machinery for getting the coal from the mine to the bunkers.

Mr. ANDERSON: The capacity of a miner depends entirely on the sort of seam he is working, how he is working it, and the position in which he is working. I can give you an idea of what the Northumberland miner can do, but such figures would give you a false general impression. As regards thin seams, it pays to work a seam of 16½ inches, and a machine specially constructed for working such seams has been introduced with great success. In Nova Scotia they work seams of nine inches at a profit, so that it is evident that we can work seams of 16½ inches. If you have realised that the great lack in our English mining system is proper and adequate use of machinery then you have got the whole gist of my lecture. It is quite impossible to properly compare the output of the miners in this country and in America as the conditions are so different. Our mines are deep and we have to have deep shafts which means terrific work getting the coal to the surface with the attendant consequence that more hands are employed and consequently the output is divided by a greater number to get at the output per head. In some cases in America the coal is above ground and had to be actually brought down, and all over the working was easier, calling for the employment of less labour. Where the Americans have the great advantage though is in their use of mechanical aids; in addition to these hillside mines, coal is obtained from open mines—practically quarries—by excavating the surface soil off by machinery then using huge machines to lift the coal. As regards their pits very few indeed are more than 500 ft. deep.

The Rev. J. H. HAYES: The seriousness of our national position with regard to coal is manifest, and I would point out that even before the war we had begun to import coal from Germany and America. Gompers, the American labour leader pointed out that the very last thing that labour should do was to minimise output. Does coal being transported from the pit-head to New York undergo more or as many changes as regards loading and unloading as in this country, and is more profit made out of it on the way from pit-head to consumer in this country than in America?

Mr. ANDERSON: The American miner would probably have no larger output than the Britisher given the same conditions. There is an immense amount of capital sunk in pumping plant alone in this country. In Staffordshire the pumping costs are a shilling a ton, and the mines nearly bankrupt as a result. You will see that American mines being much shallower will not take as much power to drain, and of course hillside mines will naturally drain themselves. Present day coal prices could no doubt be reduced by a better organisation of transport, by leaving this trade to be carried out by those who have had a life's experience of this class of work, where the details of every operation is closely followed out, and when these improved details are found let the thing be given a proper trial without any prejudice from any side. The author has got into hot water on many an occasion during the past year or two as regards trying to lead some of our so-called controlled systems into some of the methods we did successfully for many years. My own candid opinion of the coal trade during the war is that if this had been left entirely to the trade to look after the quality of the fuel, its transport and distribution, we should never have had any difficulties that could not have been got over.

There have been too many people pushed into this work who have had to drain the brains of experts. The consequence is that we are now getting the interest diverted from a scientific point to a mere question of tonnage of material moved in receptacles that are no use for the trade, totally without regard to special requirements of the user, as no doubt many of you have found out by the increase in the size of your ash heap. This muck represents a huge amount of material transported many times at a high cost, and when it does arrive to the consumer a portion of the good coal is expended on getting rid of the dirt, not mentioning the labour factor.

I could quote you many glaring instances of this kind of thing. When we are not allowed a voice in the matter but have to obey someone in connection with the authority of present day lack of system. My remedy is to take all your controls off; let us have a healthy competitive trade that sells coal as coal, where farthings are split in the making of contracts, thus there is an incentive for everyone to watch every point as regards coal from the working face to the consumer; remove this competition and I dread the consequences for future supplies, so far as price per calorific quality is concerned.

A Visitor: As one interested in the coal trade I may point out that the gas companies have to pay 250 per cent. more for coal than 30 years ago, and 70 per cent. more for labour, yet in some cases are selling gas at the same price as that at which they sold it 30 years ago. That has been made possible by improved methods of working. The rise in the price of gas is not to be laid to the gas companies' credit.

Mr. Anderson: In reply, I suggest that there are too many scattered gas making plants, and centralisation would no doubt materially reduce gas prices. I gave a glaring instance in the discussion to the last lecture. Of course, the price of gas has been assisted by the finance obtained from other material from the coal. I anticipate before many years are over gas will be a by-product from selected coal, when we get a little more advanced in the combination between science and practice.

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A. W. ROBERTSON, J.P.

The death of Mr. A. W. Robertson has removed an engineer who was well-known about the Royal Albert Docks in the early years of its history. He was the founder of the firm of A. W. Robertson and Co., and of the extension of the firm's operations as shipbuilders on the bank of the Lea, where several of the ferry boats plying across the Thames at Tilbury were built.

Mr. Robertson was born in the Carse o' Gowrie, Scotland, in 1844. He served his apprenticeship with Messrs. The Lilybank Foundry Co., Dundee. He then went to sea and served in several steamers, obtaining his certificates and promotion to Chief Engineer. His sea service was in Wilson liners, trading to the Baltic, the Mediterranean and to Calcutta, his last steamer being the *Navarino*, subsequently sold to another well-known line. Taking advantage of an opportunity when the Royal Albert Dock, London, was opened for traffic he started an engineering workshop and carried on the business of overhauling and repairing ships and machinery until his retirement some years ago, when Messrs. R. and H. Green and Silley Weir, Ltd., took over the workshops, and more recently the yard on the Lea was sold. Mr. Robertson took an active part in the operations of the Institute of Marine Engineers in the early years of its development. He served as a member of Council and Convener of Property Committee, when the premises at 58, Romford Road were extended in order to meet the growing requirements. He removed from Romford Road, Forest Gate twenty years ago to Southend, where he has devoted himself to philanthropic work and municipal duties to an extent which has won high appreciation from the residents and his many friends. We desire to express to his widow and family our sympathy with them in the loss they have sustained. Three of his sons have served in the Army during the war, one of whom Major A. W. Robertson, R.G.A., was killed in France last year.

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Election of Members.

Members elected at a meeting of the Council held on Tuesday, 3rd June, 1919:—

As Members.

Leslie Allan, Mazagon Dock, Bombay.
William Barclay, Mazagon Dock, Bombay.
Samuel Border, B.I. Engineers' Club, Bombay.
William James Boyes (Ch. A.E., R.N.), H.M.S. *Fury, c/o* G.P.O., London.
Alexander Geo. Cumming, 12, Carlyon Street, Sunderland.
William White Ellis, B.I. Engineers' Club, Bombay.
Joshua Graham, Board of Trade Surveyor's Office, Dundee.
Jonathan Edward Green, Beaconsfield Cottage, Low Fell, Gateshead-on-Tyne.

Archibald Hall-Brown, Oriel House, Farringdon Street, E.C.
Robert Henderson Hancock, 1, The Broadway, Frier Barnet Road, New Southgate, N.11.
Frank Edwin Hutson, 72, Broadfield Road, Hither Green, S.E.
Gilbert Jesse Isaac, 24, Dungoyne Gardens, Maryhill Park, Glasgow.
Robert S. Jardine, Mazagon Dock, Bombay.
Alberto Keens, Anglo-Saxon Petroleum Co., Singapore.
William Edmund McConnell, 164, Belgrave Road, Wanstead, E.11.
James McCollin, 21, Undercliff Road, Lewisham, S.E.
Homer McCririck, 3, Dongola Road, Ayr.
John Allan McIver, B.I. Engineers' Club, Bombay.
Alexander McLachlan, "Brook Side, Mill Road, Dinns Powis, Glam.
John MacLeod, 17, Galloway Road, Waterloo, Lancs.
Donald Macnaughton, B.I. Engineers' Club, Bombay.
James Mason, B.I. Engineers' Club, Bombay.
Robert Grieg Melrose, 631, Alexandra Parade, Glasgow
Ignacia de Mutiozabal, Compania Maritima del Nervion, Gran. Via 1, Bilbao.
Henry Lloyd Snaith Nicol, 56, Dock Street, Dundee.
Herbert Leigh Quine, 132, Selborne Street, Liverpool.
Colin Hamilton Rowlands, 5, Morningside, Great Crosby, Liverpool.
Harold Rutherford, B.I. Engineers' Club, Bombay.
William E. Shannon (Engr. Sub.-Lieut. R.N.R.), Hokitika, Westland, N.Z.
James Rowland Tait, 154, High Road, Balham, S.W.12.
John Allibon Taylor, 38, Kimberley Drive, Gr. Crosby, Lancs.
William Tinsley, 47, Stanbury Road, Packham, S.E.15.
Lee Wood, Pacific Steam Navigation Co., Goree Water Street, Liverpool.

Associate.

Herbert Cyrus Bond, The Leaze, Chepstow, Mon.

Graduate.

David Thomas Challis, 28, Bridge Street, Mile End, E.1.

Transfer from Associate-Member to Member.

Gordon Morgan, 153, Waironi Road, Christchurch, N.Z.

Transfer from Graduate to Associate Member.

George Ayre, 41, Knighton Road, Forest Gate, E.7.