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Presidential Address and Presentation of Awards.

By Sir DAVID GILL, K.C.B., F.R.S., D.Sc. (President).

On Monday, October 31, 1910.

For some reason, which even to the present moment I fail to entirely understand, your Council has been pleased to do me the honour of electing me President of your Institute. It is an office which I accepted with much pleasure because of the important work which the Institution has done and is doing, and I feel it to be a great honour that you have conferred upon me because of the illustrious names of those who have been among my predecessors in this chair, and I thank you cordially.

I am told that one of the principal duties of your President is to deliver the Annual Address—and, naturally, in selecting an astronomer for the office, it must be supposed that some of the subjects which have occupied his thoughts, and with which he has dealt in the course of his experience, are of a nature to interest your members.

To deliver a Presidential Address before an Institute of Engineers on some purely astronomical subject would, it seems to me, be out of place. The engineer has nothing to do with the ascertainment of the ship's position at sea or the requisite future course to be steered ; that is the astronomical part of navigation, and belongs to the navigating officer.

But the work of the astronomer, and more especially that of the modern astronomer, brings him daily into touch with subjects on which the astronomer and the engineer have common ground.

The successful modern practical astronomer must be, besides a mathematician, an engineer, a physicist, a chemist, and, if possible, also a good practical mechanic. I think it would be very difficult to define more perfectly in other words the desirable collateral qualifications of a good marine engineer.

The astronomical engineer must nowadays be able to design the mounting to carry a telescope of perhaps 60 feet in length, of which the object glass alone may weigh half a ton, and in the case of a reflecting telescope the mirror may weigh four or five tons and even more. The tube and two axes (which enable the telescope to be pointed to any part of the sky), may, together with the object-glass or mirror, weigh twenty tons. Yet the whole of this moving mass must not only be capable of being quickly turned to any required object in the sky with the utmost ease and freedom, but be then clamped with the certainty that the intended object, when the dome is opened, will be found in the field of view and be kept there under the action of clockwork, notwithstanding the rising or setting of the object resulting from the diurnal rotation of the earth. More than this, the whole of this twenty ton mass must be capable of delicate slow motion independent of the clockwork, so that the image of a star may be rigorously bisected by the cross spider lines in the focus of the telescope, or be retained between the jaws of a spectroscope slit $\frac{1}{1000}$ of an inch wide, for an hour or two at a time. These are problems in astronomical engineering which have been successfully solved.

Take another case, the dividing of a graduated circle. We have in daily use graduated circles 3 feet in diameter containing each 4,320 subdivisions, of which the actual error of any division hardly exceeds a single second of arc, and astronomers have determined these outstanding errors of original division to within a tenth part of that angle. The linear error of the original divisions therefore amounts to less than $\frac{1}{100,000}$ of an inch, and the actual error of division is known to less than one-millionth of an inch. In the measurement of angles the parallaxes of stars have been determined with probable errors within $\frac{1}{100}$ of a second of arc. Now a whole second of arc is covered by a silver threepenny piece viewed at the distance of a mile. The nearest fixed star, whether it is viewed from one side of the earth's orbit round the sun or from the other side, is not parallactically displaced from its mean position by more than two-thirds of this angle. Or put it in another way. Suppose the earth's orbit round the sun was viewed from the nearest star, that orbit of 186 millions of miles in diameter would appear almost exactly of the diameter of a sixpence viewed at a mile—and by a properly conducted series of measures astronomers have determined the radius of that circle (in other words the distance of that star) within nearly 1 per cent. of its amount.

To measure the diameter of a threepenny bit within 1 per cent. of its amount when you may not approach within one mile of it is a feat in accuracy which the engineer can appreciate and which the astronomer has accomplished.

Or take another case, the interesting one of what is called the Change of Latitude. The earth, as you know, revolves about an axis in twenty-four sidereal hours. It is in fact a huge free gyroscope, and like all other free gyroscopes it will continue to revolve about the same axis so long as there are no changes in the distribution of its mass relative to the axis about which it revolves.

I think most members of my audience are aware of the importance of the so-called balancing of all kinds of rapidly revolving machinery, and know, for example, what tremors are set up in an ordinary dynamo when it is not properly balanced. These tremors of course arise from the fact that the gyroscope (in other words the revolving armature) is not spinning about its axis of dynamical equilibrium, and it is making an effort at every revolution to spin round its true dynamical axis of equilibrium, but is prevented from so doing by the restraint of the pivot bearings. Most of you are also aware what a small amount of added weight at the proper place, in the periphery of the armature, is often sufficient to give a perfectly sweet running machine free from tremor, or in other words, to produce coincidence between the mechanical and dynamical axes. In the case of the earth, therefore, if any change is made in the disposition of masses on the earth's surface, the earth will not tremble like the unbalanced dynamo—because its axis is free to adjust itself, but it will begin to revolve about another axis, and gradually adjust itself to an axis in dynamical equilibrium.

When this meeting separates and we all go to our respective homes, we shall certainly have disturbed the immediately preceding distribution of mass on the earth's surface, and, in consequence, our earth will begin to rotate about a different axis than that about which it revolved before this meeting, that is if we suppose that no countervailing changes are produced by the movements of other persons and things on the earth's surface. But, fortunately for the astronomer, the united mass of the members of our meeting is so small compared with the mass of the earth that the change in the axis of rotation so produced will be an infinitesimally small and immeasurable quantity. I dare say if all the inhabitants of the earth were for some reason to forsake their homes and to assemble, let us say, in the centre of Africa, then I believe astronomers might be able to detect a measurable change in the position of the pole of the earth with regard to the earth itself. There would in fact result a small change in the latitude of every point on the earth's surface, but the direction of the axis of the earth's revolution referred to the stars would remain the same as before.

In nature there occur huge changes in the distribution of mass on the earth's surface, caused, for example, by the deposition of snow. These changes of mass-distribution produce small periodic changes in the latitudes of all places on the earth's surface, amounting in extreme cases to ± half a second of arc or ± 50 feet on the surface of the earth. To determine this change of latitude international stations, situated on the same latitude around the earth, have been created, so that, night after night, the latitude is determined from observations of the same stars. In this way any change of latitude amounting to the equivalent of less than a yard on the earth's surface can be detected. Now here is a marked difference between the functions of the engineer on the one hand and of the astronomer on the other. The engineer can control the phenomena with which he has to deal, the astronomer can only observe phenomena and derive the laws which regulate them, so that he may be able to compute their occurrence in the past and future. He cannot for example contrive an automatic control for the internal fixity of the axis about which the earth revolves, he can only study its variation, and endeavour to find the laws of that variation. But the engineer can balance his armature or flywheel so that it shall revolve smoothly, with its dynamical and mechanical axes of revolution in perfect coincidence. The engineer can handle and chemically analyse or test mechanically the materials which he employs ; but the astrophysicist can only derive from observation at a distance his conclusions as to the forms and features of the planets or the chemical constituents of the atmospheres of the sun and fixed stars.

But there is a point in which the practice of the astronomer and that of the engineer should coincide. Both can, if they will, design their own tools ; and he is a fool as an engineer and a fool as a practical astronomer if he takes no interest in the design of the tools that he uses. It is mainly from that point of view that I propose to speak to you to-night.

Now the astronomer owes a very great deal to the engineer. I have already spoken of the problem of mounting large telescopes with adequate precision, truth and ease of motion. In instruments of moderate size the astronomer is greatly indebted to the introduction by the engineer of ball and roller bearings, and their accurate production as a matter of commerce has greatly facilitated and improved the design of telescope mountings.

The method of relief-friction by flotation, first, I believe, practically introduced by an astronomer, the late Dr. Common, will certainly now supersede roller or ball bearings for particular purposes in the very largest telescopes. Whether that method of relief friction will ever come into practical use in other kinds of engineering I do not know. For any very heavy mass that has to be slowly and accurately revolved with a minimum of friction, flotation in mercury or relief of the friction on the guiding bearings by such partial flotation is an ideally perfect method.

If, for example, the horizontal shaft of the screw propeller of a steamship revolved once in an hour instead of once in a second, it would be worth while to float it. You have only to fit under it a semi-cylindrical trough whose radius is, let us say, $\frac{1}{8}$th of an inch greater than that of the shaft. You then fill the space between the trough and the shaft with mercury until the shaft is just lifted or barely lifted from its bearings, and now the shaft of the largest steamer could be rotated with the finger and thumb. It is easy to distribute the relief friction so as to bring the residual pressure on any of the bearings to zero, or to any required amount, by the simple expedient of adding, where required, a hollow steel cylinder concentric with the shaft, the trough being of course increased correspondingly at the requisite position.

*The diagram shows how this method is applied in the case of telescopes, where the weight is very unsymmetrically distributed and the shaft is inclined. But here the flotation can be employed to eliminate friction almost entirely, both at the end of the shaft as well as on the two bearings.

Of course I have used the case of a propeller shaft merely as a familiar method of illustration of principle and without any proposal to put such flotation in practice for ships. In the case of a rapidly revolving shaft the surface tension between steel and mercury would set all the mercury into violent agitation and destroy the efficacy of the plan, and the rolling and pitching of the ship would also have a like effect. But I do not think it impossible that the plan might be successfully employed to relieve friction in the case of revolving turrets or gun platforms, and perhaps in other forms of engineering.

All this, however, is by the way, as an illustration of the fact that astronomers ought to be and sometimes are successful engineers.

But the main feature of a practical astronomer's work is accuracy. His continual endeavour is to secure higher and higher minuteness of precision in his results. Not only is it the first instinct of the scientific mind to measure, and to measure accurately, but the necessity for so doing is impressed upon him by the fact that the value of an observation increases as the square of its accuracy (that is to say inversely as the square of its probable error). It is only within recent years that the tools and methods of astronomers have been so improved that the determination of the distances of fixed stars became a problem capable of practical solution, and to the mechanician, the optician and the engineer the pure astronomer is largely indebted for the success which in recent years has crowned his efforts in that line of research.

If accuracy is necessary to the astronomer, it is no less necessary, though perhaps in a different degree, to the engineer,

* See page 280.

I remember very distinctly, when a boy of twelve years of age, going to an engineer's workshop in Aberdeen, where they were at work casting and boring in great haste a number of mortars, to be used for shelling Russian forts during the Crimean War, which was then in progress. The proprietor of the works was very indignant that all his first batch of mortars had been rejected by the inspectors because their bore was not correct. "They want them exact to $\frac{1}{100}$ of an inch—did you ever hear of such a thing?" A gun-maker of the present day would smile very broadly at such a remark, and I think I was mechanic enough, even then, to smile too. Had that same engineer been asked to make a disc to fit accurately and smoothly in a given true cylinder, he certainly would have fitted it very far within that amount of accuracy, and his worst hand would have been ashamed to send in the job with $\frac{1}{100}$ of an inch of shake in the cylinder.

What no doubt was in the indignant engineer's mind was that these mortars were required to fire cast-iron spherical shells, which had errors of form probably much greater than $\frac{1}{100}$ of an inch. If, however, he had been provided with a gauge and had contracted to bore the mortars so that this gauge should enter the bore without sensible shake, there is no doubt but that all his mortar-bores would have been accurate probably to $\frac{1}{1000}$ of an inch.

What was wanting in his mind was the true conception of absolute measurement, and probably also the want of any accurate standard. If you had asked him to make 100 piston rods all exactly 3 inches in diameter, he would probably have made a gauge and fitted all the rods to that gauge with very close approximation to uniformity—but very probably they would all have measured 3·01 or all 2·99 inches.

In those days few practical engineers would have dreamt of making a fitting to absolute measure, they apparently could not realize that articles could be made in different workshops to fit together just as well as if they were all fitted separately together in the same workshops. It is merely requisite that the standards of the different workshops shall be the same.

Nowadays we are beginning to fully realize, especially in engineering practice, the necessity for absolute standards. Whether it is a yard or a metre, we require to know exactly what a yard or a metre means. Of course, there are many different degrees of accuracy required in our standards, let us say from the precision required in selling a yard of cloth to the precision required in determining the absolute value of a scientific, national or international standard of length.

The twenty-fifth part of an inch might be tolerated in a drapery yard or metre, but the $\frac{1}{100,000}$ of an inch would be but on the verge of toleration in a scientific international standard yard or metre to meet the requirements of science in the present day.

I deal in the first place with the scientific standards, because it is obviously only a question of experience what degree of accuracy is necessary for the practical purposes of standards of lesser precision.

What, then, is a scientific standard?

Perhaps on this subject you will allow me to quote an extract from my Presidential Address to the British Association at Leicester in the year 1907—as follows.

One of Clerk Maxwell's lectures in the Natural Philosophy Class at Marischall College, Aberdeen, when I was a student under him there, in the year 1859, ran somewhat as follows :—

> A standard, as it is at present understood in England, is not a real standard at all; it is a rod of metal with lines ruled upon it to mark the yard, and it is kept somewhere in the House of Commons. If the House of Commons catches fire there may be an end of your standard. A copy of a standard can never be a real standard, because all the work of human hands is liable to error. Besides, will your so-called standard remain of a constant length? It certainly will change by temperature, it probably will change by age (that is, by the rearrangement or settling down of its component molecules), and I am not sure if it does not change according to the azimuth in which it is used. At all events, you must see that it is a very impractical standard—impractical because, if, for example, any one of you went to Mars or Jupiter, and the people there asked you what was your standard of measure, you could not tell them, you could not reproduce it, and you would feel very foolish. Whereas, if you told any capable physicist in Mars or Jupiter that you used some natural invariable standard, such as the wave-length of the D line of sodium vapour, he would be able to reproduce your yard or your inch, provided that you could tell him how many of such wave-lengths there were in your yard or your inch, and your standard would be available anywhere in the universe where sodium is found.

That was the whimsical way in which Clerk Maxwell used to impress great principles upon us. We all laughed before we understood; then some of us understood and remembered.

Now the scientific world has practically adopted Maxwell's form of natural standard. It is true that it names that standard the metre; but that standard is not one-millionth of the Earth's quadrant in length, as it was intended to be; it is merely a certain piece of metal approximately of that length.

It is true that the length of that piece of metal has been reproduced with more precision, and is known with higher accuracy in terms of many secondary standards, than is the length of any other standard in the world; but it is, after all, liable to destruction and to possible secular change of length. For these reasons it cannot be scientifically described otherwise than as a piece of metal called a metre, whose length at 0° C. at the epoch A.D. 1906 is = 1,553,164 times the wave-length of the red line of the spectrum of cadmium when the latter is observed in dry air at the temperature of 15° C. of the normal hydrogen-scale at a pressure of 760 mm. of mercury at 0° C.

This determination, recently made by methods based on the interference of light-waves and carried out by MM. Perot and Fabry at the International Bureau of Weights and Measures, constitutes a real advance in scientific metrology. The result appears to be reliable within one ten-millionth part of the metre.

The length of the metre, in terms of the wave-length of the red line in the spectrum of cadmium, had been determined in 1892 by Michelson's method, with a mean result in almost exact accordance with that just quoted for the comparisons of 1906; but this agreement (within one part in ten millions) is due in some degree to chance, as the uncertainty of the earlier determination was probably ten times greater than the difference between the two independent results of 1892 and 1906.

Probably every standard, of whatever metal or substance it may be composed, is subject to change of length by the slow rearrangement of its constituent molecules in the course of time. If we are to have a standard which is constant for all time we must have recourse to a natural standard—and incomparably the best of these that has ever yet been suggested is Maxwell's suggestion, viz., the wave-length of some well defined monothromatic ray of light. The red line of the spectrum of cadmium vapour is, so far as we know, the best defined spectrum-line, which can be readily observed—and that is the reason why it has been selected by Michelson and MM. Perot and Fabry for comparison with the metre. Up to the present time the platinum Mètre des Archives is officially the scientific nominal standard of length. But if some centuries hence any capable physicist had to compare his results with those of the physicist of 1906, I think there is no doubt he would not refer his comparison to the platinum end-measure "Mètre des Archives," or to the platino-iridium line metre, conserved at the International Bureau of Standards at Breteuil—even supposing they then existed in apparently perfect preservation—but he would refer them to the length of the metre in 1906 as defined by the researches of Perot and Fabry in terms of the wave-length of the red line of cadmium vapour.

Of our British Standards, in the highest scientific sense, perhaps the less said the better—no man of science will, I think, refer to them seriously.

I should like to have added some remarks on the advantages of the metric system—but the subject is too large to be dealt with fully in the limited time at my disposal. From the international point of view there can be no question that uniform standards for the whole world would be an obvious simplification, and its advantages inestimably great. Is it a practical proposition to suggest that the world should accept British Standards, after all the world, except Britain and America, has adopted the Metric System ? I think not : especially when we remember how far removed it is from a scientific system. But that question has been very well dealt with in a paper by one of your members, Mr. F. Cooper, which is published in Vol. xvii. 1905, of your Transactions, and I must leave it there. When we come to discuss the advantages of a decimal system, I am aware of the well-known objection that the number ten is divisible only by two. I am entirely of opinion that it would have been better for the world if effect had been given to the proposal of Charles XII of Sweden, to adopt a duodecimal system of arithmetic, that is to say, to carry the single figures which express numbers up to 11 instead of 9. The first double figure then becomes divisible by, 2, 3, 4 and 6. But men have 10 fingers, and the whole world is not yet apparently sufficiently advanced in the process of arithmetic to dispense with the use of fingers in calculation ! So we must, for the present, at least, wait for that development.

But let us look at the common practice of British workmen in the employment of vulgar fractions to express sizes ; he has been accustomed to deal, till recently, with so many feet, inches and eighths, sixteenths and thirty-seconds and sixty-fourths of an inch. To call the system clumsy is but to express a small part of its disadvantages, and I think there is great room for improvement.

Should not the statement of a dimension on a diagram in some degree also convey the accuracy of length intended to be specified ?

If a mechanic is instructed to make a portion of a machine to a working drawing, should not the mere statement of dimensions also convey the precision required in its various parts ? In every machine, more particularly when a number of them are to be made with interchangeable parts, there are generally certain dimensions where a difference or error of $\frac{1}{8}$ of an inch or more would be of no consequence, others which involve fitting require to be stated to $\frac{1}{1000}$ of an inch or less—and it is high time we abolished such loose statements as tight fit, smooth fit, easy fit, for all these can be expressed in absolute measure. Now if constructors were to adopt the system of expressing on working plans the required dimensions in decimals, denoting the requisite accuracy by the number of decimals quoted, the whole matter would be simplified.

Thus, for example, the frame on which a comparatively small set of wheel work is to be mounted, might be figured to the first decimal in inches, the thickness of the spindles to the second decimal, the distances between the centres of the gearings and the diameters of the pivots to the third decimal and so on ; and it might be an understanding that in each case, the stated dimension is to be adhered to within plus or minus half the amount of the last decimal place quoted. That would provide for everything.

I have spoken of inches, because these are more familiar to you—but millimetres are practically more convenient and exact for this purpose. It is certainly desirable that this or some other conventional mode of stating the accuracy required in the execution of working drawings should be arrived at by common consent.

Of course, in practical construction the artizans employed must work to gauges—and these be made to represent absolute stated measure, and frequently compared with absolute standards. Then you might give out your work to any number of different workshops and sets of men, and it could all be assembled and put together without difficulty.

Perhaps this system has not been sufficiently carried out in practice because of the difficulty of comparing gauges with graduated standards, or even of obtaining these standards of the requisite accuracy. That difficulty has now been overcome for our workshops by the establishment of the National Physical Laboratory at Teddington. This admirable institution, under its very able director, Dr. Glazebrook, is now prepared to test or determine the error of any gauge of any kind required in the practice of the Arts and Sciences. It will give advice as to the best form of gauges for any particular purposes. If required it would advise where such gauges may be obtained—and will test them before delivery, rejecting all which do not come up to specification in accuracy or quality of construction.

I am sorry now that I did not devote the whole of this address to the advantages which have accrued to the Nation, and in particular to its manufacturing and engineering workshops, from the establishment of the National Physical Laboratory. It is a great theme and one that it is too late for me now to enter upon at any length.

I venture to think there is not a man in this room who would not benefit by a careful study of its annual report. He would find there an account of work done and proposed to be done, which is full of suggestion as to the possibilities of the future, and also a narrative of successful achievement in promoting the interests of nearly every department of physical science and manufacture.

A mere mention of the sub-heads of the Report, such as Electrotechnics, Electro-Thermometry, Metrology, Optics, Tide Prediction, General Problems in Engineering, such as the effect of wind-pressure on structures, the resistance of plates and models in a current of water, the resistance of materials subjected to frequent alternating stresses, the elastic limits of material under alternating stress, the tensile strength and elasticity of wires at various temperatures, the strength and efficiency of welded joints, steam research and the examination of new forms of superheaters, the resistance of materials under static loads to sudden shocks, determination of the sliding friction between metal valve faces and their seats under the action of superheated steam, etc. All these should appeal to the marine engineer.

There is a vast amount of interesting and useful work on Aeronautics, far too wide in extent even to mention.

The report of the work done in the department of metallurgy and metallurgical chemistry is no less full of practical interest and importance—as is also that of the Observatories at Kew and Eskdale, dealing with magnetics, meteorology, verification of instruments and the rating of watches and chronometers, and so on.

As a magnificent instance of the value attached by the most competent authority to the practical value and scientific accuracy of work done at the National Physical Laboratory, I may mention the gift of £20,000 made by Mr. A. F. Yarrow to establish an experimental tank for testing models of ships at Teddington. That tank is now completed—except as to the travelling gear and testing arrangements.

That surely is an addition to the resources and field of work of the Laboratory which must appeal to you.

I regret, as I have already said, that I did not devote the whole of my address to illustrating more fully the practical value of the National Physical Laboratory to every engineer and manufacturer in this country. But I think I can do better now, by making to you a suggestion, which is this, viz., that you should endeavour to secure an address on this subject from Dr. Glazebrook himself.

In conclusion, allow me to express the interest and satisfaction I have derived from a perusal of the publications of the Society for the past two years, which have been supplied to me by your indefatigable Hon. Secretary.

Many of the papers read show a thorough scientific knowledge of the practical subjects of which they treat—and the discussions are, as a rule, of an interesting and sometimes very luminous character. The regular monthly issue of these publications must tend to keep up the interest of members in the work of the Institute, and intensify the feeling of co-operation for common good which should underlie the constitution of all bodies like this Institute.

I rejoice to see that the membership of the Society keeps up so well, and I do not wonder that it does so, having regard to the information to be gained by its publications, and from study in its library, reading-room, and workshop.

The concerts and other social functions create a feeling of good fellowship, and besides afford opportunities for meeting and private talk about the things of which the hearts of earnest professional men are generally full.

Let me once more thank you for the honour you have done me, and express the pleasure it has given me to preside here to-night.

We now pass to the more formal side of my duty, viz., to summarize the work of the Institute for the past year.

Up to the present sixty-six members have been elected—an increase on the number elected during similar periods for the last six sessions, with the exception of last session, when the number of elections was abnormally large. The Internal Combustion Engine, which is largely occupying the attention of the engineering world at the present time, is the subject of three papers which have been read during the present session. "The Internal Combustion Engine for Marine Use," by Mr. W. R. Cummins (Member); "An Experimental Study of an Oil Engine," by Mr. F. J. Kean, B.Sc. (Member); and "The Internal Combustion Engine," by Mr. W. P. Durtnall (Member). Other papers read to the present time are: "The Application of Oxy-Acetylene Welding to the Repair of Marine Boilers," by Mr. L. M. Fox (Member); "Electrical Apparatus for Warping, Winding, Hoisting, etc.," by Mr. Jas. A. Liddle (Member); "The Stability of Ships," by Mr. E. Tate; "Electro-Magnetic Transmission for Marine Propulsion," by Mr. Jules Lecoche (Member); and "The Telemotor," by Mr. W. G. Gibbons (Member).

The Denny Gold Medal has been awarded to Mr. J. Clark (Member), for his paper on "Cylinder Losses, and the Adiabatic Expansion of Steam with and without Superheat," which was adjudged to be the best paper submitted during session 1909–1910.

The Lloyd's Register Scholarship of £50 per annum, tenable for two years, has been gained by Mr. Jas. D. Boyle (Graduate), of Forfar, apprentice engineer with Messrs. Rankin & Blackmore, of Greenock. Mr. Boyle has now commenced his studies at Glasgow University.

Essay Competition Awards.—The Stephen Award to the value of £2 has been gained by Mr. Jas. S. Gander (Assoc. Member), for his essay on "Notes on the Propeller Shaft." The Ritchie Award, to the value of £2 has been gained by Mr. C. V. Lewis (Graduate), for his essay on "The Steam Engine Condenser," and prizes to the value of 30*s*. to Mr. R. Riddell (Graduate), and 10*s*. to Mr. Walter Smith (Graduate). In addition to the above, Mr. Robert Clark (Companion) has given a prize of £2 2*s*. for an Open Competition for Apprentice Engineers and Graduates of the Institute. This has been awarded to Mr. G. Turner, of Monkseaton, Northumberland.

Visits have been paid to the Japan-British Exhibition, when a meeting was held in the Garden Club Hall, presided over by Sir Wm. Hall-Jones, K.C.M.G., High Commissioner for New Zealand, and at the Naval, Mercantile Marine and Engineering Exhibition at Olympia, when your present President occupied the chair.

The chief item which will engage the attention of the members this session will be the proposals with regard to the acquisition of premises in the City. A large Committee representative of the membership has been formed, and held their first meeting in July, when an Executive Committee was appointed to carry out the details, and no doubt a definite proposal will shortly be put before the members.

The Council have given careful consideration to the proposals of the Board of Trade with regard to the alteration to the Regulations affecting the granting of Certificates of Competency to Marine Engineers, and a full copy of the correspondence which has passed between the Council on the Board on the subject will be found in the August issue of the Transactions.

The following papers are on the Syllabus for the forthcoming session :

"Indicator Diagrams," by Mr. W. G. Winterburn (Member).

"Notes on Salving a Gold Dredge," by Mr. F. G. Butt (Member).

"A Short History of Lubrication," by Mr. J. Veitch Wilson.

"Causes of Deterioration in Boilers," by Mr. C. C. Nelson (Member).

Discussions will also be held on the papers read at the Japan-British and Olympia Exhibitions.

In conclusion, I should like to say a word or two about the assistance one has had at all times from your Honorary Secretary. You have not to talk five minutes with Mr. Adamson before you will find that his whole heart and soul is in the prosperity of this Institute, and I want to accord him my own thanks for all the assistance he has given me and for his kindness in every part of my duty connected with this Chair.

Presentation of Denny Gold Medal and Awards.

Sir David Gill: I have to present to you, Mr. Clark, the Denny Gold Medal of this Institute. I have looked through your paper and congratulate you upon it. I fully appreciate the wisdom of the judges in deciding to award it to you.

Mr. Clark: I am deeply sensible of the great honour conferred in awarding me the Denny Gold Medal for the paper I had the privilege of reading relating to the work of steam. Engineers of all branches meet on common ground in a discussion on this, and present day methods of utilizing its energy—and especially, by means of turbines, the energy from low pressure steam, which only recently was looked upon as a waste product—is forcing us to give the subject more attention and study. The paper only dealt with the fringe of modern thought, many mysteries and problems still remain to worry us; but without doubt these will yet be solved and can only be solved by progressively staging it forward bit by bit. Personally it will be a matter of much gratification to me if the paper is of service in helping towards this end.

The President then presented the awards gained in the Essay Competitions.

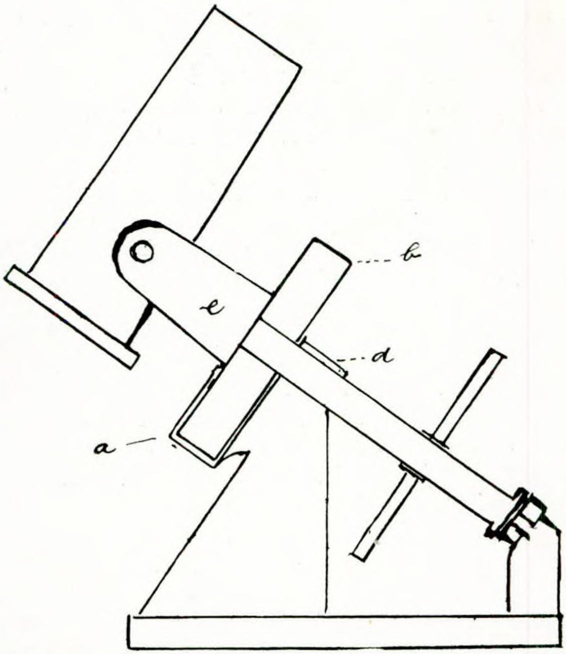
Mr. A. Boyle (Vice-President): I am sure we have all listened to the instructive address of the President with the greatest of interest and pleasure. It appears to me to be almost a romance of measurement to speak of measuring what is equivalent to the diameter of a threepenny bit at a distance of a mile. We all know that Sir David Gill is a distinguished astronomer, distinguished not only in astronomy pure and simple, but in other work connected with that science, such as making surveys in parts of the earth of which very little is known. As marine engineers, we have a great respect for astronomers, and a profound admiration for astronomy. When on watch below we are more immediately concerned with the machinery there than with the mechanical perfection displayed in the heavens above; but on a starry night, as we look upward we cannot help thinking, along with the poet who asked—

> Who rounded in His palm these spacious orbs,
> And hurled them flaming through the dark profound ?

It seems hard to grasp the inconceivably minute measurements required for estimating the distances of the fixed stars and for solving problems in astronomy which are of the greatest practical interest and importance, as in navigation. I am sure you will all accept the motion I will now put, that we accord to Sir David Gill a very hearty vote of thanks for the very admirable address he has given us this evening.

Mr. George Adams (Member of Council) seconded the vote of thanks.

The President: I am very much obliged to the proposer and seconder of this vote of thanks and to you for your hearty reception of it. In beginning the subject I wrote whatever came uppermost in my mind, and probably in things mechanical I have made a slip here and there and you are too polite to say so. There are things still in practical engineering which require systematizing, and if a plan were adopted such as I have stated, of making a diagram showing exactly the amount of accuracy which each measurement is intended to represent, it is high time it was done. Then as to accuracy of absolute measurement. If every engineer is provided, as I suppose he is, with working drawings of his own engine, and these are made to absolute measurements, then I should think there would be no difficulty whatever in getting any part replaced by means of a telegram ordering the part required, and it would come to hand so as to fit perfectly and absolutely in its place. This could be done in the minimum of time. However, there the address stands; it will be printed in due course, and you will have an opportunity of criticising it at your leisure.



The telescope turns on the axis *c*, *d*, *e*. The hollow steel drum *b*, concentric with the axis, floats in the hollow tank *a*. The space is sufficiently filled with mercury to nearly float the whole.