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The President's Address.

Tuesday, January 15, 1918.

The PRESIDENT: I need not inform you that my address is very sketchy and short, as you all know the circumstances under which we are working, and I need hardly tell you that it has been almost impossible to sit down and carefully consider a technical paper. However, I have to offer you a short account of what I have seen, and I do feel, as a repairer of ships and machinery, that London has been for many years under a cloud, and I very warmly welcomed the honour you did me and the Thames engineering firms in accepting me as your President. The Marine Engineering trade in London is an important one. Nearly all of you who are present this evening are connected with this trade and know the sort of work that is going on, but I think that London as a port has been very much side tracked in the mind of the world as a possible place for engineering, but we who are of the Port of London feel quite sure that we are worthy of consideration and confidence, and I feel convinced that if you will help us we shall have every reason to look forward with confidence to the future. I understand that you have already had under your consideration the education and supervision of the young generation, and, this being so, I am confident we shall again be able to have the finest class of engineers it is possible to obtain. We have now the necessary technical schools for the training of engineers, but the education of the young engineer needs supervision, and I know of no Institution better able to guide the rising generation than the Institute of Marine Engineers; hence I press the vital necessity of this on the consideration of your executive. I shall now proceed with the address.

I must apologise for the delay that has arisen in delivering this address, but various circumstances arising out of the war have made such delay unavoidable.

I am very sensible of the great honour you have done me by electing me your President for the current session. I feel it not only for myself but because I see in it a recognition on your part that London is still considered an Engineering Port, and, as a member of the old establishment at Blackwall Yard, I am very proud that you should have offered the Thames Engineers so high a compliment. Of course, we can no longer claim the old engineering businesses of Messrs. John Penn, Humphreys and Tennant, or the Maudslay's. The day of manufacturing marine engines on Thames side seems to have disappeared with the departure of Messrs. Yarrow and Thorneycroft. On the other hand, it is not uninteresting to note that two of the oldest original shipbuilding yards on the river, and even in the whole of the United Kingdom—Messrs. Fletcher's at Union Dock, Limehouse, and my own firm at Blackwall—are to-day probably doing a larger business in Marine Engineering than has ever been done in the Port of London previously.

It is interesting to look back over the period in which I have known the river, alas, now nearly half a century, and mark the changes that have taken place. My earliest recollections are always associated with accompanying my father from Greenwich to Blackwall Yard, generally in a Thames wherry, a method of proceeding to business which sounds slow in these days of tunnels and motor cars, but it was quite a common means of riverside transport at that time.

The whole north shore of the river from Greenwich to Blackwall was one continuous succession of shipyards.

The *Great Eastern* had not been launched from Scott Russell's yard at Millwall very many years before that time, and the tradition of that great ship was still strong in the yards, and men delighted to tell you how they had worked on her.

The first yard one passed was the Dudgeon, with their engine and boiler shop higher up the river at Millwall. I well remember seeing the unfortunate battleship *Independencia* lying half launched with her back broken, which was, I think, the finish to the firm.

Her salvage and subsequent reconstruction by Messrs. Samuda in Woolwich Dockyard was no mean feat of engineering, and when rebuilt she formed part of the British Fleet for many years, being called, I think, the *Neptune*.

Next to Dudgeon's came Westwood and Baillie, afterwards celebrated as bridge builders, and then came Samuda's, justly noted for their battleships and cruisers, mostly built to foreign account. Indeed, the earliest ships for the German Navy were built by this firm.

Then came Blackwall Yard, well occupied with corvettes for Spain and Portugal and Chili, and beyond Blackwall again was the Thames Iron Works.

At a later period Messrs. Yarrow started a small launch-building yard, which eventually became famous, on the site of Samuda's old yard, for its torpedo boats, destroyers and light draft stern-wheelers.

All these shipbuilding establishments with their engineering works have, from one cause or another, passed away, with the exception of Messrs. Yarrow, who removed to the Clyde, and so the London river ceased to be a Port for new construction.

During this time the general shipping trade of the Port had been gradually changing and increasing.

In the river itself instead of the tiers of small brigs and schooners employed in the coasting trade, the small steamer and steam collier began to make traffic busy and crowded. I wonder if to-day it would be possible, or what people would say, if they saw a 40-ton cutter yacht heave to off Greenwich pier, drop a boat, pick up a passenger and sail down to Blackwall Pier, and repeat the same manœuvre! Yet I have seen this done with my father's yacht.

Inside the docks the old East Indiaman and fast Australian Clipper has given place to ever-increasing steam vessels, from the cargo liner to the large passenger mail ship.

With these fleets of steamers has grown the present trade of the London shipbuilder and marine engineer; we have become no longer constructors, but reconstructors, and I venture to think that the technical problems which we are facing every day as repairers of ships and their engines and boilers are no slight test of our skill as Marine Engineers.

I often think that the constructor pure and simple would stand aghast at some of our feats. As an instance, I very well remember in the days when my firm was beginning to take up repairs being sent for by a superintendent to see him about one of his furnace crowns which had come down. I felt it was perhaps a little beyond our powers at that time, as we were only beginners, and so I called in the manager of one of the biggest Marine Engineers whom I knew well personally. He came on board and saw the job, and I shall never forget the look of pained surprise and horror when, with the courage of youth and ignorance, I lightly suggested that it could be pushed up again! He left that ship and I don't remember that the job was done. *Tempora mutantur*; the setting up of furnace crowns, as you well know, is now an everyday occurrence.

In ship repairing I think the most delicate problem I ever saw successfully accomplished was in connection with a certain cross-channel paddle steamer, which had proved rather unsatisfactory on trial both in speed and stability.

Fresh lines were drawn out for the under body of the ship and she was placed in dry dock. The whole of the existing under body was cut away from about the fourth water line, and a new body of some 150 tons less displacement was built in its place, and all this without disturbing any of the upper works or breaking a single steam joint in the engine room.

The raising of sunken vessels has long been a speciality of the Messrs. Fletchers, though we have also had a good deal of experience in the same line. No branch of Marine Enigneering offers more interesting problems, and I look back to some of my happiest days spent down the river working in all seasons of the year.

I need not say that since war broke out some of our staff have gone through some exciting times when engaged on this class of work in the Downs, subjected to aerial attacks from enemy aircraft during the operations.

Perhaps the most celebrated of the earlier jobs was the raising of the SS *Locksley Hall* by Messrs. Fletchers. She was a vessel of about 1,400 tons and was sunk in the Mersey, the difficulty in her case being that she was lying across the

Mersey Tunnel, and the greatest care had to be exercised that the tunnel should not be damaged. The operation was successfully carried out and the vessel raised and repaired.

The size of modern steamers has made the work of repairing quite an important branch of naval architecture, as the collision or grounding of one of these big vessels opens up very extensive structural considerations.

Prior to the war the Thames has been able to perform many noteworthy repairs, and I recall briefly two cases illustrating the tasks set us. They both belonged to the same company and were insulated ships.

The first was a very old vessel and was being sold. On opening up for survey she was found to be in a bad condition, and by the time her repairs were completed an entirely new midship body extending for about 60 to 70 feet had been built. Unfortunately for the new owners she was totally lost the first voyage she made under her new conditions. The second case was a very much bigger ship of the passenger type, but insulated throughout. She had been badly aground. In this case the whole of the bottom plating, frames and floors throughout the length of the ship were removed and renewed or repaired. This with a dead weight of some 3,000 to 4,000 tons on the blocks of the dry dock may make you realise that it was no light task.

Turning to the engineering side, I have already quoted an instance of boiler work. But I think most of your older members will look back without regret to their earlier experiences in repairing engines.

The constructors of those days or their draughtsmen never seemed to consider the possibility or probability of ever having to repair their handiwork, and all who have groped their way down old-fashioned shaft tunnels either to survey or draw tail shafts can appreciate the modern ship's spacious tunnel and after chambers where it is possible to handle your gear.

One of the constant sources of trouble in early days was the fit of propellers on the tail shaft, and most of us can remember the tussles that one had in getting a propeller started. One case always remains in my memory, one on which we wrought three days and nights without being able to get a move out of the propeller. All the blades had been removed, but every effort failed. Meanwhile with continual heating both shaft and boss had become very hot—also the superintendent engineer on the matter of delay. As a last desperate resort a $\frac{3}{4}$in. hole was bored through the shell of the boss under the seat of one of the blades and a length of ordinary gas pipe screwed into it, and the shore end coupled up to the water main. The water was turned on, and we awaited with expectation and some anxiety the result. We had not long to wait, for with a report that shook the whole ship the sudden contraction of the tail shaft shot the propeller hard against the stern post. The scared look on the face of the old superintendent as he rushed on deck from the cabin brought a general hearty laugh, which relieved the tension of tired and irritated men. No damage resulted either to boss or tail shaft, which were refitted after examination and cleaning.

Quite an interesting engineering feat has been the lifting of ship's engines in order to renew or rerivet the engine seating or tank tops without taking the engines out of the ship. A number of cases of this kind have been most successfully dealt with, engines from 3,000 I.H.P. to 4,000 I.H.P. having been lifted.

The methods vary somewhat according to size of engine and design of ship, but usually a heavy timber gantry is built over the engine, the weight being taken by legs fitted each side, and continued through the double bottom on to the dock bottom. The engine is then slung from the lifting screws by means of chain slings. To the heads of the lifting screws which pass through a strong timber beam on the gantry are fitted ratchets on ball bearings, and by these means the whole weight is lifted and lowered, blocks being fitted underneath the engine on the rise and removed on the lowering.

This method has proved most successful and avoided the much larger job of lifting the engines out of the ship.

In one case, part of the after engine room bulkhead was removed, and the whole engine bodily rolled back into the after hold.

With regard to boilers, repairs are continuous and heavy, and one of the difficulties is as a rule the very limited amount of time at the disposal of the repairer, the work generally having to be carried out whilst the ship is discharging and loading cargo, and therefore having one or more of her boilers under steam all the time.

As an instance of the difficulties which boiler repairs present, the case of one vessel may be recalled. It was one that I think reflected the greatest credit on all who were engaged upon it, and especially on the Thames boilermakers who carried out the work. The vessel arrived in London overdue and was sheduled to load in Glasgow on a certain date. She had three boilers, the centre one of which had given out on the homeward voyage and required retubing and two combustion chamber tops renewing. The time available for discharging and dry docking in London was one week. In that time we had the boiler retubed, the two combustion chamber tops cut out and new tops refitted. The ship then left for Glasgow, and we sent with her a squad of twelve boilermakers, who, working continuously in relays of two men at a time, had to drill, rivet and fit stays and dogs, and generally complete the work. The work was carried out at sea with boilers on each side under steam, but so steady were the men that the second day after arrival in Glasgow saw the boiler successfully tested and the job completed. I think this case will illustrate the difficulties of boiler repairs, and shows the standard of workmanship that we may justly claim for Thames engineering.

Recently we had the case of a large liner whose boilers, through war service, had got into a very bad condition. After an exhaustive survey and much consideration it was decided to renew the whole of the boilers—six in number—with the exception of the back plates and circumferential shell. I think this may be taken as the largest boiler repair ever undertaken, but it was successfully carried out and fully justified itself.

I have endeavoured by these few instances of the repairing trade in London to justify our claim to be still considered as an important Marine Engineering Port, where the largest and most intricate jobs can be successfully undertaken, and I trust that I have been successful in the short time at my disposal.

I would suggest to this Institution of Marine Engineers that they could materially assist us in taking some sort of interest or even supervision of the engineering apprentices now at their trade in the Port.

It has been a matter of considerable difficulty for us employers in the past to ensure a proper educational standard for our boys whilst they are going through the shops.

The Education Authorities have gradually grown aware of the necessities of this class of student, but I have always felt that an Institution of this sort might very beneficially interest itself in supervising and examining the rising generation of Marine Engineers, and I respectfully suggest that your Executive take this matter into their serious consideration.

I cannot conclude my address without paying my tribute to the profession of Marine Engineers who throughout the war have shown such splendid examples of self-sacrifice and devotion to duty.

Be they Royal Naval Engineers or members of the Mercantile Marine, they have one and all been subjected to the perils of the war at sea, and one and all have without exception splendidly upheld the tradition of the British race of devotion to duty, even to the sacrifice of life.

Gentlemen, I once again thank you for the honour that you have done me and the Port of London, and trust that we shall ever be found worthily upholding the best traditions of the profession of Marine Engineers.

I shall be only too glad to do anything I can to forward the welfare of the Institute and place my services at the disposal of the members of this Institute.

Mr. J. T. Milton: I know I voice all your feelings when I ask you to join with me in offering a very hearty vote of thanks to our President. I, personally, feel that the Institute is very much honoured by one of the Green family becoming our President, and Captain Green is worthy of all the praise you can give him. He is a prominent man; his time is very much occupied in the country's business, but he has seen fit and thought it right to give up some of his leisure in consenting to act as our President. I think the Marine Engineers of the Thames side will thank him for reminding us of the great work which has been done in the past, what is now being done, and what may be done in the future in the way of reconstructing the vital parts not only of the ships but of their motive power. I was very pleased indeed to listen to the address. I had no idea what subject Captain Green would take as his theme, but I am sure he could not have taken a better one, and it has formed a most valuable and instructive address. Not only has he dealt with the power of dealing with repairing work on the Thames, but he has mentioned the question of the apprentice, and this question is a very vital one for the country generally. It is satisfactory to note that throughout the country employers are now taking a great interest in the training of their young men. I hope that those who succeed us will be better fitted and equipped than we are for carrying on. The training of the young is an exceedingly important matter. If employers want the best results they must have competent workmen thoroughly trained. Enlightened employers are now recognising that they must give the boys in their workshops facilities for study. You cannot expect boys to work from early morning till dusk and then go home and do all their school work afterwards. They must have facilities given them for study in the daytime. I do not know how it can best be done, but I am sure our Council can advise employers on this point. Then there is another thing we have always been anxious to do, and that is to get the intelligent apprentices to join the Institute as graduates. It is a great thing for the young men to become associated with an Institute like our own. They get all our papers to read, which is an education in itself. To encourage apprentices to join the Institute as graduates is a great point, because they thus obtain a great deal of valuable information. Another great point is to encourage them to come to the meetings and hear the discussions taken part in by those who have had more experience than themselves. It is quite as useful and as pleasing to tell lads as it is to detail your experience to men of your own age and standing. So that we ought to do all in our power to encourage the lads to join; besides, a member has more affection for his Institute if he has belonged to it in his youth. The North-East Coast Institution has done well, I think, to have a graduates' section, where papers are read by graduates to graduates. There is nothing which teaches a man so much as to let him attempt to teach somebody else. When he begins to write a paper, he begins to realise how much he has to learn on the subject. We must do all we can to encourage graduates to write papers. We have attempted to do so, as Mr. Adamson will tell you, by encouraging graduates to write essays. But if there were a sufficient number of graduates to make an evening for themselves, one of the members of Council presiding, I think it would be advisable; or let them elect one of their own number to be their President if they prefer. Our President has mentioned that the Council has got this matter in hand. I may also add that we have got excellent technical schools established in London. In the train the other day, coming from Cannon Street, a number of workmen crowded in, and I asked one of them about his work. He told me that his hours were from seven to seven, and that to begin at seven he had to get up at four in order to reach the works, which are near where ships are berthed, whilst he could not arrange to live nearer than Balham. Employers must be prepared to consider some scheme for giving boys time to attend day classes. I do not presume to suggest by what means they should do this; the details must be left for them to settle. Gentlemen, please let the President know how much we appreciate his kindness in serving us as President, and convey to him our thanks for giving us this excellent address.

Mr. W. C. Roberts: I am very pleased to have the privilege of seconding what Mr. Milton has said. I have had a long connection with the Green family, extending over three generations. I believe I am the oldest superintendent engineer in this room to-night, having been for 44 years with the Glen Line of steamers. I frequently had the privilege of meeting our President and dealing with him in a business capacity in the old office, and what was formerly his grandfather's residence in the Poplar Yard.

The Green family name, from our President's grandfather down, has been a household word for their kindness and generosity to all their employees in Poplar, his father also representing the Borough as M.P. for a number of years. I am quite sure the Institute could not have chosen a more suitable President than Captain Green, and I therefore have much pleasure in endorsing all that my friend Mr. Milton has said in his favour and seconding the vote of thanks.

The President: I need not say how very much I appreciate the hearty welcome you have extended to me to-night. Mr. Roberts has been a personal friend of mine for many years, and I certainly remember him as a Superintendent ever since I came into the business; we had no better friend or engineer in London. I do not say that there were never differences, but as long as we got on with our job he was pleasant to meet, and, indeed, I may say of all superintendents that they are a very pleasant body of men to meet; there has been a great feeling of friendship through the whole of the engineering body in London, and it is a great pleasure to me to meet so many of my old friends to-night. After all, it is the old members, like the old roots of a tree going back deep into the ground, which furnish vigour and nourishment to the young branches, from them the rest of the tree grows and flourishes. This Institute is not of very old date, but it has taken firm root and is flourishing and likely to endure as long as the engineering profession endures. I should also like to say that we shipbuilders agree with Mr. Milton's remarks on the schooling of apprentices. We have been ably seconded by Mr. Silley and are all very keen on this subject. I probably appreciate education at its true value more than those who are better educated than myself, for I have had the disadvantage of being educated at a public school! It is an interesting fact that, for many years as a manager, I have been constantly at war with the Educational Authorities. I have been endeavouring now, with the assistance of my two partners, to attain some connection between the technical education of our boys and their work in the workshops. Mr. Fisher's last Education Bill—that Bill which went through the House of Commons a short time ago—is an endeavour to embody all we have been considering for many years past. We have hitherto not met with the support from the educational bodies that we are entitled to, but they are now endeavouring to provide facilities. Of course, as Mr. Milton says, we all know the difficulties of evening study for boys. Some few men contrived to get through it, but we all frankly recognise that the future education of the apprentice must take the form of part time in the schools and part time in the shop. However, both sides are anxious to get over the difficulty, and I think the future education of the apprentice will run very much on the lines of no evening work and, during the day time, part in the school and part in the shops. A few years ago the Board of Education had a standard of examination for these boys, which they constantly varied, and we were stranded on account of having no standard by which we could judge our boys. We felt it was neither useful nor advisable for us to act as an examining body, and we have felt very severely the need for an outside examining body who would take charge of the examination of these boys, and it is on these lines that I am anxious that such a body as this Institute should work. They should supervise the work of the examiners and set the standard. The educational body does not provide a better standard of examination, and I think it would be better if it were done by such a body as this.

The HON. SECRETARY: Mr. Milton has made a comment regarding the Awards Committee, and I may say that the Institute has always been very anxious to help all apprentice engineers in the past, and we are still doing what we can for them. Within the last few months I have been in communication with several quarters with a view to getting graduates enlisted from amongst engineering apprentices. The Institute has always taken a great interest in the careers of the young fellows; our graduate's fee is only 5s. per annum, and I think, after the address of our President, each one of us will do his utmost to help and encourage them. The fee is small for engineering apprentices, and they get a great deal for the money thus expended. We have awards presented year by year for essays sent in by the graduates, the subjects of which are set by the Committee, and to show that we are not exclusive there is an open competition for which all apprentices are eligible. We have had recently another award presented. One of our Companions, now deceased, took a great interest in the Institute, and his brother, realising this, has offered the gift of £200 as a memorial, to be invested in Consols, so that we may have the interest to provide awards as may be considered fitting by the Council. Captain Green has aroused a reminiscence in my mind. I was with Messrs. Dudgeon when the ill-fated *Independencia* refused to enter the water, and have always been interested in the history of Thames shipbuilding, having very early recollections of the days about the date when the *Great Eastern* was built. With regard to the Education question, our December issue of Transactions dealt largely with the subject. The reports and notes were printed in our Transactions so that members who had not the opportunity of reading these previously might have the subject before them for consideration, and we shall be glad to have their views on the question, and also we hope that all will do their utmost to help to bring our engineering apprentices up to the highest possible standard so that the future generation may be an advance on the present. Our meetings here are held with this object in view. Our last paper shows that some of our members, although deeply engaged in serving the country at the peril of their lives, have tried to help one another; many have shown the unselfish spirit by their actions. I hope that the result of this meeting and address will induce us to double our energies to advance the interests of the Institute. I may add that in our premises at Stratford in the early days before the evening classes were instituted we had voluntary classes for the juniors, until the West Ham Technical College opened, and we encouraged them to attend the classes there as soon as the College was able to take them over. We also kept on a drawing class for a short time after this to help young engineers. Technical schools have now multiplied and grown, and there are many engineers connected with these schools who do their utmost to help the young fellows, so that there is not the same necessity for classes conducted on the voluntary basis. We had also evenings set apart for the junior section arranged by a committee, on which were graduates and associates. On these evenings, papers were read and lectures given, with a view to promote study and educational advancement.

COMPETITION PRIZE ESSAY.

Refrigeration.

By ARTIFICER (MR. ALEX. J. WALKER, Graduate).

IN the present national crisis when the supply of foodstuffs from our Colonies and elsewhere is of the greatest importance, their preservation, especially when of a perishable nature, is a matter which calls for the exercise of the greatest care and consideration, and furnishes yet one more example of the practical services rendered to the Empire by Marine Engineers. Broadly speaking, refrigeration, the method of preservation, may be classified under two heads—(1) that in which a liquid is employed during the evaporation of which a considerable amount of latent heat is absorbed from the liquid, in this case brine, which is to be pumped through the system; and (2) that in which air is the cooling agent, the air being compressed and cooled in the process is allowed to do mechanical work, in doing which it expands and gives up heat.

Dealing with the first system the liquids usually employed are anhydrous ammonia (NH_3) and carbonic anhydride (CO_2). The former has found great favour as a refrigerating medium on account of its high latent heat of evaporation and the comparatively low pressure at which it can be liquified. The process of refrigeration may be explained simply thus: NH_3 is a gas which, under pressure and cooling by water, is easily condensed to a liquid form, if the pressure is relieved from the liquid ammonia it will quickly revapourise, producing as it does intense cold. An ammonia refrigerating machine consists of an evaporator or refrigerator in which the ammonia is allowed to vapourise, producing a low temperature, and surrounded by air or brine which act as the cooling mediums in the holds. Also a compressor which draws the ammonia gas from the refrigerator and compresses it into the condenser, where it is converted to its liquid form ready for vapourisation in the refrigerator. Ammonia in vapourising under low pressure in the refrigerator changing its form from liquid to gas must absorb the latent heat of vapourisation. This is taken from the brine surrounding the coils, or in the case of direct expansion from the air itself, and in condensing again to liquid form this heat is given up to the cooling water. The pressure necessary to condensation is automatically regulated by the temperature of the condensing water, and will vary from 100-

200 lbs. sq. in. The pressure in the refrigerator is controlled by a regulating valve, which is adjusted according to the temperature required, varying from 70 lbs. sq. in. absolute for a vapourising temperature of 40° F., to 20 lbs. sq. in. absolute for a vapourising temperature of 15° F., or higher or lower as required.

A sketch is given of a typical ammonia refrigerator plant, showing the connections and cycle of operations. The ammonia compressor is steam driven and is of the horizontal double acting type. For convenience and saving of space, the box bed on which the engine and compressor are mounted contains the condenser, which consists of a series of wrought iron coils in which the ammonia is condensed, the water circulating round the outside of the tubes. After passing through the refrigerator the ammonia is drawn back to the pump, to be compressed and discharged at the higher pressure into the ammonia condenser for recondensation. The ammonia circuit is complete and there is no loss whatever of ammonia, which goes through the cycle of vapourisation, compression and condensation time after time. The condensing water is drawn from the sea by a separate auxiliary pump, passes through the condenser and is discharged overboard. The cold brine is drawn from the refrigerator by the brine pump and discharged to the distributing headers, whence in several independent circuits it passes through a series of pipes in the cold chambers before coming back to the return headers. Both distributing and return headers are fitted with controlling valves so that each brine circuit may be regulated as desired. The temperatures may be regulated by allowing more or less brine to pass through the pipes; this temperature should be about 8° less than the temperature required in the holds, while the difference between the outgoing and returning brine should be about 3—5° F.

A small brine tank is fitted for mixing the brine, and is connected as shown to allow the introduction of fresh brine to make good loss by leakage, etc. In mixing this brine it is important that only calcium chloride and fresh water are used, as this salt, besides being much more intense in its action, has not the same injurious effects as sea water or common salt, which tend to set up corrosion in the brine pipes and brine pumps. The density of the brine should be about 1·25. The method of cooling the cold chambers is either by the brine pipes as described or by blowing air by means of fans over nests of coils in which the liquified ammonia is evaporated, the cooled and dried air is then distributed through the chambers by means of wooden ducts or trunks.

A sketch is given of a (Haslam's) double acting ammonia compressor. It is fitted with suction and delivery valves in the end covers, which are made concave to give room for the valves. The piston is turned an accurate fit for the covers so that the clearance is reduced to a minimum. The special form of gland with two separate packings allows of either gland being adjusted independently of the other; the annular space between the packings is kept full of oil. It is important that gland leakage on the compressor rod be reduced to a minimum, and to overcome this several expedients are resorted to. In the case of Hall's CO_2 machine, the gland is made gas tight by means of two cupped leathers on the compressor rod. A special lubricating oil is forced into the space between the leathers at a higher pressure than that in the compressor, so that whatever leakage occurs at the gland is a leakage of oil either into the compressor or to the atmosphere. This leakage of oil into the compressor is usually very small and is in itself advantageous in lubricating the cylinder. In order to make good any leakage of this oil a small hand hydraulic pump is fitted, a few strokes of which will be required, as may be indicated by the pressure lubricator piston rod. Any excess of oil which gains admittance to the compressor cylinder is carried over with the gas through an oil separator; here the oil falls to the bottom of the chamber and is drawn off from time to time.

The general principle of the ammonia system also applies to CO_2, but it differs in detail as the pressures and temperatures obtained vary, owing to the chemical nature of the gasses. The fundamental difference, however, is between what is known as the "critical" points—by this is meant the temperature above which the gas will not liquify, no matter what the pressure is. The critical temperature of CO_2 is only 88° F., at which temperature the pressure necessary to liquify is 1,050 lbs. sq. in.; the critical temperature of ammonia is 266° F., and the corresponding pressure is 1,624 lbs. sq. in. It is mainly due to this fact that the critical temperature of CO_2 is so low that it is considered to be less useful than ammonia for refrigerating purposes under tropical conditions, when the available cooling water may be as high as 86° F. At this temperature ammonia will readily liquify at a pressure of about 170 lbs. sq. in. It is for this reason that the ammonia cooling system finds favour in the Royal Navy, where the magazine cooling plant is an important item, especially in warm climates. In this case the plant is placed as near the upper deck as possible, so that in the event of a shell-burst or other explosion the ammonia fumes can more readily escape to the open air. The latent heat of vapourisation of CO_2 varies considerably with temperature and pressure; the higher the temperature the lower the latent heat, varying from about 135 B.Th.U.'s at 10° F. to about 27 B.Th.U.'s at 86° F., the latent heat of ammonia varies from about 595 B.Th.U.'s at 10° F. to 492 B.Th.U.'s at 86° F. While this certainly favours the adoption of the NH_3 system, it is counterbalanced by the fact that, weight for weight of liquid, the CO_2 is much superior, as 1 cubic foot of the latter weighs 2·75 lbs., while the same amount of NH_3 weighs only ·1107 lbs.; and, as its relative volume is greater, the CO_2 system allows a smaller compressor to be used for the same amount of work. In discussing the advantages and disadvantages of the systems the remainder may be briefly summarised thus. In the event of a leakage with CO_2, the effect while unpleasant is not dangerous except in the case of a very large quantity of gas, whilst ammonia gas being very poisonous would speedily render the compartment untenable, CO_2, however, is inodorous and not easily detected. As regards ammonia, besides the advantage of being easily liquified under tropical conditions, leaks can easily be detected, but if they occur in the air-cooling room, when using direct expansion, the cargo is liable to become tainted. Another drawback to the use of ammonia is that the gas having a great affinity for copper, this metal or any of its alloys cannot be used in the construction of any part of the machine where it comes in contact with the gas.

The compressed air system.—One of the simplest forms of refrigerating machine is that commonly known as the dry-air machine, which works by the compression, cooling and expansion of atmospheric air. These machines have found some favour for use on shipboard, owing to the low temperature which can be obtained, the dryness of the cooled air, the low pressure at which they work, and the absence of any chemical, the working medium, air, being always available. The chief disadvantage as compared with chemical machines is that no use can be made of the latent heat of the refrigerating medium; therefore, a much larger quantity has to be dealt with, necessitating larger compressors and increased power to drive them. An illustration of a compressed air machine is shown.

The air compressor is driven by any independent means, and the suction pipe, being connected to the cold chamber, draws in the warmest air from the top of the room. This air is compressed to about 50 lbs. sq. in., thus increasing the temperature to about 280° F., and is then discharged to the air cooler, consisting of a number of tubes surrounded by water, which is circulated by a separate pump. Here the air is cooled down to a few degrees above the circulating water temperature and delivered to the air expander, where it is allowed to expand behind the piston doing mechanical work by assisting to drive the air compressor. The expanding air thus gives up heat in the form of work and is thereby cooled, being reduced in temperature to about 90° F.; the air is then delivered into the cold chamber at one side near the top and, circulating through the room to the return tank, is drawn again to the compressor, the cycle thus being complete. In most cases drying pipes are fitted, their function being to dry the compressed air before it is expanded. This is done by passing it through tubes round which is circulated the returning air from the cold rooms. By this means the compressed air is cooled and any moisture is deposited in the "dryer" and discharged through cocks or valves at the bottom.

Another factor which requires careful attention is the insulation of the various cargo holds, for should it become defective at any part the efficiency of the refrigerator is greatly reduced.

Refrigeration on shipboard is a subject full of interest and one which calls for the display of some ingenuity on the part of the engineer in charge; but it is one with which an essay such as this cannot be expected to deal exhaustively, more especially on this occasion, as the exigencies of the Service will not permit of it.

"ARTIFICER."

Messrs. the Lightfoot Refrigeration Co. call attention to the remark by the essayist that in Messrs. Hall's CO_2 machine the gland is made gas-tight by means of two cupped leathers on the compressor rod, and that a special small hand hydraulic pump is fitted for pumping oil under pressure into the gland. The great feature of the Lightfoot Carbonic Acid Compression Machines is that cupped leathers are entirely done away with, both the compressor piston and compressor gland being fitted with metallic packing, which automatically takes up whatever slight wear there is in actual working. No special oil pump is required for the gland, but only the ordinary sight drop lubricator, as *the oil seal round the rod is not under pressure.*

The use of cupped leathers prevents the Carbonic Acid Machine being worked to the best efficiency under high temperature conditions, as, owing to the fact that to obtain the best working conditions with high temperature cooling water it is essential that the delivery pipe temperature should be at 180 degrees Fahr. or higher, depending on the working conditions, the cupped leathers are likely to get charred or damaged, which is not the case with one of our compressors working with metallic packing, where we have worked satisfactorily with temperatures as high as 230 degrees on the delivery pipe.

———o———

Figures A B and C are from blocks kindly lent by the Lightfoot Refrigeration Co.

A—Illustrates the principle of refrigeration, being a diagrammatical arrangement of the Lightfoot Refrigerating System.

B—Illustration of Lightfoot Steam-driven Carbonic Acid Machine, as supplied to the British Admiralty for magazine cooling on warships.

C—Steam-driven Marine type Lightfoot Ammonia Compression Machine, as supplied to the large meat vessels for the transport of frozen meat.

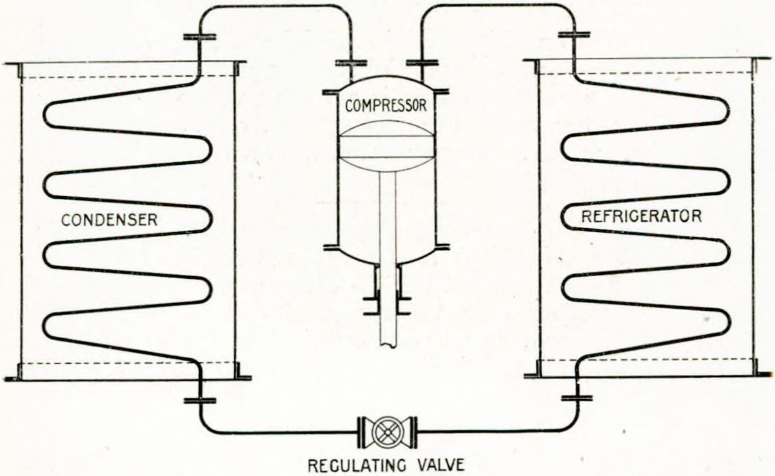


Fig. A.

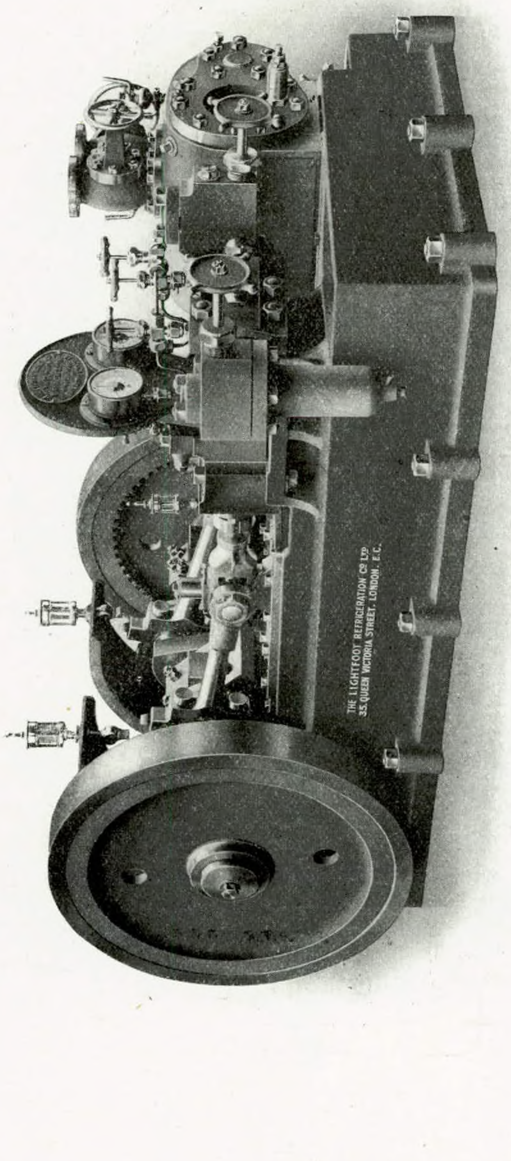

THE LIGHTFOOT REFRIGERATION Co LTD
35, QUEEN VICTORIA STREET, LONDON, E.C.

Fig. B.

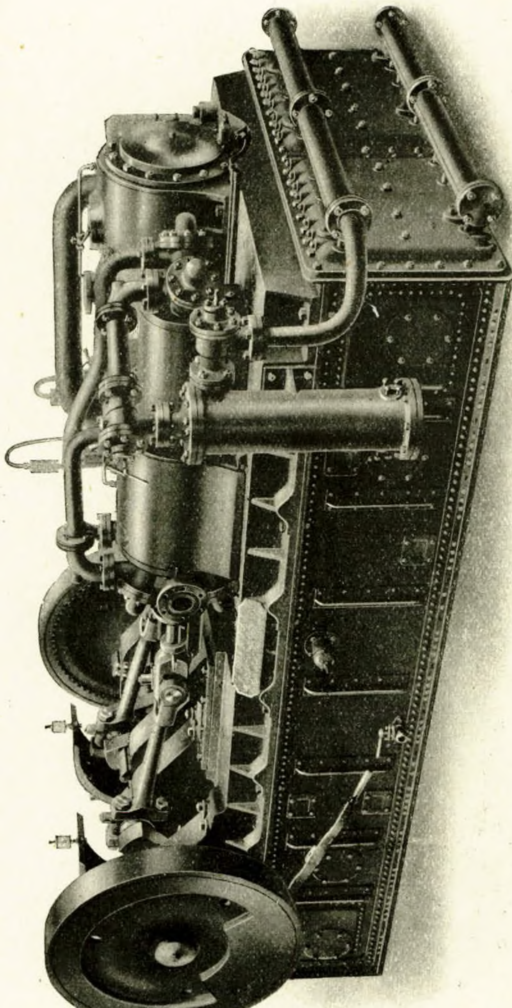
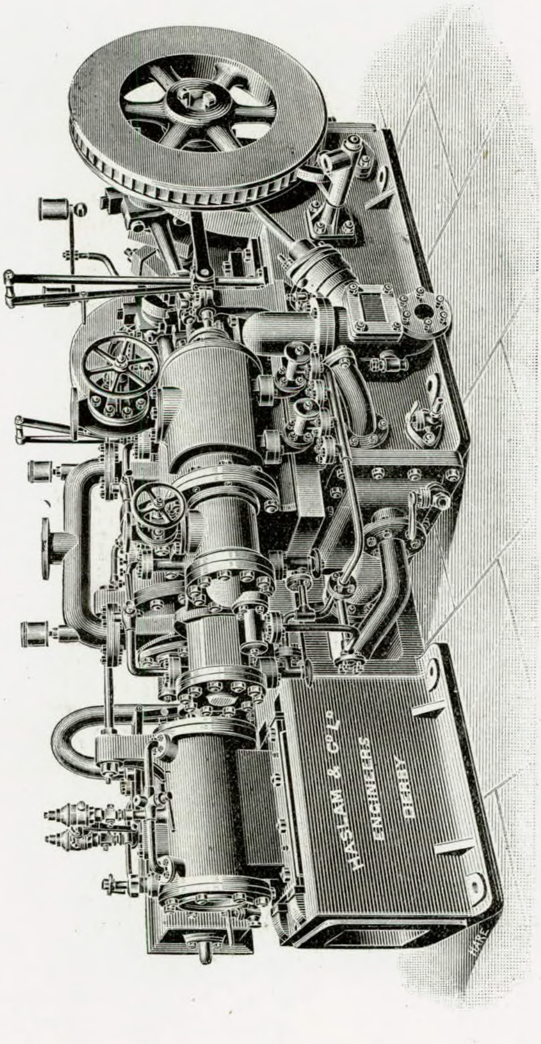
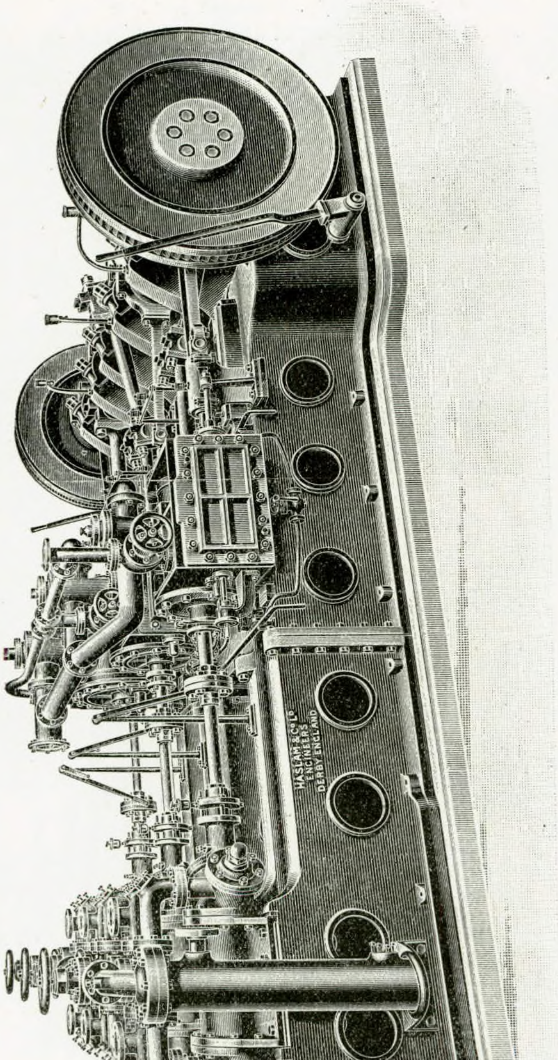
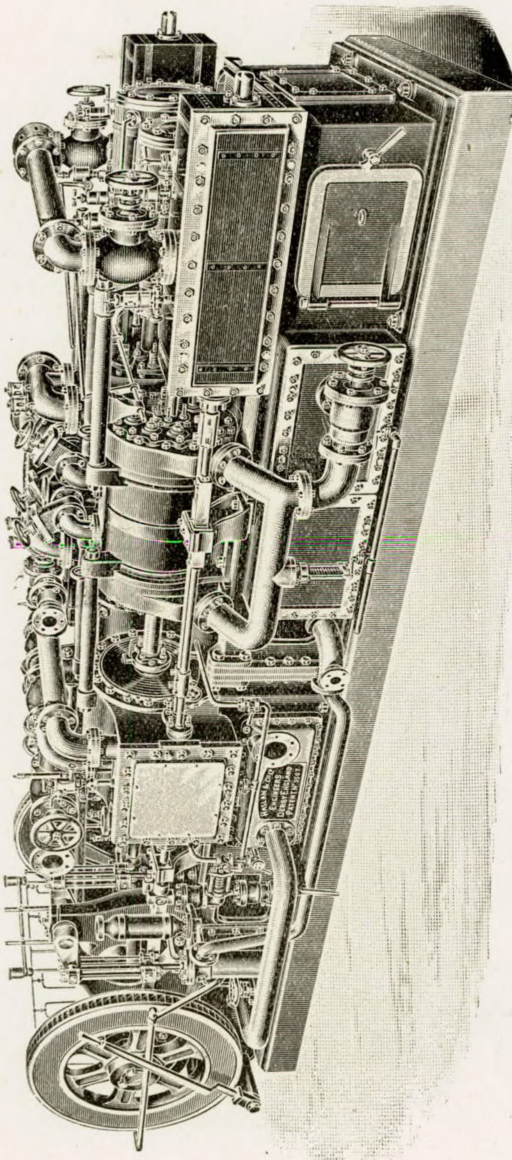


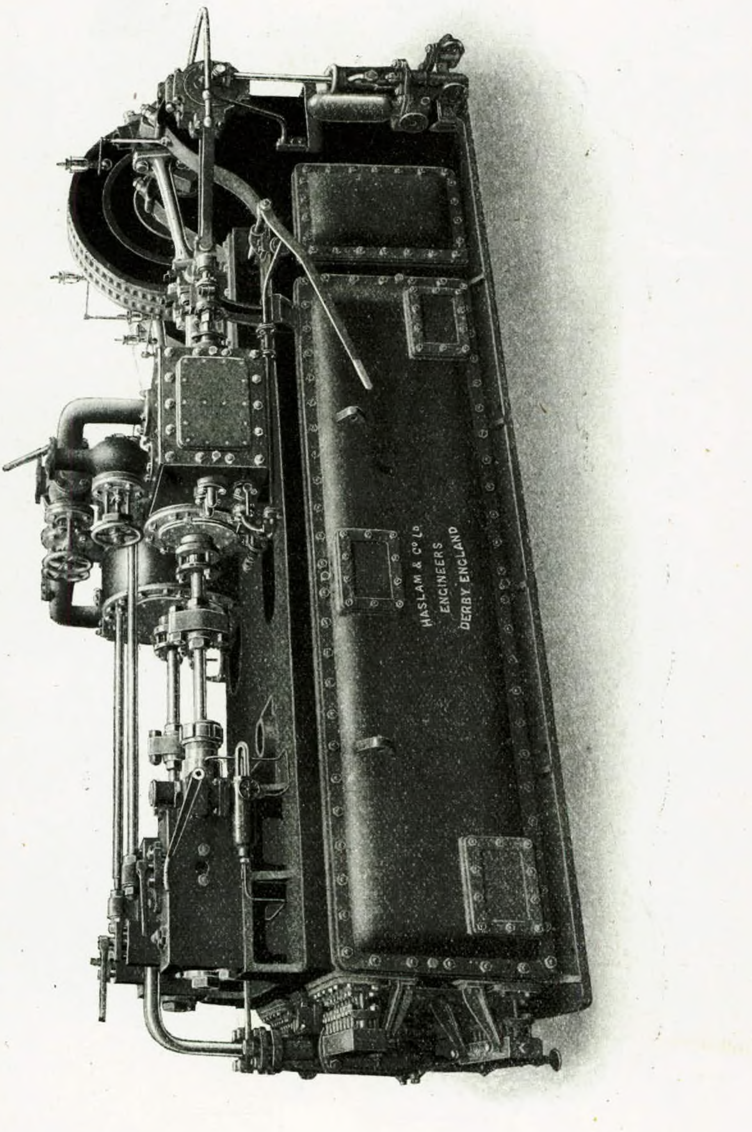
Fig. C.

We are indebted to Messrs. Haslam for the loan of the following blocks to illustrate types of their machines:—




HASLAM & Co Ld
ENGINEERS
DERBY ENGLAND

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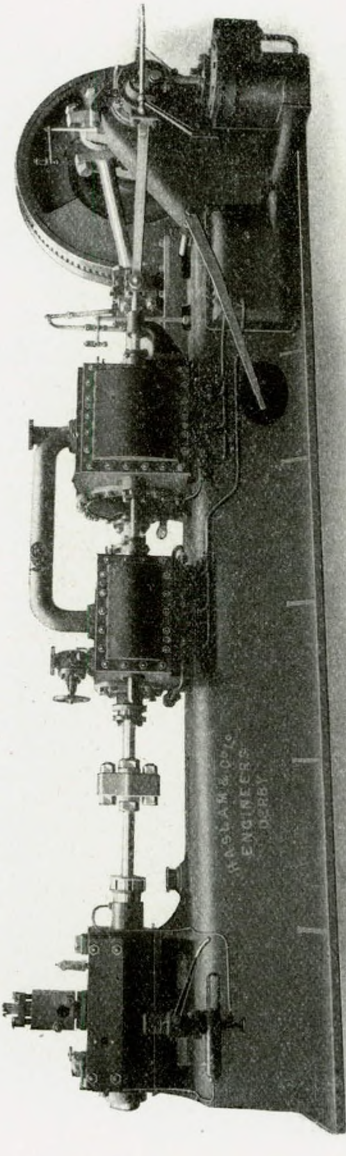
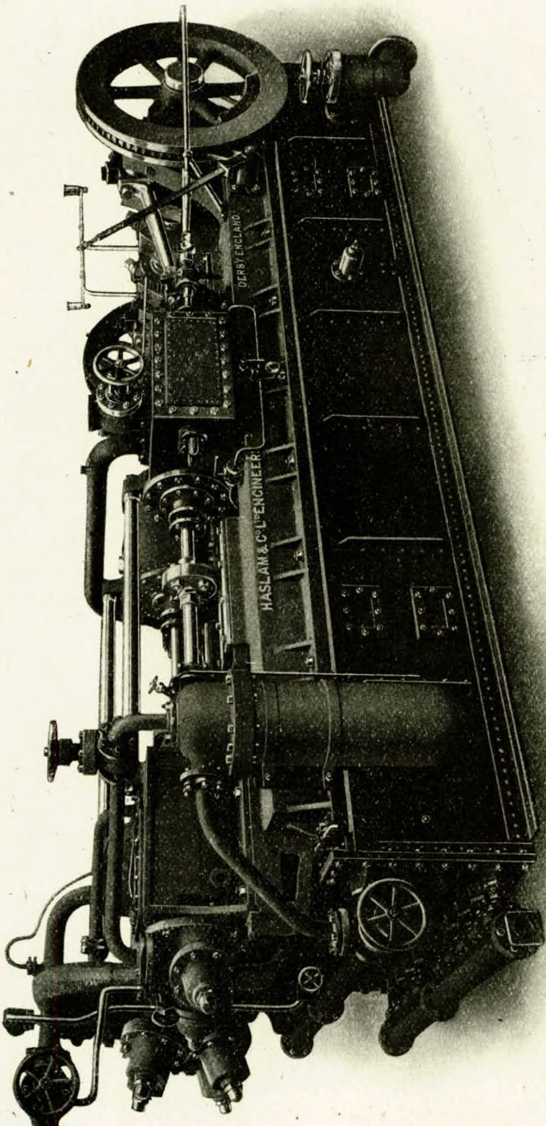

ENGINEERS
DERBY


DERBY ENGLAND
HASLAM & C° LTD ENGINEER

We are indebted to Messrs. J. and E. Hall for the following comments regarding a special detail referred to in the essay and for the illustrations of their Refrigerating Machines:—

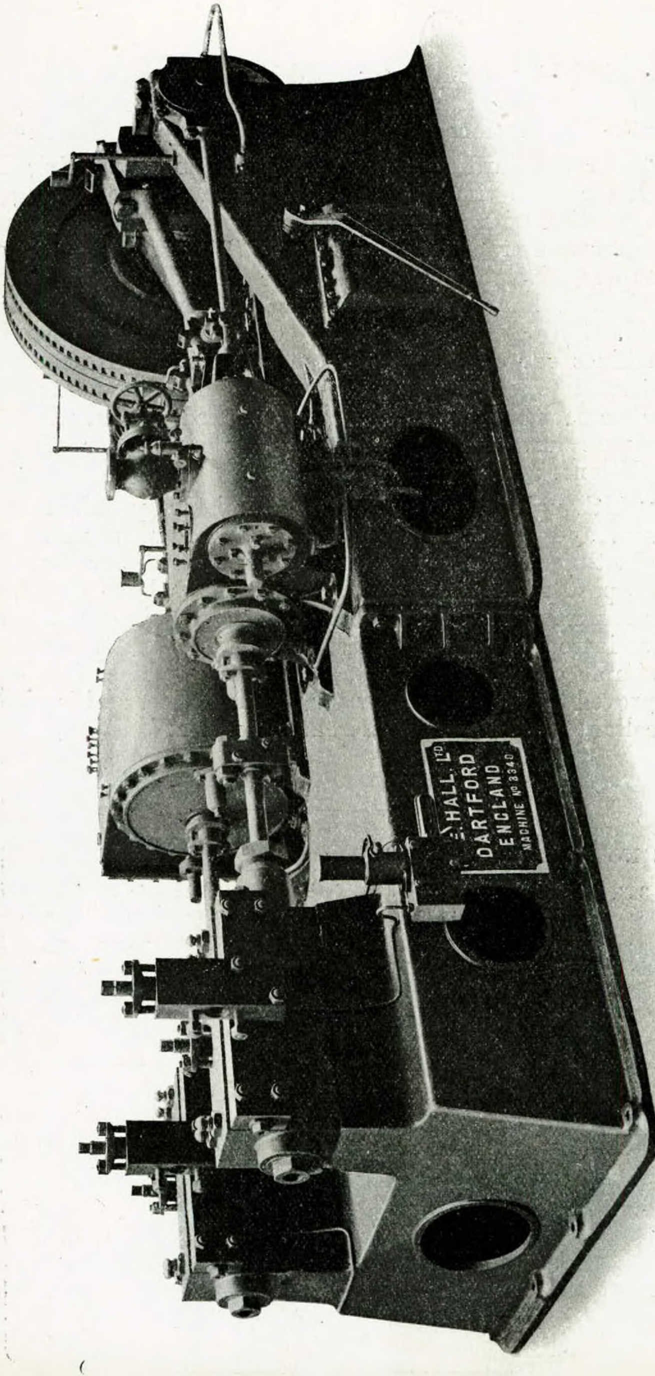
"Our standard type of compressor gland packing has been for some time past our patent metallic packing in conjunction with which a pressure lubricator pump is used. For marine practice we consider a pressure lubricator pump is advisable, not only for oil sealing the gland efficiently, but also for ensuring a perfect lubrication inside the compressors. In our latest marine type machines our compressor pistons are fitted with metallic piston rings, except in those cases where customers prefer leather packed pistons and leather packed glands, which in the past have proved very satisfactory under tropical conditions.

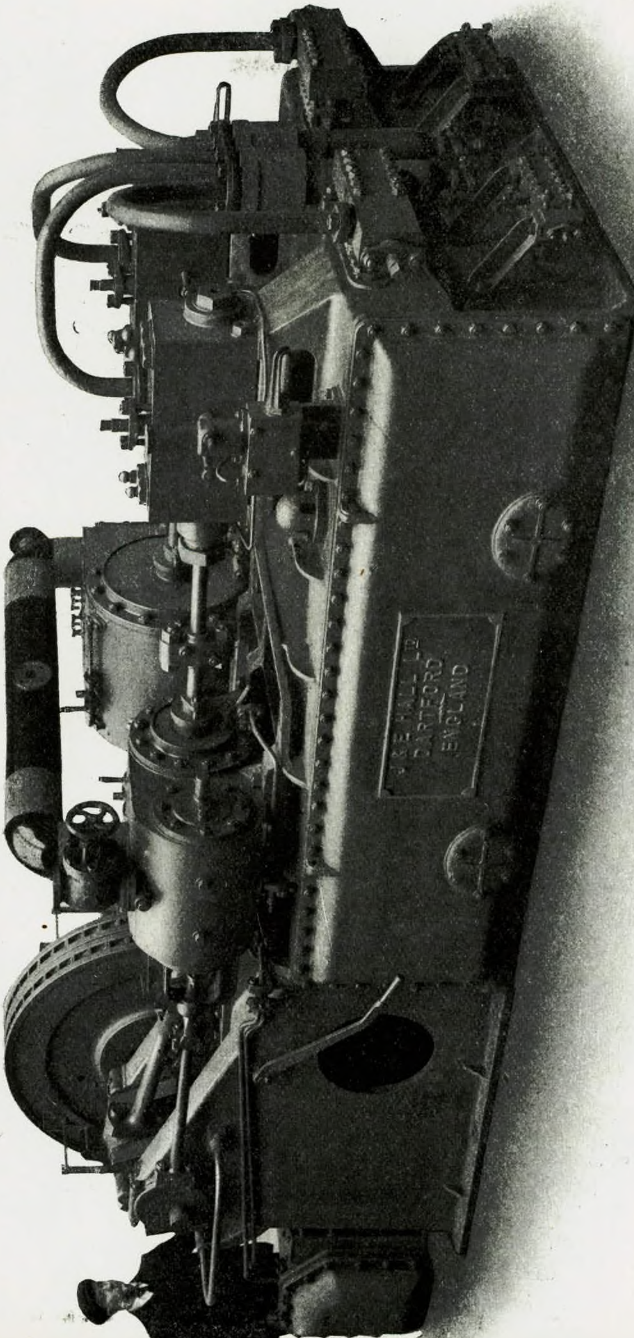
"Although leather gland and piston packings have given, and continue to give, excellent results and the highest efficiency in our CO_2 machines, we have for some time past recognised that such packings have disadvantages, particularly in these days of leather shortage. We have introduced and made standard for all CO_2 machines a simple and efficient metallic packing which has been approved by the Admiralty for naval service, and is giving excellent results in the merchant service."

PLEASE NOTE:—

Page 363, line 17.—This does not imply that more ammonia machines are in use for Marine Service than other types, the contrary is the case.—J.A.

Page 365, line 13.—This does not apply to the present standard Marine type of the Hall machine, which is fitted with metallic packing and a pressure lubricating pump.—J.A.


HALL, LTD
DARTFORD
ENGLAND
MACHINE No 3340


J & E HALL LTD
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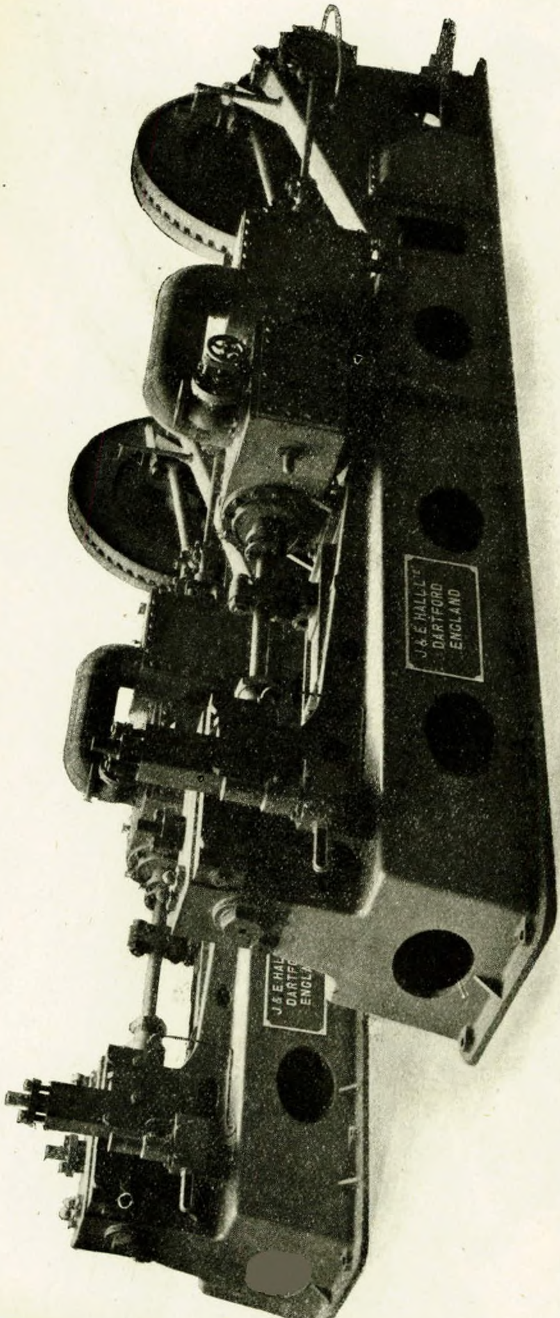
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Notes.

AWAKENING RECOGNITION OF THE ENGINEER.—In *The Canadian Engineer* of November 22nd, 1917, is reported an address on this subject, delivered by Mr. D. S. Keith before the Ottawa Branch of the Canadian Society of Civil Engineers. In the course of the address emphasis was made that "the awakening of the engineering profession involves, in the first instance, the increased recognition of the profession's responsibility to the individual, and the individual's responsibility to the profession; and, in the second place, their collective responsibility to the public, and in turn an acknowledgment from the public of the engineer's real place in national affairs, which includes status, remuneration and opportunity of service."

ENGINEERING GRADUATES AND INDUSTRIAL DEMANDS.—In the same journal a paper is reprinted on this subject from the Bulletin of the Society for the Promotion of Engineering Education, University of Oklahoma, by Associate Professor L. W. M. Morrow. Three heads were elaborated:—1. The era of the designer and inventor. 2. The era of the operator and constructor. 3. The era of the specialist and executive.

"CORROSION IN MARINE BOILERS."—In the discussion on this subject—p. 329, Mr. A. J. McLeod's contribution—the following errors occur in printing: "porous" for "ferrous"; "aquarius" for "aqueous," and p. 330 "fluorform" for "fluorine," "de-aciate" for "de-ærate."

Distinctions have been awarded to the following, whose names are on our Membership Roll:—

NAME.	DISTINCTIONS.
Allen, Richard W. (Vice-President) ..	K.B.E.
Boyle, A. H., Engr. Lieut. R.N. (Member) ..	D.S.C.
Brown, Jas. (Member)	C.B.E.
Carter, George I. (Member)	K.B.E.
Devitt, Thos. L. (Past President)	K.C.B.
Evans, Daniel, Major A. E. (Member) ..	D.S.O.
Gibson, J. Hamilton (Member)	O.B.E,
Green, E. W. (Member)	O.B.E.
Hunter, Summers (Past President)	C.B.E.
Mann, John, Engr. Com. R.N.R. (Member)	D.S.O.
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Richmond, J. R (Member)	C.B.E.
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Seabrook, J. A., Engr. Lieut. R.N. (Member)	Chevalier O.C.I. (Italy).
Silley, J. H. (Member of Council)	O.B.E.
Weir, Wm. (Vice-President)	K.C.B.

Election of Members.

Applications were received up till the end of January from the following, who have now been elected :—

As Members.

Henry E. Atkinson, 101, Guildford Street, Grimsby.
John Austin, 14, Adelaide Terrace, Waterloo, Liverpool.
Henry E. Crewe, Southfell Road, Douglas, Isle of Man.
Arthur K. Hill, 2, Northland Drive, Scotstoun, Glasgow.
Thomas C. McKay, 261, Knowsley Road, Bootle, Liverpool.
Arthur W. Oxford, c/o Cammell Laird & Co., Ltd., H.M. Dockyard, Devonport.
Walter E. Pride, 5, Lisherland Park, Lisherland, Liverpool.
Robert Rae, 35, Melbourne Road, Ilford, E.
George H. Reed, 25, Chalsey Road, Brockley, S.E.
John K. C. Stevenson, 21, McLellan Street, Mount Florida, Glasgow.
Andrew S. Yule, 55, Dalmorton Road, New Brighton, Cheshire.

Associate Members.

Thomas S. Leyland, 39, Brookfield Street, Earlstown, Lancs.
Stanley Wood, 150, Waterloo Street, Bolton, Lancs.

Graduates.

Walter Catley, 33, Gerrish Avenue, Whitehall, Bristol.
Albert H. Gardner, 5, Gerrish Avenue, Whitehall, Bristol.
Charles C. Suffield, 51, Arragon Gardens, Streatham, S.W.
Wm. E. G. Williams, 45, Dashwood Road, Battersea, S.W.

Transfer from Associate-Member to Member.

Charles Baxter, Cleveland House, Bradford Road, Shipley, Yorks.

Transfer from Graduate to Member.

E. B. Blake, H.M.S. *Shannon*, G.P.O., London.

Transfer from Graduate to Associate.

C. McVey, Carn-nilhan, Blythswood Road, Renfrew.
Alan J. Walker, 11, Great George Street, Glasgow.