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President: JAS KNOTT, ESQ., J.P.

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OF

SUMMER VISITS TO WORKS, ETC

ON

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INSTITUTE OF MARINE ENGINEERS

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SESSION 1907-8

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Visit to the Works of Messrs. David Kirkaldy & Son, Southwark

Saturday, April 20, 1907.

THE Institute paid a visit to the Testing Works of Messrs. David Kirkaldy & Son, Southwark Street, S.E., on Saturday afternoon, April 20. The firm was founded by Mr. David Kirkaldy in 1866, and the present building was erected in 1873, being specially designed to suit the operations to be carried on within. Before commencing the inspection of the works, one section of the party under the guidance of Mr. W. G. Kirkaldy, and the other conducted by Mr. A. J. Nash, the visitors passed into the private office, where great interest was shown in the coloured drawing of the ss. *Persia*, which was hung in the Exhibition of the Royal Academy in 1861,—the first and only engineering drawing admitted to that Institution as a work of genius and art. This was executed during his spare time by the founder of the firm, and the beautiful finish, delicate shading and minuteness of detail is a standing evidence of the mathematical exactness which characterized David Kirkaldy's work. Passing into the main testing room, a

spacious room on the ground floor, the object first commanding attention is the great hydraulic testing machine designed by David Kirkaldy, which plays a very important part in the work of the firm. It has a capacity of 270 tons, and, by the arrangement of various apparatus, its scope embraces a large number of different tests, including pulling or tensile, thrusting, bending or transverse, twisting or torsional, elastic stress, shearing and bulging tests. A piece of mild steel about 18″ × 2″ × ½″ was inserted, and the machine set in motion, the strain being communicated by a series of levers to a small machine at one side and recorded on a vernier scale, which in this case registered 70,000 lb. per square inch, when the steel broke. A wire-testing machine, necessarily very much smaller, was then set in operation, with a piece of ·072 binding wire in test, the indicator recording on a semi-circular scale a breaking strain of 795 lbs. Some neat little pats of cement, which had been immersed in water for twenty-eight days, were subjected to a tensile test in the cement-testing machine. One of them was inserted so as to be firmly clutched top and bottom by two arms of the machine, and after the machine was balanced, lead shot was gradually run into a tin on the opposite side, causing the upper arm to pull until the cement gave way. The manometer, a delicate instrument to measure the hardness of various metals, was now shown at work, the operation itself being apparently a very simple one, somewhat similar to that of a punching machine, a projection on the upper part of the machine causing a cup-shaped impression in the metal, the hardness of the latter being gauged by the depth of the impression.

On the first floor are situated various machine tools, lathes, planing, shaping, slotting and drilling machines, fitters' benches, with complete stocks of tools and standard gauges for the accurate preparation of such specimens as require it previous to their being tested. Great precision is aimed at and obtained, and the method and care with which specimens are prepared has gained its name for the establishment. A small impact testing machine is situated in this room. Here also was seen in course of preparation the gearing of a motor-car, which had evidently been in difficulties, and reminders of more serious breakdowns were pointed out in the museums on the second and third floors ; part of a column of the Tay Bridge which gave way in the disaster of 1880, showing the variation in thickness of the metal,

one side being extremely thin ; a broken girder from the stand of the football club at Ibrox, which broke down some six or seven years ago, and one of the stays of the roof which collapsed at the Charing Cross Railway Station in more recent days.

Many other exhibits had an interesting history. The section of a bar was shown composed of cast iron, chemically treated, the secret of which the inventor tried to dispose of for a large sum. He called at Messrs. Kirkaldy's with a prospective purchaser, and the bar easily withstood the strain which the inventor claimed it would stand. A breaking strain was insisted on by the firm, however, which revealed a steel bar embedded in the centre of the " chemically treated " cast-iron bar. A pillar consisting of four cast-iron bars, interlaced with steel laths, was pointed out as a hoped-for combination of lightness and great strength ; but although the lightness was unquestioned, the result of Messrs. Kirkaldy's work crushed the hopes for the other necessary quality. Interesting also were the steel links from the Hammersmith and Albert Bridges, experimented upon to ascertain the resistance under a gradually increasing pulling strain, and the cases containing assorted specimens of the different varieties and qualities of steel and iron castings, results of tests, collected during many years, showing in a practical form the developments and gradual improvements from the earlier years to the close-grained castings of to-day. The greatly altered and sometimes fantastic shapes assumed by the metals after undergoing a twisting or crushing test, here exhibited, seemed very curious when compared with the piece of metal beside them, showing a similar piece before testing. Portions of brick piers, large cables, tested for the Board of Trade, pieces of boilers, girders, etc., and massive ferro-concrete blocks bore witness to the size of work undertaken by the firm. The museum also revealed the variety of materials tested by Messrs. Kirkaldy : specimens of axles, rails, tyres, marine shafts, locomotive wheels, every description of steel, iron, brass, bronze, lead, and other metals, wood of various kinds, stone, leather, drain pipes, wire ropes, nothing seems to have escaped their " dissecting knife." Descending again, past the record office and the laboratory used for private tests situated on the first floor, the visitors arrived at the basement and inspected the chain-proving machine, worked direct from the hydraulic main, with a capacity of testing up to 20 tons. The hydraulic

drain-pipe bursting apparatus is also situated in this room, and a small needle machine for testing the "setting" of cement. The explanation of the working of these machines brought the visit to a close. A very enjoyable afternoon was spent, and the courtesy of Mr. Kirkaldy and Mr. Nash, and their readiness to explain and impart useful information, was much appreciated. After individually expressing their thanks the visitors left about 6 o'clock.

Visit to the Works of Messrs. Vickers, Sons, & Maxim Ltd., Erith

Saturday, June 1, 1907

On Saturday afternoon, June 1, the Institute paid a visit to the Erith works of Messrs. Vickers, Sons, and Maxim. The thunderstorm which broke over the district while the party was *en route* arrived too late to affect the attendance, and certainly did not detract from the interest of the visit, as the whole of the afternoon was spent under cover, the warring elements outside rather adding suggestiveness to the implements of war within. The ordnance works of this great undertaking have an area of nearly twenty acres, with a main gun factory covering over fifteen acres devoted entirely to the manufacture of quick-firing guns for naval and land service, and extensive additions laid down of late years, the whole of the works when in full swing giving employment to about 5,500 workpeople.

The first building inspected was the main machine room, an imposing workshop 440 ft. long, divided into twenty-nine bays. Walking down one bay after another, portions of the guns were seen in the machines in various stages of construction, the jobs gradually increasing in size from the delicate telescope sights of the 3 pounder to the huge pedestals and shields for the 6 inch and 7·5 inch. the automatic lathes, drilling, milling, and other machines being nearly all specially designed for the production of these quick-firing guns. It may be remarked that this is the only factory in the country where the sights for the big naval guns are manufactured. In this, and in the new shop, perhaps even more elaborately fitted, which was afterwards inspected, much time was spent in examining some of the machines, more especially the Bate-

man's high speed planing machine, the vertical boring mills, and the high speed automatic turning machines. The rifling machines for the big guns also claimed special attention, as did the frame in which the jackets are shrunk on to the barrels, which process was the subject of an explanation. Passing the smiths' shop, with its rows of forges now black and cold, the inspection room was next visited. In the manufacture of a gun with a range of 9,500 yards the minutest error of workmanship would have, of course, disastrous results, and it may be well believed that no risks will be run of turning out work the least shade out of truth, but surely the highest point of the mechanic's skill is reached when the work is turned out true to one ten-thousandth part of an inch, the test to which it is subjected in this room before being passed. Here, as indeed throughout the works, one is impressed with the order and extreme cleanliness prevailing. In the gallery around the inspection room are stored piles of shell carriers, tampions, and other accessories.

The next room visited revealed to a large extent the scope of the firm's work, containing as it did a specimen of each variety of gun manufactured by them, from the 3-barrel and 5-barrel Nordenfelts, deadly-looking instruments, but now very little used, to the latest types made by the firm. The quick-firing guns turned out by Messrs. Vickers, Sons, and Maxim include naval, field, and mountain guns, Howitzers and Maxims. Particulars of some of these guns form interesting reading.

The 7·5 inch fires shots of 200 lb. weight at the rate of eight rounds per minute, which penetrate at $2\frac{3}{4}$ miles range modern armour seven inches in thickness.

The 6 inch fires 100 lb. projectiles penetrating $4\frac{3}{4}$ inch armour at $2\frac{3}{4}$ miles range at the rate of 10 rounds per min.

The 5 inch field gun is 35 calibres in length, but weighs only $35\frac{1}{2}$ cwt. It develops with its 60-lb. shell a velocity of 2,050 ft. per second, sufficient to give it an effective range of nearly 5 miles. The gun is mounted so that it can be trained through an arc of 7 deg. and can be elevated 16 deg. and depressed 6 deg.

The 4·5 inch howitzer fires a 40-lb. projectile at a velocity of 1,045 ft. per second and can be elevated to an angle of 50 deg.

The 12-pounder attains a muzzle velocity of 3,000 ft. per second and an energy of 780 ft. tons, giving it an effective range of over $5\frac{1}{4}$ miles.

*

The Vickers 75 mm. mountain gun fires seven rounds per minute, and is effective at $2\frac{1}{4}$ miles range. The process of taking the gun to pieces and mounting it on the backs of mules occupies less than one minute.

The Maxim field gun of rifle calibre fires from 550 to 600 rounds per minute. This equipment is also arranged so that it may be taken to pieces and loaded on two mules.

The famous " Pom-pom " which did so much service in South Africa weighs only 432 lb. and fires a 1 lb. shot with a velocity which makes it effective at over 3 miles range. It is specially suitable for mountain warfare, being manufactured so that it may be separated in parts to form, with ammunition, loads for 6 mules.

Other guns are made to fire 6 lb., 14 lb. and 18 lb. projectiles at rates of 20 to 30 per minute with velocities up to 2,500 and 2,800 ft. per second.

After leaving this battery, silent but full of potentialities, the Instruction Room was inspected, and the party treated to a practical lesson in the art of firing a maxim, with the various operations demonstrated. Here officers and others are instructed in the use of the gun, models of the larger sizes being used for that purpose. The greatest interest was manifested in the mechanism of the breech lock, also in the rows of polished and burnished shells, shrapnel and case shot, samples of every grade and weight manufactured in the works, some complete, others cut in sections, showing the inside arrangements. Particular interest was shown in the section of shell fitted with a time fuse, and also arranged to burst upon impact—a remarkably ingenious contrivance.

Electrical power is used throughout for driving the machinery, the power house, with its four great British Thomson-Houston multipolar generators of 255 volts and 700 ampères each, with a speed of 360 revolutions, supplying the main machine-rooms and the older portion of the works, while the new section is supplied from the power station of the Erith Council. A short stay was made in the room where the smaller portions of the guns are blackened by an oxidizing process, and afterwards the new extension was visited, beginning with the splendidly-fitted machine-room already alluded to, where for the most part motor-car work is constructed. Not only the size of the shop and the large number of up-to-date machines, but the symmetrical arrangement of the machinery and the evident consideration for the employées in the matter of light and space and in the arrangements for heat-

ing and ventilation, elicited expressions of admiration. The new joiners' shop, where the wheels and bodies of the carriages are made, was next visited, but it was observed that it was nearly seven o'clock, and, to save a long wait, a hurried departure had to be taken to catch the next train, foregoing of necessity the inspection of other parts of the works.

In the course of the afternoon an adjournment was made to the Board-room, where an excellent tea was kindly provided by the Company.

After tea Mr. COOPER, in proposing a vote of thanks said : Before leaving the table I think we ought to return a most hearty vote of thanks to Messrs. Vickers, Sons, & Maxim, and especially to the members of the staff who have conducted us around. We have had a physical, mental and spiritual treat. Most marine engineers know little or nothing about guns, the only experience of some of us is of the time when the old 14-pounder used to be fired at Gibraltar, Malta, and other places to advise the inhabitants that the mail had arrived, and the method of firing that gun was rather different from the method of firing the guns we have seen to-day. The old bo'sun would load his gun, stand by the galley door for his red-hot poker, and when he got the signal, applied the poker to the fuse. The unpropitious state of the weather has been amply compensated by the warmth of our reception. I said we have had a spiritual treat, and in that sense I refer to some of the object lessons we have had of the gases that might escape and do damage at the wrong end. The physical treat we have just enjoyed, and I am sure you will all join with me in giving the heartiest possible vote of thanks for the entertainment this afternoon.

Mr. T. F. AUKLAND : We should be very ungrateful indeed if we went away from this hospitable board without returning an extremely hearty vote of thanks for the kindness which has been shown to us. We certainly have had a most delightful treat. The weather has been rather unfortunate, but as Mr. Cooper has said, the warmth of the welcome we have received has amply compensated for that. We have another thing to consider, the kindness of our friends in having given up their Saturday afternoon—the day which naturally every one looks forward to as a little opportunity of recreation after the toil

of the week. They have very kindly gone around these works and shown us anything they thought likely to be of interest and explained it in a most interesting way. We are extremely grateful to them, and I hope that this vote of thanks will meet with your cordial approval and be received with acclamation.

MR. LOWE, responding on behalf of Messrs. Vickers, said : I am sorry that Mr. Conradi is unavoidably absent this afternoon, but on his behalf I would like to say that we are very pleased to see you here this afternoon. I thank you for your kind remarks about the staff, and can only say that if we have been of service to you, your appreciation will be sufficient compensation for any trouble to which we have been put.

Visit to the London Hospital

Saturday, June 15, 1907.

THE Institute paid a visit on Saturday, June 15, to the London Hospital, Whitechapel Road, the great general hospital for East London, the largest in the country and the second largest in Europe. Merely to make a tour of the enormous building would, of course, occupy a considerable time, but the party, one section under the guidance of Mr. E. W. Morris, Secretary of the Hospital, and the other conducted by Mr. A. G. Elliott, Assistant Secretary, was shown over departments certainly calculated to impress the fact that here poverty, alike deserving and undeserving, its need its only claim, had at its call skill as high, surgical apparatus as complete, and carefulness as great as wealth itself could command. Not alone the inspection of the rooms, wards, operating theatres and other places, but the lucid explanations of matters often purely technical, given by the gentleman named, proved of the utmost interest. A start was made from the Receiving Room, a large hall where all "cases" are examined and classified, some to be sent to the Out-patients' department and the more serious to be detained. This room is never closed night or day ; during certain parts of the day it is entirely filled with men, women and children. A constant stream of diseased humanity is ever passing in and out, an army numbering over 243,000 being the total of patients treated during 1906, and one can appreciate the dangers of the docks and the London

streets when told that throughout the year one bad case is admitted on an average every three minutes. There are sixty wards in the hospital, four of which are specially set apart for children. There is nothing depressing about these children's wards, the dolls and toys being strewn about in the disorder more suggestive of a nursery. Here a sturdy little fellow is standing in his bed gaily driving the bedpost, which his imagination has easily converted into a gallant steed. He pulls up for a few moments on being questioned, and describes how he was knocked down by a heavy cart, the wheel of which passed over his leg. Another little man tells how he was tossed by a bull, and so through the ward with its rows of little patients, some with faces bandaged, others with fractured or diseased limbs, but all cheerful and smiling. Halting beside the bed of a little Jewish boy, Mr. Morris stated that one in every six of the persons treated was a Jew, special Hebrew wards being set apart, where the diet is prepared in accordance with the Jewish custom. A terrible commentary on slum life is the statement that many of the children in the districts round about the Hospital contract such diseases as rheumatism at a very early age, and so get damaged hearts for life; also in the fact that numbers of children who have been treated over a long period and then discharged as cured return to their insanitary homes, with the result that in a month or two they are admitted as bad as ever.

More operations are performed in this Hospital than in any other in the country the operations under anaesthetics in the five operating theatres numbering 17,256 during 1906. Whereas fifty years ago, before antiseptic surgery was introduced, the mortality in surgical cases was very great, to-day death as the direct result of a surgical operation is practically unknown—to quote the words of the secretary "it is safer to go through an operation here than to cross a London street." In this Hospital the aseptic system is in vogue, everything is sterilized, the air purified of dust, the conveyer of the bacillus, by suction; the instruments plunged into boiling water for five minutes, a treatment sufficient to kill the most strenuous bacilli; the cloths and bandages sterilized by steam pressure; the sponges undergoing a sterilizing process for about seven weeks; while the surgeon washes and scrubs his hands under a warm water spray immediately before operating. The old idea of the patient being the object of demonstration before a number

of students is altogether false, the only persons present being the operating surgeon, his assistant, the anaesthetist, the nurse who is to attend the patient afterwards and the necessary dressers. The anaesthetist is a man who has devoted special study to this work and does nothing else. He administers the anaesthetic (in a separate room, so that the patient may not be unnerved at the sight of the surgical apparatus), watches the condition of the patient during the operation, understands every change, and advises the surgeon accordingly, the latter being thus freed from every consideration other than the actual work of operation.

Passing into the room where the steam pressure sterilizing takes place, and afterwards into the Instrument Room, something more familiar to the engineer's eye was witnessed in the array of tools and a small lathe. The very valuable collection of instruments, however, although in great variety, had uses of which those present were, for the most part, ignorant, although an assortment of saws looked very significant.

A movement was now made along passages, with wards opening on either hand ; down stairs, through another ward, representative of the great majority, the long room, bright and cheerful, and its rows of beds, with pleasant-faced nurses here and there, forming a not unpleasant picture if dissociated from the suffering it represented, into the open ; now down again and along a subway until the Out-patients' department is reached, and the party arrives at last on the gallery overlooking the large well-lighted hall, the rows of seats partially filled with patients awaiting their turn for treatment. A strict examination is made into every applicant's social position, so as to prevent persons well able to pay, from obtaining free treatment, and as a result no fewer than 1,353 in 1906 either withdrew or were referred to a private practitioner.

Before proceeding to the Finsen Light Cure Room, Mr. Morris explained briefly the Opsonic treatment of diseases, and in this respect stated that tubercle diseases—consumption, phthisis, etc.—are not hereditary. Immunity from disease depends upon the ability or inability of the leucocytes, organisms in the blood whose function it is to overcome the germs of disease, to do their work properly, and what is inherited is a low power of resistance. The Opsonic treatment consists in raising the power of the leucocytes by inoculating the patient with disease germs which have been deprived of

life and which the leucocytes immediately attack and, of course, have no difficulty in overcoming; but although practising upon the dead bacillus they gain strength in the effort and are thus prepared for the more deadly germ when it comes along. This treatment has been practised at the London Hospital for some time with very successful results.

The Light Cure Room presented a striking appearance on first entering, a dozen human forms stretched on tables, a nurse at the head of each table, each wearing blue glasses to protect her eyes from the blinding glare of the light she was focussing on the small portion of diseased skin to be treated that day. About ten years ago, Dr. N. R. Finsen, a Dane, discovered that intense light, deprived of its heat rays to avoid destroying the skin, concentrated on any portion of the body, kills the tubercle bacillus which causes the malignant, wasting disease known as lupus. Since then hundreds have been cured of this one-time "incurable" disease, and the photographs shown of patients before and after treatment revealed at once the horrible effects of the disease and the wonderful triumph of human skill in overcoming it. It is a slow process, a thirty-thousand candle power light being directed upon a small portion of the affected part for one hour, and the pertinency of the motto of Queen Alexandra, who presented the first lamp and has since presented four others, painted along one of the beams, "There's nothing like perseverance," is borne home on being told that when the first experiments were being made one patient sat no fewer than six hundred times.

A dozen years ago the X-ray department, which was next visited, was never thought of; now it is indispensable. Formerly much time was wasted, and unnecessary pain caused, by the difficulty of locating foreign substances lodged in the body. Now an X-ray photograph is taken, a slight operation performed and the patient sent away in half the time. The collection of photographs here proved very interesting. Nails, pins and coins were shown very much out of place, and evidence of the natural tendency of the child to put everything in its mouth was seen in a photograph showing a toy soldier standing at attention in the middle of a child's throat, while another showed a toy cyclist apparently "scorching" down the throat of some other little sufferer. One or two of the visitors who happened to have slight fractures of the bones of their hands passed them before the screen and obtained a clear view of the

fracture, while others satisfied a natural curiosity to see the bones of their hands and arms in normal condition. The operator, Mr. Harnack, is a martyr to science, his hands being terribly scarred from burns received before the apparatus was covered with glass specially prepared to prevent the rays operating other than upon the required parts.

Descending again to the Committee Room, where hangs an old painting showing the Hospital in 1754, situated in the midst of green fields where to-day the squalid homes of the poor are densely crowded, and other pictures, prints and framed documents of bygone years, the party was once more united. Before leaving, Mr. T. F. AUKLAND, in proposing a vote of thanks, said : None of us would like to go away from this Institution, where we have been entertained in so interesting a manner this afternoon, without passing a very cordial vote of thanks to these gentlemen who have so very kindly shown us around, and who have taken so great an amount of pains to explain the various things which have proved of such intense interest. The wonderful surgical appliances and operations we hear of almost daily, but I do not think we should have had any idea of their real character unless we had seen and heard what we have this afternoon. But another aspect of this great Institution was impressed upon me. In passing through the wards we saw a great many nurses, and I could not help thinking of those two lines,

> When pain and anguish wring the brow,
> A ministering angel thou.

I thought they were so splendidly appropriate. We shall go away intensely pleased with our visit and desire to thank our friends in the heartiest manner possible.

MR. GEORGE ADAMS : It gives me very much pleasure to be able to second this vote of thanks. Many of us are engineers who have travelled in all quarters of the globe. We have seen many cities, but in the great majority of them we notice an absence of institutions such as this. We have seen to-day some of the " hidden mysteries " of science and some of the many applications of it, how far science helps to ameliorate the sufferings of the multitude, to restore them from the ravages of disease and to bring back to them the bloom of health. We have also to thank these gentlemen for the educational treat

afforded us, for their courtesy in explaining so clearly the various points upon which we wished to be enlightened, and in other climes, upon the seas, or in distant countries, we will always remember with pleasure our visit here this afternoon.

Mr. Morris, in responding, said : I thank you very much for your kind words. It has been a delight to us to show you round. It is always a pleasure to show over the Hospital those who are interested, who asks questions,—it only becomes a task when the one comment is " oh ! " When you come again we may have more to show you, science moves so quickly, and what is incurable to-day may then have found its remedy.

Visit to the Locomotive Works of the Great Eastern Railway Company

Saturday, July 13, 1907.

On Saturday, July 13, the Institute paid a visit to the locomotive works of the Great Eastern Railway Company at Stratford. There was a very numerous attendance, and the visit proved very enjoyable.

The Stratford works and running sheds, including the carriage and wagon departments, cover the large area of eighty-three acres and give employment to about 6,600 workpeople.

The first building inspected was that containing the hydraulic installation which supplies the power for the flanging and riveting machines, testing apparatus, cranes, etc., consisting of two two-cylinder engines, with cylinders 17 in. diameter by 24 in. stroke, and a large accumulator working with a pressure of 1,680 lb. to the square inch. Three locomotive boilers are in this building and supply steam at 140 lb. pressure to the hydraulic and other engines.

In the iron foundry, which was next visited, are five core ovens, three cupolas, one of which melts three tons and the others five tons each per hour, also several hydraulic moulding machines for moulding articles of which large quantities are required, and by which the ordinary moulding boxes are done away with.

The locomotive machine shop, containing as it does a large

number of up-to-date lathes, drilling, slotting, milling and other machines, naturally claimed a large share of attention. Typical machines were the duplex planing, travelling at the same rate backwards and forwards, both strokes being utilized by having a head at each end, boring machine fitted with a special tool for recessing the bottom part of the hole, slotting machine for shaping the curve in duplicate on radial axle boxes to two different radii, high speed drilling machines, automatic screw-cutting machines, and others evidencing the enterprise of the Company in obtaining the highest quality combined with economical working. Another machine worthy of notice is one used for turning wrought iron piston heads, in which the boring is done and the grooves cut at the same time.

Practically all the tools used are made in the tool shop adjoining, where also the repairing and grinding is done. The twist drills, to take an example, are made of high speed steel roughed out on a three-spindle lathe, milled, grooved and backed off for high speed drilling, then hardened and afterwards ground true to one-thousandth part of an inch.

The locomotive erecting and fitting shop was next visited, a building 350 feet long by 150 feet wide, divided into four bays, the centre ones fitted with half a dozen sets of rails upon which locomotives were being erected, some showing merely a light framework and others in more advanced stages of construction. A world's record in quick building—still unbeaten—was created in this shop in 1891, when a standard goods engine was built in ten working hours. It is interesting to know that a member of the Institute, who was serving his apprenticeship with the Company at the time, was one of the number who accomplished this feat. Above each of the centre bays are two 30-ton overhead travelling cranes for transferring heavy materials, and for the lighter work are four 3-ton travelling cranes. The two side bays contain several fitters' benches and several heavy machines, which include a machine for boring and facing cylinders, steam chest and slide valve faces without removing the cylinders from the frames, also two high speed grinding machines for piston rods, axle journals, etc., and a very large three-headed slotting machine, which slots five sets of frame plates, ten plates in all, at the one time.

In the Testing Room were seen a chain-testing machine worked direct from the hydraulic accumulator, with a capacity

of 75 tons on chains up to 15 fathoms in length. The principal machine in this room is the 50-ton " Buckton " testing machine, fitted with Wicksteed's patent automatic apparatus for obtaining load-strain diagrams, in which a piece from every boiler plate undergoes a bending and tensile test before the plate is used, the one machine being so arranged that with a slight alteration it will give either tensile, compression or bending tests.

Passing through the Spring Making shop, the Smiths' Shop was reached, a building containing 68 forges and 8 steam hammers, varying from 3 to 15 cwts., in addition to the usual complement of machines necessary to this class of work. Among the latter, attention was drawn to the nut-making machine. Attached to it is a small furnace, for heating the bars which the machine cuts up, and performs simultaneously the operations of cutting out the hexagonal or square nuts and punching the centre holes at the rate of about two dozen per minute, the nuts—$\frac{3}{8}$ in. to $1\frac{1}{4}$ in. diameter—leaving the machine finished ready for tapping, with the exception of a burr on the underside afterwards removed in a special burring machine. The rivet-making machine also claimed some interest, the work being done by eight dies arranged on a circular bed coming successively under a stamp which forms the head and completes the rivet, which is then lifted out by an automatic arrangement. This machine has reduced the cost of rivet-making to the Company by about 75 per cent. In the steam hammer shop are two 3-ton, two $1\frac{1}{2}$-ton and one 15-cwt. hammers used for the principal forgings, the heats for which are obtained from eight furnaces, four ordinary coal furnaces and four heated by coal-gas made in Wilson producers, the gas furnace averaging one more heat per day than the coal.

The works are gradually being electrified, but at present the only shop in which electricity is entirely used as the motive force is the boiler shop, where motors, depending in size upon the machinery, are fitted to each line of shafting. The motors vary in types and are on the three-phase system, of 440 volts, and 50 periods, coupled to the shaft either by belt or chain. In addition to the large machines in this shop for shearing, punching, planing, etc., are two hydraulic riveting machines, one with a 10-in. and the other an 8-in. ram, working at a pressure of 1,680 lb. per square inch. The large number of cranes

include three 15-ton, five 10-ton and one 5-ton overhead travellers driven by flying ropes.

In the flanging shop, which was next visited, the principal feature is the large hydraulic flanging press, which is also worked at a pressure of 1,680 lb. per square inch. It has four 6-in. rams for holding the work and one 20-in. diameter ram which forces up the die with a maximum pressure of 224 tons. A good specimen of the work done in this press may be seen in the locomotive smoke box front, the outside edge of which is flanged for the side plates to be riveted to it. The opening for the door is also flanged inwards to stiffen the plate. High pressure gas-holder ends, 6 ft. 9 in. diameter by five-eighths of an inch thick, with a 6-in. flange turned up all round and dished in the centre to a depth of 1 ft. 4 in., have been made in this press in one heat. Among other flanged work are boiler and fire-box back plates, boiler barrel rings, angle irons, throat plates, tube plates, chimney bases, safety valve seatings, tank plates, etc.

The Wheel Shop, where the wheels and crank axles are turned and fitted, contains some of the largest machinery in the works. One large wheel lathe works with six tools cutting at the same time. Crank axles, which are of forged Bessemer or open hearth steel, are first turned, and if the webs are open, are machined for hooping. After the hoops are shrunk on by being heated to a black heat and cooled down in water, the keyways are cut in a duplex milling machine and the wheels, after being turned, bored and the keyways slotted, are forced on to the axles by a hydraulic press at a pressure of from 80 to 100 tons.

The large weigh bridge, arranged so as to give separately the weight upon each pair of wheels, was then inspected, after which, crossing under the network of lines separating different parts of the works, by means of a subway, the party arrived at the Engine Painting Shop, where the engines are finished off after completing their trials, a large room, containing six sets of rails, accommodating 24 engines at a time. An opportunity was here afforded of examining some of the types of locomotives manufactured by the Company. Dimensions of representative engines for passenger and goods service may be of interest.

The 710 class, for heavy express and other passenger trains, has a boiler pressure of 180 lb., cylinders 18 in. by 24 in., four

7 ft. diameter coupled wheels, wheel base 16 ft. 6 in. total heating surface 1,476 sq. ft., grate area 21·6 ft., and a total weight of 45 tons. A number of engines of this class are fitted with " Belpaire " boilers.

The 1,150 class, for heavy long distance, mineral and other traffic has a boiler pressure of 180 lb., cylinders 19 in. by 26 in., six 4 ft. 11 in. coupled wheels, total wheel base 17 ft. 8 in., heating surface 1630 sq. ft., grate area 21·3 sq. ft. and total weight of 44½ tons.

The famous " Decapod," a large tank locomotive with ten coupled wheels, was the subject of much interest, and its size may be inferred from a comparison of its dimensions with those of the two already given, themselves engines of a very good standard type. As originally built it had five pairs of coupled wheels, its boiler pressure was 200 lb., one inside and two outside cylinders each 18½in. by 24in., total coupled wheel base 19 ft. 8 in., total heating surface 3,000 sq. ft., grate area 42 sq. ft., and total weight of 80 tons. The engine, however, was only built for experimental purposes and has recently undergone several alterations, which have included doing away with a pair of the coupled wheels, the tanks and bunker. It is now an eight-coupled tender engine, and is used principally for heavy mineral traffic.

The boilers, and many of the details, of several of the classes are interchangeable.

The locomotives owned by the Company number between 1,200 and 1,400, of which about half are tender engines, and the output on the average is one new locomotive per week. In addition to the engines, the carriages and wagons are all built in the extensive building and repairing shops at Stratford, and Temple Mills, upwards of 5,000 vehicles being included in the carriage stock, all fitted with the Westinghouse brake.

The visit was arranged by kind permission of Mr. James Holden, Locomotive Superintendent of the Company, and Mr. F. V. Russell, Manager of the Running Department, very kindly favoured the party with his presence. The visitors were conducted by Messrs. H. Haylock, F. Mann, A. R. Hare and M. Nettleton, whose explanations and comments contributed a great deal to the enjoyable nature of the visit.

Visit to the Works of Messrs. A. G. Mumford, Ltd. Colchester

Saturday, August 24, 1907.

On Saturday afternoon, August 24, the members paid a visit to the works of Messrs. A. G. Mumford, Ltd., Colchester. The old-world town, where ancient and modern dwellings are jumbled together on the ground where once stood the "royal town" of the Briton and afterwards the first *colonia* in this country of his conqueror, full of historic association and situated in the midst of a beautiful stretch of Essex country, combined with the splendid behaviour of the weather to produce a shade of regret that these must be sacrificed to the inspection of a modern factory.

The works were established about thirty years ago and have gained their reputation chiefly by the production of marine engines for small craft—vedette boats, despatch vessels, steam yachts, tugs, etc.—water tube boilers, steam pumps and auxiliary machinery generally for large vessels, a large proportion of the work at present in hand being under contract for the Admiralty and for foreign governments.

In the erecting shop which was first visited, the item which primarily claimed attention was a compound surface condensing engine of the enclosed type arranged to work under forced lubrication, this engine being one of those on order for 50 ft. Admiralty steam pinnaces, other engines of a similar type being in course of construction for a foreign government. Some time was spent in examining the arrangements for forcing the lubrication into the various working parts, and in connection with this it is interesting to note that the whole of the double throw crankshaft, together with the eccentrics, thrust collars and couplings is machined out of the solid from one forging. The speed at which these engines run is about 580 revolutions per minute. Other engines of the open type in course of construction were also examined, the sizes varying from almost model size to 14 in. and 28 in. diameter by 18 in. stroke, this latter being an engine for a water tank vessel for a foreign government.

Particular interest was shown in the Mumford patent water tube boiler, the distinctive production of these works, this

boiler being of the Express type arranged to work either in a closed stokehold under forced draught, or by means of air forced under pressure to a closed ashpit, and used with much success for vedette boats and torpedo boats in the British Navy. This type of boiler consists of one top and two bottom forged steel drums, the latter connected by water tubes to the top collector, which acts as the steam reservoir, the water being contained in these connecting tubes and in the bottom drums. Circulation of the water in the boiler is obtained by means of a T-shaped down pipe at the back of the boiler, leading from the top collector and connected to the two bottom collectors by means of horizontal water pipes. The tubes are not " staggered," but arranged in rows, so that there is a clear space between any two rows when looking in either direction, thus giving a freer draught and facilitating cleaning of the tubes. By adopting a certain method of bending the tubes whereby a a space is formed right in the midst of them, complete combustion of the gases is obtained, thus improving the generation of the steam and obviating the damaging effects of flaming at the top of the casing or funnel, which frequently occurs in Express boilers where the gases are not completely consumed. All the casings of the boilers are detachable, whilst doors are fitted to each water chamber for the purpose of inspecting the tubes. These boilers are made in sizes up to 1,000 I.H.P.

Mumford and Anthony's patent feed water regulator is fitted to this boiler, a very compact and apparently sensitive piece of mechanism by means of which the delivery of the feed is regulated by the boiler check valve.

In other parts of the works inspection was made of the various steam pumps which have made the name of Mumford familiar to most marine engineers. In the " Duplex " pumps the plungers are compelled by the arrangement of the valve gear to work exactly as if driven by cranks at right angles, thus ensuring one of the plungers always being in motion when the other is at the end of its stroke, whereby a steady flow is maintained. The brine pumps in connection with refrigeration are well known for their good service.

Various types of feed, low service, ballast, air and circulating pumps were examined in course of construction, including four large pumps for H.M. battleship *Cæsar* and large air pumps for H.M. dockyards. Perhaps the most interesting of the Duplex pumps was that fitted with Mumford and Anthony's

patent valveless steam cylinders, where, by a special arrangement of steam passages and ports in the pistons and cylinders, slide valves are dispensed with, the piston in one cylinder being the means of opening the steam to the other cylinder.

A brief survey of the foundry, smiths' shop and pattern shop brought an interesting visit to a close and an adjournment was made to the offices, where light refreshments were very kindly provided by the firm.

In the absence of Mr. Mumford, who arrived later, the members were conducted over the works by Messrs. Burner and Anthony, two of the directors of the firm, to whom hearty thanks were expressed for the trouble taken to make the visit so enjoyable.

Before proceeding to the station, the visitors had a pleasant walk through the town to the keep of the old Norman castle, the largest of its kind in the country. In the castle grounds were seen a portion of a Roman pavement and a monument commemorating the siege of Colchester by the Parliamentary army during the civil war in the time of Charles I, and the subsequent execution of Sir Charles Lucas and Sir George Lisle. At other places in the course of the walk, parts of the old Roman wall in an excellent state of preservation were pointed out.

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VOL. XIX.

PAPER NO. CXL.

NEW METHODS OF EFFECTING BOILER REPAIRS

BY

MR. H. RUCK-KEENE (MEMBER).

CHAIRMAN: CAPTAIN H. R. SANKEY, R.E.

ALSO

PAPER NO. CXLI.

VENTILATION, HEATING AND BERTHING

BY

MR. A. E. BATTLE (MEMBER OF COUNCIL).

CHAIRMAN: SIR ALEX. B. W. KENNEDY, LL.D. F.R.S.

Read at THE ENGINEERING AND MACHINERY EXHIBITION, OLYMPIA, on *Saturday, September 28th*, 1907.

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