INSTITUTION

OF

ENGINEERS IN SCOTLAND.

SESSION 1860-61.

THE FIRST MEETING of the Session was held in the Philosophical Society's Hall, Andersonian Buildings, George Street, Glasgow, on Wednesday, 31st October, 1860—WALTER M. NEILSON, Esq., President, in the chair.

The PRESIDENT delivered the following Introductory Address:—

GENTLEMEN,—In commencing the business of this our Fourth Session, it will be my duty first to notice briefly what has been done by us during the meetings of the preceding session; and I regret to be obliged to state, that, although at our first meetings of last year there appeared a prospect of an interesting and successful session, from the number of papers there was reason to believe would have been brought before your notice, your council were nevertheless much disappointed in finding that many of our members, from other engagements, were unable to overtake the preparation of the various subjects intended to have been submitted to you for your consideration and discussion. I trust, however, that we will, during the meetings of this session, not only have those papers we looked for last year, but that our members will show an increasing interest in the progress of our Institution, by devoting a portion of their time to bringing before us such subjects as they may have had their attention more particularly directed to during the recess.

I think I may state plainly that we, as an Institution yet in our infancy, do not arrogate to ourselves the position of being teachers or lights to the world, but rather the more humble place of followers in the footsteps of those parent institutions of a similar kind in England, of an older

growth, from whom we are too distantly situated to participate in their active existence. And whilst we feel it a privilege and an honour to be able to advance in any way those great and useful objects which form the study and the pursuit of members of such an institution as we profess to support, still we consider it one of the most valuable results we can attain, to excite the production of such information, knowledge, and experience as will, by intercommunication, teach one another, and assist us to occupy the positions in which we are placed, with greater satisfaction to ourselves, greater success in our onward efforts, and greater honour to our country.

In noticing the most important subjects which occupied our attention at the meetings of last year, I would mention first the straightening of the great chimney of the Crawford Street chemical works. The very successful application of the scientific skill of those engineers who advised the remedy for the injury the chimney had received from being too rapidly built, as came out in discussion, must have been very gratifying to all the parties interested in the operation. This chimney, notwithstanding its having swayed considerably from the vertical when nearly finished, by being cut with the saws and implements exhibited to you, at various places on the high or windward side, or that on which the gale acted, was made perfectly erect, and afterwards completed to its present total height of 468 feet from the foundation—now the highest chimney in the world.

The valuable paper by Mr. Milne, on the new works executed by him at the improvements on the Grangemouth harbour in connection with the Forth and Clyde navigation, deserves particular notice, as an example of a class of work we have not now often the opportunity of witnessing. The difficulties which were required to be overcome from the nature of the ground, and the peculiarities of the locality, were ably grappled with; and the novel manner in which Mr. Milne obtained the requisite depth of water, without cutting through the only safe and reliable foundation he had to build upon, exhibits a beautiful adaptation of cast-iron to such structures, producing not only a much stronger, but also, what is of great importance, a cheaper work.*

The improvements alluded to are still being carried on, and farther important works are now in execution. We hope Mr. Milne will favour us with the particulars of the whole operations; and we are satisfied that any member who takes an interest in such undertakings will be well repaid by a visit to Grangemouth harbour, which is now in direct communication with Glasgow by rail.

* By a typographical error at page 34, Vol III., the cost is made £1800. It should have been £18,000.

The subject, *Improvements in Iron Ship-building*, for both mercantile and war use, brought before us by Mr. Simons in his excellent communications, is one in which we would expect many of the members of this Institution to take a lively interest. To the public generally — the strength of iron ships is a highly important question. The many disasters of the past year have called the attention of almost every one to the safety of iron vessels, and the press has plainly stated that, in public opinion, many iron ships have not been built as they ought to have been; and our own Clyde has been pointed at as not guiltless in this direction. We are indebted to Mr. Simons, as a shipbuilder of known reputation and energy, for bringing the question of improvements in iron ship-building thus frankly before us, and challenging the discussion of the whole matter by our members. I hope, however, that the non-attendance of those whom we would expect to take most interest in this important subject, at the different times when it has been under consideration, will not be taken as any indication of their indifference to a matter which the public expect to demand from them as ship-builders their most earnest consideration. There can, I think, be no doubt, at all events, that it must be both gratifying and assuring to the public, to see that ship-builders do use all their skill and energy to make the iron ships they build of the very strongest and safest description they can obtain from their own experience or that of others.

The account of the application and construction of hydraulic presses, communicated by Mr. D. More, could not fail to be interesting, showing to what a great extent, and for how many different purposes, hydraulic power is now used in the operations connected with manufactures and commerce at home and abroad. If the communication had not been of so general a character, but had entered more into the details of construction, the recorded results of the long experience of a firm of such reputation as Messrs. A. More & Son deservedly possess for the construction of hydraulic presses, would have formed a very valuable addition to the volume of our Transactions.

I will only further mention—Mr. Tait's carefully-conducted experiments on his engine and steam-boiler, noticing the great value for reference of all carefully-conducted and reliable experiments;—Mr. Lawrie's papers on the form of ships, and on the treatment of steam for the development of power—two subjects of the very greatest importance, forming, as they do, the element of the success of steam navigation, subjects which have been much discussed, and in which there is still great room for more discussion. These, and communications from Professor C. Piazzi Smyth, Dr. Rankine, Mr. Napier, Mr. Moffat, and others I cannot overtake in detail, formed the business of our Institution during the last session.

The past year does not seem to have left us any great strides in engineering progress to record; but, although no marked leaps may be conspicuous, still the steady onward progress of improvement is not stayed —silently, but perseveringly, the useful work moves on. We are apt to be dazzled by the sudden outburst of some new effort of inventive genius, and lose sight of the great value of the perfecting of details, and the applying to useful practice the suggestions of those who may, with minds unfettered by the pressing cares of ordinary business, wander over the movements in life's busy affairs, discover some want to be supplied, some error to be corrected, or some new path onwards to which they point, but, unable to do more, leave the accomplishment to others.

The success of many useful inventions, mainly if not altogether, has often depended upon the labour and perseverance of the practised hand, who works out, and gives existence to, what is presented to him as mere visions of the mind; and perhaps the greater merit is due rather to the successful applier—than to the mere originator of ideas.

It is remarkable how much of late the public mind has been directed to the construction of implements of warfare. Science seems, in the past few years, to have somewhat left its usual course—the pursuit of the arts of peace—and turned to the prosecution of the more exciting arts of war. This has been strikingly exemplified in the many schemes brought forward for the better construction of everything required in the conduct of war, defensive or offensive.

The great perfection to which rifled arms and ordnance has been brought, beautifully illustrates the value of the directing spirit of science, and forcibly presses upon us the conviction—that our future successes before our enemies will depend upon the great intelligence and scientific skill displayed both in the construction and use of our weapons, as much as upon the strong arm and indomitable courage of our people.

The great power given to heavy ordnance naturally demands farther efforts to obtain some efficient means of defence from this new-created destruction; and now that, on the ocean, the natural element of our nation, the wooden walls of old England are no longer able to defend us, we may only trust in walls of iron, and bulwarks of steel. This necessity calls for ships of an entirely novel construction and new combinations of material; and we may reasonably consider that we have not yet arrived at the proper kind of vessel to be defended, or the proper kind of defence to be used. The shipbuilder, the engineer, and the iron manufacturer, have an opportunity of conferring great benefit upon the government and the country by giving their assistance in this matter—not only to produce vessels suitable for the purposes required, but to devise machinery and other means—by which the material and

the construction may be obtained at as small a cost to the nation as possible.

Our country's defence may be a subject which, strictly considered, does not come within the range of the objects of our Institution; but when we find the engineer called upon to take such an important part—in devising the means and constructing the instruments by which our safety from our country's enemies is to be maintained, I think it cannot be considered out of place, even here, to notice briefly something of the constructions and machinery of the modern art of war.

As stated by Mr. Simons in his paper on battle-ships, the time has evidently arrived when iron should be substituted for wood in their construction, for the very obvious reasons which he gave; and that speed will form a very essential element in the efficiency of such vessels cannot be doubted, more particularly if it should be attempted to use them, as has been proposed, for running down an enemy. Such rams, heavily loaded with their iron cases, powerful and necessarily heavy machinery, guns, ammunition, and stores, will require great skill in their construction to obtain all the qualities demanded of them. The danger of such vessels suddenly going down, in the event of any misfortune, naturally presents itself, and the means of preventing such a catastrophe should be, as far as possible, provided for.

It may be considered desirable to have another class of vessels, of a limited speed, to act as floating batteries, in fixed positions, where any portion of our coast should unexpectedly require to be defended. These vessels would be of an entirely different form from the others, and might have convenient accommodation for the naval reserves and stores of all descriptions.

Swift despatch boats will always form an important branch of our naval service, but there is little difficulty in providing vessels of this class—with sufficient speed to keep them out of harm's way.

A connected system of railways upon our exposed coasts has been suggested as a great assistance to our means of defence. It is obvious, with keen-eyed swift steamers, and well-worked telegraphs, our artillery and volunteers, with such communications, would be rendered doubly valuable by being ever ready where a foe might plant his foot upon our shores.

Harbours of refuge and fortifications open a large field to the civil engineer. The construction of fortifications is happily something new to us in this country, and we also trust the time is far distant when they will be otherwise than something new to the soldier on the soil of Great Britain. One cannot but feel alarmed at the prospect of the execution of such great works being undertaken by our government. We have

some experience of how works of immense magnitude have been completed by private enterprise, and trust some means may be adopted through which the patience of the nation will escape a trial which, in comparison with such works as the building the houses of parliament, with the misfortunes of Big Ben into the bargain, will be but a phantom.

I will venture to say it will be unfortunate for the people of this country, and much to be regretted, if that localized concentration of the directing powers of the nation in our great metropolis, should deliver up the construction of those great works—perhaps the greatest the government of this country has ever undertaken—into the hands of those only who are directly connected with the government, or others fortunate by the influence which proximity to the seat of power has given them—to the exclusion of all others less favourably situated, but who, nevertheless, have equal claims for participating in the opportunities which the expenditure of so vast an amount of the nation's wealth gives for the exercise of their profession; and I would say more—it seems hardly fair to Scotland, with her fame for ship-building and steam-engine making, and with her great powers of production in all works of iron, that there should not be one single royal dockyard or arsenal within her bounds; and that the benefits, which the constant disbursements of the large amount of public money confer upon the districts in which these establishments are located, should be altogether denied to this northern portion of the kingdom.

In taking a cursory view of what, at present, more particularly occupies the attention of those who, like ourselves, are engaged in the pursuits of such objects as properly come under the consideration of our Institution, I can only notice, within the limits of this short address, a few of those which come most prominently before us, and in which we are more immediately interested. Steam-ship building very naturally presents itself—one of the most important practical subjects we can turn our attention to—and economy of fuel in marine engines, a department of this subject which, at the present time, occupies considerable attention. I have already, on former occasions, remarked that the consumption of fuel in our marine engines demands the immediate and earnest attention of our engineers; and it is gratifying to observe the successful efforts now being made in that direction. I also pointed out what appeared to me the means to be used to obtain the desired end; and ventured to predict that surface condensation and higher pressure of steam would be universally adopted in all marine engines. Surface-condensation is no new thing to the engineers on the Clyde. Very many years ago considerable efforts were made by one of our then eminent engineers, and not without some success, to introduce surface condensers into our Clyde steamers; but the difficulties of constructing and maintaining the appa-

ratus in an efficient state were so great that the idea was abandoned; and engineers have gone on from year to year, turning out annually thousands of horses power, without almost giving the matter of economy in fuel a consideration. It is an established fact that a most perfect vacuum can be obtained by the system of condensation we allude to; and we cannot for a moment doubt that the practical skill and perseverance of the present day, aided by the perfection to which the production of constructive material has attained, will overcome all the difficulties—which have hitherto prevented one of the greatest improvements in the marine steam-engine from taking its proper place in the grand economy of steam navigation.

The pure water obtained for evaporation from the new condenser will for ever banish from existence that vexatious annoyance of salting in the boilers, and allow of no excuse for priming; thus giving a far greater freedom to boiler construction, opening up an extended field for the skill of the boilermaker—which leads us to hope that ere long a cheap, compact, and safe marine boiler for pressures above 100 lbs. will become an article of common manufacture. Then nothing will be wanting but to perfect the details, and compete for the best results from the whole system.

It is generally admitted that in iron ship-building there are many improvements yet to be made, and we have of late seen various proposals for increasing the strength of vessels—by using different forms of material, as well as by differently arranging its position in the structure of the vessel. But the form and proportions of the hull itself as a whole, and the figure and disposition of the weight of the part above the water line, in relation to the portion immersed appears to be an important matter for consideration, in order to obtain a structure in which the severe strains caused by labouring in a heavy sea will not concentrate their destructive forces on some weak point, which would have been otherwise able to bear its own proportion of (fatigue) stress, but gives way—in consequence of the unequal duty it is called upon to perform, by the malconstruction of the other parts of the vessel. No doubt vessels ought to be differently built to meet the requirements of the different trades for which they are intended, both as to cargoes to be carried, and the seas to be sailed in. It may seem to some curious that iron steam vessels should be specially built for particular service, whilst the old wood-built ships were considered fit to sail in any sea; but the necessarily weaker form, from the great length required to obtain the speed, must not be forgotten, and the fatigue a sailing vessel suffers at sea cannot be compared to what any screw trader has to submit to. The steamer takes its course in whatever direction the wind may blow or the sea roll, and by being forced against the waves in every possible direction, is strained, twisted, and shaken in a manner no sailing vessel can be.

Many of our members who are familiar with the practice of ship-building must admit the fact that, in their experience, the forms and proportions of both the submerged and emerged portions of vessels are not governed by any distinct rules, deduced from any known laws, which would undoubtedly be discovered by a thorough investigation into those forces which act upon the vessel, under all the circumstances to which it may be exposed, and the resistances to those forces, which the vessel, in the performance of its duty, must be able successfully to give.

I would venture to suggest—a better quality of iron, and a more secure system of rivetting would do much to increase the strength of iron vessels. I have repeatedly had striking examples of the very great differences in the strength and durability of constructions composed of plates of iron—particularly when above three-eighths of an inch in thickness—rivetted together in the ordinary manner, when compared with similar examples, where the corresponding rivet holes were carefully made parallel, and the rivets fitted tightly in their places. It is, of course, impracticable to obtain perfect accuracy in the rivet holes of a ship's plates, but any means or system which could improve the practice would, in my opinion, be of great value.

If the improvements which have lately been made in the economy of the production of steel, be still farther carried out, it is not unreasonable to presume that that material may yet enter largely into those constructive parts where very great strength is required, at the same time, not increasing the weight of the whole vessel, whilst adding very greatly to its strength.

I will here only farther repeat—what I stated in my address at the commencement of last session—how much it is to be regretted that the members of our Institution, more particularly interested in this matter, do not bring forward the results of their experience in iron ship-building, in order that the opportunity which this Institution gives might be taken advantage of—to compare different results, by which much valuable data might be obtained, and laws discovered as already referred to, and the various questions be discussed, upon which there is so great variety of opinions, such as—the form and dimensions to produce given desired results; the amount of power that can be most effectively applied to different kinds of vessels; how to obtain the greatest amount of power with the least quantity of fuel; form, diameter, pitch, and speed of propellers; arrangement of masting and rigging to give the best combined result of propeller and canvas; steering; rolling in a sea way; the unpleasant vibration produced by some propellers, and the great lateral oscillation observed in some vessels, both obviously tending greatly to aggravate the evil of insufficient rivetting; peculiarities in setting compasses of different vessels; deviations of compass in the same vessel;—and many

other inquiries which will suggest themselves to those more practically acquainted with the subject than I can be.

In the landward department, of the great business of locomotion, the increasing demand for greater facilities, in accommodating the locomotion of the ever accumulating crowds of the people, urges forward the engineer to yet greater efforts. And now we have the extraordinary work going on of forming an underground railway through London—burrowing among a labyrinth of sewers, gas mains and water mains. This railway pushes on to connect all the termini of the railways in the metropolis.

The propriety of connecting the different termini in large cities is becoming every day more apparent. The transit of passengers, goods, and minerals, from one depot to another, is a source of great inconvenience to the traveller, expense to the trader, and nuisance to the citizen; thoroughfares are crowded, streets are worn and destroyed,—by a traffic which the business of our cities has no right to be encumbered with. Even in our own city, should it continue to enjoy the prosperity with which it has been favoured in past years, ere long some of the streets, wide as they are compared with those of sister cities, will become unmanageable, and their deficiencies a great hindrance to the active energy of our merchants and traders. If our railway termini were connected,—with a branch to the harbour, and rails upon our quays to the ships' sides—bringing the shipping in direct communication with the rising manufacturing and coal-producing districts around Glasgow, an immense boon would be conferred on the trading public, on our citizens, and on our shipping interest.

The time seems to have arrived when the ordinary facilities for conveyances, even in our cities, in their crowded thoroughfares, are not considered sufficient for the demands of the age. In America, and in France, we have had for many years street horse railways; and if we consider for a moment the number of horses, carts, waggons, omnibuses, &c., in Glasgow, and calculate the power necessary to draw the loads over the streets, and estimate how much less power would do the same work on a railroad, the saving of horses power which could be effected would be enormous; and, be it remembered, not steam horse power, but real flesh and blood horses power, the cost of which very few are well aware of. Of course, the cost of transit would be proportionally reduced; and the saving in "rolling stock," and tear and wear of street paving, would form a large item in the common economy. Our public authorities and the conservators of our roads are, perhaps, scarcely yet prepared to give way to the rail; but there seems no reason to doubt that the public convenience, and even the public safety, would be greatly increased by adopting

properly constructed street railways; and the difficulties to be overcome in their construction and management are not such as, in the present state of engineering intelligence, ought to be considered insurmountable.

It would appear now to be considered as a matter not to be questioned, that, in the present state of locomotive progress and experience, an engine can be made to run and do work satisfactorily on common roads. Several engines at work in England have given considerable promise of success, but there appears still to be some difficulties yet to be overcome in producing a good serviceable and durable road engine. That such a thing is at present required, there is no doubt, and the mechanical engineer has a new field to open up, in this direction, for his skill and industry.

Upon our railways we observe a continued tendency of traffic to flow in certain great streams. This is naturally to be expected. Our great cities, with their busy suburbs, form centres to which railroads converge, ministering to the wants of the immense populations, and carrying away the produce of their industry. These great carrying lines are well named trunk lines, and the feeders branches; or, they might as appropriately be compared to great rivers, with their tributary streams running into them. We consequently find the increasing demand for transport on these trunk lines requiring more powerful means of transit and greater speed, larger trains and larger engines. The locomotive engine has now been increased in power and in size, almost we should think, to the extreme limits the narrow gauge will admit of. As examples of, perhaps, the most successful of this class of engine, I may mention those recently built for the Caledonian railway by Mr. Connor, the locomotive superintendent of that line. The cylinders are 17½ inches in diameter, and the stroke 24 inches, with driving wheels 8 feet in diameter, weighing each engine about 27½ tons. The first of these engines has been at work now for about a year, and its performance has been in every way satisfactory. I remember well the engines made for this same railway in 1831 (then the Glasgow and Garnkirk) by Messrs. Stephenson of Newcastle. The cylinders were 10 inches diameter, stroke 14 inches, with four wheels 4½ feet diameter, and weighed 5 tons. Certainly a striking contrast to the engine of the present day, and affording a forcible example of the progress of the power of locomotion. On trunk lines the necessity for, and the economy in, such powerful plant and high speeds, has been well established; but in the branch lines, where the trains are smaller, and there is no necessity for any such high speed, I think a greater effort should be made, in an opposite direction, to accommodate the rolling plant, and also the permanent way, more to the limited amount of traffic carried on these lines.

The economy to be arrived at—by low speeds, and locomotive plant

particularly adapted for such a system, does not appear to be sufficiently appreciated. The saving in the cost of bridges, permanent way, and its maintenance, would be very great; and if railways were made strictly on this principle, many of our thinly-scattered populations might yet participate in the benefit of railway communication—now the great high road on which the commercial intercourse of the country is conducted—and without which, those unfavoured districts of our country must remain deprived of one of the greatest stimulants to progress and improvement.

Situated as Glasgow is, in the midst of an immense coal and iron district, where the production of the one, and the manufacture of the other, is carried on to so large an extent, we have reason to feel disappointed that we have had, I may say, almost no communications on the engineering works connected with this great and important department of our industry.

The mining engineer—has no where more scope for the exercise of his profession than in the West of Scotland, and there is much that comes within the range of his experience that would form most valuable subject for the notice of our Institution. I need only mention the various methods of surveying and the instruments used;—testing mineral fields by boring; the different ways of conducting coal and ironstone workings, especially in peculiar or difficult mineral fields; the difficulties encountered, and how they are overcome; sinking of pits where they ought to be sunk; draining, pumping, ventilation, and such like. The mechanical engineer engaged in making mining machinery might also perhaps profitably to himself, as well as instructively to others, submit for discussion blowing engines, pumping and winding engines, rolling-mill engines, with their boilers, and numerous machineries to which they are attached —all no doubt brought to great perfection, but we must not assume that there is not yet room for farther improvement.

We have much to look for from the civil engineer—in the construction of docks, harbours, quays, and jetties—our Clyde furnishes excellent examples of certain descriptions of such works. And the numerous harbours around our coasts, although they may not be of large extent, would still give opportunities of showing that, within the scope of the profession under which such works properly fall, there is not wanting among us that experience and skill, sufficient without foreign aid, to undertake such new works as the increasing trade and commerce of our own part of the country must periodically demand.

I cannot at this time farther particularize the numerous subjects which present themselves to us within that great field upon which the engineer is called to operate—railway works, water works, gas works, telegraph works, sanitary works of every description—all offer ample opportunity

for investigation, and tempt the enterprising spirit into an arena within which many have found honour, and have reached the highest pinnacle of fame.

I have now called your attention, although, I fear, in a very imperfect manner, to a few of those topics which appeared to me most conspicuous in the great engineering progress of our country. I doubt not, however, but the views I have taken, and the opinions I have not avoided giving expression to, may not meet with your unanimous approval, and be subject to much just criticism. This I expect, neither could I desire it to be otherwise, but would rather court the utmost freedom in the expression of opinions, which set one against the other, stand or fall, by the facts with which they are supported, and lead to truth—the great aim and end of all well-directed inquiries. This leads me to notice, before I close, what I daresay has not escaped the notice of you all—the desire shown at the present day,—by men engaged in the various pursuits connected with those arts which constitute the business of our lives,—to associate themselves together for the purpose of better acquiring a knowledge, and assisting the progress and development, of those objects to which their every-day labours are directed. The existence of scientific societies we have been long accustomed to, but it must be a matter of satisfaction and encouragement to us to observe so many of those engaged in the noble art to which we have the honour to belong, associated as we are, for the purpose of collecting and investigating facts, deducing from them truths, and the laws and rules by which the successful accomplishment of these great works have been attained, works which stand out as monuments of the genius, the industry, and wealth of our nation.

On the motion of Professor MACQUORN RANKINE, seconded by Mr. WILLIAM JOHNSTONE, a unanimous vote of thanks was passed to the PRESIDENT for his able and interesting address.
