INSTITUTE OF MARINE ENGINEERS
INCORPORATED.

SESSION, 1894-5.

MECHANICAL APPLIANCES FOR THE SHIPMENT OF COAL,

BY MR. S. W. ALLEN.
(MEMBER).

READ AT
GRESHAM COLLEGE, BASINGHALL STREET, E.C.,
On SATURDAY, FEBRUARY 24th, 1894.

CHAIRMAN:—W. H. WHITE, Esq., C.B., LL.D.
(PRESIDENT 1893-4).

DISCUSSION CONTINUED AT
58, ROMFORD ROAD, STRATFORD,
On MONDAY, MARCH 12th, 1894.

READ AT
THE UNIVERSITY COLLEGE, CARDIFF,
On TUESDAY, MARCH 13th, 1894,

CHAIRMAN:—PROFESSOR S. C. ELLIOT, D.Sc.
(LOCAL PRESIDENT).

READ AT
THE HARTLEY INSTITUTE, SOUTHAMPTON
On THURDAY, MAY 24th, 1894.

CHAIRMAN:—C. S. DU SAUTOY, ESQ.
(LOCAL PRESIDENT).

ONE of the greatest sources of the mineral wealth of Great Britain is her coal fields, and many important districts rely almost entirely upon the vast quantities of fossillised sunshine that lie at various depths beneath the surface. Great care and much ingenuity has been, from the earliest times, displayed in order to bring into the market the coal in as large and unbroken masses as possible. Notwithstanding all the care that can possibly be bestowed, a very large proportion is broken up into small particles, and thereby reduced considerably in value. The small coal at one time being almost unsaleable, and at the present time, even when there is a large market for it in the manufacture of patent fuel and coke, the loss entailed in bringing it to the surface, and the small price that can be obtained for it, only serves to emphasize the fact that the greatest care should be taken that the lump of coal hewn from its bed shall be transferred through all its varied travels to its destination, in as near as possible the same state as it left the colliers' hands in his stall in the depths of the coal mine. (View A.) Many of the most important colliery districts are situated a considerable distance inland, and as the coal trade of this country depends to a great extent upon foreign shipment, it follows that the coal must be carefully conveyed by railway, canal, or other means to a port of shipment, and various systems have been in use for this end. Animals were largely used at one time, and it is not an uncommon thing, even in the present day, in Pembrokeshire, for instance, to see a train of donkeys or mules, with bags of coal piled upon their backs, wending their way along the country roads—in charge of a sturdy old lady, towards the vessel waiting for its cargo of culm or anthracite. In some places, such as on the River Tyne, the trams, or corves, in use at the colliery, are taken direct from the mines, and deposited in the vessel's hold, without any intermediate handling; but this system is only available in places, where the colliery is situated in close proximity to the dock, or river, where the shipment takes place.

As it is the purpose of this paper to deal especially with the coal shipping side of our subject, we will not enter into the various methods in use at the collieries for the transference of the coal from the trams to the waggons or other receptacles; (View B.) but suffice it

---

* A and B are Colliery Views.

to say that the tram is generally discharged into a shoot, or screen, the small passing into a hopper, or what is called a "Billy Fair Play," placed underneath to receive it; and the large, sliding out at the other end, and falling into the waggon ready for conveyance to the port of shipment. In some cases the coal was deposited in barges, or keels, as they are called in the neighbourhood of the Tyne, and were then brought to the side of the vessel, and loaded by hand through ports in the side; this was of necessity but a slow method of procedure, and the growth of the steam coal trade within recent years soon demanded some mechanical methods, in order to keep pace with the times. To do this efficiently much ingenuity and scientific skill have been displayed in devising means to meet the requirements of different localities, and varieties of coal. It will be sufficient for our purpose to divide the various kinds of coal into two classes—viz., coal with a close, dense, and compact structure, such as that found generally in the North of England, and the coal with a loose structure, breaking with an uneven fracture, the angles of which point in all directions, such as the celebrated steam coals of Glamorganshire and Monmouthshire. The class of coal first mentioned will slide freely down an inclined plane, of small angle, and its natural smoothness and evenness of fracture allows it to be very easily handled, and transferred from one receptacle to another with comparatively little loss from breakage, whereas the latter, or Welsh steam coal, requires an inclined plane of considerable angle before it will descend with its own gravity, in consequence of its uneven fracture and open and porous nature, whilst its fragile and tender structure necessitates that special means shall be employed to allow it to slide easily, and to prevent its falling any considerable height when being loaded either into waggons or the holds of vessels. The early history of coal shipping is more particularly identified with the North of England and Scotland than any other part of this country, and to the neighbourhood of the River Tyne, or the Weir we should repair in order to commence our review of the principal machines in use in days gone by. Some of the oldest of the mechanical systems on the Tyne may be seen still at work in that neighbourhood. In some cases where the colliery was situated close to the river side, the waggons were taken direct from the mouth of the pit and run down an incline, the descent being governed by a rope passing over a pulley at the head of the incline, the descent of the full waggons pulling the empty waggons back again; and in other cases, by a winding engine hauling the empty waggons back, and allowing the full ones to descend. The vessels at this time were comparatively of small dimensions, and in order to deposit the coal on board, the height of the staging had to be sufficient to allow the coal to fall by gravity into the vessel's hold. In other cases the coal was deposited in lighters, or keels, and then conveyed alongside of the vessel, the keel men shovelling the coal in through ports in the side, in baskets The system of allowing the coal to fall by gravitation has been brought to very great perfection at the north-east ports, and it will not be out of place here to describe the principle on which this system is based. (View No. 1).

A staging or staith is erected on the river or dock side, on to which the waggons run, an opening is made in the platform, of considerable length, and sufficiently wide to come in between the rails; under this opening a large hopper is constructed, into which the coal falls, and at the bottom another opening is made, and connected up to a wooden tube or spout, down which the coal runs into the hold of the vessel, the speed of its descent being governed by an adjustable door in the spout. The hopper is always kept full, and as the coal runs out of the spout, in a steady stream, the waggons are being constantly emptied into the hopper. These waggons are invariably constructed with doors fitted into the bottoms through which the coals fall vertically, and the sides and ends made sloping outwards, the top being considerably larger than the bottom. (View No. 2).

No arrangement was made for the varying height of vessels, or the amount of rise and fall of tides. It soon became necessary to adopt means to meet these circumstances. The staiths had to be increased in height, and the spouts made to rise and lower, and the openings in the hopper were provided at various heights, each governed with regulating doors. A section of one of these arrangements is shown in which the appliance for raising and lowering the shoot is shown at A B, the regulating doors at C C C C, and the hopper and waggon at D. (View No. 3). Owing to the narrowness and length of these spouts it has been rendered possible to allow of a considerable latitude for swinging the point in a horizontal direction. This has been found of great advantage in loading into hatchways that do not come exactly opposite the centre openings in the staiths, thus allowing, in many cases, the coal to be shipped into two or more hatchways at the same time.

Probably the most elaborate system of staiths erected on this principle may be seen in operation at the Hendon Dock, Sunderland. The whole of the work is built of iron and supported throughout on iron columns of massive proportions, a pen and ink sketch of this splendid structure is shown. (View No. 4).

So far we have only considered the mechanical loading of coals by the hopper and spout systems at the north east ports, and in order to illustrate the different arrangements in use for this purpose, I have made sketches at different ports.

It will readily be seen that coal only of a certain class can be thus dealt with; *i.e.*, coal that will slide at a comparatively slight angle, and which is of sufficient strength to hold together under such treatment or when very large lumps have not to be dealt with. In the latter case various means were adopted to lower the waggon bodily on to the deck of the vessel when the doors were released, and the coal allowed to fall direct into the hold. Several of these original and very ingenious machines may be seen still at work on the Tyne, a view of one is shown (View No. 5), which was sketched some time ago in the neighbourhood of Wallsend. The machine is, I believe, still in use.

It will be seen that this is a combination of the spout and the drop system, and although there is no arrangement for regulating the height of the spout, the drop has a very considerable range. (View No. 6). The waggon is brought to the front of the tip and is pushed on to a swinging cradle or platform with an aperture in the middle, this platform is suspended by four rods to a cross bar, affixed to the ends of two upright poles or jibs, the bottoms of which are hinged to the upright posts of the front part of the staith, so that the cradle with the poles is allowed to fall forward and descend in a radius of a circle to the depth required, It became necessary to apply an arrangement to regulate the lowering, and to bring back the empty waggon and cradle to the original position, this is effected by attaching a wire rope or chain to the top of each of the poles, the other end of the rope being made fast to a barrel fixed upon a horizontal shaft placed at the top of the staith; and at the outer end of this shaft were also fixed other barrels to which were attached wire ropes. At one end the ropes fastened securely to the bottom of a long pole or pendulum, the top of the pole being attached to fixed uprights and the lower end being free to travel as the rope was being wound on to the barrel by the descent of the loaded cradle; a large cast iron weight attached to the lower end of the pendulum brought it back to its vertical position, and correspondingly, the cradle with the empty waggon to its proper level in order to have it replaced by a full one. The regulation of the descent and return of the cradle was governed by a large brake wheel fixed on the transverse shaft, the lever being in charge of the brakesman. A man usually descends with the waggon and cradle to release the door fastenings, and frequently to hammer away with a sledge on the sides of the waggon, in order to persuade any obstinate coal that may have remained behind, that an eviction was necessary. This system is still largely in use in the North of England, and has been elaborated to a considerable extent on the Weir and in Sunderland Docks, where we may find many excellent examples, most of which are on the principle shown, View No. 7, where the waggon comes on the staith also, on a high level, and is transferred on to a cradle, as before described. Instead of wire ropes and poles being used the side supports are after the fashion of a portion of a huge beam or cantilever, one end of which is attached to a very strong shaft, and to the other is suspended the cradle for sustaining the waggon, the shaft being considerably below the level of the platform, or railway; to one or both sides of this shaft, and to the supporting beams are attached immense brake wheels with large balance weights fixed to their lower ends to govern the descent and return of the waggons. Sketches of one of these are shown by View No. 8, taken from those in the Hudson Dock, Sunderland, and on the Weir, the whole of the machinery being constructed of iron and well designed for its purpose. These drops are capable of loading coal into very large sized vessels. Another method adopted was to run the waggon on to a suspended platform directly over the vessel's hatchway, the cradle and waggon were then lowered vertically by means of chains fixed at one end to the cradle, and the other attached to sheaves on to a brake wheel shaft situated overhead, the descent and return being governed by balance weights as shown by View No. 9. This sketch was taken at one of the docks in West Hartlepool.

A somewhat similar plan was also in use at the port of Cardiff, at the West Bute Dock, then called the Bute Ship Canal. The waggon in this case was not lowered vertically, but the front part was made to descend in order to allow the coal to slide out at the end of the waggon (View No. 10), the doors being placed at the end in all coal waggons in the South Wales District. This system worked very well in all cases, where the vessels were small, and consequently little variation in height occurred, but the constant increase in the sizes of vessels, and the amount of damage the coal suffered in falling into the hold, soon necessitated other methods being adopted, and therefore they have been for very many years obsolete, and have long since been replaced by more modern appliances. On the river Usk, at Newport (Views Nos. 11 and 12) may still be seen many ancient contrivances for lowering the front ends of the waggons, and lifting the back ends when shipping into vessels, at the top of high tides. In all the methods adopted on this river, the waggon is tipped into shoots, the front end of which is lowered on to the hatchway, and is ingeniously arranged so as to be easily pulled back out of the way, and prevent its projecting into the river when not in use.

The lowering of the waggon on to the hatchway of the vessels has therefore received every attention at the hands of engineers, but owing to the size of the hatchways there has always been a difficulty to lower the waggon into the hold and this difficulty has been greatly increased in consequence of the dimensions of the waggons themselves, as most of the trucks in modern use are from 18 to 20 feet in length over the buffers.

A very excellent arrangement is in use at the Hull Docks for raising the entire waggons upon the cradle from the low level. (View No. 13.)

I do not think it is the practice, however, to lower the truck into the hold, but we can see no difficulty in carrying this into effect provided a suitable swiveling arrangement be placed on the crosshead over the waggon, as it is absolutely necessary that the coal should be allowed to slide out of the waggon in *every* direction, so as to facilitate the trimming.

In the early part of the present century, and down to a recent date, tubs were largely employed on the river Weir, at Sunderland. These tubs fitted into a barge or keel, the trams were lowered immediately over the keel, and the coal then dropped into the tubs, the barge was then taken and placed between the wharf and the vessel, and the tubs lifted out and lowered down into the hold, the bottom of the tub being made to open, the coal was deposited with as little breakage as possible. One of these elaborate machines used for this purpose (View 14) consisted of a large beam supported on central trunnions, a sheave was placed at each end, and a rope or chain was passed over them and connected at one end to the barrel of a winding engine. The tub was first hoisted in a vertical direction and on continuing the revolution of the engine, the beam was caused to rotate upon its axis, until the tub was over the hatch, when the engine was reversed and the tub lowered over into the hold. Various other methods were in use at that time for lifting the tubs from the barges, and a floating barge fitted with a steam engine, and machinery by which the tubs were transferred from the keel to the ship was also employed, but on account of its unwieldy nature, was soon rendered obsolete.

In dealing with South Wales Steam Coals, very special means have been from time to time employed, and owing to the continued enormous demand for what is generally admitted to be the best steam coal in the world, the ports of Cardiff, Barry, Newport, and Swansea in particular, vie with each other in providing appliances to rapidly and carefully ship this valuable commodity with the minimum of breakage and maximum of speed. The steam coal trade is of such a recent date, that the history of it is almost identical with that of the steam engine, and steam shipping.

Thirty years ago, very few steamers came to these ports for coal, and the majority of vessels were small craft with an occasional full rigged ship or barque, with small hatchways and a long distance for the men engaged in the hold to trim the coal into the far end of the vessel. No mechanical contrivances as far as I am aware have ever been used in the Welsh ports for this purpose, but I find that considerable attention was given to this point in the neighbourhood of Liverpool and the North of England, and I also find in a blue book dated 1850, by Messrs. Wm. Laird and Alfred Edward Cowper, that several very clever contrivances were proposed for this purpose, by them, and as the question of breakage is at the present time of so much importance, I have no doubt that a reference to their invention will not be out of place here, and I therefore append an extract with copies of drawings from their Blue Book. (View No. 15.)

"We claim as our invention the application of an endless chain of buckets or blades for the purpose of lowering coal and similar descriptions of cargo into ships and other vessels as herein described. We also claim the application of an endless web or chain, placed horizontally, or nearly so, for the purpose of conveying and distributing coal and similar cargo into ships and other vessels, by means of a trunk kept constantly filled, so that the coal may gradually descend as it is withdrawn from below instead of dropping unchecked to the bottom. (View No. 16). We also claim the application of a railway suspended to the deck beams for the purpose of loading and discharging cargoes in ships and other vessels."

I am not aware whether these inventions were ever practically used, as I fear that owing to the amount of time required in order to erect and take down such a formidable structure, the time usually allowed for loading vessels in the present day would scarcely permit it, when it is a common occurrence for a 1,000 ton vessel to enter the dock on one tide, and get loaded and away by the next tide. (View No. 17). Mr. Westmacott advocates a system of telescoping tubes, as shewn.

The character of any mechanical contrivance for lowering the coal from the waggon into the hold, and distributing it when there, is one that deserves particular attention, and there can be no doubt that the old system of boxes, as employed at the West Bute

Dock, Cardiff, (old ballast crane, View No. 18) up to about the year 1860, was as perfect a plan as could be desired for carefully shipping the South Wales steam coal without breakage; but, owing to the small hatchways and want of more powerful machines it soon became evident that other and quicker methods of work were an absolute necessity, and the old machinery was, at about the date mentioned, taken down and re-erected at the East Bute Dock, and was in use regularly from that time until the last few years discharging ballast.

The machinery referred to consisted of a long projecting jib, reaching out over the dock a distance of 30 feet, and fixed 35 feet 6 inches from the ground, upon which worked a travelling carriage carrying sheaves, over which the chains passed for lifting the boxes; backing in and out was performed by a horizontal winding engine, with a single cylinder of 18 inches diameter and 3 feet stroke, driven by a Cornish boiler 5 feet 6 inches diameter and 18 feet 3 inches long, working at a pressure of 25 lbs.; the engine was reversed by a gab end on the eccentric rod being dropped on one or the other of a pair of levers attached opposite each other on the weigh shaft that actuated the slide valve, and a simple throttle valve, with handle, was used for shutting off the steam for starting and stopping; a complicated arrangement of hand levers and treadle governed the various brakes, also the clutches and levers that were required to be used every time the box was raised, lowered or backed in and out; while at work, therefore, the attendant was engaged in a kind of dance from one treadle to the other, while his hands were fully occupied with brake valve and eccentric levers, but notwithstanding all this complication, I do not ever remember a single accident happening to this old machine. The boxes were of iron, and contained about two tons of coal. They were brought to the docks on a kind of framework on wheels, the whole having a very similar appearance to an ordinary coal waggon. The train of waggons were run on to the line of rails between the engine house and the dock wall, the full boxes being lifted from there to the hold and the empty returned again on to the waggon, and so on. I feel convinced that had this system been carried out with better appliances there would have been no necessity for the present method of tipping the waggons. The whole arrangement might easily have been mounted on wheels and made to traverse along the dock-side to any distance.

At Cardiff and the neighbouring ports, a system of balance tips have for a long time been in successful use, and where the coal is brought in at a sufficiently high level to ship into the largest vessels it must be admitted that this system is as rapid a method of shipment as can be desired, and with improvements in the apparatus for allowing the coal to pass gently into the hold, I have no doubt that as little breakage can take place with this method as with any other. The most perfect tips of this kind can be seen in the East and West Bute Docks, Cardiff, and at Penarth Dock. The level of the water in the East and West Bute Docks being constant, and not varying with the tide, as at Penarth and Barry and other tidal docks, the distance therefore from the rail level to the water always remains the same, the highest tip being 28 feet from the water to the rail level. (View No. 19). It will thus be seen that when a modern steamer, measuring say 30 feet from the water's edge to the top of the bunker hatch, is to receive her bunker coal, that even the level of these tips is much too low for such a purpose, and in order to increase this height various methods have been adopted which we will endeavour to describe in due course. The principle of the Bute Docks balance tips may be described as follows:—At a sufficient height a train of loaded waggons is brought in and shunted as close up to the tip as to allow of each waggon being detached and accurately weighed, it is then brought forward by either horse power, or hydraulic capstan, on to a turntable, where each waggon is turned round, the door being invariably at the back end in this district, in order to prevent the doors from being strained during its transit by rail from the Collieries to the Docks. (View No. 20). The waggons are then hauled on to a cradle suspended by wire ropes passing up overhead, and attached to heavy balance-weights governed by a large pair of brake-wheels and powerful lever, the weight of the coal causing the waggon to descend and the balance weights bringing back the cradle to its original level. When the height of the tip is insufficient to ship into a very large vessel, it is usual to lift up the tail end of the waggon, and if necessary, also lower the front end. The lifting was formerly done by hand, by means of a powerful crab-winch, but this has been done away with for some years and a hydraulic ram has taken its place, the winch only being used for hauling up the slack when tipping by balance alone.

In working these tips, counter-weights are used in nearly every operation; thus in raising the butt or point of the shoot the labour on winch handles is very materially reduced by their assistance, while the clever anti-breakage arrangements can scarcely be improved upon in this respect. At the commencement of loading a vessel the coal is allowed to slide down a shoot into an anti-breakage box. This box holds about a ton of coal, the weight of which causes the box to descend, and is governed by a rope, one end of which is brought on deck, and the other is attached to a brake lever, so that the whole arrangement is perfectly under the control of the man on the deck of the vessel. When the box is empty, the brake rope is released, and the box is thereby brought back to be filled again, and so on until a cone or pyramid of coal is formed in the hold, after which the box is allowed to rise out of the way. The remainder of the cargo is allowed to slide down the sides of the cone into the distant parts of the hold where the trimmers are employed to place the coal where required.

Most modern steamers engaged in the coal trade are now built specially for this purpose and very little trimming is necessary. The amount of manual labour to handle waggons containing ten tons of coal is by this system reduced to a very small amount.

The incline down which the trains of coals are brought to the tips is very slight, being only sufficiently steep to allow of the capstan drawing about 20 or 30 waggons with ease, and $3\frac{1}{2}$ inches in 100 feet has been found to answer this purpose admirably, being just enough to enable the men to start the waggon with the aid of the capstan, while with the momentum thus obtained they can be run on to the weighing machine, and then easily stopped without applying very great pressure on the brakes, the hydraulic power being only required to give the waggon a start, each waggon therefore is weighed, turned around, tipped, turned around again, and is then sent down an incline of about one in seventy, this being sufficient to allow them to run down quietly by their own gravity. (Views 21, 22, 23, 24, 25.)

In consequence of the continued increase of the height of vessels coming to this port to be loaded and especially for bunkering into steamers when light, tips have had to be specially constructed, the existing levels being insufficient. The tips for this purpose are capable of raising a waggon 12 feet above the ordinary height of the high level railways. These tips are worked entirely by hydraulic power, drawings of which are shown. (Views 26, 27, 28.)

At Penarth the tips are entirely on the high level system, and the dock being tidal, a much greater height can be obtained from the water level to the high level railway than in the new tidal docks at Cardiff except on the top of spring tides when the loading has to be stopped until the tide recedes sufficiently and thus any required depth can be obtained.

The principle of these tips is practically the same as those at Cardiff, but with the exception that hydraulic power is used for working the anti-breakage box, and the details of the machinery are slightly different, the manner of bringing in the loaded waggons and taking away the empty ones is sufficiently different to warrant our giving a description of it. (View 29.)

The tip sidings are parallel with the dock and the trains of loaded waggons are shunted down an incline (View 30, 31), until it is arrested by a stop block at the safety catch, each waggon is then separated from the train as required and the catch allowed to fall back, the remaining waggons following on down the incline as far as the stop, entirely by gravitation, the incline being sufficient to allow of their doing so without any other assistance. The waggon being detached, is then pushed by hand on to a turn-table, then turned at right angles, and pushed off to a short incline leading to the tip; after the waggon has been tipped, an operation identical with that performed at Cardiff, it is pushed on to a return incline, at the end of which is another turn-table and upon this the waggon is again turned at right angles, in order to transfer it on to the empty road incline, from where the train of empties is taken away by the shunting engine when required. It will be seen that no horses or hydraulic capstans are used, but there is a very large amount of manual labour required in order to bring the waggons from such a considerable distance to the tip and then to return them again to the empty road. Gravitation has been employed to its fullest extent in each of these operations. These tips are built upon projecting jetties, and thus enable ships to be scarphed or to lie at an angle to each other, an accomodation that is of very great advantage when shipping into long vessels, as it allows the tips being built closer together than would otherwise be the case, thus considerably economising the room in the dock.

Having so far described some of the appliances in use during the early history of coal shipment in South Wales and the North, together with the excellent modern balance tipping arrangements in the neighbourhood of Cardiff, we will turn our attention to some of the various systems of coal shipping by hydraulic power, and to Cardiff, Barry, Newport and Swansea we should repair in order that we may see to what perfection hydraulic power has been applied for this purpose. Probably the first use to which this power was applied for coal shipping was the old arrangement in use many years ago in the Glamorganshire Canal at Cardiff, at the old sea lock where the coal was brought down in canal boats, fitted with large iron boxes similar to the system formerly employed at Sunderland to which we have referred. The boxes were lifted up out of the boat by a vertical ram and two horizontal rams pushed them out over the vessel, a gantry being fixed above for that purpose, this system has been for very many years obsolete, but as far as I am aware I have no doubt that it was the pioneer of hydraulic coal shipping. (View 32.)

The hydraulic tips made for the port of Cardiff, by Sir William Armstrong are all on the low level system and consist of a central ram and cylinder fixed below the level of the dock wall, the top end of the ram is attached to a strong iron cradle working between a pair of upright guides of sufficient length to allow the ram and cradle to be raised to the required height, upon this cradle is fixed a tipping platform hinged at the front ends by means of strong gudgeons, the back being attached to another ram working in a cylinder 9 inches diameter and fixed by oscillating trunnions to the main cradle, the waggons are weighed, turned, and brought on and taken off much in the same way as on the high level balance system. When the loaded waggon is brought on to the cradle, the pressure water is admitted to the main cylinder by an attendant perched up in a house at the top of the tip so that he can watch all the movements of the machinery under his control, the cradle being raised to a sufficient height,the door of the waggon is loosened and the tipping ram at the back of the platform is brought into play, causing the back end of the waggon to rise and the waggon to assume an angle of 45° in order to allow the coal to slide out in the shoot. The pressure water for the tipping cylinder is taken from the main cylinder, the valve being situated on the rising cradle, and actuated by the attendant turning around a long square bar running the entire height of the tip and passing through an opening in the cradle. (View 33). Upon this bar a valve lever with a square hole is allowed to slide freely, the other end of this lever is connected up to the valve levers, so that upon the bar being turned in one direction the pressure valve is opened and the exhaust in the opposite direction, the raising and lowering of the shoot is also performed by the motion of the cradle, thus—when the butt of the shoot is required to be raised or lowered, two arms are made to project from the front of the cradle, and upon the pressure being attached to the main cylinder, the cradle rises with the shoot to the required position, the lowering being accomplished by simply opening the exhaust valve, allowing the water to escape. (View 34). A vertical rack is fixed each side of the main uprights, and a self-acting catch is fitted to the butt of the shoot, so as to hold it any height required, the point of the shoot is caused to rise or lower by means of a pair of chains attached to each side of the point, and passing over four sheaves at the top of the tip and down each side near the central guides, a claw to fit the link of the chain flatways is pushed between an oblong slot in the cradle at any point desired, the rise or fall of the cradle causing a corresponding rise and fall of the point of the shoot, and a similar claw is fixed each side near the top of the tip in order to keep the point in any desired position.

At the Alexandra Dock, Newport, (View No. 35,) and at the Prince of Wales Dock, Swansea, the coal is brought in on the low level and the trains of waggons run down an incline entirely by their gravity, they are then weighed and turned round and brought on to the cradle of the tip, being hauled on by means of a hydraulic capstan, the waggon is then raised to the required height and is then tipped up by the ordinary Tipping Ram as before described, the waggon being emptied, is run on to a high level incline overhead, down which they descend by their own gravity and are taken away by the Dock locomotives. The advantage gained by this system over the ordinary low level is that a full waggon can be brought up in readiness to place upon the cradle while the other is being tipped and run on to the incline, and thus very little time is lost in each operation. (View 36). The perfection to which hydraulic power has been utilized in the shipment of coal by Sir William Armstrong has left very little for outsiders to do in this class of machinery, and consequently very few firms have turned their attention in this direction. Among the latter are Messrs. Brown Brothers, Edinburgh, whose low level tips at the East Bute Dock, are excellent examples. In these tips the central ram hitherto universally adopted in hydraulic Tips has been entirely replaced by suspending the cradle by means of a series of six round wire ropes one inch diameter, these ropes pass around sheaves fixed under the cradle and up over similar sheaves fixed at the top of the structure, and down again on each side, one ram being placed at each side of the tip working downwards, the ropes being passed around sheaves at the head of each ram and the ends fixed to the cylinder, large weights are also attached to the head of the rams and assist in balancing the cradle, &c., so as to economise the water power as much as possible. The waggon is tilted by means of wire ropes attached to the tipping cradle, and passing overhead and down one side and around a ram placed under-ground at the back of the tip, the other end being fixed to the bottom of the cradle so that the latter is free to travel up and down, and upon the ram being brought into play, the tipping cradle is raised or lowered as required. A crane is fixed at the side for use in working the Anti-breakage Box and other work as required, and the whole is under the control of a Top-man situated in a small house fixed high up on the side of the structure. The method of working the shoot, &c. is very similar to that employed on the Armstrong Tips.

Thomson's Patent Coal Tips as used at the Leith Docks, Edinburgh, next claim our attention. These machines, as hitherto made, with a separate tipping ram, require a man stationed aloft to work the hydraulic apparatus, and who stops the rise of the platform at the proper place and then tips the waggon by hand-gear. The cost is thus incurred ot the constant attendance of a comparatively skilled man, the most expensive of any employed in the operation, and unless he stops the ascent of the platform and waggon at the precise moment required, which he can seldom do, the coals are exposed to a considerable fall when they leave the truck, the waggon being necessarily higher than the shoot. This, as all coal merchants know, causes an amount of breakage that is most detrimental to the marketable value of the coals. In Thomsons' Patent Coal Tips these various disadvantages have been obviated by the invention of a simple and effective means of tipping the waggon by the action of the same ram that raises it. This operation, also, is performed at the exact height that is required by a simple automatic apparatus, and without the least attention or interference of the men working the tip.

The greatest perfection to which hydraulic coal tipping has attained up to the present, may be seen at the newly constructed Docks at Barry and at Cardiff, where the latest developments of tipping arrangements are now employed. The high level tips at Barry, (View 37) are on the hydraulic principle, and are built by Messrs. Tannet Walker & Co., of Leeds. The height of the ordinary tipping level is sufficient to meet the requirements of most vessels at H.W.S.T., but where it is necessary to ship into the bunker hatches when light upon the high spring tides, it becomes necessary to raise the waggon still higher, These tips are arranged so that the platform can be lowered right down to the level of the coping or raised to the height of 37 feet from the coping, thus enabling the shipments to be made into the largest vessels afloat. The hydraulic rams for lifting the cradle are arranged, so that when the loaded waggons are run on from the high level, the whole of the pressure water is forced back into the hydraulic mains by reason of the weight of the coals in the loaded truck, the empty waggon being lifted by the pressure water which is only admitted to one of the rams, there being a series of four rams attached to each cradle so that either or all of the rams can be used simultaneously, but it is never necessary to admit pressure to more than one of them for lifting the empty waggon and cradle, but where the loaded waggon has to be lifted the other rams are brought into play. The ram for lifting the cradle is suspended on trunnions in the usual way, but the pressure water after being used is conveyed to the return mains through a system of walking pipes that rise and fall with the cradle.

The whole of the water used at Barry Dock throughout the hydraulic system is returned through a series of pipes, back to the hydraulic engine house, to be again pumped under pressure, and a portion is returned back into the pressure main when the full waggon is descending.

In this paper, up to the present, we have only dealt with machines of a fixed description, so that ships can only be loaded at fixed points. In these days, where rapidity of loading is of the greatest consequence, it is necessary, in order to get sufficient despatch, that the coal should be tipped into two or more hatches at the same time. Many and various schemes have been devised for this purpose, and a great number of patents have recently been taken out. The first practical machine of this description that I am aquainted with, was used at the old dock at Newport. The waggons were run on to the cradle from an inclined way. There were two fixed positions that the tip could be fixed in, each of which had an inclined bank, up which the loaded waggons were drawn, in order to raise them sufficiently high to run on to the cradle. A winding engine and boiler were placed inside of the structure, for hoisting the cradle with the waggon sufficiently, to be tipped into the shoot.

I will just notice here the design of Mr. Butler (Views 38 and 39), which is sufficiently novel and practicable to engage our attention. He proposes to use an ordinary balance tip, constructed after the lines of the Bute and Penarth Tips, but mounting the whole upon wheels; and in order to convey the wagons on to the tip from the high level, a bridge is constructed of sufficient length to connect up to the back portion of the tip, to an abutment some distance away, in order to allow the tip being traversed along the dock wall, the girder or bridge having an arrangeat each end to allow of its movement.

Mr. George Taylor, of Penarth, has devoted an enormous amount of time in developing schemes for movable tipping arrangements, the most notable of which are the movable tips at the Roath Basin, Cardiff, and built by Sir William Armstrong, Mitchell and Co. (View 40.) The waggons are brought on to the cradle from a series of curved lines, each communicating with a turn-table, and from which each curve line radiates. This system has proved highly successful, and is in daily operation at Cardiff.

At the Alexandra Dock, Newport, Messrs. Tannett, Walker & Co., of Leeds, have erected a movable tip on a somewhat different principle from the former. The waggons in this case are brought in at right angles to the dock, where they are run on to a traverser, this apparatus being traversed along with the loaded waggon until it comes opposite the position where the tip is placed. It is then run on to the cradle, raised by hydraulic power, and tipped, the empty waggon being then transferred on to another traverser, which travels upon an elevated way, which extends the whole length of that portion of the dock that the tip is capable of travelling over; the empty waggon is then run down over an incline, the upper end of which is fixed at a certain position on the elevated way. Lifting the waggon up bodily, by means of a crane, and swinging it out over the vessel, is a method which has been in use at several ports for a long time, worked by hydraulic and steam power, but the employment of a movable crane (View 41) for this purpose, I think, is confined to the Bute Docks, Cardiff, where a very powerful crane is in use, built by Sir William Armstrong, Mitchell & Co.

An ingenious arrangement has been devised by Mr. Charles Hunter, of the Bute Docks, for preventing the breakage of coal in its descent into the hold of the vessel. A large hopper is placed over the hatchway, and a kind of telescopic vertical tube is attached thereto. An inverted conical bottom, connected with the central chain, governs the exit of the coal and assists in trimming it in the hold.

We will now refer to the elaborate arrangements presently in use at the New Roath Dock, at Cardiff. (View 42, 43, 44, 45, 46).

In this system the coal is first deposited into a large box, which is placed in a pit that runs parallel with the dock side. This box is carried upon a low carriage which runs on rails at the bottom of the pit. Powerful hydraulic travelling cranes are then used for lifting the loaded boxes up out of the pit, then swinging them around and lowering the box and its contents into the hold of the vessel, the bottom of the box, being made conical, is then by a separate gear lowered and the coal deposited in the hold. Several of these cranes and tip-up arrangements are employed at the Roath Dock and are capable of shipping into the largest vessel afloat.

Messrs. Tannett, Walker & Co. have erected at Barry Dock one of their Patent Movable Tips, (View 47, 48), the cradle of which is lifted by means of four cylinders with pistons and rods attached to each corner of the cradle. A very powerful jib is projected from the centre of the tip out over the hatchway and to which is suspended a 5 ton anti-breakage box, into this the coal is allowed to descend and then lowered into the hold in the usual way. To get the coal on to this tip, movable turn-tables travel along a prepared way and are always fixed in the position that the tip is required to work. Short inclines of movable rails are laid down to connect the main line up to the turntables.

Messrs. Fielding & Platt, of Gloucester (View 49), have supplied the Barry Co., with one of their Patent Movable Tipping arrangements. This consists of a powerful travelling crane running parallel with the Dock wall. A bridge, connecting the High Level Railway to its main structure, is at a considerable height above the roadway below. This bridge is made so as to allow the front or crane portion to travel 100 feet along the dock wall so as to suit the varying position of ships' hatchways. The shore end of the bridge is provided with a series of movable rails to drop in the gaps occasioned by the varying positions of the bridge. This tip is used exclusively for tipping the waggons of coal into specially designed boxes which are lifted up vertically and then jibbed out as far as the hatchway of the vessel. The box is then lowered into the hold, doors in the bottom and sides being then opened by hydraulic gear and the contents deposited as desired.

Having now described and shown the leading features of the various forms of Coal Shipping Appliances that have been used for a considerable time back, and some of the modern contrivances introduced within the last few years, I have come to the conclusion that no better system has ever been employed for shipping the very fragile South Wales Steam Coal, than the system of boxes introduced from 20 to 40 years ago, but as long as the demand for rapid shipment is so universal, I am afraid it will be impossible to return to this very excellent arrangement.

Next to this however, must be given the preference to the system of shipping into a large anti-breakage box placed at the mouth of the shoot. View 50) It makes very little difference whether the shoot is a long one or a short one, as the coal sliding down it suffers no injury. It is the sudden fall that the coals gets when being emptied from the waggon and the long drop that does the mischief. The shoot should always be kept full of coal, and the anti-breakage box as large as possible with sufficient strength in the machinery for carrying the weight.

Modern hydraulic cranes for lowering the full anti-breakage box are no advance upon the old system of balance weights, unless the ram is made use of for pumping water into the pressure mains upon the descent of the full box.

Movable coal tips certainly are the ideal method for rapid shipment, as by this arrangement coal can be loaded into every hatchway of the vessel at the same time, but it has been found in practice that with the best system of fixed tips, (View 51) placed at sufficient distances apart, the coal can be shipped quite as fast as is required, and when proper care is taken in using the anti-breakage boxes, as little breakage occurs as in any other arrangement.

In rapid loading with fixed tips, the following may be taken as a sample of what has been recently done at Barry:—

On May the 8th, two steamers were loaded at No. 6 tip, a total quantity including Cargo and Bunkers of 3,997 tons in 22 hours. That would be at the rate of 181·681 tons per hour.

The *S.S. Cookham* loaded at one tip with 2,000 tons, Cargo and Bunkers, in 3 hours and 35 minutes, at the rate of 338·02 tons per hour.

The *S.S. Britannia* loaded at one tip, 1,192 tons 7 cwt., Cargo and Bunkers, 3 hours and 35 minutes, at the rate of 305·1 tons per hour.

And 68 waggons have been tipped into a vessel in one hour, at the rate of about 680 tons per hour, a speed that should satisfy anyone, even in these go-a-head times.

INSTITUTE OF MARINE ENGINEERS

INCORPORATED.

SESSION, 1894-5.

President—SIR THOS. SUTHERLAND, K.C.M.G., M.P.

Volume VI.

DISCUSSION

(With Illustrating Diagrams)

ON THE

FIFTY-FIRST PAPER

(OF TRANSACTIONS)

Mechanical Appliances for the Shipment of Coal.

BY

MR. W. S. ALLEN

(MEMBER).

READ AND DISCUSSED AT

THE GRESHAM COLLEGE, LONDON, E.C.,
On Saturday, February 24th, 1894.

THE UNIVERSITY COLLEGE, CARDIFF,
On Tuesday, March 13th, 1894.

THE HARTLEY INSTITUTE, SOUTHAMPTON
On Thursday, June 7th, 1894.

DISCUSSION CONTINUED AT

58, ROMFORD ROAD, STRATFORD, E.
On Monday, March 12th, and April 9th, 1894.

PREFACE.

58, Romford Road,

Stratford, Essex,

August 1*st*, 1894.

A Meeting of the Institute of Marine Engineers was held in the Premises of the Institute on Monday, March 12th, when the discussion on the Paper by Mr. Allen *(Member)* on "Mechanical Appliances for the Shipment of Coal," read on Saturday, 24th February, at Gresham College, Basinghall Street, E.C., was resumed.

The discussion was again adjourned and continued at the next and following Ordinary Meeting, when the interest was much enhanced by Mr. Capper *(Honorary Member)* kindly exhibiting a very fine model, illustrating a system of loading steamers, adopted in Cardiff, showing the whole process, with model trucks, rails, cranes, and steamers alongside the wharf. Mr. Paul also kindly exhibited and explained a model, illustrating his system for coaling steamers' bunkers.

Mr. Allen kindly read his Paper in Cardiff and Southampton also, illustrating it, as at Gresham College, by means of views thrown on a screen by lantern. A selection of the views are published along with the discussion in the following pages.

JAS. ADAMSON,

Honorary Secretary.

INSTITUTE OF MARINE ENGINEERS.

INCORPORATED.

SESSION 1894-5.

Volume VI.

DISCUSSION

ON

COAL SHIPPING APPLIANCES

HELD IN

The Gresham College, Basinghall Street, E.C.

ON SATURDAY, FEBRUARY 24th, 1894.

CHAIRMAN :—

W. H. WHITE, Esq., C.B., LL.D. (Past-President).

The CHAIRMAN : Gentlemen—the Honorary Secretary has informed me that it is intended that two papers shall be read to-night. The first, by Mr. Aisbitt, is on "Damage Surveys," and the discussion on that will be taken subsequently at the rooms of the Institute. Then, when the proceedings on that paper are concluded, it is proposed to proceed at once with the reading of Mr. Allen's paper on "Mechanical Appliances for the Shipment of Coal." I presume that if there should be any time for remarks on that paper, they will then be proceeded with, and the discussion afterwards adjourned. I will now call on Mr. Aisbitt to read his paper on "Damage Surveys."

Mr. AISBITT (Member) : It was not until Monday night last that I was asked to write a paper for this evening's meeting, and it struck me that the subject of "Damage Surveys" is one in which all engineers are interested. I therefore sat down at half-past ten in the evening and wrote until I was called upon by a higher power to adjourn. I would rather have had an opportunity of thinking over the matter for a fortnight. However, I just jotted down my ideas and I will now read the result.

(Mr. Aisbitt then read his paper on "Damage Surveys.")

The CHAIRMAN: I see from the programme that the vote of thanks to the author of the paper will come later in the proceedings, but I am sure you will all agree with me that it is a great happiness for us that the higher power did not summon him sooner on the occasion when he prepared this paper, and, I should say, as compared with some of the professional papers one reads, that if this is to be taken as an indication of what may be expected when papers are begun late at night, I hope some more papers will be commenced at the same time. There is in this paper a good deal of suggestiveness and a good deal of common sense mixed with some dry humour, which enlivens the paper and assists to drive some of the remarks home. I do not think that we are any the worse for a little fun at times, even in the Institute of Marine Engineers. If it were not that the discussion is to be adjourned, I should be disposed to say something on some of the points which have been raised by Mr. Aisbitt in connection with the so-called strengthening of vessels. Perhaps, as I shall not have the opportunity of being at the meeting when the discussion will take place, I may say how cordially I endorse that portion of the paper. I well remember that some years ago, when I was not in the Admiralty service, I was asked to go and see a vessel about which there was a great dispute, and which was made the subject of an arbitration that extended over a very considerable time, and led, I think, to the practical ruin of the two parties to the arbitration. It was, I believe, a great benefit to the lawyers and the arbitrator, but I do not think that anybody else got any benefit out of it. In this case the particular point under consideration was, whether the vessel had been substantially and properly built at the after part—whether it was properly shaped, properly framed and properly plated. When I went to see this vessel it was not with any idea of taking part in the proceedings, but simply because I think we all learn by seeing failures, and we criticise with much greater freedom when they are the failures of others. I went for the purpose of studying the features of this case, and I found that the vessel was being strengthened —strengthened, so called. I do not know how much weight was added, but I am quite certain of this, that not an ounce of what was put on to that vessel was of the least service to her. There could be no doubt of that when one saw what was being done, for, after the most careful scrutiny that I could bestow upon her, I did not notice the least signs of working or signs of weakness at that part of the vessel where the plating was being added. I have seen many other cases of that kind, and I think that Mr. Aisbitt in drawing attention to this matter is doing a real service, especially to shipowners. Having regard to the special experience of the members of this Institute, including as it does superintendent engineers, and engineers still in active service afloat, a paper such as this must lead to a very instructive and valuable discussion, and as a peg to hang many other anecdotes upon, having practical value—perhaps of more practical value than was the career of J. Brown, between the 5th and the 8th December, noted in the paper. It has been well said that next to being witty oneself it is a good thing to be the cause of wit in others. No one can accuse Mr. Aisbitt of not being witty himself, and I am quite sure he will be the cause of wit in others in the discussion on this paper. I will now ask Mr. Allen to read his paper.

(Mr. Allen then read his paper on "Mechanical

Appliances for the Shipment of Coal," and sketches and views of the numerous appliances and arrangements referred to in the paper were projected on a screen by means of lime light.

The CHAIRMAN: We have the pleasure of the company here to-night of several of our members from the Cardiff centre, whose experience on this matter of coal loading is quite special, and as they may not be able to attend when the adjourned discussion proceeds, it would be a great satisfaction to the meeting if one or more of them would now offer a few remarks. According to the programme we have some time to dispose of in that way, and I will ask Professor Elliot to start the discussion.

Professor ELLIOT (Vice-President): The very completeness of Mr. Allen's paper, it seems to me, renders casual criticism, which is alone possible on a first hearing, a matter of some difficulty. For example, I had it in my mind to suggest to-night a modification of the carrier or continuous elevator to the purpose in hand—an idea which naturally took possession of one on considering that the ordinary hydraulic or other hoist is, as a machine, equally effective for its purpose when lowering and when raising goods or passengers. But from Mr. Allen's interesting and valuable historical summary one learns that that notion is old, and belonged originally, with many other excellent mechanical adaptations and inventions, to the late Mr. E. A. Cowper. I would like to see some authentic statistics of actual performances by the various kinds of tips. From a conversation which I had with Mr. Allen on the way from Cardiff to-day, I was prepared to find that he had hardly touched on this part of the subject, because, as I understand him, Mr. Allen not only regards record performances with suspicion—and I am bound to say natural suspicion—but is further of opinion that any good tip can ship coal faster than the trimmers are able to deal with it, or faster than the waggons can be tail roped to and from the tip. Now it seems to me that though practically the tip may be, and usually is able to keep ahead of the trimming and tailing, yet with special arrangements, such as would be made at a trial, the tip could be worked at its maximum capacity. These trials, I conceive, would be practically measures on an approximately fair basis, of the efficiency of tips, for, in the end—but apart from questions of first cost—what has to be measured is, not so much the mechanical power required to ship a given quantity of coal, but the men's time consumed in working levers and in waiting for hoisting, slewing and lowering, and the amount of breakage sustained by the coal. There are, as Mr. Allen has shown, fixed tips and movable tips, and there is Messrs. Hunter and Lewis's tip which, though fixed, is capable of working two hatches. Now, in practice, the movable tip does not appear to have much advantage over the fixed tip, because I have it on the authority of Mr. Archibald Hood, who is deeply interested in Barry Dock, where both kinds of tips are in use, that captains and those primarily responsible for the work of coaling ships choose fixed and movable tips indifferently. If the matter is largely a question of trimming the explanation is simple, seeing that whether the tip is fixed or movable in the ordinary sense, only one set of trimmers can be kept going. On the other hand, Messrs. Hunter and Lewis's arrangement cuts a long way into the trimming difficulty, if, as they hold, it is possible to work two hatches simultaneously. I had heard much of Messrs. Hunter and Lewis's system before I saw it at work. Now I am very familiar with it. The first difficulty is to understand from a mere description how it is possible to turn the contents of a ten-ton waggon into a high narrow box without a lot of leakage. In actual work the operation is astonishingly clean and neat, and there is no leakage, practically speaking. Mr. Allen has credited the ordinary modern tip with a capacity of one ten-ton truck in two minutes—that is to say 300 tons per hour. I observed in the *Times* some two or three days ago a paragraph—evidently inspired—dealing with Messrs. Hunter and Lewis's tip, and it was there stated that one such appliance had actually shipped 293 tons in one hour. Taking both sets of figures as correct, the next question is breakage, on which head we have, as yet, no data. Broken or small coal is in itself bad, because, mechanically, it is difficult to burn. There is the further consideration that, in the breaking, valuable gases escape. Again, the surface exposed to weathering is enormously increased and easily oxidised, particles on the fresh surfaces exposed are burned in the atmosphere as surely and as completely as in the boiler furnaces. Small coal is no doubt cheaper than large; but, as engineers, we are interested that what is originally good coal shall not be spoiled by smashing. If we can prevent the breaking of coal at the quay-wall, it means very nearly that we get the original sized coal at the same price as the smashed coal.

Mr. DAVID GIBSON (B.C.C. Vice-President): I have to congratulate Mr. Allen on the completeness of his paper, and I think we are all agreed that this is a subject that comes very close to engineers. Those of us who have been abroad and have seen the small coal coming over the side, know what disadvantages we have had to put up with in using that coal at sea; invariably we have paid for it the price of large coal. It is just owing to the want of proper appliances for shipping the coal in the condition, as far as possible, in which it comes from the pit. Mr. Allen has spoken of the efficiency of the box for taking the coal from the mouth of the shoot, and he says that that is about as good an arrangement as can be applied for preventing breakage. From what I have seen of it the adoption of this box is quite a delusion. When the ship goes to the tip they use the box for the first few loads, but as soon as the coal superintendent is out of sight, and there is nobody present whose interest it is to see the coal shipped large, they simply teem the coal into the hold from a height of twenty feet and more. Unless you have a man standing over the tip during the whole of the loading, I think this trimming box is next door to a delusion. With the Welsh coal it is of extreme importance that it should be kept as large as possible. That does not apply so much to north country coal. With north country coal you can always get steam by working it, but as Welsh coal is a dry coal it is different, and with a dry coal, when you have a run of small, it is next to impossible to get anything like steam. It is impossible to put the tools into it, because as soon as you begin to knock the fire about it all goes dead and blue. With north country coal you can always work it and keep a fairly good fire burning, but with a dry coal, as soon as you get it small, it is impossible to burn it out. For the rapid shipment of coal I think the cranes in the Roath dock are about the best that I know of, and the coal has the least fall of all. The box goes right down to the bottom of the hold each time, and drops the coal right on to itself as it were, and you frequently see that one of those cranes is tipping the coal into two bunkers at the same time.

MR. M. W. AISBITT (Member): I think, sir, that we all agree in heartily thanking Mr. Allen for the exhaustive and able paper which he has this evening laid before us on this matter. After a cursory perusal of the paper it has struck me that the two principal points to be attained in the shipment of coal are, first, despatch, or rather rapidity of loading, and, secondly, a minimum of breakage of the commodity dealt with.

In comparing the various systems adopted in the North of England and in South Wales, two important points, I think, should be taken into consideration.

Firstly—The geographical position of the various ports of shipment. Secondly—The nature of the coal shipped.

As regards the former, the Tyne and Wear districts have an advantage over the South Wales ports in the fact that the banks of the rivers and those immediately adjoining the docks are of considerable altitude, and hence, by the common law of gravitation, the coals there laden can be shot into the vessel's hold without any exercise of artificial power. Moreover, owing to the coal of that district being, as Mr. Allen states, of a close, dense and compact structure, it is less liable to breakage, and will run easier than that of the South Wales district. It must therefore be admitted that owing to those special conditions, coal can be shipped quicker and cheaper than can be done in South Wales. On the other hand, from the very frailty of its nature, the South Wales coal will always take precedence as the finest steam coal in the world.

Mr. Allen has described and illustrated to us the various methods adopted in the north country, which practically consist, first, of either discharging the coal from the waggons into iron shoots and delivering it direct into the vessel's hold; or, secondly, of lowering the waggon on a balance platform to a level with the vessel's hatchway, and then discharging it through the bottom of the waggon direct into the hold.

Although the latter in times past has proved a very efficacious means to effect the object desired to be obtained, I think it will be agreed that, owing to the dimensions of the present vessels, the former process is the most suitable for the north country ports.

Before leaving this matter, as regards north country ports, I should like to refer to one process of loading which I do not think Mr. Allen has noticed, viz., that used in Glasgow, where the waggon and coals together are lifted from the rails by means of a large crane, swung over the vessel's hatchway, and, by means of tipping, the coals are shot into the hold. However, from what I have seen of it, I fancy this process is somewhat a slow one.

As regards the loading of coal in the South Wales ports, especially in the case of Cardiff, it must be remembered that most of them are simply deltas formed by several streams or valleys converging to a given point, the ground level of which is seldom more than a few feet above the high water mark, hence the facility with which large coal trains are brought down from the collieries in such valleys as the Rhondda, Rhymney, and others. It is therefore necessary on this account to re-elevate the coal to a sufficient height, in order to enable it to be slid down into the holds and bunkers of comparatively high vessels, and as the dimensions of coal-carrying vessels have rapidly increased of late years, various appliances and alterations to the coal shoots have had to be made in order to cope with the matter.

Generally speaking, the three systems, as adopted in Cardiff and Barry, are as follows:—

Firstly—The fixed tip, fitted with a powerful hydraulic ram, which raises the laden waggon to a sufficient height, when a second ram is applied for tipping purposes, so that the coal may run easily down the shoot, in conjunction with which an anti-breakage box is usually employed during the first process of loading, so as to obviate the long drop of the first two or three hundred tons.

Secondly—A movable tip of the same description, to accommodate the various positions of the vessel's hatchway.

Thirdly—Messrs. Lewis and Hunter's portable crane, carrying an anti-breakage box, deposited in a specially constructed well near to, and parallel with, the sides of the dock, and into which the coal is first tipped from the waggon on the ground level, the whole is then lifted up, swung round and lowered through the hatchway of the vessel to within a few feet of the ceiling.

As regards the fixed tip, I think, so far as speed is concerned, they can compete successfully with either of the other two, but in both this system and that of the movable tip, owing to the small size of the anti-breakage box, the latter is frequently prematurely discarded and the coal allowed to fall a considerable distance, with damaging effect.

However, I notice that Mr. Allen states that in Barry Dock they have adopted a five ton anti-breakage box, which possibly may be the means of obviating a large portion of the breakage.

Messrs. Lewis and Hunter's movable crane has, undoubtedly, the advantage of depositing the coal as low as possible in the vessel's hold before dropping it. It has also another advantage, I think, of being able in some cases to serve two hatchways at the same time. On the other hand it must be remembered that in this process the coal is actually tipped twice, *i.e.*, first from the waggon into the hopper, and then from the hopper into the vessel. Mechanically, it would appear unorthodox to lower coal from a given level, and then afterwards raise it back to the same level.

There is also the question of the extra cost of making the well, consisting of solid masonry and stone work (and being practically water-tight) into which the coffer is placed, as also the cost of a powerful steam crane, as compared with that of an ordinary standard tip.

I note Mr. Allen states that the breakage done to the coal is not so much owing to the distance it has to travel in the coal shoot, as to the height of the drop from the end of same to the bottom of the vessel. It has often struck me that it might be possible to arrange for an extension of the present shoot, suspended from the beams of the vessel, and made of a jointed nature so as to run the coal well back in the wings of the vessel. However, no doubt this idea has already been well considered by those who are experienced and competent in these matters.

The CHAIRMAN: I would now invite Mr. Allen to reply to the discussion, so far as it has proceeded, for the benefit of members present, who may be unable to attend the next discussion.

Mr. ALLEN: I do not think that there is very much to reply to. Dr. Elliot was the first speaker, and he made some remarks about trimming mechanism. I have been trying for a long time to scheme out some kind of mechanism, and I could never make up my mind how I could get a machine into the hold of a ship and get it out again, especially when the hold is full of coal. I have made very elaborate drawings in trying to scheme this thing out, but when you come to deal with Cardiff coal you find lumps half as large as this table. Some of the lumps in Cardiff coal are three or four feet high, and coal of that character cannot be dealt with like other coal that we know of. There are kinds of coal which you can scheme to trim anywhere—it will run down Mr. Aisbitt's telescopic shoot like quick sands—but that is not the case with Cardiff coal. There have been a lot of schemes for twisting the nose of the shoot, and one gentleman schemed a kind of spiral staircase, down which the coal was supposed to slide, but I do not think the idea has ever been tried. I do not think these big lumps would go down that kind of shoot. I think they would rather go over the side than go round the corners. With regard to statistics as to the rapidity of shipment, that is a matter which it seems to me depends entirely on bringing up the coal quickly, and taking away the empty trucks. I am prepared to say that the slowest and most primitive coal tip will tip coal as fast as the more modern scientific appliances. Take the old balance tip on the high level at the Bute Dock as an instance, and consider what is the tipping? It is nothing It is only a matter of two or three minutes to tip a waggon. The point is getting the coal there and getting the empties away again. I do not think, therefore, that statistics as to the tipping would be any good. The difficulty is to get the coal to the tip, and to get it trimmed after it is tipped—it is not in the actual tipping of the coal, but in getting it there and getting it away again.

The CHAIRMAN: Before I call upon Mr. Sage to propose the resolution, of which he has charge, I should like to say that I have listened to the paper which Mr. Allen has given us with very great pleasure, perhaps the more so as this is a subject which I happen to know something about. Some time ago we were considering the best arrangements that could be made in connection with the coaling of the fleet at various places, and, incidentally, I did go to various ports—and to Cardiff among others—and made a study of what was being done in the way of putting coal into ships in large quantities. I am bound to say that, at the first blush, Mr. Aisbitt's objection to Messrs. Hunter and Lewis's method seems to have considerable force. In fact, I mentioned the same idea to Mr. Hunter himself, and he said what I am sure we shall all recognise as very forcible. It was asked, why could not the anti-breakage box be the railway truck to come down on the line. That was immediately met by a statement which shewed that that was not a point the consideration of which had been overlooked by these gentlemen. They pointed out that if the box became the railway truck, there would be difficulties in connection with rolling stock which now are avoided, and that the box of this crane was designed to go down an ordinary hatchway, and answered that purpose admirably. It was pointed out that you only wanted one such box, or two at the outside, for each crane, but that you have a great many railway trucks which come down and tip the coal into that box. It may not be altogether, at first sight, an economical use of power to lower weights in order to raise them again, yet we must not forget that there is a very considerable amount of lowering that has to be done when the coal gets to the vessel, and their view is that the anti-breakage box must be lowered into the vessel, if the best value of the coal is to be obtained. Another thing that was forced on my mind, as the result of my inquiries, was, that in coal-carrying vessels a great deal might be done in the special arrangement of hatchways for facilitating the getting of the coal into the vessel. The most perfect thing of its kind in that way was a whale-back vessel, which I had the pleasure of going over at Liverpool, where the hatchway was the whole length of the ship, but there were other features in that vessel which we should not care to adopt. The geographical conditions of the place where the coal has to be shipped must affect the relative efficiency of different methods, and I can quite believe that what Mr. Aisbitt says is true, that dealing with the north country coal, and having these advantages, it is easy to get a rate of loading which, under the circumstances of Cardiff, require very elaborate mechanical appliances to attain. I will not trouble you now with any further remarks on the paper, but I do hope that this discussion will go on, and I am confident that Mr. Allen will have made a contribution to the proceedings of the Institute, which will be recognised as of very great value to all concerned in the shipment or use of coal. The discussion now stands adjourned according to the timed programme, placed in my hands for the guidance of the evening's proceedings, and I will now call upon Mr. Sage.

Mr. SAGE (Member of Council) : It is with very great pleasure that I rise to propose a vote of thanks to Mr. Aisbitt for the paper which he has read to us to-night on "Damage Surveys"; it has the merit of brevity, but that we will not count a merit, and, coming from such a source, I certainly think that this Institute will only look upon it as a first instalment of a very much longer paper on the same subject. I do not know a member of the Institute better qualified to write on a matter of the kind, and I look forward with pleasure to having a good long paper from Mr. Aisbitt. I hope he will only consider this a first instalment, and that he will give us the benefit of his experience on the subject at greater length.

Mr. J. H. THOMSON (Chairman of Council) : I have very much pleasure in seconding the motion, and quite endorse the remarks of Mr. Sage.

Mr. AISBITT : I thank you very much for your vote.

I only hope that the next time I have the pleasure of reading a paper, if I should have that pleasure, the paper will be more worthy of the Institute of Marine Engineers.

Mr. A. THOMSON (Vice-President): I have to propose a vote of thanks to Mr. Allen for what I consider a most instructive paper, illustrative of what I think a great many of us know very little about. As marine engineers going to sea, I think very few of us ever consider anything about the transportation of coal until it comes alongside, and I know from experience how I used to look at the barges or coal trucks to notice if the coal was in large lumps or very small. When we saw that the coal was very small we knew we should not keep full steam that voyage. For myself, I do not know much about the transportation of coal by means of these modern appliances, but I happened to be at Cardiff a little time ago and I saw some of these great tips, and I could see that a large amount of time in shipping coal is wasted in that process of getting the waggons to the tip. I watched the process for an hour or two, and I could see that it was a very slow arrangement. I am delighted to be here this evening, and hope that this lecture will lead some of our members to set their brains to work, so that in the result some process may be devised by which that great delay will be avoided. When practical engineers do try to think out a matter it is wonderful sometimes what they produce. I was very much interested in noticing the great difference between the earliest methods of loading coal and those now employed. I think Mr. Allen must have commenced sixty or seventy years ago, and followed the progress of events up to the present time. When one looks at those photographs and considers the enormous amount of capital that must be invested in those tips and machinery, one must recognise the importance of the subject. But it seems to me that there is something yet to be done, and it has just struck me how that loss of time in bringing up the waggons, and, in some instances, in lowering the waggons down, might be avoided. In other instances they drop the coal into receptacles. Now I think myself that the work ought to be done without either lowering the waggons or putting the coal from the waggons into a box. I think you might have one general large receptacle on an incline, into which the waggons could deliver the coal. You could make the receptacle to hold 1,000 tons of coal if you like. That coal would go down by its own gravitation. It would not be necessary to let the coal go down at full speed or all of a rush. Some means could be arranged by which it could be allowed to go down very slowly, and I just throw out the suggestion for what it is worth. It occurs to me that such a thing could be done. The waggons could be brought along, and, without lifting or lowering them by hydraulic or any other kind of machinery, the coal could be dropped into this receptacle, from which it might be lowered down an incline through different kinds of shoots that would meet the requirements of all the different kinds of hatches, and in that way the coal might be loaded without any breakage whatever. I will not say any more about it now, but perhaps we shall be able to think it out before our next meeting. In the meantime I ask you to join me in according a very hearty vote of thanks to Mr. Allen.

Mr. F. W. Wymer (Vice-President): I have much pleasure in seconding the proposition.

Mr. Allen: I thank you very much for your very hearty vote of thanks, and I can assure you it has been a very great pleasure to me to come to-night to read this paper. It is a subject I have had on my mind for a long time, and I have been very glad to get it off. There are many points that I should have liked to have touched upon, but owing to the length of the paper I was compelled to omit a good many things that I at first intended including in it. I had one scheme that was somewhat on the lines suggested by the last speaker (Mr. Thomson)—an elaborate contrivance of travelling bands, with a large hopper and other features, but it got so full of cogwheels and claptrap that I thought I had better not show it.

Professor ELLIOT (Local President, Bristol Channel Centre) : I have the unexpected pleasure and the undeserved honour of submitting a motion with respect to our President. I have to propose that we accord him a very hearty vote of thanks. It is, as I have said, a pleasure, but the pleasure is tinged with melancholy. I am informed that this is the last occasion on which our present President will *officially* occupy the Presidential chair. Dr. White, we all know, is a man of multifarious engagements. In a sense he carries upon his shoulders almost the responsibilities of the nation, and when he consented to become our President, I conceive that he bestowed upon us an exceedingly great favour. I cannot speak as I should like to speak of Dr. White in his presence, and will only say that I trust that he has not regretted the step he took when he accepted the Presidential Chair, because I can assure him that the union of sympathies which he has brought about in the Institution, and the spirit of enterprise which he has fostered among us have gone a great way to make his term of office a record one. We have had very excellent men as Presidents in the past; we can, however, say distinctively that Dr. White has been a working President, and I trust he will always look back with pleasure on the work he has done. The spirit which the President has fostered among us has been largely due to the fact that in him we have a distinguished Naval Architect, an Engineer, and a man of Science, and we are all of us the better for having come personally into contact with such a man. I would desire to associate with this vote the name of Mrs. White, who has graced our receptions and social gatherings with her presence.

Mr. GEORGE SLOGGETT (Honorary Local Secretary, Bristol Channel Centre) : I have very much pleasure in seconding the motion, and I am perhaps even better able than Professor Elliot to speak of the value of the services which can be rendered by a President, because Professor Elliot is the President of our Bristol Channel Centre. During the existence of the Bristol Channel Centre it has had most serious difficulties to contend with, and it has only been by the great interest and the untiring zeal of Professor Ellict that we have tided over those difficulties. It is mainly through the efforts of our Local President, Mr. Gibson (Vice-President), and others that we are now in a prosperous condition and have a bright outlook before us. But we are proud to have it on record that during this session Dr. White has honoured us by being our guest in the Bristol Channel Centre. By his presence on that occasion, and by being here to-night, he gives us just the kind of encouragement we like, and fosters that spirit of advancement which it is most necessary to maintain in an Institution of this character.

The CHAIRMAN: I am extremely grateful for the very kind terms in which this vote has been proposed and seconded, and for the way in which you have received it, and I am certain that when I tell Mrs. White what has passed to-night she will be equally pleased, for, believe me, she takes the greatest interest, although not an expert in engineering, in the success of this Institution. It has not been possible for me to do what I should have wished to do as your President this year. But I have endeavoured, as far as my time and engagements have permitted, to assist the Institution during my year of office. So far from regretting having been your President, it will always be a pleasant memory and a source of satisfaction that you in this Institute, so young and vigorous and flourishing, as I hope it will always continue, thought fit to ask me to succeed men like Lord Kelvin, Dr. Denny and others, who had previously filled this chair. Of course there has been to some extent something incongruous in the fact that I, who am first of all a Naval Architect, have been President of an Institution of Marine Engineers. Dr. Elliot has referred to me as an engineer. Of course engineering is a wide term. It embraces much in utilizing the forces of nature in the service of mankind, and I hope I am in that sense an Engineer. Although I do not count myself a Marine Engineer, yet it is necessary for me to know something about Marine Engineering, and if study of the work of Marine Engineers and admiration for their enterprise can bring a man into sympathy with your Institute, then certainly I am in that position. It was my particular wish that before retiring from this chair, and having the honour of welcoming a successor in Sir Thos. Sutherland, of whom you may well be proud, I should have an opportunity of meeting you again. Our worthy Honorary Secretary at once took steps, with the support of the Council, to arrange for this gathering here to-night, and I cannot help feeling that it was a graceful and useful thing to make this meeting one which should be, in a certain sense, a re-union between the parent society in London and its very promising and vigorous young Centre in Cardiff. I think it is on all sides a source of congratulation that at this meeting we should have had two papers read by members of the Bristol Channel Centre—two papers which will, I am sure, take a good place in the proceedings, and often be referred to in the future. I thank you again most heartily. I wish to thank the Council Honorary Secretary, and every one connected with the management of this Institute, for the kindness that has been shown to me throughout this year. I believe that, although I shall very soon cease to be your President, I shall not cease to be a member of this Institute. Nor shall I cease to be warmly interested in its welfare, and to the best of my ability I shall be as ready to serve you as one of your members as I have endeavoured to do as your President.

Now, before I sit down, I want to express on behalf of all of us who are members of the London Centre of the Institute, our warmest congratulations to the Bristol Channel Centre at the success which has been there achieved, and at the hopes there are for its future development. I know I only speak the feeling of everyone here in London when I say that there can be no success in the Bristol Channel Centre, not even if it should be a success which might seem to endanger the success of the London Institution, which we should not heartily welcome. I know what Cardiff people think of Cardiff; I know what Swansea people think of Swansea; and I know what Newport people think of Newport. I think it is within the truth to say that there is a wholesome rivalry between those great Centres. Then there is Bristol, which gives its name to the Centre, which has a history that can never be forgotten when we think of British shipping, and which in the present is not so played out and exhausted as some people would have us believe. I sincerely hope that in all those great ports in the Bristol Channel it will always be true that there will be an Institute of Marine Engineers – a flourishing Institution increasing in numbers and usefulness. There is one feature in which it occurs to me the Bristol Channel Centre has an advantage over the London Institution, and that is, that the Bristol Channel Centre has so far had the benefit of a continuation in its presidential arrangements. I will not say all I think of the value to the Institute of Professor Elliot's services, but I do say that in that respect I am certain Mr. Sloggett did not exaggerate what is the feeling of the members of the Bristol Channel Centre. I hope that my successor as President here, when he comes to the end of his term of office, will have an opportunity of repeating and emphasizing that which I now again offer to Dr. Elliot and all the officers and members of the Bristol Channel Centre—our heartiest congratulations at their great and well merited success.

Mr. DAVID GIBSON (Vice-President of the Bristol Channel Centre): On behalf of the members of the Bristol Channel Centre, I beg to say that we are extremely grateful for those very kind congratulations which Dr. White has offered us. I think they are very encouraging, and they will tend to give us an impetus to progress still further. We have made some little advancement at Cardiff and that progress is due mainly to the untiring services of our President and Honorary Secretary. We certainly have had, as Dr. White has said, the continuous presidential services of Dr. Elliot, and if we had not had those services I am afraid we should have come to grief. We have also been greatly assisted by the Honorary Secretary of the parent Institution. He is continually giving us advice and helping us along with every advice and encouragement that it is in his power to give, and he seems never to have the pen out of his hand in furthering the interests of the Bristol Channel Centre. We find now that we have a competitor, and competition always does good. We have a competitor now in Southampton, which I understand has a larger membership roll than our own. It will have the effect of rousing us from our slumbers, and cause us to increase our members. We lack somewhat in sea-going members. We embrace nearly the majority—in fact, the whole of the Superintending Engineers of Cardiff, but we lack, as I have said, sea-going members. It will be our special endeavour in the future to enlist the sympathies of sea-going Engineers, and if the members in London will assist us in that matter they will be doing us a great service. I thank you again Dr. White for your kind congratulatory remarks, and we thank you also for your visit to Cardiff, which did us a very great deal of good.

Mr. McFARLANE GRAY (Vice-President) : I rise to propose a vote of thanks to the Governors of Gresham College for the privilege they have conferred upon us in allowing us to hold our meeting in this building. It is a very high honour that has been conferred upon us. When we think of the historical associations of this place—when we remember what illustrious names have been connected with Gresham College in the past—such names as Wright, Boyle, Briggs, Hooke, Wren, and Newton—we ought to consider it a great honour that our young Society is privileged to have a City meeting place in the rooms of an Institution, which, in its early days, was the home of the Royal Society for more than fifty years. Newton's great discoveries were first made public in the Lecture Hall of this College, which at that time was over what was then the Royal Exchange. To meet at such a place with the Director of Construction of the British Navy in the chair, himself a member of the Institute of Marine Engineers, and also a Fellow of that Royal Society, is indeed a distinguished honour. I think we ought to recollect this honour, and the duty we owe to the public in return for it. We have had to-night some beautiful lantern views in illustration of Mr. Allen's paper. I have applied for and obtained the promise of a liberal-minded gentleman, who has perhaps the finest lantern in London, that that lantern shall be at the service of any member of this Institute who may require it for the purpose of illustrating any paper. He has promised that he will be pleased to come to any of our meetings and bring this lantern without making any charge. Members preparing papers will therefore please bear this in mind. I ask you to give a hearty vote of thanks to the Governors of Gresham College for their kindness in allowing us to meet here.

Mr. James Adamson (Honorary Secretary): I have very much pleasure in seconding that proposition, and I can testify to the unvarying courtesy which we have always received from Mr. James Watney, the Secretary to the Gresham Committee, whenever we have applied for the use of this hall. This was the only night we could have it at about this time, and it is very fortunate that it happened to be a Saturday evening when our friends from Cardiff could attend, and that we have had so pleasant a meeting, technically and socially considered, is a matter for congratulation and remembrance.

The Chairman: In declaring the business of the evening concluded, I quite endorse the remarks which have fallen from the Honorary Secretary, that this is a meeting which would be likely to be remembered by all present for a long time to come. The Discussion will be continued on Mr. Allen's Paper, at the Institute Premises, on the 2nd Monday of March.

INSTITUTE OF MARINE ENGINEERS

INCORPORATED.

SESSION 1894-95

President—SIR THOS. SUTHERLAND, K.C.M.G., M.P.

MECHANICAL APPLIANCES FOR THE SHIPMENT OF COAL.

BY

MR. S. W. ALLEN,

(MEMBER.)

DISCUSSION AT

58, ROMFORD ROAD, STRATFORD,

On MONDAY, 12th MARCH, 1894.

CHAIRMAN—MR. J. H. THOMSON
(Chairman of Council.)

THE CHAIRMAN: Most of you, I think, were present at Gresham College when Mr. Allen read this paper. The subject is very interesting so far as the loading of ships is concerned, engineers are more specially interested as to getting coal into the bunkers and the using of it afterwards, however.

Enlightenment on these points is of special value, as while we are getting information as to the means available for conveying the coal from the pits and lowering it into the holds, we are always getting some knowledge in the right direction. It is of very great importance that we should have the coal on the stoke-hold plates with the least possible loss and breakage. There are different kinds of coal—the hard coal from the North and the soft steam coal from South Wales—and the author refers to the different angles required for sliding these down. The north-country coal requires a less angle than the South Wales coal. Several methods of shipping coal are commented on, that, of putting it into pockets and then opening a sluice to drop the coal gently into the holds seems a good plan. There is the difficulty of measuring coal, and the occasional discrepancy between the bill of lading quantity and the quantity delivered. If the shoot or pocket is filled up to a certain level before the coal is allowed to drop into the hold, and filled up to the same level again after each discharge, there should be a very fair estimate of the quantity of coal shipped.

We shall be glad to hear any one who is prepared to speak on the subject for information to himself or others. Mr. Capper is very much interested in this subject and I understand some models were expected, but have not arrived. However, I will ask Mr. Capper to open the discussion this evening, if he will kindly do so.

Mr. R. CAPPER (Honorary Member): In the absence of the models I have little to say, I have taken, however, a great deal of interest in this matter. For about ten years I had to do with the whole of the coal shipments at Swansea, beside having some experience ot the handling of north-country coal. This question of shipping coal as large as possible certainly does interest engineers, if you remember only the fact that the smaller the coal the more it measures. I have often heard this view controverted by people who do not understand it, but it is a fact nevertheless. The chairman referred to the question of shortages. Complaint has been made of the shortage of coal cargoes, especially at Dieppe. Within the last three or four weeks I have been to Gibraltar with Sir William Thomas Lewis, and we came back overland for the purpose of calling at Dieppe to see if we could learn anything about these shortages. We there found that while the Cardiff Corporation and the Cardiff Chamber of Commerce have been complaining that the railway companies on this side do not tare their wagons often enough, they forgot to ascertain what the French railway companies did in this respect. As a matter of fact the French railway companies keep the same tare on the wagons for two years at a time, the consequence of which is, that shortages are often declared against the ship, and one instance was cited where there was declared to be a shortage of five per cent., but it happened that that particular cargo was sent to a cotton mill 25 miles away, and the man who sold the coal got paid for the full bill of lading weight, for the coal that passed over the weigh bridge into the mill weighed the same. The alleged shortages are entirely due to the fact that the railway companies on the other side never re-tare their wagons.

The element of safety comes in for consideration in shipping coal. Speaking at Liverpool recently on the occasion of his retirement from the position of underwriter to one of the great Liverpool Marine Insurance Companies, Mr. Wallace declared, as the result of his actual knowledge and e perience, that one-half of the coal-laden vessels which are lost at sea are so lost owing to the fact that their cargoes include a large proportion of small coal. This is a statement which must bring home to engineers the importance of the matter, for every man has some regard to his personal safety, and it is not a pleasant thing to go to sea with a feeling that one's ship contains this great element of danger. I expected to have had at this meeting a model of the Lewis-Hunter patent improved crane for shipping coal, as used at the Roath Dock, Cardiff, but the model has not arrived. I may say, however, that practically these coaling cranes arose in a certain sense from some large cranes that were made by Sir William Armstrong for Sir William Thomas Lewis, for the purpose of lifting a ten-ton wagon of coal and putting it straight into the ship. Of course, it will not do to drop such great lumps as are to be found in Cardiff coal from a height of twenty or thirty feet into a ship's hold, but it was found that lifting a wagon off the rails and putting it into the ship was not quite such a simple or easy process as was at first supposed would be the case. A ten-ton railway wagon is a nasty thing to swing about, especially in a ship's hold, and there is always the danger that it may drop and go through the vessel's bottom. Well, then, to overcome these difficulties the Lewis-Hunter crane does this :—The whole of the coal from a ten-ton wagon is put into what I call a scuttle, dropped from a height not exceeding five feet, and this scuttle is lowered down to the bottom of the ship, or to the surface of the cargo where the coal is deposited, without any fall whatever. The only fall that the coal experiences is in going from the railway wagons into the scuttle. As many as four of these cranes can be put on to one ship at the same time and they have done some remarkable work. They have shipped coal at the rate of 1,200 tons per hour. The result of all this is that the loading of coal becomes a pure question of trimming. The trimming now is the gauge for loading coal cargoes. You can put the coal into the ship very much faster than men can trim it. Sir William Thomas Lewis has sent me a statement about these coaling cranes, and if it is desired I can read it. Of course we have all heard of the extraordinary speed that is now possible in putting the coal into the ship, but there is such a thing as putting it in too fast so that the people connected with the ship have no time at all on shore. But the two facts which seem to me to be extremely interesting are, firstly, that the safety of the ship largely depends on the size of the coal; and, secondly, that the ship will not carry her carrying capacity in weight if the coal is small. If the model had been here I could have said a great deal more, but I shall be very pleased to come down on another occasion when I will see that the model is available.

Mr. MITCHELL (Member): Will you kindly read us the remarks of Sir William Thomas Lewis?

Mr. CAPPER: I shall be very happy to do so, it is as follows:—

"The group of models and views exhibited at the reception of the Institution of Civil Engineers, on the 23rd February, 1892, represent the mode of shipping coal, the invention of Sir William Thomas Lewis, General Manager, and Mr. Charles L. Hunter, Engineer, of the Bute Docks, adopted by the Bute Docks Company, at their Roath Dock, Cardiff.

This system was adopted by the Bute Docks Company, in 1887, after giving the fullest consideration to the various kinds of appliances then in use at the best equipped coaling docks, and the result has been that the steam coal shipped thereby has been placed into the vessels in a better condition and with greater dispatch than has ever been possible by either fixed or movable staiths. Two cranes with their accessories were first erected on a berth 300 feet long and the working was so satisfactory as regards dispatch and saving the breakage of coal that the company have now nine cranes erected on a quay space of 1,500 feet long.

The following is a brief description of the advantages, capabilities and working of this mode of shipping. With this system the cranes, which are movable, can be brought into such positions as to plumb each of the hatchways, and as many as four cranes have been employed simultaneously loading the same vessel. Then the cranes are not only movable, and provided with a swing motion of some forty feet radius but are also provided with a derricking motion, so that they can plumb the coaling pits and hatchways at will and are also enabled to steer their loads clear of rigging, funnels, &c. This simultaneous loading is an enormous advantage, not only as regards time, but prevents the ship being dipped either by head or stern, or having great weight put amid-ships with the ends empty.

The rate at which the coal can be loaded depends upon the trimming power applied, but experience has proved that vessels can be loaded at the rate of 293 tons per crane per hour.

By this process the coal is shipped in a very much better condition than is possible by the old system of staiths and shoots, and owing to the construction of the carrying boxes and the provision of a cone valve or bottom which is only released to let out the load when the box is swung around and lowered into the hold on to the flooring of the ship or cargo as the case may be, the breakage is reduced to a minimum. In fact there is scarcely any difference in the appearance of the coal in the hold of the vessel to what it is when coming from the collieries to the port, which of course is an enormous advantage to the consumer, especially with South Wales steam coal, as well as not damaging the vessel's hull by the coal dropping from such a height from the point of the shoot, as in the old method. Often lumps of coal weighing several hundredweights fall from twenty to thirty feet on to the floor of the vessel, which is most objectionable, and, it stands to reason, to the ultimate serious cost of the ship's owner. Another great advantage to the ship owner when shipping coal by the Lewis and Hunter's system is, that there is scarcely any dust made on the decks of the vessels, the enormous clouds of coal dust made by the old method finds its way into state rooms, engine rooms and machinery. The value of these points will be appreciated by all who take any interest in shipping matters, and who know how important it is to avoid the accumulation of small coal and fine dust in the ship's hold which is generally the result of pouring a large quantity of coal through a fixed shoot at one point in the hold. And we have the highest testimony from some of the largest firms using these cranes that the coal shipped by the cranes is in infinitely better condition than what is known as double-screened coal shipped by the old method of tips, and which is in every way so very much more costly to the consumer.

It is obvious to anyone practically acquainted with the shipment of coal by the old method, that the shoot and screen bars really act as a disintegrator, not forgetting that after the coal has passed over the screen bars in the shoot the coal still has to drop from the point of the shoot to the bottom of the vessel, in point of fact it is the very apparatus adopted in many parts, especially the Anthracite districts of America for breaking the coal to bring it into sizes for marketable use.

The cranes, which have a lifting power of eighteen tons, deal with the whole contents of a ten-ton railway wagon, which is slid into a box with a conical bottom in such a manner that the greatest and only fall to which the coal is subject is one of five feet, and that only applies to the first few lumps in the filling box. Whereas, under the other systems of coal tipping by staiths and shoots, the coal after falling from the wagon on to the shoot has to roll down over the shoot twenty to twenty-four feet in length, and then according to the depth of the vessel, is subject to an actual drop of between twenty and thirty feet, the result being the conversion of a considerable proportion of the coal into small as well as into fine dust, both of which should be avoided as far as possible.

The cranes which move along the whole length of the quay can be set to the varying distances between the hatchways of different vessels, and, if desired, cranes can be placed in each hatchway of a vessel simultaneously, thus securing the greatest possible dispatch for the vessel while placing the cargo in the hold in the best possible condition.

In addition to the advantages described, tho cranes are provided with appliances for a two-ton lift, so that, in case of necessity, steamers may, if they desire, discharge their inward cargoes simultaneously with the loading of their outward coal cargoes. This double operation is facilitated by means of two lines of railway constructed along the quay, which are spanned by the cranes, and thus enable the railway companies' trucks to be placed alongside the vessel without any interference with the coaling operations.

The overlookers of the largest steamers frequenting the port of Cardiff are so eager to secure these berths for their steamers that they frequently elect to wait for a coaling crane berth in preference to proceeding under a ready staith.

These facilities have enabled steamers to receive cargoes of from 7,000 to 8,000 tons of coal in the best possible condition in a comparatively short time, and the following are a few recent examples of the dispatch given where two cranes only have been working at each vessel:—

s.s. *Rhympha*	loaded ..	3,303	tons in	16 hours.
„ *Isle of Anglesea*	„ ..	2,033	„	13 „
„ *Inchlonga*	„ ..	4,133	„	27 „
„ *Orsino*	„ ..	2,781	„	12 „

A case may also be stated of a steamer which went into berth at 5 o'clock p.m., and by 5.30 next morning she had taken in 1,609 tons of coal, or an average after deducting stoppages of 189 tons per hour, so that the 1,609 tons were shipped by one crane in eight-and-a-half hours.

The nett loading time, after deducting stoppages for coal, of the s.s. *Samoa*, was twenty-eight hours, in which time she took in 7,484 tons of cargo and 1,750 tons of bunker, making a total of 9,234 tons, or an average of 330 tons per hour."

The CHAIRMAN : After Mr. Capper's statement, you will no doubt have some questions to ask or some remarks to make upon it. The statement that the small coal occupies greater space in the bunkers than the larger coal seems debatable. (To Mr. Capper). Is that right. ?

Mr. CAPPER: The smaller the coal the more it measures.

The CHAIRMAN: I was about twenty-three years at sea, and it was always considered that small coal packed closest, and that we could pack a greater quantity of small coal into the bunkers than large. I am quite open to accept Mr. Capper's statement, but it has not been my experience and I daresay there are other members present whose experience has been the same as mine. Large coal I have found to occupy more space than small. However, I daresay Mr. Capper's calculations are based on another basis than mine.

Mr. CAPPER: If you only come to think of it there are more interstices in small coal than in large.

The CHAIRMAN: But if you take the large and the small together you have, say, one large piece of coal and then you have the small coal to fill up all the corners.

Mr. CAPPER: But that is just what it does not do.

The CHAIRMAN: Did I understand you to say that a ship loaded with small coal is safer than one that is loaded with larger coal?

Mr. CAPPER: No, the other way about.

The CHAIRMAN: Then the larger the coal the safer the carriers, and with small coal there is a greater chance of spontaneous combustion? (Mr. Capper: Yes.) That is worth while remembering. With regard to the drop of the coal in loading; I see a great amount of skill has been displayed in making the different arrangements for dropping the coal into the holds with the least possible damage, but as Mr. Allen said, it is all very well to have stowing gear or trimming gear, the trouble always is in getting that gear out of the hold. With regard to bunkers, where you have a shoot of, say, two feet diameter, where there is not much room for getting out trimming gear, you have to depend on manual labour. Means may be employed for trimming coals in the holds of a ship, but it is a very different thing to trim the coal in the bunkers, where indeed there cannot be much improvement made, especially in passenger steamers with small shoots. Speaking to some of my friends about this paper, I was informed that with regard to many of the ships which go regularly to Sunderland, it is known exactly what each vessel will take; the quantity of coal is poured into the ship and on to her decks as quickly as possible, so that she can get away by the next tide. Trimmers are put on board, who then get the coal all stowed into the corners and wings of the ship after she leaves the coaling berth, continuing the trimming meanwhile, generally only completing, to return with the tug. It is a serious matter if a cargo begins to shift after the ship gets to sea, and it is therefore very necessary that the coal should be properly trimmed. I should like to hear the experience of some sea-going engineers about this small coal. I should like to know whether they have found in practice that the small occupies greater space than the large or mixed coal.

Mr. W. WHITE (Member of Council): Mr. Capper said that they could now put coal into a vessel quicker than it could be trimmed. I have a vessel under my charge that does not require any trimmers at all, and that is the vessel of the future. You can put the coal in as fast as you like, and it does not require any trimming.

Mr. CAPPER: That is due to the large size of the hatchways, but they are only home-going steamers. Speaking generally, the trimming is now the gauge for speed of shipmen.

Mr. J. JOHNSTON (Member): I was once in a steamer, the bunker capacity of which was supposed to be 500 tons, and if we coaled at Swansea, Cardiff, or Barry, 500 tons of coal filled her bunkers. But if we coaled in the Thames we got 560 tons of smaller coal into those same bunkers. That leads me to think with Mr. Thomson, that the smaller the coal, the more weight you can carry. If you buy coal abroad, 100 tons will not fill the same space as 100 tons shipped at Cardiff or Barry. I say that the smaller coal occupies less space, weight for weight.

Mr. BROWN (Member): I have had a little experience with South Wales coal, and I have found that if a steamer's bunkers were filled quite full at Cardiff, Newport, or Barry with large coal, and thoroughly trimmed, there was an empty space of some three feet at the top of those bunkers after 15 or 20 days of fairly rough weather, although no portion of the coal had been used. But if we shipped small coal we did not find this space. With large coal the space was sometimes as much as four feet, especially after rough weather, and the ship rolling about for 15 or 20 days. The explanation is that with large coal you cannot fill all the holes and corners caused by angle irons and the like, and owing to the rolling of the ship the small coal rolls down, so that the whole of the contents of the bunkers settle down and leave that vacant space at the top. You do not take the quantity for the measurement of youi bunker at one of the South Wales ports. I will give you an instance. I know a steamer, the bunker capacity of which was said to be 224 tons, but if you got 200 or 205 tons of large coal into those bunkers at Cardiff you did very well. If, however, you shipped small coal you could get 224 tons into them. You will find a difference of about 20 tons in the actual capacity of bunkers of 224 tons capacity nominal, as between large and small coal.

Mr. A. B. BULL (Member): A good deal depends on what you call small coal. You can get coal so small that it is just like sand, and it stands to reason that that will stow very much closer than mixed coal. If you have the coal too large you cannot get it into the bunkers. I always made it a practice to break up my coal before sending it down the shoot. I believe that the small coal is heavier than the large coal per cubic foot of bunker space.

Mr. H. C. Wilson (Member): The question of the shipment and proper stowage of coal is a subject that is of particular interest to sea-going engineers, and although I did not hear the paper read, I have been very much interested in the valuable information and useful facts which have been given us by Mr. Capper. There is, however, one point upon which Mr. Capper touched, which seems to have been overlooked by subsequent speakers, and that is the question of "Shorts." A deficiency in the weights or measures got when coaling is, I am afraid, more the rule than the exception, with sea-going engineers. It has been my lot at different times, and in different capacities, to take bunker coal at that, shall I say, celebrated coaling station, Gibraltar. I do not think 98 % of engineers taking coal there ever got their full weight, the odd 2 % being the fortunate exceptions to the rule. Even with the slight advantage of a knowledge of Spanish, I feel convinced that I never got the full weight by some 5 %. Other coaling stations are bad enough, but as far as my experience goes, and what I can hear besides, I really think that Gibraltar carries off the palm for coal shortages. Liners, which coal at their own hulks, are not concerned, but this question is a most serious one for, say the Chief Engineer of a tramp. His principal aim is to reduce his coal bill, but unless he makes his calculations to allow for a loss of about four tons in 75, he will find, in spite of all possible care on his part, that he will be in danger of running short of coal, if he takes his tallies as a criterion. The deficiency in quantities when measured is, I think, largely one of stowage or trimming, and to accept the statement of a Gibraltar trimmer as evidence, is to fly in the face of Providence. In short, the Chief Engineer is fairly on the horns of a dilemma, and any suggestion would be gratefully accepted that helped to solve this great coaling difficulty.

The Chairman: Let us take the case of a solid block of coal weighing, say, one ton. If that block is broken up will the coal occupy less space or more space. ?

Mr. WHITE : More space.

Mr. CAPPER : Yes, the smaller the coal the more it measures.

Mr. WHITE : Break up a cube or block of a ton weight, and you cannot get the broken coal back into the same space as the solid block occupied. It is impossible. It is a well-known fact.

The CHAIRMAN : The question, however, is about stowing it in the bunkers. That is where the rub comes in. If you are putting cubes of coal a ton weight into the hold of a ship, and into another ship of similar dimensions you put small coal, which ship is going to take the most coal ?

Mr. WHITE : The one with the cube properly stowed.

The CHAIRMAN : I think that in practice you will find that with ordinary ships' bunkers you will get a greater number of tons of small coal into those bunkers than if you take coal of a larger size.

Mr. MITCHELL (Member) : I am inclined to take the same view as Mr. Capper. A solid block will go into less space than the same weight of coal broken up. I believe that the larger the coal the more weight you will get into a bunker of a given size, whether it is put in haphazard or built up, and the larger the capacity of the bunker or hold the greater will be the advantage arising from large coal. With regard to careful loading of coal, the fact to which Mr. Capper has called our attention as to the greater danger of small coal ought not to be lost sight of. It would appear that a coal ship is not so liable to spontaneous combustion if loaded with large as with small coal, from which it would seem to follow that the more carefully coal ships are loaded the less we shall hear about ships being lost at sea through burning. Of course, in some passenger ships with side bunkers only ten feet athwart, if you have very large lumps they will block up the space, and in that case you could perhaps get in more small coal.

Mr. JOHNSTON : I do not believe in theory upsetting practice. I have given you an instance in which a ship's bunkers will take 560 tons of coal in the Thames but only 500 tons at Cardiff. That means to say that practice shows than coal if broken up occupies less space.

Mr. CAPPER : No, it does not. Cardiff steam coal that is supplied to steamers in the Thames is brought straight from the colliery in one truck to Brentford, where it is tipped over a very low shoot, not more than five feet high, into a barge which takes it to the ships in the docks. In the case of the coal shipped at Cardiff, it is brought from the colliery down to the docks; it is tipped over screens which help to break it up, and it is then dropped into the bunkers, a distance of some twenty feet. I have no hesitation in saying that the coal shipped at Cardiff is more broken up than the coal shipped in the Thames, and this will account for the greater weight shipped in London.

The CHAIRMAN : Do you say, Mr. Capper, that the coal as put into barges and taken to the Victoria Docks has suffered less knocking about than that put on board at Swansea or Cardiff?

Mr. CAPPER : Yes.

The CHAIRMAN : That is information to some of us.

Mr. JOHNSTON : The coal that I referred to did not come through Brentford. It comes round in colliers and is loaded from derricks.

Mr. WHITE : At Gibralter we may have seen the coolies running across with baskets of coal and we stop the men every now and then and weigh certain baskets. In my experience I have found the basket with one large lump in it to weigh more than the basket which was full of small coal. Break that big lump and it will more than fill the basket.

Mr. JOHNSTON: Large coal does not adapt itself to the exigencies of stowage in ships' bunkers, and it is in consequence of this circumstance that a greater weight of small coal can be carried. You cannot get the large coal to adapt itself to the shape of the ship. If you could run the coal in solid, or if you could get a lump of coal to fit exactly into the bunker, no doubt you would then have the most weight, as Mr. Capper contends. But the argument is this, that in stowing coal in the bunkers of modern ships, small coal will go into the little intricacies and corners better, and that therefore a greater weight of small coal can be carried.

The CHAIRMAN: Say we have a bunker that will contain 500 tons of coal of a moderately large size—about ten inch cube. Suppose you try to fill a similar bunker of the same capacity with small coal—say half-inch cubes. Which bunker will contain the greater weight, the one with the large or the one with the small coal?

Mr. MITCHELL: The one with the large coal.

The CHAIRMAN: Has that been proved in practice?

Mr. WHITE: It certainly is so.

The CHAIRMAN: This has been a very interesting discussion, and it will direct our minds to investigating the subject and proving our conclusions. As to coal at the different out ports I may say that the coal owners at these ports have to struggle very hard to keep up their weights. If you have a heap of coal and you move it from one place to another you generally lose from one to three per cent. So that people at the out ports, wishing to keep up their quantities, have to manage matters a little bit so as to keep their books square. We are very much indebted to Mr. Capper for what he has told us, and we may have the opportunity of meeting him again, also of seeing a model of the Lewis-Hunter apparatus. Is it suitable for loading bunkers?

Mr. CAPPER: No, not so suitable for that, because the hatches are so small.

The CHAIRMAN: I am sure it would be very acceptable if we could have some fresh ideas as to putting coal on board ship so as to keep up the quality.

Mr. JAMES ADAMSON (Honorary Secretary): I expected Mr. Paul would have been here to-night. He has an arrangement that has been at work in the Royal Albert Dock for coaling bunkers, but, unfortunately, he has been laid up with influenza, and is not able to be with us. I hope, however, that on a future occasion he will be able to attend for the purpose of explaining his system, and I hope we shall also have the pleasure of Mr. Capper's company on that occasion. While we were talking about this matter of round coal and small coal, I remembered an incident which quite upsets the fallacy advanced by Mr. Capper:—

Mr. CAPPER: It is not fallacy, but fact.

Mr. JAMES ADAMSON: A certain steamer came into port, and I examined the coal remaining in the bunkers. as was my usual practice. In this particular case I was especially careful to satisfy myself exactly how much coal was in the bunkers before the coaling was commenced. After the bunkers were supposed to have been filled, I asked how much coal had been put in, and was told a certain quantity. I said "nonsense, there is room there for another 80 tons at least." I was again assured that the bunkers were full to the bung, and that no more coal could be got in. The coal shipped was large coal, and after speaking to the Second Engineer—the Chief Engineer being on leave—we found space for another 10 tons here, and another 15 tons there, and in the result we actually got another 80 tons into those bunkers. The large coal had arched at different places, and the other coal having been poured in on top of it, the bunkers had appeared to be full, when in point of fact they contained a very much less quantity than they could and should have held. I was not quite serious when I spoke of upsetting the *fallacy* advanced by Mr. Capper, as will be seen from my illustration. In the course of his paper, Mr. Allen says: "It will be sufficient for our purpose to divide the various kinds of coal into two classes—viz., coal with a close, dense, and compact structure, such as that found generally in the North of England, and the coal with a porous or loose structure, breaking with an uneven fracture, the angles of which point in all directions, such as the celebrated steam coals of Glamorganshire and Monmouthshire." I do not know with what kind of fractures the different classes of coal break, but I should say that is a question involving considerations which should have weight. Coal which breaks into a hexagonal shape should pack more closely than other coal of more irregular fracture and I should say that these different kinds of coal might break in a way that would cause them to vary greatly in the matter of stowage. One class of coal would stow very much closer than another, so that you might have a difference of five or even ten per cent. Some eight or ten years ago I remember hearing a dispute about Scotch coal. Some held it stowed forty-two cubic feet to the ton, others forty feet. A sample of this Scotch coal was weighed and it stowed into thirty-eight cubic feet per ton! This coal it was held had never been known to go into so small a space before, so that we all may be agreeing and yet disagreeing on this very point, differing mainly on a question of stowage in holds and bunkers with many angle irons and stringers or corners to contend against. I was in hopes that Mr. Bull would have given us some of his experiences with Indian coal. I believe Mr. W. W. Wilson is making a tour of the various ports of India in order to investigate the qualities of the different kinds of coal obtainable at those ports. From the report that have reached me I believe that some of these coals have been found exceedingly good and some otherwise. The quality, I believe, is very good, but you require a somewhat different arrangement of fire-bars with plenty of air spaces, to get the best results.

The CHAIRMAN: The discussion now stands adjourned until Monday, April 9th.

INSTITUTE OF MARINE ENGINEERS

INCORPORATED.

SESSION, 1894-5.

BRISTOL CHANNEL CENTRE.

DISCUSSION

ON

COAL SHIPPING APPLIANCES

HELD IN

THE UNIVERSITY COLLEGE, CARDIFF,

On TUESDAY, 13th MARCH, 1894.

CHAIRMAN—PROFESSOR A. C. ELLIOT, D.Sc.

At this meeting of the Bristol Channel Centre of the Institute of Marine Engineers, a paper was read by Mr. S. W. Allen (Member, Cardiff) on "Mechanical Appliances for the Shipment of Coal." Professor A. C. Elliott, D. Sc., President of the Centre, occupied the chair. As before, at Gresham College, London, Mr. Allen illustrated his paper by an extensive series of lime-light views, embracing the various tipping arrangements that had been used from about fifty years ago to the present time. Some working models, kindly lent for the occasion, were also shown. Having described and explained the leading features of the various appliances, the author said he had come to the conclusion, that for shipping the very fragile South Wales steam coal, no better system had been employed than that of the boxes introduced twenty to forty years ago. The present demand for rapid shipment, however, rendered it impossible to return to this excellent arrangement. Next to it must be given the preference to the system of shipping into a large anti-breakage box placed at the mouth of the shoot. The shoot should always be kept full of coal, and the anti-breakage box as large as possible. Modern hydraulic cranes for lowering the full anti-breakage box are no advance upon the old system of balance weights unless the ram is made use of for pumping water into the pressure mains on the descent of the full box. Movable tips are certainly the ideal method for rapid shipments, although it has been found in practice that with the best system of fixed tips placed at sufficient distances apart the coal can be shipped quite as fast as is required, and in using anti-breakage boxes with the latter as little breakage occurs as with any other arrangement.

In the discussion which followed the reading of the paper:—

The President testified to the warm reception the paper had met with at Gresham College, London, and said the commercial efficiency of a tip was measured by the mechanical efficiency, the interest on first cost, and the number of men required to work it. In comparing rival tips some remarks had been directed to mechanical efficiency only; but from a rough calculation he thought a 10-ton tip required on the average about from 25 to 50 horse power, which in current charges meant something like one shilling per hour. He was, therefore, of opinion that the general handiness, as measured by the number of men required and the time taken to ship a given quantity, were the things really important.

Mr. David Gibson (Vice-President) complimented Mr. Allen on the completeness of his paper, which was bristling with interest thoroughout. It might be asked what Marine Engineers had to do with Shipping Coal and Anti-breakage, but he maintained that, to the marine engineer who had to do with the superintendence of the coal consumption, the subject was an all-important one. Those of us who had been at sea knew full well the results, when there was a run of small coal, or slack, especially if it happened to be a dry steam coal, for the speed of the ship simply fell to about half or perhaps less if the fireman was not a skilful man. In time of war a run of small coal might mean the loss of a naval engagement. From the remarks of Dr. W. H. White (Director of Naval Construction), at the meeting of the parent Institute when this paper was read, it would appear that the Admiralty attached some considerable importance to the question of Anti-breakage and had taken official cognizance of the subject, as Dr. White had made an official inspection of the various systems of shipping coal throughout the country. The anti-breakages part of the paper only affected the district of South Wales, as the coal of Northern coalfields was hard and close and also bituminous, so that breakage in shipment did not materially affect its steam producing qualities.

Mr. Gibson, continued: The anti-breakage boxes on the high level tips of the Cardiff, Penarth and Barry Docks, are in my opinion a complete farce, they hold, I believe, about 15 cwt. and is it reasonable to expect that trimmers will lower, say about one-third of a vessel's cargo into the holds by lots of 15 cwt.? As a matter of fact, they do not. In the absence of the coal inspector or shipping foreman, they simply hold the box at the mouth of the shoot and allow the coal to run over it. This box to be of any use wants to be enlarged to hold about five tons. Coming to the Lewis-Hunter crane,—it ships the coal in as unbroken a condition as any system that has come under my notice, but this is attained at an enormous cost, and I might say an entire disregard of cost. Natural position has not been taken advantage of, nor have the gravitating forces, that are so much utilized in other systems been turned to account. No attempt is made to force any of the exhaust water back into the mains, but it is all thrown into the dock. In fact I regard it, as the most profligate system of shipping coal, that is now in existence. In point of speed there is no system so quick as that adopted on the north-east coast, notably Tyne Dock and Blyth. I was astonished to learn recently that the shipments of Tyne Dock, which is about one-third the area of Barry, exceeded those of the latter port, this is a very remarkable achievement and it is done without the cost of one farthing in hydraulics or complicated machinery.

MR. COUNCILLOR T. HARRY RICHES (Engineer of the Taff Vale Railway and Penarth Docks) said Mr. Allen appeared to have overlooked the fact that the tips at Penarth had recently undergone some material improvements as to facility for working wagons on and off, and further that the three new high hydraulic tips which had recently been placed there, were capable of tipping coal forty-seven feet above the water, and are being furnished with second cranes to deal with the screenings. The water used for all work below the platform level—that is the ordinary platform level—simply flows from a tank at the top of the tip and is used for brake power only, the empty wagons being raised by a small ram, which is kept under constant pressure by the accumulator. By this means the loaded wagon acts as a pump and forces the high-pressure water back against the accumulator and the low-pressure water out of the large ram up into the tank at the top of the tip. When the wagon is emptied the low-pressure water from the tank named flows back into the large ram, and the high-pressure water, flowing back into the small ram, counterbalances the empty wagon, and brings it back to the platform level. The tipping arrangement is by means of an upper ram fixed on the end of the two first named, which are both inverted rams, the tipping ram being used under ordinary conditions, when the table is simply rising or falling to the tipping or platform level, as a support for the sheaves which run the back cradle chains round the rams, but when the table is required to be tipped the ram is shoved out, and as the sheaves upon it are within the loop of the tail chains of the cradle, this tips the cradle without any supplementary attachments, and will, of course, as you will see, tip the cradle at any point that may be required without having any separate attachments to make for this purpose.

As to the speed, I may tell you that at Penarth we have frequently tipped as much as 500 tons an hour on one tip, and it is a very common occurrence to tip 250 or 300 tons an hour. The arrangements for anti-breakage are as complete, I believe, as any tips in the country. It is not for me to criticise the appliances of other companies, but only to claim that we can at least do as rapid work, and as good work, in the shape of preventing breakage, and rapid loading, at Penarth as as can be done at any other dock in the Channel. The method of working these hydraulic tips is by chains, which run through the platform table, and therefore can be handled by the tippers at any point at any level, wherever the cradle may happen to be, and I am justified in thinking that these tips are as far in advance as anything that exists.

CAPTAIN RALPH POMEROY (Dockmaster, Cardiff), said:—Our friend Mr. Allen is deserving of our best thanks for the paper he has read, and the views he has shown this evening. The time devoted to and the expense connected with this matter must both have been very considerable, and what our friend is going to get out of it I fail to see, unless it is the satisfaction of posing as a philanthropist for the benefit of those who have the manipulation of the shipment of coal. Another matter which puzzles me somewhat, is the fact that out of six columns of newspaper matter, thirteen lines should be considered sufficient to describe the *modus operandi* of the Lewis-Hunter system which has been admitted by friends and foes alike, to be the greatest stride in the development of coal shipping appliances for many years, combining the maximum as regards dispatch, with the mimimum of breakage, and not to be equalled by anything dealing with the shipment of coal in the world. With this system, as many as four cranes lifting forty tons of coal have been employed simultaneously loading at the same vessel, as the cranes can be brought into such positions as to plumb the steamers hatchways. The cranes are not only movable, and provided with a swing motion of some forty feet radius, but they are also provided with a derricking motion so that they can plumb both hatchways and coaling pits at will. This motion also enables the cranes to steer their loads clear of rigging, funnels, &c.. The maximum speed of loading is at least 300 tons per hour per crane; 293 tons of coal have actually been shipped in an hour by one crane. The coal is shipped in much better condition than is possible with the staith system, and owing to the construction of the carrying boxes with the cone valve forming the bottom, which is only released to let the load out when it is lowered down into the hold of the vessel within some eighteen inches of the floor of the ship, or the cargo as the case may be, the breakage is reduced to a minimum, in fact there is scarcely any perceptible difference in the appearance of the coal in the vessel to what it is coming from the collieries to the port. The largest carrying cargo steamers in the world, taking over 9,000 tons of coal have been loaded under these cranes, and the overlookers for steamers of this large class, state that there are no berths equal to the Bute Docks coaling crane berths in the kingdom, and they—the overlookers—frequently wait for one of these berths rather than go under the tips.

The following are a few examples of the dispatch given by these cranes, two cranes being employed in each instance:—

s.s.	*Lancashire*	loaded	5,817	tons in	20	hours.
,,	*Asama*	,,	5,833	,,	30	,,
,,	*Knight Companion*		6,411	,,	34	,,
,,	*Runic*	,,	6,218	,,	28	,,
,,	*Medgid*	,,	3,910	,,	13	,,
,,	*Wingales*	,,	2,866	,,	11	,,

I admit there may be something in the point raised by the Vice-President regarding the expense of erecting the Lewis-Hunter cranes, but this is a paper which deals with the shipment of coal, and passes by the question of expense. I fully admit that this is a very important factor, and the Vice-President was right in mentioning it.

At this stage Captain Pomeroy read a letter from a firm in one ot the Mediterranean ports testifying to the excellent condition in which the coal shipped by the Lewis-Hunter cranes turned out, and expressing a wish that all their coal might in future be shipped by this system. That letter (he continued) was unbiassed and unsolicited testimony, and how anyone can possibly stand up in this University College, before a body of engineers such as are here present, and with the Professor of Engineering in the chair, and say that no advance has been made in the method of coal shipping for the last forty years, I can hardly understand, and it certainly merits some explanation other than we have received to-night. I may tell you this, and my colleague, Mr. David Morgan, will bear me out, that such is the demand for this improved class of appliance, viz., the Lewis-Hunter crane, that his judgment and capacity as traffic manager are tested to the utmost, in arranging and manipulating, to cope with it. Speaking as a sailor, as regards ships or steamers loading under tips, it must be patent and clear that the lame side of that ship or steamer must be the near side, *i.e.*, the side directly under the point of the shoot, and however uprightly the ship may be worked by the coal on upper deck, there will always be a tendency when the coal settles down—which takes place directly the ship commences to pitch or roll—for the ship to take a list on the side of the small coal. But when loading under the Lewis-Hunter cranes the small is distributed both fore and aft, and into both wings, so that the vessel has no lame side, and is consequently free from the danger which overtakes so many fine vessels, and which has cost both the loss of life and property.

Mr. J. H. HALLETT, Mr. FOTHERGILL (Hartlepool), and Mr. M. W. AISBITT also took part in the discussion.

Mr. GEORGE HUNTER, of the Bute Docks Company, contributed some further statistics, showing the phenomenal results that had been obtained with the Lewis-Hunter cranes. He had not gone thoroughly into the question of cost of shipment, but was of opinion that their system would not compare unfavourably with any other in this respect, all things being taken into consideration. Speaking from actual experience of the working of the cranes, he did not know that any inconvenience had been caused by the complications in the machinery of the cranes referred to by some of those who had joined in the discussion, and he failed to see where the complications existed. The cranes were easily handled, required little or no attention or repairs, and did their work well. At a later stage of the proceedings Mr. Hunter showed a complete working model of the Lewis-Hunter arrangements.

Mr. RICHARD LAYBOURNE, J.P. (Newport) exhibited a working model of his Anti-breakage Coal Shipping Hoist. The present method of shipping coal, he said, had been termed a barbarous one, and it well deserved the name. To lift the coal 30 or 40 feet for the purpose of bundling it down a shoot and then dropping it into the hold of a larger ship deserved no other term. He agreed with Mr. Allen that the system formerly adopted by the Powell Duffryn Company and Messrs. Nixon, of shipping their coal in boxes sent direct from the colliery was a most excellent one. He had made enquiry and found the plan was abandoned owing to the cost of repairs to the boxes, and although the exporters were willing to pay an extra price of one shilling per ton for coal shipped by this method, the practice had to be relinquished. Starting from this point he had devised a hoist by which the coal wagon is lowered in a cage provided for the purpose, to the bottom of the hold and then gently tipped, the cage afterwards righting itself automatically. All the movements are controlled by the attendant in an elevated cabin, from which he is enabled to view the whole of the shipment. He had satisfied himself by measurement of the hatchways of the ships arriving at Newport Docks that 90 per cent. of the modern steamers would admit a ten-ton coal wagon, and his system also had the advantage over the fixed and spout system when loading into the smaller hatchways, as the wagon can be lowered to the level of the deck and quietly tipped on a distributing cone with shoots for depositing the coal into four separate heaps, and thus materially lessening the breakage by trimming. It would be seen from the illustrations shown by Mr. Allen and from the model he exhibited, that the cage was suspended at two points eighteen feet apart, thus preventing the twisting and swaying of the suspended load inseparable from the practice of suspending it from one point only. He claimed for his system an advantage on the method of tipping into boxes and then lowering them into the hold, as he did not disturb the coal after leaving the colliery, but quietly deposited it at the bottom of the ship with a minimum of breakage.

Mr. S. W. ALLEN in replying said,—I am not aware that there is any particular question raised by the speakers in discussing this paper, requiring a direct answer on my part, but some observations have been made to which I am obliged to refer. In the first place I much regret that my paper has not been so much up to date as Mr. Riches, the engineer of the Taff Vale Railway, seems to think necessary, and that some of the recent improvements made at Penarth Dock have not been mentioned, and particularly so when I have to thank the Taff Vale officials for affording me every facility in acquiring information at various times; but inasmuch as the major portion of the paper was written a considerable time back when the new improvements spoken of by Mr. Riches had not been introduced I was unable to do so, I am obliged to him, therefore, for referring to it now, and had I not considered the paper sufficiently lengthy already, I should have had the greatest pleasure in illustrating and describing his recent improvements. Captain Pomeroy feels aggrieved that I should have devoted only thirteen lines of my paper to describe the *modus operandi* of the Lewis-Hunter system. I cannot see myself where his grievance comes in, as my paper was not written for the purpose of advertising any particular system or company, or for the purpose of introducing any appliance of my own, and considering that not only have the Bute Dock officials been extremely jealous of my getting any information from that source, but have actually given instructions to their people in charge to prevent my getting any information, and upon more than one occasion when I have been professionally engaged in going to and from steamers in the Roath Dock I have been requested to "move on," and thus prevented from even looking at these cranes. Now, I want to know what there is in this system that should require its being kept secret from myself and others. What is there about these awe-inspiring cranes that we dare not look at? Surely Captain Pomeroy ought to have been satisfied, as I was particularly careful in my remarks to say not a single word of an uncomplimentary nature in reference to this particular system. Coal tipped into a box, raised by power, swung out over the ships, and lowered into the hold, I have shown you was done nearly half a century ago. Therefore, as far as the system is concerned, I have described it fully in the early part of my paper. By the system employed at the Cardiff Roath Dock, the wagons of coal are brought down from a high level to that of the dock coping, and the wagon after being weighed and turned round in the usual manner, is brought on to a tipping cradle, the back end of the wagon raised and the coal tipped into a shoot, and thence into the box. Now this box being of considerable depth, corresponds to a certain extent to the hold of the vessel were it placed in this position, and, therefore, as far as the coal shipping is concerned, it would have been finished with. Now the box with its contents, weighing something like eighteen tons altogether, is raised about forty feet vertically into the air, in order that the bottom of the box shall clear the coamings of the vessel. Then the whole of the top part of the crane, with its eighteen tons suspended, is swung round for about eighty feet travel, and then down 40 feet into the hold, where the coal is deposited by the lowering of the conical valve in the bottom of the box. I do not say whether the coal suffers less breakage by the means adopted than by shipping in the usual way, but this I will say, that whatever small is made is spread more evenly throughout the cargo than is the case with the ordinary shoot system, where the small coal naturally lies in a heap on the side of the vessel opposite the shoot, where it acts as a bed for the lumps to fall on. After leaving the box, the lumps themselves are slid along the temporary shoots or telegraphs by the trimmers. The empty box is then again raised forty feet, turned round as before, the jib of the crane being more or less operated to plumb the hatchway or pit, the box lowered to be again refilled and the operation repeated. I again assert that if the box is placed at the mouth of the shoot, immediately over the hatchway of the vessel, and then lowered into the hold, the whole could be manipulated by counter-balance, and this enormous waste of energy obviated. The drawings projected on the screen have indicated my meaning more fully than can be gleaned from the wording of this paper, and although Mr. Gibson is perfectly right in his estimation of the small anti-breakage box, his remarks do not at all apply to a box capable of holding a full wagon of coal, or even of the capacity of five tons, as seen at the Barry Docks.

The meetings terminated with the usual votes of thanks.

GEORGE SLOGGETT,

Honorary Local Secretary.

INSTITUTE OF MARINE ENGINEERS

INCORPORATED.

SESSION 1894-5.

"MECHANICAL APPLIANCES FOR THE SHIPMENT OF COAL."

BY

MR. S. W. ALLEN

(MEMBER).

ADJOURNED DISCUSSION

AT

58, ROMFORD ROAD, STRATFORD,

On MONDAY, APRIL 9th, 1894.

CHAIRMAN—MR. J. H. THOMSON.

(Chairman of Council).

We are met to-night to continue the discussion on Mr. Allen's paper on "Mechanical Appliances for the Shipment of Coal," read at Gresham College on February 24th, followed by a discussion here on March 12th. Mr. Capper, who was present that evening, has kindly sent this model as he promised. One subject brought up at the last meeting was the stowing of coal in bunkers. Some held the larger coal went into a smaller space than the small coal when stowed in the bunkers, and that more than 200 tons of small coal could be got into ordinary 200 ton bunkers. That was contradicted by other members; we may have more light on the subject to-night. We have here a model of a machine that will be very interesting to sea-going engineers, and also to shipowners as well as the officers of the ship generally. It is for the shipment of coal from barges into bunkers, doing away with hand labour to a considerable extent, and getting rid of the dust which is so objectionable during coaling. Mr. Paul, the inventor of the machine, is here, and will be able to explain it and answer any questions that may be asked about it. Mr. Capper was to commence the discussion to-night, but as he has not yet arrived I propose to give Mr. Paul an opportunity of explaining his model, while reading a few notes descriptive of his machine. The machine is called Paul's Patent Rapid Coal Barge. The inventor's description is as follows:—

"This system comprises a specially constructed barge which is provided with an endless conveyor, arranged centrally fore and aft of the craft. At the forward end the conveyor is inclined upwards by means of guides and passes up and over a derrick in the bows. This derrick is hinged at the foot, and can either be raised to a vertical position or lowered and set at any angle to suit the level at which the coal has to be discharged. The conveyor is composed of a steel chain, each link of which has attached to it a steel plate with the sides turned up, the whole forming an endless vertebrated trough. Every third plate has a transverse rib formed upon it, and as the conveyor carries the coal forward up the derrick to the points of delivery the ribs prevent it slipping back. There are thus practically a series of shallow buckets arranged in dredger fashion. The conveyor receives its motion from a drum geared up to a small engine, which is placed in the stern of the barge, and which can also be used to drive a screw to propel the barge. The conveyor travels forward on a level to the foot of the derrick, at which point it passes over a loose drum and then up the derrick and over another loose drum at the derrick-head, where it delivers the coal. It then returns empty beneath the loaded portion to the stern, and with the buckets upside down as in a dredger. To the underside of the conveyor chains are attached at intervals, light axles carrying small loose rollers, which, during the forward motion, run between a pair of guide-rails placed one above the other. On the return journey of the empty conveyor the rollers run on a single rail, as there is no tendency in the conveyor to rise. The barge has a series of bunkers arranged on either side, the floors of which are inclined towards the conveyor, the course of which follows the line of the keel. The coal is retained in the bunkers by sliding doors opening vertically, and which are raised in succession as required. Upon the doors being opened the coal slides out upon the moving conveyor. The latter carries it forward to the derrick and thence upward to the point of discharge, which may be a steamer's bunker, a lighter, or a wharf. In order to prevent the escape of dust into the atmosphere there is a closed shoot from the derrick-head—where the creation of dust commences—down to the bunkers. By this means the dust nuisance is obviated.

If it should be preferred, the coal bunkers or the floors of the barge may be hinged at their edges adjoining the travelling bed, each floor may then in the normal position be horizontal or may even incline downwards towards the side of the barge. The object of this construction is to enable the floors of the coal bunkers to be gradually raised by mechanical means, so that the whole of the coal may be fed to the travelling bed without requiring manual assistance.

This construction has the further advantages that the stowage capacity of the barge is better utilized owing to the avoidance of rise of floor in the bunkers. Provision has also been made for cleaning away any coal dust that may have filtered through and accumulated between the bed of the travelling chain and the bottom of the barge, there being a clear space of one-and-a-half inch between the top of the buckets of the chain bed and the bottom of the barge. This provision has been made by fixing a piece of india-rubber, one-and-a-half inch thick on one of the buckets, by means of bolt and screw removable at pleasure, and as the belt revolves and the rubber reaches the bottom level of the barge this india-rubber acts as the well-known squeegees used on board the ships for cleaning the decks. This apparatus brings the dust up to the tumbler at the stern of the barge, and if an iron plate is fixed, say, six inches or less from the tumbler in front, all the dust will accumulate there, and as the accumulation increases in height, it will be carried away by the return empty buckets and elevated with the other bulk of the coals. So there is not even any dust wasted or left in the barge. On the last occasion when the barge partially coaled the P. & O. s.s. *Paramatta*, nearly five ordinary buckets of very fine dust accumulated out of seventy tons of Welsh coal as the india-rubber and the plate above-mentioned were not then fixed. When the first trial of the barge with 120 ton of coal was made at the Dock only six buckets of dust was accumulated, the coal being hard north country coal accounted for this."

The CHAIRMAN: What struck me, when I first saw this model and the drawings, was the waste of space here (pointing to the space between the sloping floors of the bunkers and the bottom of the barge) but Mr. Paul says he will get over that by having the floor of the bunkers flat and raising it by mechanical means.

Mr. Paul having shown his model in operation and explained the method of working, a number of questions were addressed to him on the subject.

A MEMBER: What is the quantity of coal that your barge will lift in an hour and put on board a steamer?

Mr. PAUL: My system will put on board ship from 20 up to 240 tons of coal per hour, if such a low rate of delivery as twenty tons an hour should be required.

On one occasion the barge actually put sixty tons into a steamer's bunkers in thirty-three minutes, and at a demonstration of the system, 120 tons were loaded in an hour and fifteen minutes, including several stoppages. I have loaded at the rate of 180 tons an hour, and I could do 240 tons an hour if necessary. It only depends on the revolutions of the engine.

The CHAIRMAN : I suppose it would also depend to a great extent on the speed at which it can be taken into the bunkers?

Mr. PAUL : Yes, but I can supply it up to the rate of 240 tons an hour if the bunkers can take it.

A MEMBER : Of course there is no ordinary ship that can take it at that rate.

Mr. PAUL : To coal quickly, I propose to have four shoots for each steamer—a couple on each side—to work simultaneously.

A MEMBER : Is the machinery equally efficient for all sizes of coal?

Mr. PAUL : Yes. The buckets are so strong that when the lumps of coal get on to them they are carried along beautifully. When we coaled the *Paramatta* it was with Welsh coal, and there were some very large lumps mixed with some very fine powdered dust, and it made no difference whatever. In fact, the larger the coal the better—the better it is for the machinery, because the larger the coals the larger will be the delivery, on account of the weight. On the occasion when we loaded sixty tons in thirty-three minutes it was a very fine gas coal, and it ran out just like grain. I do not think that there were any lumps in it larger than six inches. In fact it was so fine that it was just like water going down.

The CHAIRMAN : It is going to be a very expensive affair I think, and that I am afraid will be one drawback.

Mr. Paul : It is a matter of from £400 to £500 between the cost of my barge of 250 tons capacity, and the cost of an ordinary lighter of the same size. You pay at present, under the ordinary system, for lighterage, loading, trimming, &c., from 2s. 6d. to 2s. 7d. per ton—under my system it can be done for less than 6d. per ton, including lighterage and trimming, and the difference of 2s. per ton will soon cover the £500—the extra cost of the barge. I reckon it out in this way. It will require four men to look after the barge and work it, and a donkeyman. It is only a six-horse power engine and the barge can discharge 250 tons in from three to four hours, but we will reckon it at four hours. That will be £1 for the four men at 5s. each, and 6s. for the donkeyman. The boiler will only require a sack of coke, for which I allow 2s., this to include necessary lubrication, &c. That is the total expense of working the barge which is to discharge 250 tons in four hours, and it comes out at a little over a penny per ton. I allow 3d. per ton for the trimming on board the steamer, and the rest of the 6d. remains for wear and tear of the barge and insurance.

A Member : What is the price of the barge finished, including the machinery ?

Mr. Paul : Reliable estimates have been given at about £8 per ton to build a 250 ton barge, and about £7 per ton for a 500 ton barge.

The Member : Does that include the new scheme for having the bottoms of the bunkers so that they may be elevated ?

Mr. Paul : No.

The Member : Because it appears to me that that is rather an impracticable idea, and would be very difficult to carry out. You have had no experience of that idea ?

Mr. Paul : No.

Mr. STRAKER (Visitor) : But you contemplate doing it?

Mr. PAUL : No, not at present.

Mr. STRAKER : Is any trimming necessary in order to clear the bunkers of the barge?

Mr. PAUL : The only trimming that is required is when the bunker has been about three parts emptied, and the little remaining at the end will require assisting.

A MEMBER : Has a 250 ton barge been built?

Mr. PAUL : My present barge is constructed for 100 tons, but it will carry about 140 tons.

Mr. STRAKER: Have you any difficulty with the labour question?

Mr. PAUL : No, Sir, not at present.

Mr. STRAKER : Do you contemplate having any difficulty?

Mr. PAUL : No. The Labour Commission seem to be in favour of more machinery, because it gives more employment.

Mr. A. W. ROBERTSON : Assuming that this barge of yours is in the hands of a novice—a man who has no knowledge, or only a partial knowledge of machinery, and he opens all the sluices or doors at once, and allows the coal to run down to a height of, say, two feet, is your power sufficient to continue to act without jamming?

Mr. PAUL : First of all, the whole of the doors are not intended to be opened all at the same time, although it may be done. But you cannot overload it, as I have tried it over and over again. You do not want to open all the doors. Open one or two and watch the buckets.

As long as the buckets are full, that is all you want. With regard to the novice who does not understand anything about engineering, this matter is just like everything else. When I was coaling my first 120 tons, I had to work with men who had been employed at a timber yard. I did not have any coal navvies, nor men who knew anything at all about shovelling. But one of the four men to be employed must be appointed the head of the barge—the ganger—and he must be taught what to do—how to open the doors, when, how far, and how to shut them.

Mr. A. W. Robertson: I wanted to know if the weight of the coal at any time would be likely to exceed the strength of the machinery to deal with it, and so cause a breakdown?

Mr. Paul: Oh no.

Mr. A. W. Robertson: Of course you do not object to a little criticism. You have put forth the fact, that this barge complete, to carry 250 tons, will cost about £2,000—that is £8 a ton. I suppose you are aware that an ordinary barge, to carry that weight, can be built for £850 or £900. Considering the method of working ships in London—the system of bunkering—and I presume your object is to confine the use of this barge to that purpose—do you think that you are justified in investing such a large capital as £2,000 for the purpose of putting 250 tons of coal into a ship, say once every four days. Because, whenever this barge is empty, it is inoperative so far as its machinery is concerned. Having once discharged its cargo, it must go out into the river again and go alongside a ship or wharf to be reloaded, and that performance will probably run into four or five days at the least. That is a matter that cannot be accomplished in 48 hours. You put 250 tons on board a steamer in two hours—that is, assuming the capacity of the bunkers and the trimming are adequate to enable you to keep working at that rate. Well, then you will have two hours' work for, say 60 hours' idleness. Even allowing two trips a week, 25,000 tons is all that your barge would be able to put on board ship in a year. That, I think, is the most you could possibly accomplish.

Mr. PAUL: It does not require four or five days to reload the barge. We load her now in two or three hours, with the ordinary appliances in use on the Thames. In actual working, we have reloaded the barge within six hours after completing the discharge of her previous cargo, and in that six hours the barge proceeded from the Surrey Commercial Dock, some 8 miles down the river, to Messrs. Lambert Brothers' coal wharf, at the entrance to the Royal Albert Dock, where she received the coal like any ordinary barge.

Mr. A. W. ROBERTSON: I admit that if special advantages were extended, no doubt it could be accomplished in the time you have just mentioned, but are you going to have the coaling system in London altered to accommodate you in the working of this barge, in order to give such quick despatch as you have stated. It would have to take its turn with other barges I should think.

Mr. PAUL: I do not see why.

Mr. ROBERTSON: The mechanical arrangement is on the old fashioned principle of the elevator—a principle that the oldest millwright has been associated with from his infancy. At the same time it has been introduced here in a very novel manner, and the mechanism of the machinery must strike every one present as being very ingenious and very applicable for this work. I very much doubt, however, if the invested capital that would be required to bring this appliance into use would not practically make it non-commercial, because we all know that the commercial point must be taken into consideration. It is not only that the barges now in existence would be obsolete, which would be a very great loss of capital, but the steamers now running into the Thames would have to be made adaptable for meeting the requirements of this method of coaling.

Mr. PAUL: Why should the steamers be altered?

Mr. ROBERTSON: I mean the colliers.

Mr. PAUL: There was no alteration at Lambert Brothers' wharf. We took the coal on board just the same as any ordinary lighter.

Mr. ROBERTSON: I should have thought that to make this a success the proper way would have been for the steamers to have had the proper discharging appliances on board, and for these barges to go alongside. The present system of discharging coal on the Thames is by cranes. Some are hydraulic and some work by steam, but they have all got a special method of discharging, and for working this special system the present method would require to be done away with and a new one introduced. In my opinion that would add so much to the first cost that I cannot see how it can be made a commercial success. I do not speak of the difficulties to be contended with from an engineering point of view, but I am very much afraid that the invested capital that would be required for the adoption of this system would be so great that it would fail to be a commercial success. We all know the wear and tear there is in machinery, and this particular machine is of such a nature that we cannot put the wear and tear at a lower figure than from $12\frac{1}{2}$ to 25 per cent. of the first cost per annum.

Mr. PAUL: I allow for all that, and even taking it at the lowest figure—your own estimate of 25,000 tons per barge per annum—this will give a saving of £2,500 per annum per barge in favour of my system. This allows for only two trips a week, but a barge could make four trips a week at the very least.

Mr. ROBERTSON: And then it must be remembered that the quantity of coal to be shipped is not a constant quantity. One week the dock may be full of steamers and another week there may be very few ships. Therefore it will be impossible to put down a fixed quantity for this barge to discharge on board in consequence of the erratic running of steamers.

Mr. PAUL: But we know how much bunker coal is required in London, and it does not matter whether it is shipped to-day or to-morrow. This barge can make two trips in one day if necessary.

Mr. ROBERTSON: To make your scheme a success it ought to be introduced universally, and that of course would mean a great alteration in present methods and present appliances.

Mr. PAUL: I do not see that any alterations are required either in colliers or in ships' bunkers.

A MEMBER: Is this barge only intended to be worked in London?

Mr. PAUL: No, anywhere—all over the world, wherever an ordinary barge can go.

A MEMBER: What saving is the shipowner to effect by using this barge as compared with the ordinary system?

Mr. PAUL: We could save the shipowners sixpence or more per ton, besides a great many other advantages, as, for instance, absence of dust, less breakage, and, above all, most valuable time saved. In fact since this model was constructed I have made several improvements in details in the big barge which has been working for seven or eight months to the satisfaction of everybody who has witnessed its working.

The CHAIRMAN: As time is pressing we ought to give Mr. Capper an opportunity. The majority of us will recognise that, as a machine, this barge of Mr. Paul's is very ingenious and well adapted for the purpose for which it is designed. As to the probability of its commercial success that is a matter for Mr. Paul himself. I think, however, we shall all wish Mr. Paul success in his undertaking, and if he will advise us when actual coaling is going on many of us would like to have an opportunity of seeing it. Now I think I must call upon Mr. Capper to explain his models.

Mr. R. CAPPER (Honorary Member): My principal object in coming here to-night is for the purpose of dealing further with the question raised at the last meeting as to whether it is true, as I then asserted that "the smaller the coal the more it measures." It took thirty years to alter the mode of selling coal in London from measurement to weight. I do not know whether Mr. Paul contemplates waiting thirty years before he sees his system adopted, but it does appear to me that it is a system which is quite adaptable to existing ships and existing methods, and things certainly move a little faster in these times than they did a generation ago. I would rather that Mr. George L. Hunter, a son of one of the inventors of the Lewis-Hunter cranes, should explain this model, and then if any gentleman present is not satisfied that "the smaller the coal the more it measures," I have come prepared with a bushel of facts to try and satisfy him.

Mr. HUNTER, with the aid of the model, then described the working of the Lewis-Hunter system of shipping coal. He said there were nine of these cranes in 1,500 feet of quay space, and the great advantages claimed for them were that besides giving ships good dispatch there was little or no breakage of the coal. It often happened that they had four cranes working simultaneously on one ship, into which they had loaded 1,200 tons of coal in one hour, and this, he thought, was a record that had not been beaten. The whole of the coal from a ten-ton railway wagon was dropped from a height not exceeding five feet into a scuttle or carrying box, and owing to the construction of this carrying box and the provision of a cone valve or bottom, which was only released to let out the load when the box was lowered into the hold on to the flooring of the ship or cargo, the breakage was reduced to a minimum. The whole of the quay space was available for other purposes while the loading of the coal was in progress. There were two lines of railway underneath the cranes, so that other goods could be loaded at the same time.

The CHAIRMAN: What percentage of the contents of a hold would require to be trimmed after using your cranes?

Mr. HUNTER: That entirely depends on the build of the steamer. If she is what is known as a collier, it would be five or six per cent., but if she has a between decks it would be a little more. But the great point is the saving of breakage. In the case of the *Iona* we put 2,000 tons of coal into one hold without trimmers going down at all. This system has been actually at work since 1887, so that it is by no means new.

The CHAIRMAN: Perhaps some one will raise that question about the stowage of coal which Mr. Capper says he is now prepared to demonstrate. I think the question was whether you could put a greater quantity—a greater weight—of small coal into bunkers than if you were filling them with large coal. There is an idea that with small coal which will fill all the holes and corners, you can get a greater quantity into a ship's bunkers. What has been the experience of members.?

Mr. G. SHEARER (Member): My experience in coaling extends over a good many years, and I should say I could always get most coal in by mixing it. I always liked to get as much large coal as possible but I wanted that large coal mixed with small. I think every seagoing engineer ought to know pretty well that you can never get your weight in small coal. Let him weigh a single bucket full, and he will find that as between large and small coal there is a difference of from eight to ten per cent.

Mr. CAPPER: Yes, that is it. In fact, when there was a duty of 6s. on coal the Government used to stipulate that the measurement should be made of what they called middling coal—large and small together—and by adding the two together it made a difference of ten per cent. In stowing coal in confined spaces, large lumps do not adapt themselves to the shape and internal construction of the bunker, like small coal. Therefore, exceptions to the general rule creep in, but as Mr. James Adamson pointed out on the last occasion, there is a difference between the stowage of coals in the holds and in the many small spaces allotted to bunker room. Wet coal does not measure so much as dry coal, for the small clogs together and forms hollows or cells. When large and small coal are shipped together, an addition of ten per cent. can be stowed, the small going into the spaces left between the large lumps; but where the same hold is loaded wholly with small coal the weight is not so much as with large coal, the larger space filled being not sufficient to counteract the difference in the density of the two descriptions of coal. This is one of the points to which I alluded at the last meeting because I think it is a matter which interests Marine Engineers very much. The other point was about small coal in the centre of the hatchway, and you will remember that I called attention to a statement by Mr. Wallace, a Liverpool underwriter, to the effect that one-half of the coal-laden vessels lost at sea, were so lost owing to the fact that their cargoes included a large proportion of small coal in the centre of the hatchways which caused spontaneous combustion. It is a startling fact that was told by Mr. Wallace. In fact, as far as that goes, it is stated that the larger volume of coal now put into vessels has given rise to, or increased this danger, and coal that formerly was not considered fiery, now turns out to be fiery coal, but I think it is entirely due to the fact that these cargoes contain a larger accumulation of small, owing to the coal being now discharged into the holds, in many instances from a greater height, sometimes as much as forty feet. Mr. Wallace gave a table of ships that had been lost, as evidence of what he was saying, and he put the loss of these vessels down to this cause. In consequence of the facts, to which Mr. Wallace has called attention, I believe the Insurance Companies have doubled their premiums on coal laden ships. That is the way to test the thing—bring it down to pounds, shillings and pence.

Mr. A. W. ROBERTSON : Is there any reduction in the premiums charged for the insurance of ships loaded by means of this system of yours?

Mr. CAPPER : That is a question of which, as they say in the House of Commons, I ought to have had notice. Whether they are getting any reduction at the present moment I do not know, but that they will get a consideration I think there can be no question. At any rate the fact remains that there is a great run upon this particular system of loading, and it is bound to tell. I have heard so many people, including people of repute, contradict the statement that "the smaller the coal the more it measures," and having regard to the reception I met with at your last meeting I have looked into the subject further, and I find that what I told you is really correct. I turned up a book that was written by my father forty years ago, and the whole thing is there set out just as I have been telling you. It tells you all about the legislation that took place and the time that it took to bring it about; and the story of the movement which resulted in Parliament enacting that coal should be sold by weight instead of measure is very well told. It is certainly very interesting. There are a good many curious facts about coal in this connection if you like to look them up. I may also add this further fact that buyers who wished to have double-screened coal are charged ninepence per ton more for it than for ordinary screened coal; and inasmuch as the coal, when put in by the Lewis-Hunter cranes, is equal in condition to double-screened, and no extra charge is made for it, there is a distinct advantage of ninepence per ton to the buyer.

The CHAIRMAN: What is the title of the book to which you referred?

Mr. CAPPER: "The Port and Trade of London." It was published in 1861 or 1862.

The CHAIRMAN: We might perhaps obtain a copy for the Institute Library.

Mr. CAPPER: I think it is out of print now, but I may perhaps be able to obtain a copy for you.

Mr. D. ROBERTS (Visitor): I do not consider that the advocates of the Lewis-Hunter system of coal shipping by cranes have been fair in their treatment of the system of loading by tips. The illustration of loading by tips shown on the wall does not show the anti-breakage box which is worked by a hydraulic crane at the corner of the tip, nor does it show the cone of coal which is formed in the vessel's hold until it reaches almost to the point of the shoot. The wagon is first raised or lowered to the butt of the shoot, the door is then opened and the coal slides down the shoot. I have here a drawing, which I shall be happy to pass round the room, showing how the cone is formed in the holds of vessels by means of the anti-breakage boxes. The coal merchants have men on board during the loading who attend to the wings in the shoots and prevent the coal running too rapidly into the boxes. I contend that there is less breakage of the coal by the tip system than by other methods. With regard to what Mr. Capper says about the coal being more broken now that the tips are built so much higher, I fail to see what the height of the tip has to do with it, for Mr. Capper must know that by means of the hydraulic system wagons can be either raised or lowered to suit the position of the shoot. Now that steamers are so much larger, and we have frequently to bunker them light, the tips are of course erected much higher, but this in no way increases the breakage of the coal. I may say that at Barry, which is the dock I am connected with, we have bunkered steamers of 7,500 tons burthen, light, and we have loaded the s.s. *Cookham*, of London, a vessel of 2,000 tons burthen, in 5 hours, 55 minutes at one tip This included the time occupied in shifting from hatch to hatch.

Mr. R. CAPPER: I have been taken to task, and in reply have to say that if the diagram in question is going to deceive anybody, it is, I think, suggestive of deceiving oneself. Members can read plans, diagrams, and sections as well as I can, and I am surprised at Mr. Roberts putting forward such a point. We have simply shown in that illustration, on a very small scale, the idea of high tips in shipping coal by the old method, and how a game side can be given to a ship. With regard to Mr. Roberts's statement about the *Cookham*—the *Cookham*, I believe, is a self-trimmer. That makes a very great deal of difference in the loading of the ship, and you cannot compare the *Cookham* with a White Star Liner, capable of taking 5,000 tons of coal and more. With regard to the anti-breakage boxes spoken of by Mr. Roberts, it has already been stated by one speaker in the course of this discussion, that they are very seldom used, and I should like to ask Mr. Roberts if these boxes have doors at the side or the bottom. I have heard that the anti-breakage box is often fixed at the end of the shoot, and the coal is simply allowed to run through it. They profess to use the boxes, but unless somebody in authority is looking on, no use appears to be made of them. In these days of hurry, is it likely that men will load their ships at the rate of one ton a lift, when by the same operation, and in the same time, from seven to eleven tons can be put on board? I have had experience in dealing with coal, going back to the year 1861, and I have had as much to do with north country coal coming into London, being shipped at Newcastle and Sunderland, as I have had to do with South Wales coal. I therefore do know something about it. The diagram was never meant to illustrate otherwise than a fair comparison between the systems.

Mr. ROBERTS: If Mr. Capper says that the anti-breakage boxes are never used, all I can say is that he knows nothing of the shipment of coal at South Wales ports. The anti-breakage boxes at Barry have both side and bottom doors, and are capable of holding 15 cwt., 30 cwt., 5 tons, and, in fact, up to 12 tons. The *Cookham* is a self-trimmer, but was not the vessel referred to by Mr. Hunter, a self-trimmer also, when she could take in 2,000 tons in the main hold without any trimming. I can also claim to speak with some authority in the matter, as my experience extends over thirty years.

Mr. HUNTER: Not at Barry.

Mr. ROBERTS: No, not thirty years at Barry, but five at Cardiff, twenty at Penarth, and five at Barry.

Mr. CAPPER: I should like to put one further question to Mr. Roberts. If he says they always use anti-breakage boxes at Barry, I have nothing more to say.

Mr. ROBERTS: I will not say that. We are in the hands of the coal merchants, who are anxious, for their own sakes, to ship the coal as large as possible, and many of them keep men for the purpose, called wing men. The purchasers' inspectors also watch to see that the boxes are used.

Mr. A. SCOBIE (Member): I have much pleasure in proposing a vote of thanks to Mr. Paul for attending here this evening and showing us his model. I am sure we wish him every success in his undertaking.

Mr. A. W. ROBERTSON: I propose a hearty vote of thanks to Mr. Capper and Mr. Hunter for their kindness in coming here this evening and showing us this very handsome model of their system for coaling vessels.

Fig. 1.

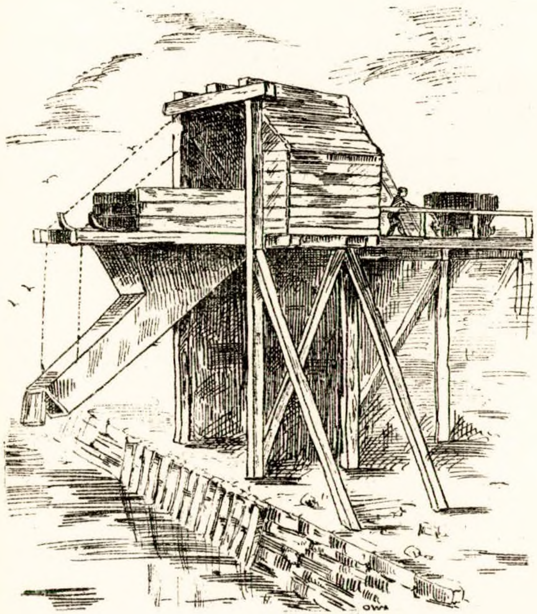
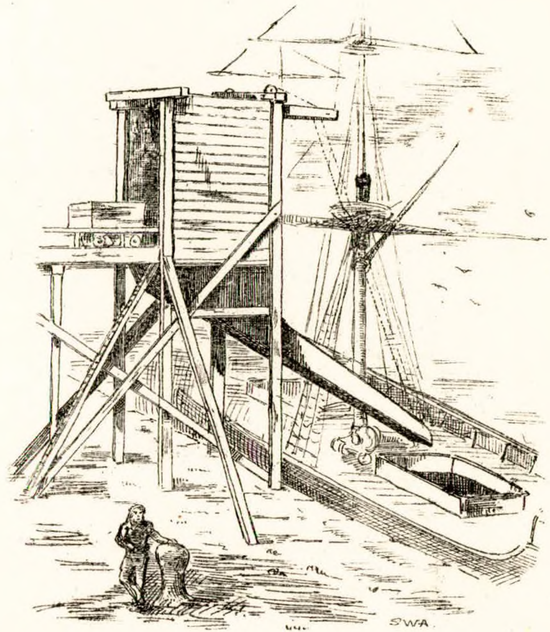


Fig. 2.



Coal Spouts
at West Hartlepool.

Arrangement of Coal Spouts at the North-East Ports.

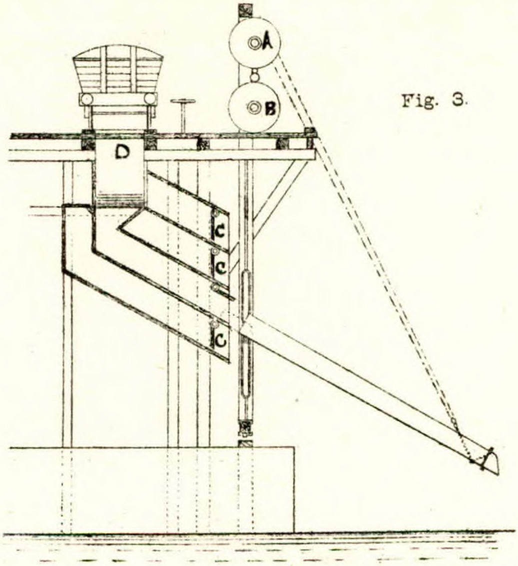
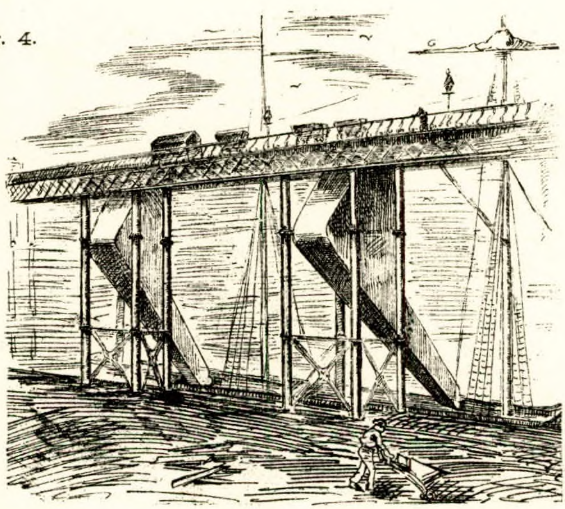


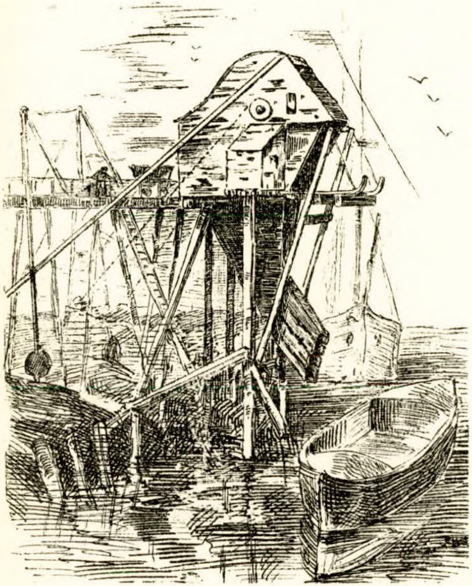
Fig. 3.

Fig. 4.



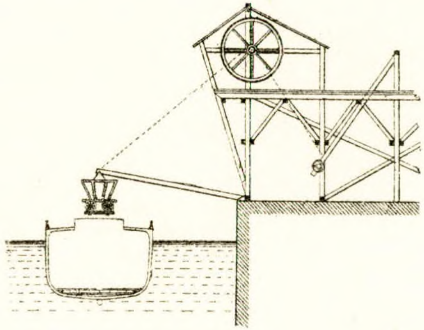
Coal Spouts
at Sunderland.

Fig. 5.



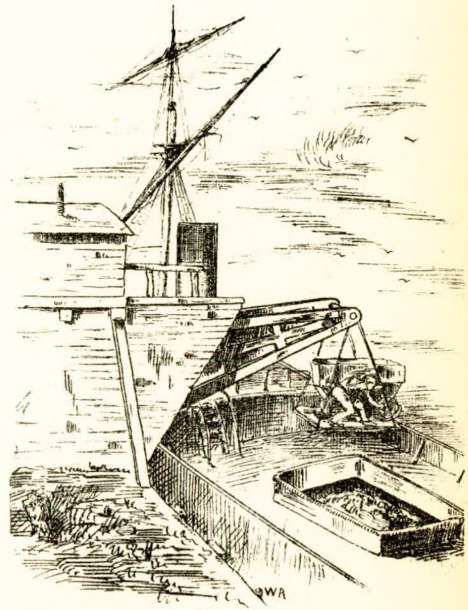
Old Coal Spout and Drop
at Wallsend.

Fig. 6.



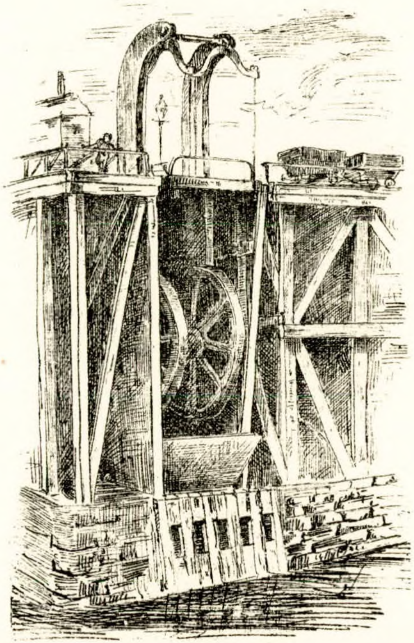
Old Coal Spout and Drop
at Wallsend.

Fig. 7.



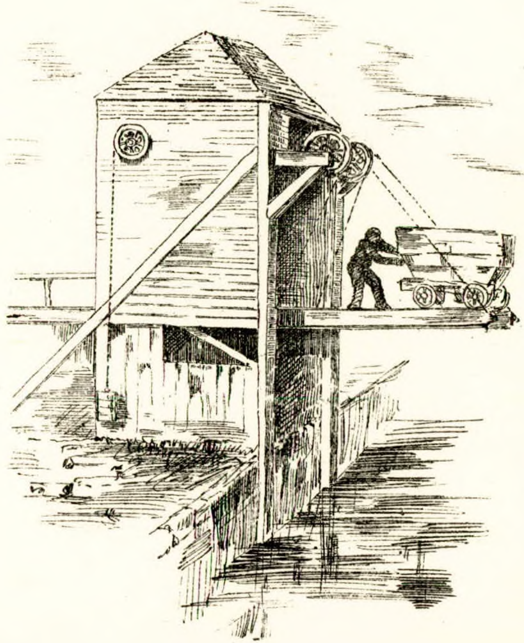
Coal Drop on the River
at Sunderland.

Fig. 8.



Coal Drop,
Sunderland Docks.

Fig. 9.



Coal Drop,
West Hartlepool.

Old Arrangement of Coal Tip,
West Bute Dock, Cardiff.

Fig. 10.

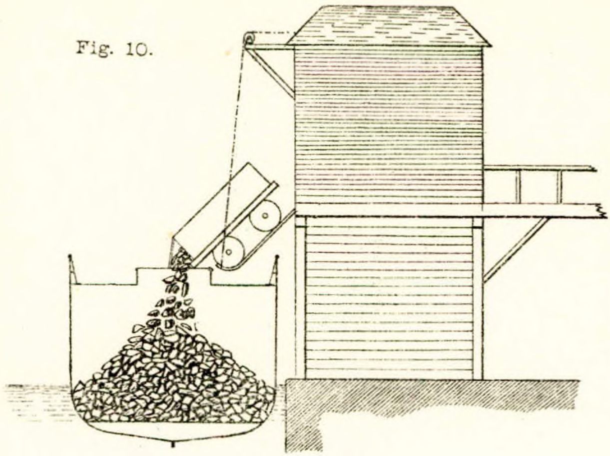


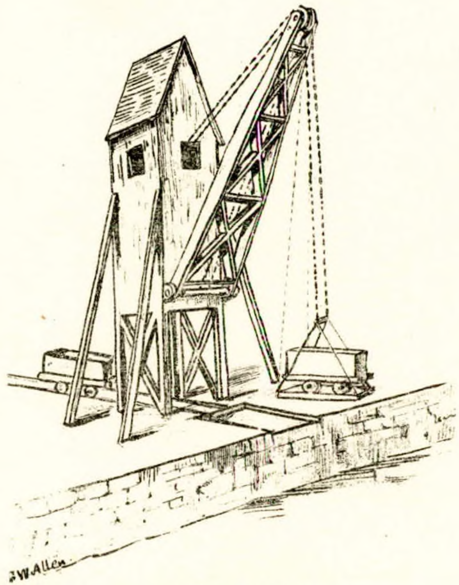
Fig. 11

Coal Tip,
Newport River.

Fig. 12.

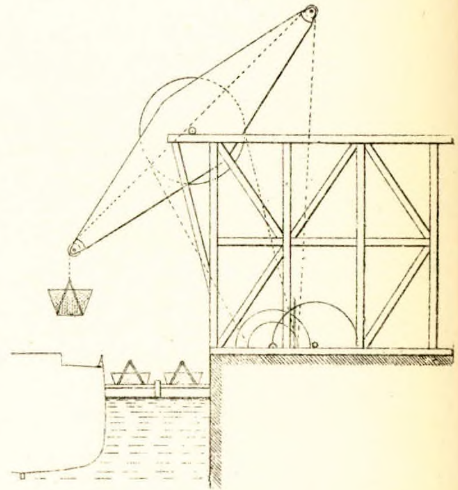
Coal Tip,
Newport River.

Fig. 13.



Coaling Crane,
Hull Docks.

Fig. 14.



Old System at
Sunderland Docks.

Fig 15.

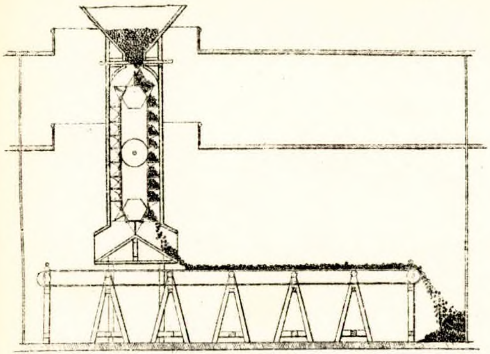
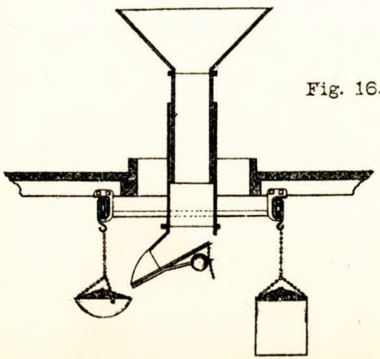


Fig. 16.



Suggested Coal Trimming Arrangement
by Mr. E. A. Cowper.

Suggested Arrangement by
Mr. Westmacott.

Fig. 17.

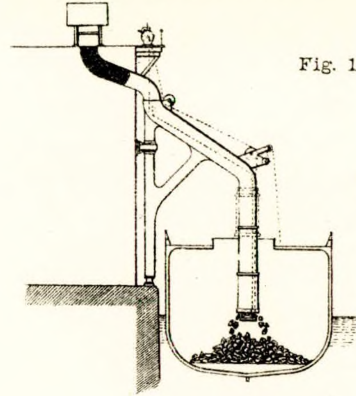
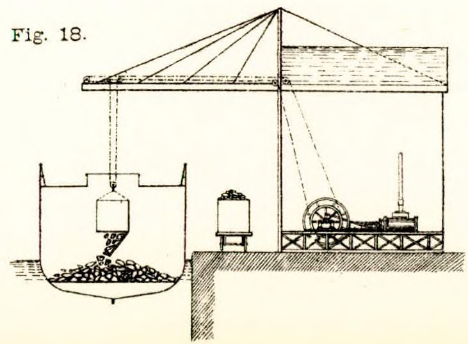
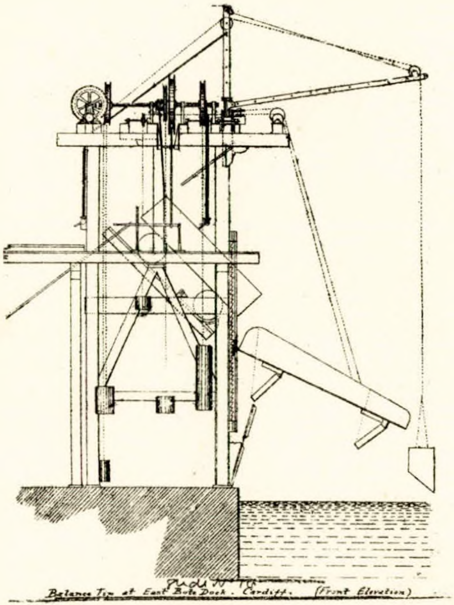


Fig. 18.



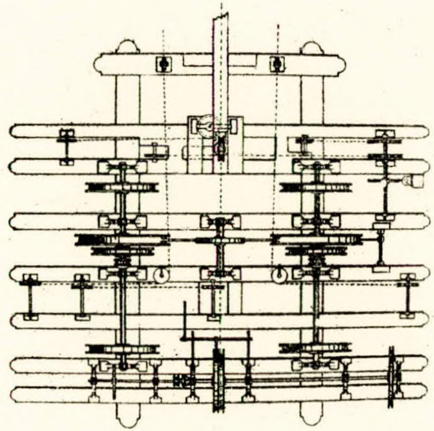
Old Coaling and Ballast Crane,
Bute Docks, Cardiff.

Fig. 19.



Elevation of Balance Tips,
East Bute Dock, Cardiff.

Fig. 20.



Plan of Balance Tips,
East Bute Docks, Cardiff.

Fig. 21.

HYDRAULIC HIGH LEVEL TIPS, BUTE DOCKS, CARDIFF.

Fig. 23.

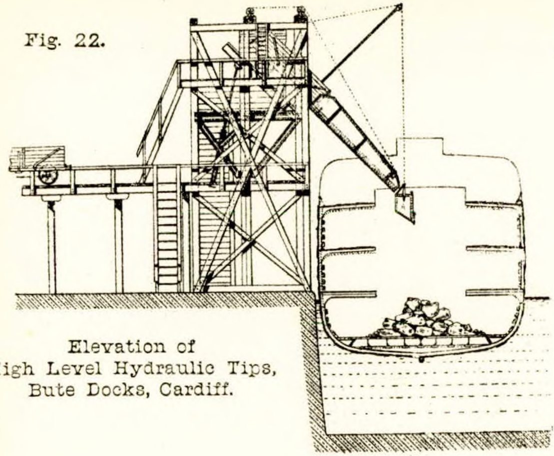
HIGH LEVEL BALANCE TIPS AT PENARTH DOCK.

Fig. 25.

Fig 26.

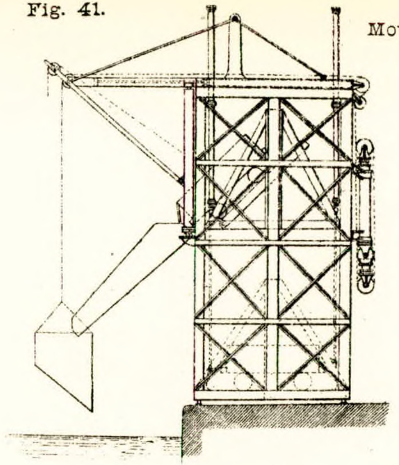
LOW LEVEL HYDRAULIC TIPS, ROATH BASIN, CARDIFF.

Fig. 22.



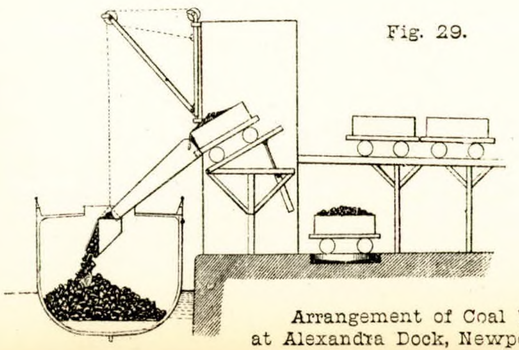
Elevation of
High Level Hydraulic Tips,
Bute Docks, Cardiff.

Fig. 41.



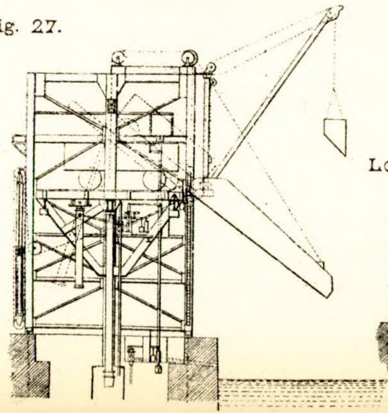
Moveable Coal Tip,
Barry Dock.

Fig. 29.



Arrangement of Coal Tips
at Alexandra Dock, Newport, and

Fig. 27.



Low Level Hydraulic Tip,
Roath Basin, Cardiff.

Fig. 28.

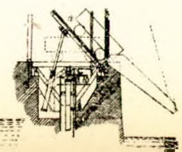


Fig. 31.

Low Level Hydraulic Coal Tips,
Barry Dock.

Fig. 30.

High Level Hydraulic Coal Tips,
Barry Dock.

Fig. 32.
VIEW OF BARRY DOCK,

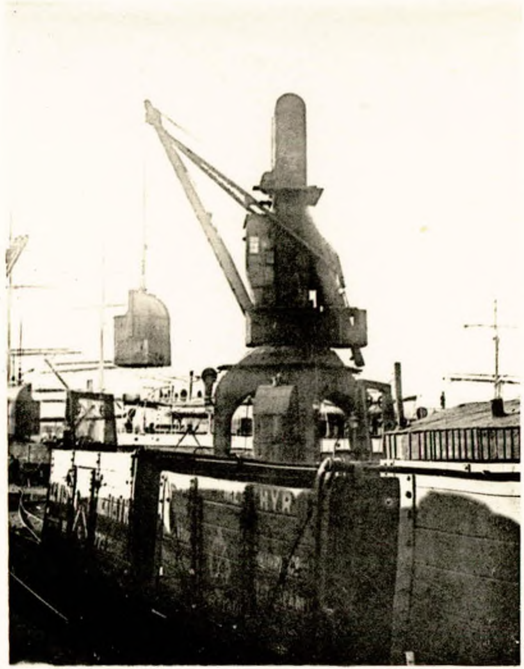
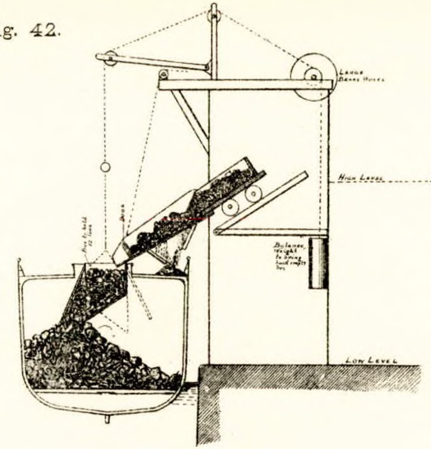


Fig. 36.
NEW HYDRAULIC COALING CRANES,
BUTE DOCKS, CARDIFF.

Arrangement of 10 ton Anti-breakage Box, used in connection with an ordinary Balance Tip.

Fig. 42.



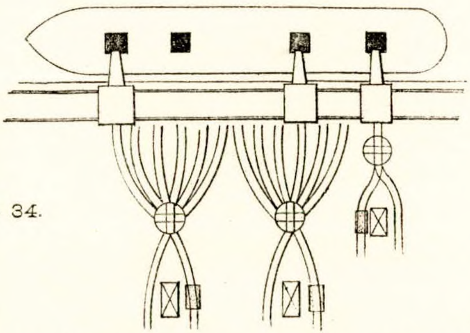


Fig. 34.

Plan of Taylor's Patent Tipping Arrangement at Roath Basin, Cardiff.

Arrangement of Moveable Tip proposed by Mr. S. B. Butler.

Fig. 33.

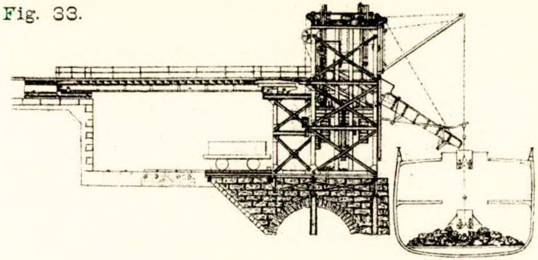
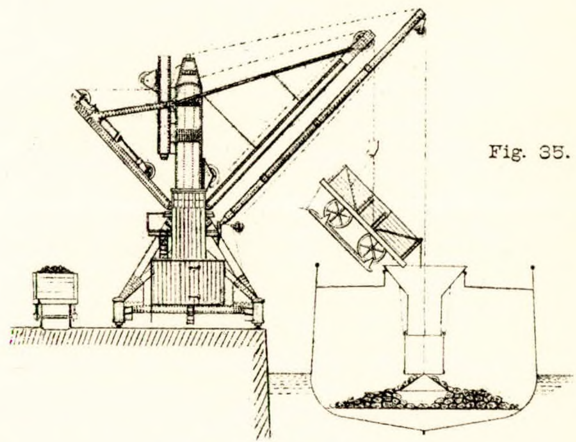


Fig. 35.



Crane for Lifting Coal Wagons, Roath Basin, Cardiff.

Fig. 37.

Fig. 40

NEW HYDRAULIC COALING CRANES, BUTE DOCKS, CARDIFF.

Fig. 38

Fig. 39.

NEW HYDRAULIC COALING CRANES, BUTE DOCKS, CARDIFF.