sulphonation process, as we now call it. These two sulphonic acids are, of course, of first-rate importance in the dyestuff industry, the β-acid being the source of β-naphthol, one of the most important dyestuff intermediates. Sulphonation is used for rendering all classes of dye soluble in water.

The history of the development of dyestuffs, from Sir W. H. Perkins' discovery of mauve in 1856, by oxidising crude aniline from coal tar by means of sulphuric acid and bichromate, down to the latest discoveries of modern times, is extraordinarily well told in the catalogue of the exhibition. Perkins' mauve was a beautiful shade on silk (a dyeing of a preparation made by Perkin himself is shown), but it is fugitive and became superseded by better dyes. The primitive artificial dyes were safranine, the magentas, and the Manchester group (aminoazobenzene, Bismarck brown, Manchester yellow), then followed Witts' chrysoidine, the tropæolins, azo scarlets, and reds (from β-naphthol). A sensation was caused by the direct cotton dyes (1884), then followed the gay but fugitive triarylmethane dyes. Synthetic alizarin and some of its congeners were developed by Perkin in England and also by German chemists; later came the fast acid anthraquinone dyes, to be followed at the beginning of the twentieth century by the wonderfully fast anthraquinone vat dyes. Jade green, the most brilliant and fast of this series, is a British post-War development, as is also an improved form of indanthrene blue, the great discovery of Bohn. The indigoid dyes, sisters and cousins of indigo itself, in shades of yellow, blue, red, and violet, form a gay quartet and arouse speculation as to the influence of constitution on colour. In this connexion there is a remarkable series of dyes of the indolenine series, basic dyes containing two substituted indolenine groups joined by a chain of $(:CH\cdot)_n$ groups. When $n=1$ the colour is yellow; $n=3$, pink; $n=5$, blue; $n=7$, green. In other words, in this series an absorption band moves right across the visible spectrum as the length of chain increases. This series will interest students of the carotin series of natural dyes. Finally, mention must be made of Prof. Robinson's exhibit of preparations of synthetic flower colours and their chemical relationships.

Power.*

By Sir ALFRED EWING, K.C.B., F.R.S.

TO explain the task of the Bramwell lecturer we must recall the meeting of 1881, when the Association was celebrating its jubilee in the heyday of Victorian prosperity and confidence. It was a jubilant jubilee. Never, perhaps, was applied science more actively progressive. From day to day its achievements compelled attention. Electricity was knocking at the door, bringing a wallet big with gifts, wonderful gifts that established new contacts between the sciences of the laboratory and the arts of social life.

Think for a moment of what the late 'seventies and the early 'eighties gave to mankind. The telephone, the phonograph, the incandescent lamp, the dynamo in a practical form, the electric motor, the storage battery, the transformer, the internal combustion engine using liquid fuel, cold-storage and refrigerated transport of food, the idea of public electric supply, the use of alternating currents, the first clear recognition of the potentialities of electricity as an agent for lighting, for traction, for the conveyance and distribution of power. There, indeed, was a dish to set before the potential rulers of a kingdom which was waiting to be explored, where every engineer in the bud might well fancy himself to be a coming king.

> "Bliss was it in that dawn to be alive,
> But to be young was very heaven."

Among those fertile years I would specially mention 1881, which was the date of Bramwell's prophecy as well as the jubilee of the British Association. Apart from that, it marks an epoch. For the world then realised that a problem was at last solved with which it had been much concerned, the problem called the subdivision of the electric light. Before that the electric light had meant the electric arc—a dazzling unit, brilliant, overpowering, capricious, admired out of doors, but quite unfitted for the home. It was a tiger burning bright which declined to become a domestic pet.

Then came Edison and Swan, who, working separately, taught us how to tame it by inventing the incandescent filament enclosed within a vacuum bulb. Near the end of 1881, Sir William Thomson (as he then was) lighted his house in Glasgow by means of Swan's lamps. For prime-mover he chose the new gas engine of Dugald Clerk, which completed its cycle in two strokes, unlike the already familiar Otto engine, which required four. Clerk's engine was itself a novelty the importance of which we have come to recognise. To this day all internal combustion engines use either the Clerk or the Otto cycle, and for large powers the Clerk cycle has advantages which tend to give it the favoured place.

Fifty years ago the gas-engine was much in the public eye. No engineer who gave the matter serious thought could fail to see the advantage of having heat developed within the working substance itself instead of being conveyed to it by conduction through a containing shell. Another obvious merit of internal combustion was one that Carnot had recognised in the immortal little treatise where he laid the foundations of thermodynamics —the advantage which you secure by supplying heat to the working substance at a much higher level of temperature than can be reached with steam. Finally, there was this broad difference: the gas engine had the indefinite promise of youth;

* From the presidential address to Section G (Engineering) of the British Association, being also the Bramwell Trust Lecture, delivered in London on Sept. 25.

the steam engine was an old servant the limitations of which were well known. Nobody expected that steam would change its ways. Small wonder then that the engineers of those days looked to the future of the gas engine with exaggerated hope.

It was in that spirit that Bramwell made the prophecy we have now, after fifty years, to review.

At the jubilee meeting in 1881 he gave an address "On Some of the Developments of Mechanical Engineering during the last Half-Century". It reviews a great field with the lucidity of which he was a master, dealing specially with applications of the steam engine, and it includes a section relating to the transmission of power. Electrical transmission is barely touched on: it had, in fact, scarcely begun; but he speaks of transmission of power by means of gas, and in that connexion he remarks:

"I think there is a very large future indeed for gas engines. I do not know whether this may be the place wherein to state it, but I believe the way in which we shall utilise our fuel hereafter will, in all probability, not be by way of the steam engine. . . . I very much doubt whether those who meet here fifty years hence will then speak of that motor except in the character of a curiosity to be found in a museum."

Bramwell returned to the question when president of the British Association in 1888. In his address he repeated the forecast of 1881, and added: "I must say I see no reason after the seven years which have elapsed since the York meeting to regret having made that prophecy or to desire to withdraw it". It is evident that he took his 'prophecy' very seriously. He was the acknowledged sage and spokesman of the engineering profession, occupying, in that regard, a unique position, such as no one could possibly hold in the more complex conditions of to-day. He was a humorist, and doubtless there was a conscious touch of humorous exaggeration in what he said; but for all that it was an engineering judgment delivered *ex cathedra*, and his judgments were accustomed to command respect.

Finally, when within a few months of his death, at the age of eighty-five years, he wrote to the president of the British Association, saying that he wished to keep alive the interest of the Association in this subject, and for that purpose offered a sum, which was to be paid as honorarium in 1931 "to a gentleman to be selected by the Council to prepare a paper having my utterances in 1881 as a sort of text, and dealing with the whole question of the prime-movers of 1931, and especially with the then relation between steam engines and internal combustion engines".

That is the task I am now attempting to discharge. The prediction has, in great measure, failed to come true. Steam is neither dead nor dying. To-day, it is a much more efficient medium than it was for the conversion of heat into work, and we find it actuating engines of vastly greater individual and aggregate power than any that were even imagined when Bramwell spoke. But alongside of that we have wonderful achievements on the part of the internal combustion engine which go far to justify the enthusiasm that stirred him fifty years ago.

Looking back now, one is amazed at the boldness of his prophetic outlook. It was more than bold; it was almost foolhardy. Remember that he had nothing to go by except the performance of the gas engine, and that only in very small powers. Gas, whether the ordinary illuminating gas distilled from coal, or the cheaper product of the Dowson process, was the only fuel then in practical use for internal combustion. The oil engine in its various forms, the petrol engine, the Diesel engine—these were still to come.

The success of the Otto gas engine led makers to design engines operating in much the same way, but using for fuel a spray of oil instead of gas. Such engines found a place where gas was not available, as in the driving of agricultural machinery. For the most part their fuel was the safe and familiar oil of the paraffin lamp. Like the gas engine, they were heavy and they ran at very moderate speeds, such as 200 revolutions per minute. About 1883, Gottlieb Daimler set himself to produce an engine with much lighter working parts which should run at a far higher speed, five times as fast, or more, and should use for fuel an oil so volatile that a carburettor would serve to charge the incoming air with combustible vapour. After successful trials with a bicycle he applied his motor, in 1887, to drive a car on the road. That was the beginning of a new era in locomotion. The world discovered in Daimler's petrol engine an appliance such as it had not possessed before—a light, convenient, inexpensive prime-mover, yielding amounts of power which were ample for road vehicles, easy to start and stop and regulate, demanding little attention and no particular skill. Before long it gave city streets an altered character and country roads an unsuspected value. Man acquired a new mobility which changed his notions of distance and of time. In due course the petrol engine also achieved the conquest of the air. At the end of 1903, only a few days after Bramwell's death, the brothers Wright took their first flight in a motor-driven aeroplane. It is the petrol engine that must bear the responsibility—the grave responsibility—of having made it possible for man to fly.

The era of the road-motor began with Daimler's experiment of 1887, but a good many years were to pass before it took the dominant position it holds to-day. The horse was already in possession, and did not yield without a struggle. That sensitive animal had a frank dislike of the horseless car. To meet his objections our legislators ordained for mechanically-driven vehicles a speed not exceeding 4 miles an hour, and required each of them to be in charge of three persons, one of whom should carry a red flag in front. Not until 1896 was the Red Flag Act repealed. The sinister emblem has gone, and the horse has nearly gone too. But engineers will not let his memory perish. Thanks to the initiative of James Watt, they treasure his name in one of their most necessary words. The horse may become little more than an instrument of sport or an excuse for betting, but it is safe to say the horse-power will never die.

About 1895, Rudolph Diesel initiated another epoch-making change. Instead of compressing a combustible mixture, he compressed the air alone, bringing it to a very high pressure, and thereby making it so hot that when the charge of oil was forcibly injected at the dead-point there was instant ignition. This escaped all risk of pre-ignition and greatly augmented the efficiency of the action, as a thermodynamic consequence of the very high temperature at which the fuel gave up its heat. To force the fuel in, he at first employed an auxiliary supply of still more highly-compressed air, but this plan is now less common than the simpler one of using a high-pressure pump, which delivers the oil in a spray of exceedingly fine drops. The essential feature of the engine is that the fuel does not enter the cylinder until the air there is highly compressed and the working stroke is about to begin. It is this feature which has made the Diesel engine the most efficient of all known means of obtaining mechanical work from the combustion of fuel.

Imagine our prophet of 1881 brought back to earth so that he may see for himself in what measure his expectations have been fulfilled. He will come, of course, by aeroplane, and on the way the pilot will tell him of the part which the internal combustion engine played in the War; of submarines and road-motor transport, and tanks and aircraft. He will be told of Zeppelins and air-raids, of the horrible superiority of attack over defence that characterises modern war. He will learn how prodigiously man has increased his power to kill his fellows and destroy their works. The old gentleman will be saddened to think that the world owes this to engineers, and especially to the internal combustion engine. It will grieve him to reflect that the island safety of England has departed, never to return. On the other hand, he will be told of air-mails to India and Australia and the Cape, and it will interest him much to learn that the engine which is bringing him so swiftly and comfortably to earth weighs no more than a couple of pounds per horse-power, and that engines of the same type, but lightened and tuned to the uttermost for racing, can develop more than a horse-power for every pound of weight. He will hear, perhaps with less enthusiasm, of speed records by air and sea and land, amazing records which are set up only to be broken. "Brief life is here our portion" might be said of the records, and also, alas, of many of the record makers and record breakers. As he approaches London our aerial voyager will note the highways thick with motor-cars, coaches, and lorries, and will wonder for a moment what has happened to the railway shares he left behind, doubtless selected as a secure investment of the terrestrial fruits of his industry and thrift. For in Bramwell's time there were still people who practised these now exploded virtues, and there were even Chancellors of the Exchequer who encouraged them.

We may imagine that the pilot brings him over the river and the docks, where he may see big motor-ships like the Nelson liners arriving with their frozen or chilled cargoes. One of his pet bits of engineering was mechanical refrigeration, and he will take particular satisfaction in noticing ships that are not only driven but also cooled by internal combustion engines. From the docks they will proceed over the City, where at every crossing he will observe the congestion of motor-cars and taxis, and the multitudinous motor-bus—but never a 'growler', which was the vehicle he used to favour. I well remember his taking me to visit a cold store on the south side of the river; we were on our way in a 'growler' when the bottom fell out and we were left sitting in the road. He was, as I have hinted, no light weight; my part in the comedy was only that of the last straw. The cab stopped without injury to life or limb, Bramwell forming an effective automatic brake. His genial dignity suffered no eclipse. His spirits were undamped—and his person too, for luckily the street was dry.

Finally, let us think of the pilot bringing him over Waterloo Place to revive his memories of the beloved club where he used to spend many placid hours. Below him will be the Athenæum, more than ever a haven of rest for the mature, but now on the outer edge of a vortex which is fed by torrents of one-way traffic from the Haymarket and Trafalgar Square—a veritable inferno of internal combustion—an inferno that would be intolerable were it not tempered from time to time by authoritative outstretchings of the arm of the law. As he watches the maelstrom, and perhaps sees a bishop trying to reach the club, he will thank the fate which has removed him from the present-day terrors of the pedestrian, from compulsions to unseemly agility and temptations to unseemly profanity. Such temptations are, of course, only for laymen, but life in Waterloo Place, even for bishops, must sometimes be furious as well as fast.

When all these things have been seen, we must not imagine Bramwell posing as the satisfied prophet who complacently remarks "I told you so". He had too judicial a temper for that. He would want to know about other users of power, and would ask many questions. What about our navy, and other navies, the biggest liners, the railways and the great factories, and the coal pits with their plant for winding and ventilating, and what about the distribution of light and power from central stations—on what kind of prime-movers do these rely? And the answer would be steam, and steam, and yet again steam. He would soon learn that steam still does a great part of the work of the world, and that one need not go to the Science Museum at South Kensington to find specimens of its remains. But if he did go to the Science Museum he would see admirably displayed there some remarkable engines. Side by side with the mementos of Newcomen and Watt, those fascinating heralds of the dawn, he would see engines of a far more recent type enshrined in the honour they so well deserve, not as relics of an obsolete past but as precursors of the modern era which was opened to the world by the genius of Charles Parsons. For among the treasures of our national museum of science is Parsons' first steam turbine, which dates from 1884, the first turbine to which he fitted a condenser, which dates from 1891, and also a part of his famous little craft, the *Turbinia*, by which in 1897 he demonstrated the applicability of the steam turbine to the propulsion of ships.

These dates are all subsequent to Bramwell's prophecy of 1881. Many factors have contributed to prevent that prophecy from being fulfilled, but none has been so potent as Parsons' development of the compound steam turbine. That invention was no mere throwing out of a happy thought. It was the life-work of a man who, to an extraordinary degree, combined creative imagination with energy and persistence and practical skill.

Such a man lives on in his achievements. To Parsons it was granted as to few men to see the fruit of his ideas and his labours. Long before he died the world recognised that he had revolutionised steam engineering. He had taught us how to generate power on a scale and with a concentration never before approached. Nothing, in a sense, could be simpler than his steam windmill with its successive rings of vanes, each in turn taking up a small fraction of the whole energy of the blast. To conceive such a device was one thing, to give it being and action was quite another. That meant many subsidiary inventions and years of toil; it meant the removal of mountains of prejudice and difficulty. But the triumph is complete. Engineers, all the world over, are whole-heartedly converted. They build their steam windmills on a colossal scale, crowding 50,000 or 100,000, sometimes even 200,000 kilowatts into a single unit, confident in the knowledge that no more trustworthy and economical prime-mover is available for the gigantic stations which play so important a part in modern civilisation as centres for the production and distribution of light and of power.

Review the great power stations of the world, and you find their method of manufacturing electric energy from heat is almost wholly through the medium of steam. To illustrate how small a place is taken in them by the internal combustion engine, let me quote some figures for British power stations. A return published in 1930 by the Electricity Commissioners gives the aggregate capacity of the generative plant of various types as follows:

	Kilowatts.
Steam turbines	5,531,952
Reciprocating steam engines	138,806
Oil engines	71,331
Gas engines	17,473
Water-power plant	42,208

Oil engines and gas engines together make up only $1\frac{1}{2}$ per cent of the whole. Abroad, as well as at home, the steam turbine is dominant.

It is in great power stations equipped with large turbines and coal-fired boilers, using steam of high pressure and high superheat, that we find the most economical production of power from fuel. A modern turbine can generate one electrical unit with a consumption of barely 1 lb. of cheap coal, which means that it converts into electrical energy fully 30 per cent of the potential energy of the fuel. The internal combustion engine finds little favour in power stations, save as a stand-by to assist occasionally in meeting the peak load.

Turning now to another field, we find that in railway traction the supremacy of steam is maintained. Much attention has been paid to the Diesel engine as a possible alternative, but so far the number of Diesel locomotives that have found employment in main-line working is a negligible proportion of the whole. If the steam locomotive is to disappear, there is no indication that its place will be taken by an internal combustion rival. What is much more likely is that it will in time be driven out—wholly or in part—by electric traction, as Lord Weir's Committee has recently suggested for the British railways. But electrification will mean that the prime-mover is still steam, though acting at a central station—except, of course, in countries which have available reserves of hydraulic power.

Such a country is Switzerland, and there the transformation from the steam locomotive to electric traction is already almost complete. The playground of Europe has lost little or nothing of its charm through becoming dotted with hydraulic power houses. Already its exports to less favoured neighbours include many million units of electric energy, which it delivers through the graceful catenaries that girdle its mountains and span its valleys. The shrewd inhabitants doubtless demand a remunerative price for exported electricity, just as they quite properly do for the other amenities of their delightful land. A time may come when subterranean stores of coal and oil run low, but, so long as the sun shines and the rain falls, mankind will be able to continue its struggle for existence, though it may suffer a change in the centre of gravity of its industrial life. Industry will learn, like the Psalmist, to look to the hills whence cometh its help, and Geneva will be more than ever the natural rallying point of a community of nations, physically linked by a comprehensive 'grid' on which they depend for whatever modicum of light and power they are still permitted to enjoy.

For road motors, and for the air, the internal combustion engine is, of course, supreme; it has created as well as supplied a vast demand. We ought, I think, to pay tribute to the constructive talent that has made these engines the convenient and reliable prime-movers they have in fact become.

Turning to the field of ocean navigation we find a situation which is puzzling, unsettled, and difficult to analyse. For in the selection of prime-movers for ocean-going ships, there are sharp differences of opinion and of practice; there is no sense of finality; there is even—so it seems to me—a good deal of fashion and caprice, and of the probability of change which one associates with such moods of the mind.

In our own navy and foreign navies there is a practical monopoly on the part of steam, except, of course, in submarines. But the mercantile marine is in a state of flux. Before the War there were almost no motor-driven ships. The *Selandia*, which dates from 1912, was the first conspicuous example of a large ship driven by Diesel engines. Her economy of fuel at once commanded attention. She was naturally hailed with delight by the powerful oil interests whose position, already strong in the mercantile marine through the extended use of oil under boilers, would become impregnable if the Diesel engine were generally adopted. In some important quarters the Diesel engine became the vogue. During the post-War years of marine reconstruction the number of oil-driven motor-ships rapidly increased, and it is still increasing. Of merchant vessels launched during the year 1930, considerably more than half the tonnage was motor-driven. At this rate, a superficial observer might fancy that steam was in process of being driven off the high seas. But if that were his conclusion I think he would be quite wrong.

None of the greatest and fastest ships is motor-driven—neither the *Leviathan*, which at present heads the list, nor any of the other leviathans of the deep, with their tonnages of 40,000 or 50,000 tons or more, and their speeds ranging from 20 to 28 knots. This is true not only of the older ships but also of the newest, such as the *Europa* and the *Bremen* and the *Empress of Britain*, and the giant Cunarder which is now on the stocks and is confidently expected to surpass them all. For such vessels, motors do not give the concentration of power that is needed, whereas turbines do give it, and give it easily.

When we turn to vessels of intermediate types, we find the liveliest contest between the steam turbine and the Diesel motor. Some nations, such as Denmark, Norway, and Sweden, conspicuously favour motors. Others, such as America, no less conspicuously favour steam. One feels that both cannot be right. Nor can British practice, which is much divided, be right either. The choice would sometimes seem to depend more upon the taste and fancy of a dominating personality than upon a careful weighing of arguments such as appeal to engineers. One finds some shipowning companies going strongly for Diesel engines and other companies going no less strongly for steam. A notable example in the steam group is the Canadian Pacific Company, the superintending engineer of which, Mr. J. Johnson, has communicated to the Institution of Naval Architects a very full statement of the grounds which have governed that company's engine policy. His paper deserves careful study; I have not been able to find any equally detailed and convincing statement on the other side.

When we attempt to appraise the merits of the rivals and to estimate their chances in the more distant future, we see that from the thermodynamic point of view the Diesel engine still has a small advantage. On the other hand, its oil is more costly than fuel oil for boilers; it must have lubricating oil, too, and the first cost of the engine is substantially greater than that of steam plant. In respect of weight and of space occupied there is not much to choose. As to durability, I cannot speak; so far as I know, there is still a dearth of published facts about the cost of upkeep with Diesel engines. *Prima facie*, the great number of reciprocating parts is a serious drawback. There must be a great number because the safe limit of cylinder size is soon reached, and it is only by having many cylinders that any large aggregate of power is developed. In a recent Diesel-engined liner of the luxurious type, 12 Diesel cylinders operate on each of four shafts, making 48 in all, to produce a speed of 18-20 knots. Besides these 48 main cylinders, there are 24 more which serve purposes that are auxiliary but essential to the working of the main engines. Consider the number of working joints, of valves, of valve-rods and tappets, besides pistons and connecting-rods, which this involves. Does such an accumulation of reciprocating pieces with their hammer-blow accelerations mark a real engineering advance as compared with the cosy hum of a turbine engine-room, and has it come to stay? Frankly, I think not.

Now, a final question. Can anything be done to re-establish the ancient connexion of the merchant service with the British coalfields? Remember that here, and in most other places, the cost of coal is substantially less than that of oil for the same quantity of heat. Where oil scores is in its greater convenience of handling. Much has been said and written about restoring prosperity to the miners by converting coal into oil. As a chemical operation it is quite possible to make oil from coal; as a commercial proposition it is impracticable, so long as Nature continues to supply oil directly from the bountiful stores on which man now draws with prodigal ease. Ships that burn oil must have it come to them from sources outside Great Britain. Can we expect ships to return to the use of coal as fuel? For some classes of ships I think we may, though not all classes. Neither in the navy nor in what one may call the upper division of the mercantile marine—the luxurious express liners which carry fastidious passengers and must keep to a time-table that means quick fuelling—can one expect a reversion to coal so long as oil fuel can be got at anything like its present price. But with cargo-liners and big cargo-boats the case is different. I think those engineers are right who contend that for such ships a highly economic mode of working would be to use pulverised coal for steam-raising in a small number of large boilers of the water-tube type, with a pressure of, say, 500 lb. and a temperature of 750° F., each boiler having its own pulverising mill and being fitted also for burning oil as an alternative fuel. In such a scheme there would be no untried elements, but the combination of the elements would be experimental, and a conclusive demonstration of its advantages can be obtained only by testing it out on a large scale in sea-going ships.

In taking leave of our prophet of 1881, if we were to catch from him the mantle of prophecy we should wear it ruefully; we should all be Cassandras or Jeremiahs, obsessed with the cheerlessness of the industrial outlook, and finding no escape from the conviction that the easy supremacy of Britain, as Bramwell knew it, can never be recalled. But my last word must not be an unqualified Ichabod. The engineers of to-day have as much courage and enterprise as their fathers, and they have an infinitely better understanding of the scientific principles on which, as on a smooth highway, the advance of engineering must steadily proceed. Moreover, to recognise evils, and the causes of evils, may be the first step towards their cure. The world has learnt, through a sharp lesson, that the gifts of the engineer are good gifts only if they are wisely used; that the new powers he has evoked have brought new dangers against which mankind must resolutely guard if it is to save its soul alive. The malignity of individuals and the madness of nations now command forces of destruction such as more primitive communities never knew, and were happier not to know; and apart from clamant and appalling abuses of gifts which ought to be beneficent, we have become aware of a more subtle and perhaps graver social menace. We see the mechanised arts of production overreaching themselves, supplying commodities in a volume which cannot be absorbed, and with a facility that tends to deprive man of his richest blessing to body and spirit—the necessity of toil.

But these thoughts take us too far afield. They point to problems now conspicuously urgent, which, for the salvation of society, the engineer, the economist, and the moralist must jointly set themselves to solve.

The British Association Centenary.

COMMEMORATIVE SERVICE AT LIVERPOOL CATHEDRAL.

THE Dean and Chapter of Liverpool lose no occasion to make their great Cathedral the scene of public commemoration, and the centenary meeting of the British Association for the Advancement of Science was celebrated there with a ceremony on Sunday, Sept. 20, which will remain vivid in the minds of everyone who assisted in it. It happens that this year's Lord Mayor of Liverpool, Alderman Edwin Thompson, was one of the Association's local secretaries for the meeting in Liverpool in 1923, and is the son of a local secretary of the meeting of 1896. He was therefore able in a special sense to express the feelings of Liverpool people on this occasion; he entertained the president, and president-elect of the Association at the Town Hall, and conducted them in full state to the Cathedral, where representatives of the University of Liverpool, the medical profession, and other public bodies, in academical robes, made a bright mass of colour in the choir, and the nave was filled to the doors; indeed, the greater part of the service had to be repeated later in the day. The thanksgiving service fell into three parts. The Dean, with the two presidents, and other members of the Association, presented themselves before the Bishop at the junction of choir and nave, and the president-elect, General the Rt. Hon. J. C. Smuts, addressed him in the following words:

Sir,—Bid a Blessing on this congregation assembled to render thanks for the increase of knowledge by the devoted labours of men and women in many lands, and more especially for the British Association for the Advancement of Science. This body was established a hundred years ago to give more systematic direction to scientific inquiry, to promote intercourse between those who cultivate science in different parts of the British Empire with one another and with philosophers of other countries, to direct the general attention to the objects of science, and to remove disadvantages of a public kind which impede its progress. The Spirit of God has used it to interpret the process of Nature and the doings of man, and by unrestricted interchange of observations, projects, and beliefs, the outlook of the nations on the world in which they live has been transformed. Vain fears and anxieties have been assuaged by clear thinking and wise endeavour. The real dangers and perplexities of our daily lives have been relieved by forethought and mutual help. The amazing structure and intricate processes of the universe have been set forth for reverent and devoted contemplation by students young and old, of all sorts and conditions. In these several ways human sympathy has been widened in the common task of mutual enlightenment and public service, men's minds have been awakened to the revelation of that which works in all and through all, and their grasp has been strengthened on the principles and the meaning of life.

The Bishop replied to General Smuts in historic words, as follows:

May God, the Fountain of all knowledge, fill you, who have gathered in this house for commemoration, with understanding and joy. May He keep you steadfast and persevering in your search for truth. And may the blessing of the Lord come upon you abundantly.

O Thou, who in every generation hast moved Thy chosen servants to seek Thy truth: continue we beseech Thee, so to inspire us in this age that, searching the works of Thy hands, we may find Thee in all that Thou hast made, and finally may know Thee perfectly revealed in the Spirit of thy Son, Jesus Christ our Lord.

A lesson was read from Ecclesiasticus xliv., by the president, Prof. F. O. Bower, "Let us now praise famous men, and our fathers that begat us", and an anthem was then sung:

Lord, who hast made us for Thine own, hear as we sing before Thy throne.
Alleluia, Alleluia.
Accept Thy children's rev'rent praise for all Thy wondrous works and ways.
Waves, rolling in on ev'ry shore, pause at His footfall and adore,
Ye torrents rushing from the hills, bless Him whose hand your fountain fills.
Earth, ever through the power divine, seedtime and harvest shall be Thine.
Sweet flowers that perfume all the air, thank Him that He hath made you fair.
Burn, lamps of night, with constant flame, shine to the honour of His name.
Thou sun, whom all the lands obey, renew His praise from day to day.
Alleluia, Alleluia.

The commemoration was delivered, in the form of a bidding prayer, by Prof. J. L. Myres, one of the