INSTITUTION

OF

ENGINEERS IN SCOTLAND.

SESSION 1859-60.

THE FIRST MEETING of the Session was held in the Philosophical Society's Hall, Andersonian Buildings, George Street, Glasgow, on Wednesday, 26th October, 1859—WALTER M. NEILSON, Esq., President, in the chair.

The PRESIDENT delivered the following Introductory Address:—

GENTLEMEN—This being the first time I have been called upon to preside over your meetings, I must take the opportunity of acknowledging the compliment you have paid me in electing me your President; but at the same time you must permit me to express my regret that I am not more able to discharge the duties I may be called upon to perform. This I feel more particularly, when remembering that I succeed my friend, Professor Macquorn Rankine, who has so ably filled this chair during the past two sessions. I therefore ask your assistance in conducting these meetings, and in any other matters I may be called upon to undertake.

It is now my duty, in opening this our Third Session, to take a cursory view of what we have done in the past year, and lay before you, as far as I am able, somewhat of a prospective view of the subjects more immediately before us for consideration in promoting the objects of our Institution.

I have much pleasure in being able to state, that our Institution continues to prosper and improve, as the reports laid before you will show. Our numbers increase; our funds are sufficient, leaving a small balance to our credit; and what perhaps is as important and satisfactory, a greater interest in our favour seems to be springing up among those from whom we are entitled to look for support and co-operation.

Our papers last Session were not numerous, but highly important; and

the spirited discussions to which many of them gave rise, are a very satisfactory proof of the interest our members take in the subjects brought before them.

It is unnecessary to enumerate in detail the various papers that have been read, as they are printed in our Transactions for the year.

The papers on the Economic use of Steam, by Mr. Carmichael and others, gave ample opportunity for the expression of opinion, and the inquiry into facts on this all-important question, from which much information might be gained, particularly when aided by the sound and standard data of our valued member, Dr. Rankine, from whom I hope we will receive this Session additional information as to the results of his investigations into this subject.

The very practical matter of burning coal in locomotive engines, was fully illustrated by Mr. Stirling, Mr. Clark, and Mr. Yarrow; and the particulars of the experience of other engineers, detailed during the lengthened and interesting discussions on this subject, brought out important practical conclusions. As these gentlemen will now have had still greater experience of the various plans exhibited to us, we may expect further communications from them as to their practice.

We must notice the valuable paper by Mr. Bell on Patent Slip Docks. The immense convenience of these slip docks for such ports as our Clyde, is well known and appreciated by shipowners. Much praise is due to Mr. Bell and his partner, Mr. Miller, for the labour and attention they have bestowed in perfecting this important branch of engineering.

The various papers and discussions on marine engines and steam-vessels, British and American, could not fail to be interesting. I think, however, we might have more communications on marine machinery. The subject is a large and important one; there can be no want of experimental data and peculiar results amongst a large section of our members, which would be of value if recorded, and form most interesting subjects of inquiry at our meetings.

The subject of Patent-law Reform, which was brought before our notice by our secretary, ought still to have our attention. Whatever may be the difference of opinion as to the scale of charges enacted by our legislature for the privileges given to inventors, there can be no difference of opinion as to the propriety, or, I ought to say, the justice of applying the immense revenue obtained from patentees to the erection and maintenance of large museums, for the reception and exhibition of models of patents; and to the establishment of libraries for specifications, where, by proper care and arrangement, they might at all times be consulted without inconvenience.

We have had few papers on miscellaneous subjects, such as those on

frictional gear, by Mr. Robertson; and on centrifugal pumps, by Professor James Thomson. Although such communications may not of themselves bear directly on any important branch of engineering that may be before the world, still I consider this class of papers of great value, more particularly those which relate to improvements in machines or tools. We are much indebted to the great perfection to which tools and machines have been brought for the present state of constructive engineering, in whatever department, and for the great monuments of engineering skill and enterprise that have been raised of late years. No positive improvement on any tool or machine ought to be considered too trifling a matter to bring before our meetings.

The very valuable results of experiments on the strength of wrought-iron and steel, presented by Messrs. R. Napier & Sons, deserve special notice. These gentlemen, in making experiments, originally for their own particular information, carried them out to an extent, and put them into a form, which will be found most useful; and with their usual liberality, presented the whole to our Institution, to be printed in the Transactions. The most scrupulous care and attention bestowed upon these experiments by Mr. David Kirkaldy, under whose immediate superintendence they were conducted, has contributed very considerably to the value of the production; and the manner in which the results have been brought out, in the distinct tabulated form, is highly creditable to him. We have elaborate and reliable experiments on the strength of cast-iron, in various forms, by Hodgkinson, Fairbairn, and others; but there have not been sufficient investigations into the strength of the various kinds of malleable or manufactured iron. This deficiency will, we trust, be supplied by "Napier's experiments on wrought-iron." At the present time, when the construction of iron bridges on such principles as will require the least amount of material, occupies so much the attention of engineers, a knowledge of the correct value of the material they have to deal with is of the very highest importance. Great exertions, too, are being made by manufacturers to produce an iron of higher quality than hitherto known, at a moderate cost; and it is most desirable that some standard data be established, by which they may compare the result of their labours. I trust the Messrs. Napier will allow those experiments to be carried out much farther, and that Mr. Kirkaldy will communicate to us the result of his observations and experience in conducting them, as I have reason to believe he would bring before us some very interesting and striking facts, which have never yet been noticed, and add still more to the value of his labours, for which we are so much indebted.

Your Council took a leading part in an attempt to form an association in Scotland, similar to what exists in England, for the prevention of boiler

explosions, the economy of fuel, and prevention of smoke. Our exertions, however, met with no support from the public, nor from those for whose benefit more particularly the association was proposed—even those of our civil authorities who used boilers and produced smoke, declined to join in the undertaking, which was consequently abandoned.

The past year's Transactions contain memoirs of the late Mr. David Tod and Mr. Daniel Mackain, deceased members of our Institution, men whose unbroken friendship I have for many years enjoyed. Mr. Mackain took a very lively interest in our Institution, and we are much indebted to him for his zealous assistance, when in our infancy as a society.

Gentlemen—I feel it is good to meet together as we now do, were it only that we might know each other better, and be better able to appreciate each other's worth, and mourn each other's loss, as one by one we leave the fields of our labours.

The question of a decimal system of weights and measures is still much discussed. While it is everywhere admitted our systems are bad, and ought, as soon as possible, to be changed, what decimal system to adopt, and how to set about it, is a very vexed question. The advocates of Mr. Whitworth's system of the inch divided into a thousand parts appear resolved to push it into the workshops, while the committee appointed by the "British and International Decimal Association," has reported in favour of the adoption entire of the French metrical system. As you are aware, I do not agree with those who insist upon retaining our inch as the standard unit of measure of a new system; to do so, would be to commit, in my opinion, a grievous error. The metre, as subdivided by the French, appears to me to be as perfect a system as could be devised, and in every way most suitable for the purposes of the engineer. The arguments in favour of this system are many and powerful, and the difficulties in the way of its becoming universal are, I consider, little if any greater, than would exist in the changes that would be caused by adopting any other decimal system. So far as we are more immediately concerned, the question of measures is perhaps more important to us than that of weights, and as the matter will in all likelihood be decided rather by the adoption of one system or another by some of the leading engineers than by any act of the Legislature, it would be well that the members of this Institution should consider what they would recommend for the assistance and guidance of others.

The economy of the steam-engine at present occupies much attention, more particularly as applied to propelling vessels. The searching investigations of those scientific men who make it their province to inquire into the laws which regulate the action of heat in steam, and the skilful application of the knowledge to practice, now being carried out by many enter-

prising engineers, is likely soon to be productive of results which will be most valuable to the commerce of our country. It is gratifying to find our own Clyde foremost in this progress. Steam first floated on her waters; she first gave to the sea-waves iron-built ships; and I trust she ever will be first in the perfecting of her offspring.

Your late President, in his last year's address, noticed the successful efforts of Messrs. Randolph & Elder, who in the economy of fuel of marine engines had surpassed all other makers. We may now add the efforts of Mr. John M. Rowan, as having gone beyond an experiment in obtaining a still greater economy—a result which has created among engineers and shipowners a considerable degree of excitement and expectation, and I doubt not it will ere long be proved that the system adopted is the one to which we must look for economy of fuel in our marine engines.

I do not intend to enter into the theoretical question of the conduct of heat, as produced on the grate bars by the chemical action of combustion, and communicated to water as the best medium we know by which to develop its force in the steam-engine. Much has been written and yet will be written on each successive step, and much has to be done, as we are evidently yet far from perfection in any point of the process. Professor Rankine, at the commencement of last Session, drew your attention to several important facts relative to the laws which regulate the mechanical action of heat in steam. We are much indebted to him and to Dr. Joule of Manchester (now an honorary member of our Institution) for their valuable researches into this subject. The attention of practical engineers ought to be given to the results of these researches. We are apt to overlook that it is heat, and not steam merely, we must deal with. The combustion of the fuel ought to be so effected, that the greatest possible quantity of the heat obtained should be communicated to the water, and as little as possible lost or wasted by improper arrangement of the furnace, management of the fire, or of the draught. Much heat is necessarily carried off in the products of combustion, which we have as yet no means of utilizing. The question of volume of steam used in the cylinder of the steam-engine, so as to develop the greatest amount of force from a given amount of heat, is an important one. We may have the same quantity of heat either in a smaller or larger volume of steam; and if we condescend upon the limits to which the elastic force of the steam be allowed to extend, then it would appear that the smaller volume of steam containing the greater quantity of heat employed as the initial volume to be acted upon, gives the greater economical result in force developed. As steam on its expansion decreases in temperature, no portion of its original heat should be allowed to be taken from it by any external agency during its action in the cylinder. Not only ought the steam to be

maintained at its maximum density, for its actual temperature due to the amount of expansion, but considerable gain of elastic force may be obtained by increments of heat, according to the law of elastic fluids; and particles of water held in suspension, may also thereby be converted into steam. Steam jackets, or other means of maintaining the cylinders at or above the original temperature of the steam, consequently effect economy in this respect. Superheating steam, in its passage from the boiler to the cylinder, has been practically found by Mr. Penn of Greenwich to give an economy of about 20 per cent. over the ordinary use of the same steam in marine boilers. It would be interesting to know the comparative economy obtainable by similarly superheating the steam in a steam jacket round the cylinder. I apprehend, however, a practical difficulty will be found in using anhydrous steam at high temperatures, from the absence of that lubrication which saturated steam provides. Superheating may no doubt be applied with advantage to existing steam boilers and engines, but it appears to me the great economy is to be looked for in the proper use of steam at high pressures, or rather high temperatures. For marine engines this necessarily requires surface condensation, to obtain pure water for the supply of the boilers. The three grand requirements may be stated as—a safe and suitable boiler for pressures of 100lbs and upwards; a good arrangement of engine to receive the initial force of the steam without shock or liability to derangement, and carry out expansion to the greatest practical limits; and lastly, an efficient surface condenser. I have for many years looked forward, with unshaken confidence, to the time when long sea voyages would be practicable and profitable by the means I have just named, and it gives me the greatest pleasure and satisfaction now to believe that that time is at hand, if not already come.

Without any acknowledged principle or rule, shipbuilders seem to have arrived at considerable perfection in the form of their vessels. Nevertheless, the importance of the discovery of some law by which these forms would be more definitely regulated, is acknowledged by both scientific and practical men. As you are aware, a committee appointed by the British Association have had this subject under their consideration for some time, and are endeavouring to collect data for their guidance; but as yet we have had no particular results from their labours. It is much to be regretted that our own members do not bring before us draughts of vessels they may have built, with their results. It is needless to observe how much such a practice would assist in arriving at a more definite knowledge of the proper forms of vessels, an object as much to be desired by the builders themselves as by this Institution or the public. No doubt the skill possessed by a shipbuilder in forming his vessel, is a valuable part of the capital of his business. But the general good that would

accrue from the perfecting of such an important art as the modelling of vessels, ought to outweigh all narrow-minded or selfish considerations. I would therefore appeal to the liberal spirit of our shipbuilders, and should it be considered desirable not to publish to the world such data as they may favour us with, the information might be retained for the exclusive use of our own members, and not printed in our Transactions, unless by special permission.

It is gratifying to notice the success of the spirited efforts to obtain high speed by our river steamers. We may safely say that no steamers in the world surpass some of those on the Clyde in speed. The power, in proportion to the displacement necessary for such speeds as twenty miles an hour and upwards, is indeed very great. But when speed is essential to success, as is the case with the steamers in question, the cost is warrantable.

It is very different, however, with the bulk of sea-going steamers, where cargo, and not passengers, is what profits must be made from. The true value of such vessels may almost be reduced to the two following properties—quantity carried; and cost per mile. It is by these a merchant shipowner ought to judge of the value of his ship, not by its length, breadth, or horses power; these last may be left to the builder and engineer, and may constitute the cost, but not the true value of the vessel.

The construction of light draught paddle steamers for shallow river navigation, has of late had more than ordinary attention. Several such vessels for towing trains of barges, have been sent to India; but with what success they have performed the work anticipated, has not yet been made public. The difficulty in steaming against strong currents in shallow rivers is very great; the practicability, in a commercial point of view, may even yet be questionable, and some means may have to be resorted to, by which the power may be applied to the bed of the river, instead of the shallow, rapid-running stream, with which so much power must be expended to obtain sufficient resistance.

The use of the propeller in canal navigation continues to give satisfactory results. A vessel is now completed to carry passengers on the Forth and Clyde Canal, propelled by a screw. Even coal barges can be conveyed more economically by propeller engines than by horses. A simple, cheap, and easily-applied arrangement of machinery is much wanted for this purpose. The power necessary to propel a coal barge at the slow speed required is so small, that one of our members, Mr. James Ferguson, suggested a compact portable engine might be made, to fix to the deck of any barge, and be removed to another while the loading and discharging was being done. Certainly such a scheme does not appear impracticable, and would be very economical for the coalmaster.

The enormous capital invested in railways causes the question of

railway economy to be one of the greatest importance in the hands of engineers. If by any means the working expenses of railways (averaging about nearly the half of the whole receipts) could be reduced, a great boon would be conferred upon the public. It may not be expected that this much-desired object will be accomplished by one great or sudden step; on the contrary, it would appear more reasonable to expect that the persevering efforts and attention of the engineer should, by gradual means and many small improvements, bring us to a more satisfactory position in this matter. I may mention the use of coal instead of coke, in the locomotive engine, as one great step towards the end in question. The practicability of using coal instead of coke in the locomotive, without producing an offensive quantity of smoke, is now admitted. We, however, have yet to know which of the numerous schemes before us—some involving complicated arrangements, others remarkable for their simplicity—gives the best economic results. Much valuable information is yet to be obtained from reliable experiments on the various kinds of coal, both as regards the economy in steaming, and the effects produced upon the fire-box and tubes by impurities in the coal.

In a series of experiments now being made upon a railway out of London, some extraordinary results have been obtained by the use of water as a lubricator for carriage axles. After running 1600 miles, a bush was taken out of an axle-box and weighed; on being compared with a similar bush that had run the same distance with ordinary grease, it was found the bush with grease as a lubricator had lost seven times the weight the bush with water as a lubricator had lost. The great superiority of water as a lubricator over any other substance known, seems to be satisfactorily substantiated; but the difficulty of retaining the water in the axle-box had not been completely overcome, although runs of upwards of 300 miles had been repeatedly accomplished, without any additional supply of water having been required.

Efforts have been made to obtain a more effective mode of quickly braking a train, in order to avoid as much as possible accidents from collisions. Various schemes have been experimented upon, and put before the public. Without enumerating them, I would only remark, that we not only require a brake that may give satisfactory results at an experiment, when the men are prepared to work them and everything is put in the best of order for trial; we require some simple arrangement that needs no preparation, but in the ordinary handling of a train is always ready to be acted upon. The engine-driver, I apprehend, is the proper person in whose hands the safety brake ought to be put; his eye is always on the road; and if he could suddenly brake all the wheels of his engine and tender, which together often equal the weight of the whole

train, the concussion would be sufficient communication to the guards to let off their brakes by some spring and catch arrangement such as proposed by several inventors.

Much has been done of late years in the more economical construction of the permanent way. The average cost of lines of railway made during the last ten years may be taken at £10,000 per mile, whilst for railways made before that time the average cost was about £34,000 per mile. Recently, however, single lines have been made in Scotland at as low as about £5000 per mile. The enormous cost in forming lines with ordinary gradients, in unfavourable localities, is strikingly exemplified by those great structures, which, whilst they give to the engineer opportunities of displaying that skill and experience we may have reason to be proud of, at the same time render many great undertakings all but ruinous to their promoters. Should it be impossible altogether to avoid the necessity of such works, it is not unreasonable to expect that means may yet be discovered very much to diminish the cost of them. One thing is evident, unless we can fall upon some less expensive railway system, many thinly populated districts of our country must long remain shut out from that busy intercourse in which progress and improvement are found, and landowners there must be content with the diminished value of their lands.

Civil engineers have had full sway over the immense capital placed at their disposal in carrying out the objects of the promoters of our great schemes, undertaken for the investment of surplus capital, and for the benefit of the district of country in which the undertaking may have been located. In one view, it may not be matter of regret that the engineer has somewhat overlooked the second or ultimate object desired. It has given us the great works we have alluded to, and the results of many experiments, which, under other circumstances, the world could not have possessed. But, unfortunately, it has also bequeathed to many of these localities, favoured with such railway monuments, a perpetual and heavy tax upon that great necessity of their lives, locomotion. We cannot blame those men who have lived, and been the instruments by their great genius, skill, and industry, to fulfil the needy capitalist's demands. Their labours have been honourable, and their works most useful as examples of the past; but now, may we not rest satisfied, may we not even be satiated, with great works, and for the future be prepared to give the palm to economy of capital, in carrying out the many great and useful works yet requisite to supply the wants of advanced civilization?

The field of civil engineering is a large one, and I cannot within the limits of this short address, even were I capable, attempt to go over in detail the various departments, in which we would find a vast amount of

important and interesting subjects for inquiry and discussion. The very great and apparently difficult work of the drainage of our large and increasing towns yet to be accomplished, would of itself, if touched upon, occupy all our time and attention; not to mention the supply of towns with water, of which, perhaps, we have the finest example in the world in our Loch Katrine scheme, all but completed. The construction of harbours, docks, river and canal navigation, telegraph works, and many others I must pass over, in the hopes that at a future time they may be taken up by more able hands.

Your late President last Session stated, he was sure that all the members concurred with him in regretting that that unparalleled work of Mr. Brunel and Mr. Scott Russell was still unfinished. I am sure we must now feel much gratified that the *Great Eastern* is at last, we may say, finished. The result of the gigantic practical experiment to be made by this utmost effort of the enterprise and skill of our country, is looked forward to with almost feverish expectation by all engineers, and not without great interest by the world at large.

We cannot but pause here to pay a passing tribute to the memory of Mr. Brunel, who, notwithstanding his failures and his faults, was still a great engineer. Borne down by difficulties in realizing those gigantic schemes which overwhelmed him by their greatness, it was sad to see him fall at the moment when his greatest but most hard-won victory seemed all but gained.

But we have also now to lament the loss of another chief, whose career was more successful, and his works not less great. It becomes us, met as we now are, to express our sorrow for the death of Robert Stephenson, and pay our meet tribute to his memory. Although a stranger to us here in person, his name was familiar with us as a household word. Who among us does not know the works of this great man? They are monuments from which ages will not efface his memory. I will not presume but to repeat what has already been a thousand times repeated of him, who, like all truly great men, "was as good as he was great; and the man was even more to be admired than the engineer. His benevolence was unbounded, a man of the soundest judgment and the strictest probity; with a noble heart, and most genial manners, he won the confidence of all who knew him. Without a spark of professional jealousy in his own nature, he was liked by all his fellow-engineers. He has passed away, if not very full of years, yet very full of honours. The creator of public works—a benefactor of his race—the idol of his friends." Such was the son of a once very poor man, risen to too high a fame to be tarnished by the empty titles of common men. He dies—the nation laments his death, and gives to his burial the highest honours of the illustrious dead.

Permit me, in conclusion, to say a few more words about our Institution. It is very gratifying to find that we seem to be looked upon with increased favour as we progress. At our commencement, many who were qualified to join us seemed indifferent, and showed reluctance to enrol themselves with us. Many of these have now come forward, and I have reason to believe others will follow their example. There are many members on our roll who never attend our meetings; many cannot conveniently do so whose names we are glad to have. But there are others who content themselves with having our transactions, and imagine they obtain all the benefit that others do who attend regularly. This is a great mistake. No doubt the greater part of the papers are printed, and also a portion of the leading discussions; but that most valuable benefit arising from communication of ideas, and the opportunities of gaining information by question and reply, is lost to the absentee, and this, in my opinion, is one of the most important advantages obtained from our meetings. I have been asked, What good our meetings could do? Now, there are men who practise engineering, in one department or another, for the mere purpose of making money, without a higher object. And there are others who, when they also desire to make money, derive much of their pleasure in life from the line of their profession. That such an Institution as we profess to support will be valued and appreciated by the latter class, I need not mention. They are conscious that everything which advances the profession or art to which they are attached will advance themselves, and they feel proud to be in the foremost ranks in the progress; but the mere money-maker may find it to be to his pecuniary loss to be in the rear of the movement, in which, and by which he lives. Engineering cannot be stationary in such times as we live in; its forward strides are so great and rapid, that any one who desires to keep up with the leaders must embrace every aid, and use it diligently. If we go into a factory or engine-work, we there see the thousand instruments, the workmanship of a thousand hands. As we look upon that noble steamer, or that fiery engine, and the architecture over which it speeds, we admire the mechanism of the machine, and the beauty of the structure; but ere the form was given to these works, the mind conceived the image of the object, and knowledge and experience were the roots from which all sprung; not the knowledge or wisdom of one man, but the perfection, step by step obtained from many minds—the brain-work of many men. Can any one say that meeting as we do to interchange the knowledge and experience we daily gain, we do no good. Do we not add knowledge to knowledge, experience to experience; assist each other's progress, and hasten forward those great works which have done so much for the comfort, the peace, and the civilization of the world?

Professor RANKINE proposed that the meeting should pass a cordial vote of thanks to the President for his very admirable address. He had never heard so full a statement of the condition of any profession as that which they had just heard from Mr. Neilson. He had gone over all those branches of engineering whose present condition and progress were matters of interest, and had pointed out in the clearest way the advantages arising from discussing them in this society. He thought that addresses such as they had now heard were of very great utility to point out the work before them, and to indicate what sort of information and what subjects for discussion required their attention. They also formed a periodical record of the progress that engineering had made, and the parts of it in which progress was needed. He proposed that a cordial and unanimous vote of thanks be passed to Mr. Neilson for his address.

A paper was then read entitled:—

On the Restoration of the Great Chimney at the Crawford Street Chemical Works, Port-Dundas, Glasgow. By Mr. D. MACFARLANE.

A lengthened discussion followed the reading of Mr. MacFarlane's paper, and a vote of thanks was passed to him for it; and also to Mr. Townsend, the proprietor of the chimney, for exhibiting the tools used in the restoration.

Professor RANKINE then exhibited and described

Mein's Improved Machine for Making Glass Bottles.

Professor RANKINE said, the object of the machine was to enable one man to do the work of four. It consisted of a mould formed in two halves, and with the neck portion turned downwards. The workman took a quantity of glass in a soft state, and after removing the top or cover, dropped it into the mould, when it settled down into the neck, in which was inserted a nozzle. He then shut down the lid or cover, and by means of a pair of bellows, introduced air through the nozzle. When the soft glass was blown into the proper shape, he opened the mould, and took the bottle out. The chief novelty of the machine consisted in the position of the bottle in the mould, and in the mode of blowing in the air. The machine was in use in the Clyde Bottle Works, St. Rollox.

A vote of thanks was passed to Professor Rankine for describing the machine; and to Mr. Mein for sending it.
