# PART II.

# PAPERS.

14th March, 1907.

## ADDRESS BY THE PRESIDENT.

### MR. RUSSELL SINCLAIR.

In opening the Thirty-seventh Session of the Association, I have first to thank you for the honour you have conferred by electing me to preside over its business and deliberations. It is a position that carries with it a good deal of responsibility and anxiety, and one that requires a fair share of energy to ensure that the result of the year's meetings and work will show that we as an Association have done something towards the object for which it was formed and incorporated, and which, as stated in its Rules and By-Laws, is "for the general advancement of engineering and mechanical science," and more particularly those branches of civil and mechanical engineering which tend to develop the resources of Australia.

I am confident that with the help of an energetic Council and the sympathetic assistance of all members generally, the Session will not be a barren one. As mentioned in the annual report of your Council for last Session, ending 30th September, 1906, the membership of all grades had reached the total of 149, as compared with 123 at the close of the previous year. This, while very gratifying as showing a marked increase, will, let us hope, be only one step in the upward grade, and that we shall go on steadily increasing our members till we have reached and passed the highest total of previous years, which was 190 in 1888.

During the year, thirty-four new members were elected, three resigned, four ceased to be members, and one was lost by death. Since the close of last Session I regret to say we have lost by death three other members, namely, Mr. R. M. Scott, an associate member, Mr. T. J. Grainger, and Mr.

R. W. Finlayson, members. By the death of Mr. Finlayson many of us feel we have lost a personal friend, and the members generally will feel the loss of one who, as member of Council and Vice-president, gave much of his time and knowledge to further the objects of the Association in which he always took a deep personal interest. We have, however, gained five by election since the close of the financial year, they being elected at the annual meeting in October. During the year eight regular meetings were held at which there was the very creditable average attendance of sixty, and the papers were not only most interesting and instructive, but elicited in most cases keen and animated discussions.

The past year was also made instructive by a number of visits of inspection to places of interest. These visits or excursions are a very valuable help to the usefulness of the Association, as there are many of our members who may not be in a position to attend a regular meeting but can join us in an excursion; and the Council will welcome any suggestions from any member as to possible visits. One item which is entered in the annual report under the head of excursions I would like to refer to specially, as it was something more than an excursion, namely, the conducting of a trial of the s.s. "Lady Northcote" by a committee of the Association made possible by the courtesy of the directors of the Balmain New Ferry Co. It would be a good thing if the Association could follow this up and at least once a year have some such investigation carried out by a committee appointed from the members, to conduct trials or tests and report to the Association. It would not only open the way to good discussions but would make the work of the Association really valuable and enable the transactions to rank with those of kindred associations. Other institutions, such as the Mechanical Engineers, do this, and though we have neither the membership, funds, nor scope of engineering development around us that these greater associations have, yet I feel confident that we have a large enough membership and many capable members who could undertake such a duty; and there are many suitable developments in general as well as marine engineering around us to ensure its being a success.

I am pleased to be able to say that an opportunity of conducting a series of tests and observations will be shortly afforded us by the directors of the Sydney Ferries, on the occcasion of the trial of their new ferry steamer "Kookoo-burra." A committee of members will assist in the test, and the results will be prepared and submitted for your consideration during the session at one of our general meetings. One other function referred to in the annual report is worthy of mention, that was the conversazione of kindred associations held in the rooms of the Royal Society. This was admittedly a great success, not only as a means of friendly intercourse between the members of each of the societies joining in, but from an instructive point it was most valuable to all, both seniors and juniors. It is proposed to hold a similar function this year, and it is hoped annually, and your Council look forward to the fullest support from all members, when the time comes to provide exhibits of interest, and by attendance.

The annual dinner held at Baumann's Cafe on the 2nd November was a most pleasant and successful function, and is now justly recognised as a fitting termination to our Sessions.

It is always difficult to select a subject for an annual address, and in looking round for a clue as to what would be suitable, it occurred to me that it might be both useful and interesting to glance briefly at the present position of mechanical engineering, noting what indications there are of future developments.

During the last century, and especially the more recent periods of it, there have been marvellously rapid developments in mechanical engineering: It has seen the birth and growth of steam navigation to its present position. The steam engine has developed from a crude mechanical apparatus using steam of 1 or 2 lbs. per square inch and consuming 11 lbs. of coal per horse power, to a highly perfected combination of mechanism, producing power with certainty and economy, regularly making use of steam up to 200 lbs. per square inch, consuming as low as 1 lb. of coal per horse-power. The perfecting of the steam engine has called into commercial being numerous allied services such as land transport, hydraulic and electrical transmission of power and lighting, refrigeration, ventilation, etc., etc., but to me it appears there are indications that the next few years will show even more startling developments.

The rapidity of development during the last twenty-five years has exceeded that of any previous period; in fact, it would almost appear that as time passes it is gaining impetus. It may be said that last century was the age of the steam engine. Who can say what this one will be? But present developments would almost tend to show that we are entering on an age when the internal combustion engine will be the dominating feature in mechanical engineering, and that the use of steam, as generated in a boiler, then used expansively in a reciprocating or rotating engine, will have a very energetic rival, and, it may be, will be, gradually supplanted.

The recent improvements in gas, oil and similar engines, when carefully considered, give colour to such an opinion. One indication of commercial value is that many large manufacturing firms who have been for many years engaged in making steam engines have recently either set apart portions of their works or built large additions, and in more than one instance acquired the works of other firms entirely for the manufacture of internal combustion engines. These, in addition to those firms who have for years been developing this class of engine, will surely have the result of so greatly improving the reliability of the type that I may be excused for having attempted to forecast that the internal combustion engine will run the steam engine a very close race for supremacy in the near future. One feature that is in favour of the internal combustion engine for general use, in Australia at least, is that in the great bulk of plants the power to be developed is comparatively small, not justifying the initial cost of compound or triple expansion engines. With a single cylinder non-condensing engine the consumption cannot be much reduced below 40 lbs. water and 5 lbs. fuel per brake h.p. per hour; while an ordinary gas engine using town gas can be relied on to give one b.h.p. for a consumption of 23 cubic feet gas of 650 units value, which is equal to 1.095 lbs. of coal, or, to give it a money value comparison, taking coal at the low average cost of 10s per ton, and gas at 4s. per thousand, the relative costs per b.h.p. per hour are: gas, 1.11 pence; steam engine, .268 pence. The gas engine using town gas must therefore depend on its greater convenience and less attendance for its preference to steam.

It is in the use of producer gas that the gas engine will really depend for its progress. The pressure producer gas, as for example the Mond and similar systems, in which the gas is usually generated in a generator, though in the later plants dispensing with a gasometer with all its attendant apparatus for scrubbing and cleaning and steam boiler, has so far only been practicable for relatively large installations, where the power exceeds 150 h.p.

During the last ten years, however, the introduction of and improvements in the suction producer gas plant has placed in the hands of the mechanical engineer an apparatus for the economical production of power in small units which promises to be very rapidly developed.

We recently had a paper read before the Association on one type of this plant, and I have hopes that some of our members, who have experience in the subject, will favour us with another during this session, as it is peculiarly interesting.

Briefly, the suction gas plant consists of a vertical circular iron cylinder lined with firebrick, with a grate at bottom and closed at top by a hopper. The action of the gas engine produces a suction effect which is made use of to draw air to the grate and through the fuel in the generator. The generator is surrounded with a water-jacket, the vapour from which is also drawn through the fuel along with the air supply. The gas passes through a cylindrical scrubber, which is filled with coke, over which water is continually sprinkled, the gas being washed and cooled; it then passes through an expansion box to the engine. The gas produced is of course of a low calorific value—only about 130 to 150 b.t.u., which means that a gas engine of a given size will develop considerably less power on suction gas than on town gas. The proportion is usually about 12 per cent. less. Owing to the danger of clogging the valves of the engine only anthracite coal, or coke, can be used, but as in Australia no anthracite is available, coke has to be used; this is usually ordinary gas coke, as there would not be sufficient draft to burn oven coke. The consumption of gas coke has been found to average 1¼ lb. per b.h.p. per hour, which, at coke costing 17s. per ton, works out at .117 of a penny per b.h.p. That is to say, that a 10 b.h.p. engine could be run 8 hours for just under ninepence halfpenny (9½d.).

As indicative of the progress made with suction gas plant I might mention that two British firms have between them turned out over 1800 plants in a few years, while in Australia and New Zealand it is estimated that there are over 100 at work.

Gas engines with gas producers are now being tried for use on board ship instead of steam boilers and engines. So far the progress made has not been very great. I believe a test plant was recently made by the Admiralty, while Messrs.

Beardmore on the Clyde have built a launch 60 ft. x 10 ft. x 2 ft. 6 in., fitted with a suction producer plant and gas engine. The engine is of the 4-cylinder type, 60 h.p., running at 360 revolutions. The space occupied by the plant is 8 ft. 3 in. x 3ft. 9 in. x 6 ft. high, which is less than what would be occupied by a boiler and engine. The same firm have under construction a much larger plant for a cargo boat, which has had steam engines, so as to give a comparison with previous records. The results will be of extreme interest. A similar experiment is being tried in Melbourne at present, where the paddle steamer "Queen" has her engines and boiler removed and is now being fitted with two complete sets of vertical gas engines and suction producers, each engine driving a propeller at one end of the vessel. The total effective horse power being 140. I am informed by Messrs. Walsh and Co., who are doing the work that the saving in space will be 50 feet fore and aft, and the saving of weight 14 tons as against 45 tons.

To show the recent developments taking place in Europe in gas engine practice for large power, I give the following figures gleaned from several papers read at the last meeting of the Iron and Steel Institute, describing the working of gas engines using the waste gases from blast and smelting furnaces. In Germany alone there are over 349 engines with a total effective horse power of 385,000, as much as 35,000 effective h.p. being at one single works. In other continental countries there are said to be 176 engines, aggregating 166,000 h.p., while in Britain there are reported to be over 242,410 h.p. Most of these engines are about 1000 h.p. each, while engines of 2000 h.p. are not uncommon.

As it was only about ten years ago that the idea of adopting blast furnace gas to be burned directly in the cylinders of a gas engine was first mooted, such a development is remarkable.

An interesting feature of these large gas engines is that many of the largest are double acting on the four cycle principle, the valves being arranged similarly to the drop valves on a trip gear steam engine, that is the admission valve on top and the exhaust valve on bottom of the cylinder.

Of other types of internal combustion engines, I need only mention the enormous development in the use of those working with petrol. benzine or kerosene, as applied to motor cars, launches and small power engines for agricultural and general uses. Everywhere we see their use being extended, and it cannot be denied the difficulties which were at first experienced are being gradually got over, and a more reliable engine being evolved

We have onlv to read the technical journals to note how rapidly the use is extending. In agriculture in Great Britain farmers are using motors for field work such as plowing, etc. In every harbour motor boats are being built in extraordinary numbers, they are being adopted now for trading vessels, while the Admiralty are testing them for torpedo and similar fast moving craft.

We have already had these brought before us, but there is scope for members to give us many papers on different subjects, relating to these engines, dealing with the different features of the various types and advantages of benzine, petrol or kerosene, four or two cycle, the supply of fuel under pressure as in the Diesel engine, or by suction.

The boldest attempt so far in Australia at the adaptation of the internal combustion engine to a vessel for commercial purposes is that of the twin-screw vessel "Motor Gem," recently built in Sydney by Holmes for the Gem Ferry Co. Proprietary, Ltd. This vessel is 86 ft. overall length, 17ft. 6in. moulded beam, 6ft. moulded depth, 4ft. draft.

There are two sets of Jersey City Standard Oil Engines, each with 4 cylinders 8in. dia. x 10in. stroke, the propell rs are each 36in. dia., with 3 blades and 4ft. 5in. pitch. The engines run at 400 revolutions per minute, and each indicate 72 h.p., or together 144 i.h.p.

The vessel is certified to carry 203 passengers in Port Phillip. On her trial trip in Sydney Harbour over the mile in January last a speed of ten knots was made, but since then she is reported to have improved this to 12 knots. While not being actually built for the purpose of ferry service but rather for excursion traffic, she has frequently been employed in running the service between Port Melbourne and Williamstown piers, a distance of $1\frac{3}{4}$ miles, and has proved very suitable, making and leaving the wharves satisfactorily.

During a recent visit to Melbourne, I had an opportunity of inspecting her, and was informed by Captain Strickland that the engines give no trouble and are easily handled. The actual consumption of benzine being under 14 gallons per hour. This works out at the equivalent of .97lbs. coal per i.h.p., taking benzine as 16,000 b.t.u., or equal to 1.25lbs. of coal. The vessel is worked by three men and a boy.

I should mention, however, that the vibration of the machinery is felt to a considerable extent; this, however, could probably be greatly reduced.

The subject of the internal combustion engine cannot be left without mentioning the increasing use of alcohol as a fuel. In Germany and other continental countries for some years past alcohol in the form of methylated spirits has been used on quite a large scale for small power engines such as motors, and especially for small agricultural motors, and the United States Government have recently deputed practically one department to collect all possible information on the subject for the purpose of ascertaining the possibilities and advantages of its adoption, which will in due course be issued as a bulletin for the benefit of manufacturers and others in that country.

Though alcohol has a lower heat of combustion than oil, benzine or petrol, being only about 11,000 b.t.u., yet when used in a motor its efficiency is more than twice as great, and if its first cost to the consumer can be regulated so as to be at a price equal or lower than the latter, there is no reason why the development of its use should not greatly extend.

The price will depend on the excise regulations of the Governments of the different nations. In Great Britain since September last year methylated spirits for commercial use are duty free, while the present regulations of the United States of America now also permit methylated spirits free of duty, and this, I am glad to say, is the case under our own Commonwealth regulations

The great advantages in favour of alcohol over the oils are that it is not so dangerous, as it is not so explosive by radiated heat, and should it catch fire, it can be put out by water, while water only tends to spread a fire of benzine or petrol. Most important of all is that so far all fuel oils have to be brought oversea to us, and we are therefore subject to variations of supply and stocks, while an unlimited supply of alcohol can be manufactured within the Commonwealth. Its development as a motive power is therefore worth our attention.

But while the internal combustion engine is being so rapidly developed, there are continued improvements taking place with the steam engine, which in conjunction with its great convenience and reliability will for a very long time yet assure it the premier place. In the selection of a motive power for any desired purpose it is not only the lowest ratio of consumption of fuel per horse power which has to be taken into account, but conditions relating to space, adaptability to the nature of the business, the accessibility of fuel and the reliability of the machine under variations of load, with also the intelligibility and training of the available attendants in charge.

The steam engine has been gradually improved so that it is possible with a well designed multiple expansion condensing engine to obtain a result of 14lbs. of steam per i.h.p.

per hour, and with the use of 130 degrees super heat this can be reduced below 12lbs. of steam, these figures being of course for fair sized units.

The developments of recent years in steam engineering have been greatly assisted by the requirements of our electrical friends, who have demanded engines of high speed and economy to drive their generators, and steam engineers are greatly indebted for this incentive to higher class work.

To meet the requirements of high speed work some years ago, the single acting engine, getting steam on the top of the piston only was evolved and greatly used, but even with the best type the economy was never great. With the introduction of forced lubrication the high speed double acting compound engine has been rapidly developed, and has practically displaced the single acting for this class of engine.

Forced lubrication is now almost universal, both for horizontal and vertical engines, and its adoption allows of greater horse power with lighter weights. A few years ago a piston speed of 300 to 400 was usual, now with enclosed type engines and forced lubrication 600 to 700 is common.

The developments on these lines have only been possible through the use of high class tools, most accurate machinery and the standardisation of parts. It is to the improvements in the manufacture of engines, ensuring a reliable prime motor, practically free from risk of breakdown or damage, that we may look for the steam engine retaining its position for many years yet.

During the last few years the increase in the number and size of steam turbines has been rapid, and it is interesting to note that it is in the direction of securing greater expansion in conjunction with high vacua apparatus that the turbine will lend itself for still further economies in the use of steam. In multiple expansion engines the total expansion of the steam is limited to from 8 to 16 times, thus rendering the increase of boiler pressure above 200lbs. useless as far as economy is concerned, and the amount of superheat that can be adopted is restricted by the difficulty of lubricating valves and pistons.

In the turbine the steam can be expanded usefully to ing neglıgible, and the amount of superheat that can be ap- any number of times, the internal friction with dry steam be- plied only short of what would heat the vanes and guides too much for the metal to stand.

The chief applications of the steam turbine so far have been to the driving of rotary machines such as dynamos, centrifugal and helical pumps, fans for forced and induced draft, blowers, and for the propulsion of vessels. One of the most interesting recent adaptations of the turbine principle is its application to blowing engines and replacing of large reciprocating blowing engines driven by steam engines for the delivery of quantities of air under a moderate pressure. In these a steam turbine of the usual Parsons type is coupled to what is practically a similar turbine with rotors and fixed guides, and as the steam turbine revolves by the action of the pressure and velocity of steam, the air turbine draws in at one end and imparts velocity to the air in the air turbine, as it passes each row of moving blades it receives an increment of velocity and pressure till it is finally discharged at a pressure of 10 to 15lbs.

A number of these turbine fans have been set to work in England. In one experimental instance an air pressure of 60lbs. per square inch was actually obtained.

I am informed that one of these machines has been recently set to work at the Lithgow Iron Works of Messrs. Sandford, for supplying 20,000 c.f. free air per minute to the blast furnace, against a pressure of 10lbs. per square inch, but capable of delivering it to 15lbs. pressure when required. I am in great hope we shall be favoured with a paper on turbines this session.

It is of great interest to recall that this year is the centenary of steam navigation on a comercially successful basis, as it was in 1807 that Robert Fulton built and first ran on the Hudson River in America the steamer "Clermont," which made the first really successful voyage by steam from New York to Albany, a distance of 150 miles in 32 hours against current and wind. The success of the "Clermont" was such that she was soon advertised, and continued to ply regularly for traffic for years. The "Clermont" has therefore the right to the honour of being the first commercially successful steam navigated vessel.

The present wonderful position of marine engineering cannot be better emphasised than by briefly glancing at the difference between that vessel and the gigantic proportions of the two largest steamers ever built in the world, viz., the new Cunarders "Lusitania" and "Mauritania," which are expected to be running shortly. The "Clermont" was of the following dimensions:—Length, 133ft.; beam, 18ft.; depth, 9ft. She was fitted with paddle engines, made in England by Boulton and Watt, having one cylinder 2ft. dia. x 4ft. stroke, which were said to be 20 h.p. The dimensions of the Cunard vessels are:—Length overall, 785ft.; depth moulded, 60ft. 6in.; beam, 88ft.; gross tonnage, 33,500 tons; maximum draft, 37ft.; displacement at 37ft. draft, 43,000 tons; total i.h.p., 68,000; speed, 25 knots per hour. To obtain this speed the coal consumption will be approximately 1050 tons per day. This is truly a marvellous development in one century. The system adopted for the propulsion of these vessels has been, and will, for a long time be a matter of keen interest to all engineers. The fact of their being four propellers driven by four lines of shafting, the two inner shafts revolving outwards, while the two outer shafts revolve inwards, when going ahead, constitute a departure in Naval Engineering, the results obtained from which in actual practice will be of great interest.

The results of the adoption of the system of steam turbine for driving the propellers are being eagerly looked for, as on the data obtained will greatly depend whether the development and adoption of this type of engine for mercantile naval work will be rapid or otherwise.

The two inner shafts are driven by the low pressure turbines, the two outer shafts by the high pressure turbines. On the inner shafts are fixed the two go astern turbines.

That special concern has been given to one feature of steam turbines, which has been reported to be a defect not yet overcome, is shown by the method which has been adopted for fixing the blades. Instead of each blade being fixed in separately with a packing piece and caulked, the circle of blades is built up in segments, which are afterwards wedged into grooves in the rotors or casings.

It is always difficult to obtain accurate information as to failures or troubles, but it has been said that the liability of the blades to come out and cause considerable damage to the remaining blades, as the mass revolves rapidly, has been one of the reasons which influenced a rival Trans-Atlantic Steamship Company to adhere to the reciprocating engine for their newest vessels.

We engineers in Australia being so far removed from the seat of these gigantic operations can only look on with intense interest at the development of what may aptly be termed a war of Titans.

To illustrate the rapidity of development in the use of the turbine for marine work, I am able to give the following figures. Up to the present 26 of the principal shipbuilding and engineering companies in Britain and five in the United States have taken up licenses to maufacture steam turbines on the Parsons system. At present the British Admiralty have under construction to be fitted with turbines no less than twenty-four first-class torpedo boats, seven 30-knot destroyers, one 36-knot destroyer, 3 first-class cruisers, and 3 battleships. In addition there are several cross channel steamers and ocean-going passenger steamer being