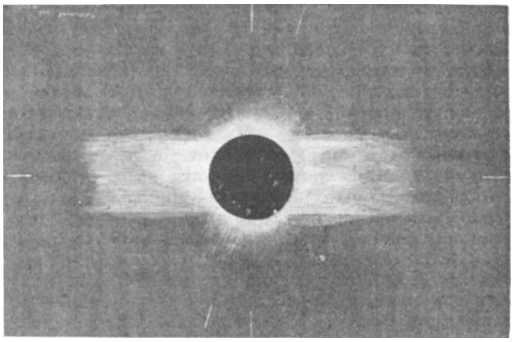
paraffin candle burning 100 metres away appeared quite bright. After about a minute the bright prominence *a* was seen, and it seemed to penetrate slightly into the dark body of the moon; this was seen for quite two minutes. Just before third contact the blood-red chromosphere appeared. At this time the temperature had steadily fallen to 31° C., but the lowest temperature recorded was $30^\circ{\cdot}25$, at 2h. 6m. 30s., making a total fall in temperature of $4^\circ{\cdot}5$ C.

Through a ruby glass the corona was invisible, except an irregular rim about one-eighth of the sun's diameter in width.



No air movements were noticed during the eclipse. Birds were not noticed to go to roost, but it was stated that some fowls did so. There is an insect known to the Dyaks as the "six o'clock insect," which invariably gives utterance to a very loud horn-like cry just before dark (*i.e.* about 6 p.m.), but its call was not heard during the eclipse.

THE AIMS OF THE NATIONAL PHYSICAL LABORATORY.[1]

THE idea of a physical laboratory in which problems bearing at once on science and on industry might be solved is comparatively new. The Physikalisch-Technische Reichsanstalt, founded in Berlin by the joint labours of Werner von Siemens and von Helmholtz during the years 1883–87, was perhaps the first. It is less than ten years since Dr. Lodge, in his address to Section A of the British Association, outlined the scheme of work for such an institution here in England. Nothing came of this; a committee met and discussed plans, but it was felt to be hopeless to approach the Government, and without Government aid there were no funds.

Four years later, however, the late Sir Douglas Galton took the matter up. In his address to the British Association in 1895, and again in a paper read before Section A, he called attention to the work done for Germany by the Reichsanstalt and to the crying need for a similar institution in England.

The result of this presidential pronouncement was the formation of a committee which reported at Liverpool, giving a rough outline of a possible scheme of organisation. A petition to Lord Salisbury followed, and as a consequence a Treasury committee, with Lord Rayleigh in the chair, was appointed to consider the desirability of establishing a National Physical Laboratory. The committee examined more than thirty witnesses and then reported unanimously "that a public institution should be founded for standardising and verifying instruments for testing materials and for the determination of physical constants."

It is natural to turn to the words of those who were instrumental in securing the appointment of this committee, and to the evidence it received, in any endeavour to discuss its aim. As was fitting, Sir Douglas Galton was the first witness to be called. It is a source of sorrow to his many friends that he has not lived to see the Laboratory completed.

And here may I refer to another serious loss which, in the last few days, the Laboratory has sustained. Sir Courtenay Boyle was a member of Lord Rayleigh's committee, and as such was convinced of the need for the Laboratory and of the importance of the work it could do. He took an active part in its organisation, sparing neither time nor trouble; he intended that it should be a great institution, and he had the will and the power to help. The country is the poorer by his sudden death.

Let me now quote some of Sir Douglas Galton's evidence. "Formerly our progress in machinery," he says, "was due to accuracy of measurement, and that was a class of work which could be done, as Whitworth showed, by an educated eye and educated touch. But as we advance in the applications of science to industry we require accuracy to be carried into matters which cannot be so measured. . . . In the more delicate researches which the physical, chemical and electrical student undertakes, he requires a ready means of access to standards to enable him to compare his own work with that of others." Or again, "My view is that if Great Britain is to retain its industrial supremacy we must have accurate standards available to our research students and to our manufacturers. I am certain that if you had them our manufacturers would gradually become very much more qualified for advancing our manufacturing industry than they are now. But it is also certain that you cannot separate some research from a standardising department." Then, after a description of the Reichsanstalt, he continues, "What I would advocate would be an extension of Kew in the direction of the second division of the Reichsanstalt, with such auxiliary research in the establishment itself as may be found necessary." The second division is the one which takes charge of technical and industrial questions. Prof. Lodge, again, gave a very valuable summary of work which ought to be done.

It is now realised, at any rate by the more enlightened of our leaders of industry, that science can help them. This fact, however, has been grasped by too few in England; our rivals in Germany and America know it well, and the first aim of the Laboratory is to bring its truth home to all, to assist in promoting a union which is certainly necessary if England is to retain her supremacy in trade and in manufacture, to make the forces of science available for the nation, to break down by every possible means the barrier between theory and practice, and to point out plainly the plan which must be followed unless we are prepared to see our rivals take our place.

"Germany," an American writer who has recently made a study of the subject has said, "is rapidly moving towards industrial supremacy in Europe. One of the most potent factors in this notable advance is the perfected alliance between science and commerce existing in Germany. Science has come to be regarded there as a commercial factor. If England is losing her supremacy in manufactures and in commerce, as many claim, it is because of English conservatism and the failure to utilise to the fullest extent the lessons taught by science, while Germany, once the country of dreamers and theorists, has now become intensely practical. Science there no longer seeks court and cloister, but is in open alliance with commerce and industry." It is our aim to promote this alliance in England, and for this purpose the National Physical Laboratory has been founded.

It is hardly necessary to quote chapter and verse for the assertion that the close connection between science and industry has had a predominant effect on German trade. If authority is wanted, I would refer to the history of the anilin dye manufacture, or, to take a more recent case, to the artificial indigo industry, in which the success of the Badische Company has recently been so marked. The factory at Ludwigshaven started thirty-five years ago with 30 men; it now employs more than 6000 and has on its staff 148 trained scientific chemists. And now, when it is perhaps too late, the Indian planters are calling in scientific aid and the Indian Government are giving some 3500*l.* a year to investigation.

As Prof. Armstrong, in a recent letter to the *Times*, says, "The truly serious side of the matter, however, is not the prospective loss of the entire indigo industry so much as the fact that an achievement such as that of the Badische Company seems past praying for here." Another instance is to be found in the German exhibit of scientific instruments at the Paris Exhibition, of which a full account appeared in the pages of NATURE.

And now, having stated in general terms the aims of the Laboratory and given some account of the progress in Germany, let me pass to some description of the means which have been placed at our disposal to realise those aims. I then wish, if time permits, to discuss in fuller detail some of the work which it is hoped we may take up immediately.

The Laboratory is to be at Bushy House, Teddington. I will

[1] A discourse delivered at the Royal Institution on Friday, May 24, by Dr. R. T. Glazebrook, F.R.S., Director of the Laboratory.

pass over the events which led to the change of site from the Old Deer Park at Richmond to Bushy. It is sufficient to say that at present Kew Observatory in the Deer Park will remain as the Observatory department of the Laboratory, and that most of the important verification and standardisation work which in the past has been done there will still find its home in the old building.

Bushy House was originally the official residence of the Ranger of Bushy Park. Queen Anne granted it in 1710 to the first Lord Halifax. In 1771 it passed to Lord North, being then probably rebuilt. Upon the death of Lord North's widow in 1797, the Duke of Clarence, afterwards William IV., became Ranger; after his death in 1837 it was granted to his widow, Queen Adelaide, who lived there until 1849. At her death it passed to the Duc de Nemours, son of King Louis Philippe, and he resided there at intervals until 1896.

In spite of this somewhat aristocratic history, it will make an admirable Laboratory. A description of the Laboratory, with illustrations, will be found in NATURE, vol. lxiii. p. 300.

The floor space available is much less than that of the Reichsanstalt. But size alone is not an unmixed advantage; there is much to be said in favour of gradual growth and development, provided the conditions are such as to favour growth. Personally I should prefer to begin in a small way if only I felt sure I was in a position to do the work thoroughly, but there is danger of starvation. Even with all the help we get in freedom from rent and taxes, outside repairs and maintenance, the sum at the disposal of the committee is too small.

Science is not yet regarded as a commercial factor in England. Is there no one who realises the importance of the alliance, who will come forward with more ample funds to start us on our course with a fair prospect of success? One candid friend has recently told us in print that the new institution is on such a microscopic scale that its utility in the present struggle is more than doubtful. Is there no statesman who can grasp the position and see that with, say, double the income the chances of our doing a great work would be increased a hundredfold?

The problems we have to solve are hard enough; give us means to employ the best men and we will answer them, starve us and then quote our failure as showing the uselessness of science applied to industry.

There is some justice in the criticism of one of our technical papers. I have recently been advertising for assistants, and a paper in whose columns the advertisement appears writes, "The scale of pay is certainly not extravagant. It is, however, possible that the duties will be correspondingly light."

Now let me illustrate these aims by a more detailed account of some of the problems of industry which have been solved by the application of science, and then of some others which remain unsolved and which the Laboratory hopes to attack. The story of the Jena Glass Works is most interesting; I will take it first.

An exhibition of scientific apparatus took place in London in 1876. Among the visitors to this was Prof. Abbé, of Jena, and in a report he wrote on the optical apparatus he called attention to the need for progress in the art of glass making if the microscope were to advance, and to the necessity for obtaining glasses having a different relation between dispersion and refractive index than that found in the material at the disposal of opticians. Stokes and Harcourt had already made attempts in this direction, but with no marked success.

In 1881 Abbé and Schott, at Jena, started their work. Their undertaking, they write five years later in the first catalogue of their factory, arose out of a scientific investigation into the connection between the optical properties of solid amorphous fluxes and their chemical constitution. When they began their work some six elements only entered into the composition of glass. By 1888 it had been found possible to combine with these, in quantities up to about 10 per cent., twenty-eight different elements, and the effect of each of these on the refractive index and dispersion had been measured. Thus, for example, the investigators found that by the addition of boron the ratio of the length of the blue end of the spectrum to that of the red was increased; the addition of fluorine potassium or sodium produced the opposite result.

Now in an ordinary achromatic lens of crown and flint, if the total dispersion for the two be the same, then for the flint glass the dispersion of the blue end is greater, that of the red less than for the crown; thus the image is not white, a secondary spectrum is the result.

Abbé showed, as Stokes and Harcourt had shown earlier, that by combining a large proportion of boron with the flint its dispersion was made more nearly the same as that of the crown, while by replacing the silicates in the crown glass by phosphates a still better result was obtained, and by the use of three glasses three lines of the spectrum could be combined; the spectrum outstanding was a tertiary one, and much less marked than that due to the original crown and flint glass. The modern microscope became possible.

The conditions to be satisfied in a photographic lens differ from those required for a microscope. Von Seidel had shown that with the ordinary flint and crown glasses the conditions for achromatism and for flatness of field cannot be simultaneously satisfied. To do this we need a glass of high refractive index and low dispersive power, or *vice versâ*; in ordinary glasses these two properties rise and fall together. By introducing barium into the crown glass a change is produced in this respect. For barium crown the refractive index is greater and the dispersive power less than for soft crown.

With two such glasses, then, the field can be achromatic and flat. The wonderful results obtained by Dallmeyer and Ross in this country, by Zeiss and Steinheil in Germany, are due to the use of these new glasses. They have also been applied with marked success to the manufacture of the object glasses of large telescopes.

But the Jena glasses have other uses besides optical. "About twenty years ago"—the quotation is from the catalogue of the German exhibition—"the manufacture of thermometers had come to a dead stop in Germany, thermometers being then invested with a defect, their liability to periodic changes, which seriously endangered German manufacture. Comprehensive investigations were then carried out by the Normal Aichungs Commission, the Reichanstalt and the Jena Glass Works, and much labour brought the desired reward."

The defect referred to was the temporary depression of the ice point which takes place in all thermometers after heating. Let the ice point of a thermometer be observed; then raise the thermometer to, say, 100°, and again observe the ice point as soon as possible afterwards; it will be depressed below its previous position. In some instruments of Thuringian glass a depression of as much as 0°·65 C. had been noted. For scientific purposes such an instrument is quite untrustworthy. If it be kept at, say, 15° and then immersed in a bath at 30°, its reading will be appreciably different from that which would be given if it were first raised to, say, 50°, allowed to cool quickly just below 30°, and then put into the bath. This was the defect which the investigators set themselves to cure.

Table I. gives some details as to thermometers.

TABLE I.

Depression of Freezing Point for various Thermometers.

	°
Humboldt, 1835	0·06
Greiner, 1872	0·38
Schultzer, 1875	0·44
Rapps, 1878	0·65
English glass	0·15
Verre Dur	0·08
16‴	0·05
59‴	0·02

Analysis of Glasses.

	SiO_2	Na_2O	CaO	Al_2O_3	ZnO	B_2O_3
16‴	67·5	14	7	2·5	7	2
59‴	72	11	—	5	—	12

Weber had found in 1883 that glasses which contain a mixture of soda and potash give a very large depression. He made a glass free from soda with a depression of 0°·1. The work was then taken up by the Aichungs Commission, the Reichsanstalt and the Jena factory. Weber's results were confirmed. An old thermometer of Humboldt's, containing 0·86 per cent. of soda and 20 per cent. of potash, had a depression of 0°·06, while a new instrument, in which the percentages were 12·7 per cent. and 10·6 per cent. respectively, had a depression of 0°·65.

An English standard, with 1·5 per cent. of soda and 12·3 per cent. of potash, gave a depression of 0°·15, while a French "verre dur" instrument, in which these proportions were reversed, gave only 0°·08.

It remained to manufacture a glass which should have a low depression and at the same time other satisfactory properties. The now well-known glass 16''' is the result. Its composition is shown in the Table.

The fact that there was an appreciable difference between the scale of the 16''' glass and that of the air thermometer led to further investigations, and another glass, a borosilicate containing 12 per cent. of boron, was the consequence. This glass has a still smaller depression.

Previous to 1888 Germany imported optical glass. At that date nearly all the glass required was of home manufacture. Very shortly afterwards an export trade in raw glass began, which in 1898 was worth 30,000*l.* per annum, while the value of optical instruments, such as telescopes, field-glasses and the like, exported that year was 250,000*l.* Such are the results of the application of science, *i.e.* organised common sense, to a great industry. The National Physical Laboratory aims at doing the like for England.

I have thus noted very briefly some of the ways in which science has become identified with trade in Germany, and have indicated some of the investigations by which the staff of the Reichsanstalt and others have advanced manufactures and commerce.

Let us turn now to the other side, to some of the problems which remain unsolved, to the work which our Laboratory is to do and by doing which it will realise the aims of its founders.

The microscopic examination of metals was begun by Sorby in 1864. Since that date many distinguished experimenters, Andrews, Arnold, Ewing, Martens, Osmond, Roberts-Austen, Stead and others, have added much to our knowledge. I am indebted to Sir W. Roberts-Austen for the slides which I am about to show you to illustrate some of the points arrived at. Prof. Ewing a year ago laid before the Royal Institution the results of the experiments of Mr. Rosenhain and himself.

This microscopic work has revealed to us the fact that steel must be regarded as a crystallised igneous rock. Moreover, it is capable, at temperatures far below its melting point, of altering its structure completely, and its mechanical and magnetic properties are intimately related to its structure. The chemical constitution of the steel may be unaltered, the amounts of carbon, silicon, manganese, &c., in the different forms remain the same, but the structure changes, and with it the properties of the steel.

Sections of the same steel polished and etched after various treatments show striking differences. For instance, if a highly carburised form containing 1·5 per cent. of carbon be cooled down from the liquid state, the temperature being read by the deflection of a galvanometer needle in circuit with a thermopile, the galvanometer shows a slowly falling temperature till we reach 1380° C., when solidification takes place; the changes which now go on take place in solid metal. After a time the temperature again falls until we reach 680°, when there is an evolution of heat; had the steel been free from carbon there would have been evolution of heat at 895° and again at 766°. Now throughout the cooling, molecular changes are going on in the steel. By quenching the steel suddenly at any given temperature we can check the change and examine microscopically the structure of the steel at the temperatu re at which it was checked.

[Slides were shown representing the microscopic structures of steels subjected to different treatment as regards temperature and annealing.]

These slides are sufficient to call attention to the changes which occur in solid iron, changes whose importance is now beginning to be realised. On viewing them it is a natural question to ask how all the other properties of iron related to its structure; can we by special treatment produce a steel more suited to the shipbuilder, the railway engineer or the dynamo maker than any he now possesses?

These marked effects are connected with variations in the condition of the carbon in the iron; can equally or possibly more marked changes be produced by the introduction of some other element? Guillaume's nickel steel, with its small coefficient of expansion, appears to have a future for many purposes; can it or some modification be made still more useful to the engineer?

We owe much to the investigations of the Alloys Research Committee of the Institution of Mechanical Engineers. Their distinguished chairman holds the view that the work of that committee has only begun, and that there is scope for such research for a long time to come at the National Physical Laboratory. The executive committee have accepted this view by naming as one of the first subjects to be investigated the connection between the magnetic quality and the physical, chemical and electrical properties of iron and its alloys, with a view specially to the determination of the conditions for low hysteresis and non-agency properties.

At any rate we may trust that the condition of affairs mentioned by Mr. Hadfield in his evidence before Lord Rayleigh's Commission which led a user of English steel to specify that before the steel could be accepted it must be stamped at the Reichsanstalt, will no longer exist.

The subject of wind pressure, again, is one which has occupied this committee's attention to some extent. The Board of Trade rules require that in bridges and similar structures (1) That a maximum pressure of 56 lbs. per square foot be provided for; (2) that the effective surface on which the wind acts should be assumed as from once to twice the area of the front surface, according to the extent of the openings in the lattice girders; (3) that a factor of safety of 4 for the iron work and of 2 for the whole bridge overturning be assumed. These recommendations were not based on any special experiments. The question had been investigated in part by the late Sir W. Siemens.

During the construction of the Forth Bridge Sir B. Baker conducted a series of observations. The results of the first two years' observations are shown in Table II., taken from a paper read at the British Association in 1884. Three gauges were used.

TABLE II.

Revolving gauge.		Small fixed gauge.		Large fixed gauge.	
Mean pressure.		Easterly.	Westerly.	Easterly.	Westerly.
lb.	lb.	lb.	lb.	lb.	lb.
0 to 5	3·09	3·47	2·92	2·04	1·9
5 to 10	7·58	4·8	7·7	3·54	4·75
10 to 15	12·4	6·27	13·2	4·55	8·26
15 to 20	17·06	7·4	17·9	5·5	12·66
20 to 25	21·0	12·25	22·75	8·6	19
25 to 30	27·0		28·5		18·25
30 to 35	32·5		38·5		21·5
Above	65		41·0		35·25
(One observation only above 32·5).					

In No. 1 the surface on which the wind acted was about $1\frac{1}{2}$ square feet in area; it was swivelled so as always to be at right angles to the wind. In No. 2 the area of surface acted on was of the same size, but it was fixed with its plane north and south. No. 3 was also fixed in the same direction, but it had 200 times the area, its surface being 300 square feet.

In preparing the table the mean of all the readings of the revolving gauge between 0 and 5, 5 and 10, &c., lbs. per square foot have been taken, and the mean of the corresponding readings of the small fixed gauge and the large fixed gauge set opposite, these being arranged for easterly and westerly winds.

Two points are to be noticed: (1) only one reading of more than 32·5 lbs. was registered, and this, it is practically certain, was due to faulty action in the gauge.

Sir B. Baker has kindly shown me some further records with a small gauge.

According to these pressures of more than 50 lbs. have been registered on three occasions since 1886. On two other occasions the pressures, as registered, reached from 40 to 50 lbs. per square foot. But the table, it will be seen, enables us to compare the pressure on a small area with the average pressure on a large area, and it is clear that in all cases the pressure per square foot as given by the large area is much less than that deduced from the simultaneous observations on the small area.

The large gauge became unsafe in 1896 and was removed; but the observations for the previous ten years entirely confirm this result, the importance of which is obvious. The same result may be deduced from the Tower Bridge observations. Power is required to raise the great bascules, and the power needed depends on the direction of the wind. From observations on the power some estimate of the average wind pressure on the surface may be obtained, and this is found to be less than the pressure registered by the small wind gauges. Nor is the result surprising, when the question is looked at as a hydrodynamical problem; the lines of fluid near a small obstacle will differ from those near a large one, and the distribution of pressure over the large area will not be uniform. Sir W. Siemens is said to have found places of negative pressure near such an obstacle. As Sir J. Wolfe Barry has pointed out, if the average of 56 lbs. to the square foot is excessive, then the cost and difficulty of erection of large engineering works is being unnecessarily increased. Here is a problem well worthy of attention, and about which but little is known. The same, too, may be said about the second of the Board of Trade rules. What is the effective surface over which the pressure is exerted on a bridge? On this again our information is but scanty. Sir B. Baker's experiments for the Forth Bridge led him to adopt as his rule, Double the plane surface exposed to the wind and deduct 50 per cent. in the case of tubes. On this point again further experiments are needed.

To turn from engineering to physics. In metrology, as in many other branches of science, difficulties connected with the measurement of temperature are of the first importance.

I was asked some little time since to state, to a very high order of exactness, the relation between the yard and the metre. I could not give the number of figures required. The metre is defined at the freezing point of water, the yard at a temperature of 62° F. When a yard and a metre scale are compared they are usually at about the same temperature; the difficulty of comparison is enormously increased if there be a temperature difference of 30° F. between the two scales. Hence we require to know the temperature coefficients of the two standards. But that of the standard yard is not known; it is doubtful, I believe, if the composition of the alloy of which it is made is known, and in consequence Mr. Chaney has mentioned the determination of coefficients of expansion as one of the investigations which it is desirable that the Laboratory should undertake.

Or, again, take thermometry. The standard scale of temperature is that of the hydrogen thermometer; the scale in practical use in England is the mercury in flint glass scale of the Kew standard thermometers. It is obvious that it is of importance to science that the difference between the scales should be known, and various attempts have been made to compare them. But the results of no two series of observations which have been made agree satisfactorily. The variations arise probably in great measure from the fact that the English glass thermometer, as ordinarily made and used, is incapable of the accuracy now demanded for scientific investigations. The temporary depression of the freezing point already alluded to in discussing the Jena glass is too large; it may amount to three- to four-tenths of a degree when the thermometer is raised 100°. Thus the results of any given comparison depend too much on the immediate past history of the thermometer employed, and it is almost hopeless to construct a table, accurate, say, to ·01, which will give the difference between the Kew standard and the hydrogen scale, and so enable the results of former work in which English thermometers were used to be expressed in standard degrees.

TABLE III.—*Values of Corrections to the English Glass Thermometer Scale to give Temperatures on the Gas Thermometer Scale found by various Observers.*

Temp.	Rowland.	Guillaume.	Wiebe.
0°	0°	0°	0°
10	− ·03	− ·009	+ ·03
20	− ·05	− ·009	+ ·00
30	− ·06	− ·002	+ ·02
40	− ·07	+ ·007	+ ·09
50	− ·07	+ ·016	+ ·14
60	− ·06	+ ·014	
70	− ·04	+ ·028	
80	− ·02	+ ·026	
90	− ·01	+ ·017	
100	0	0	

This is illustrated by Table III., which gives the differences as found (1) by Rowland; (2) Guillaume; (3)? Wiebe between a Kew thermometer and the air thermometer.

It is clearly important to establish in England a mercury scale of temperatures which shall be comparable with the hydrogen scale, and it is desirable to determine as nearly as may be the relation between this and the existing Kew scale.

I am glad to say that in the first endeavour we have secured the valuable cooperation of Mr. Powell, of the Whitefriars Works, and that the first specimens of glass he has submitted to us bid fair to compare well with 16‴.

Another branch of thermometry at which there is much to do is the measurement of high temperature. Prof. Callendar has explained here the principles of the resistance thermometer, due first to Sir W. Siemens. Sir W. C. Roberts-Austen has shown how the thermopile of Le Chatellier may be used for the measurement of high temperatures. There is a great work left for the man who can introduce these or similar instruments to the manufactory and the forge, or who can improve them in such a manner as to render their uses more simple and more sure. Besides, at temperatures much over 1000° C., the glaze on the porcelain tube of the pryometer gives way.

So far we have discussed new work, but there is much to be done in extending a class of work which has gone on quietly and without much show for many years at the Kew Observatory. Thermometers and barometers, wind gauges and other meteorological apparatus, watches and chronometers, and many other instruments are tested there in great numbers, and the value of the work is undoubted. The competition among the best makers for the first place, the best watch of the year, is most striking and affords ample testimony to the importance of the work.

Work of this class we propose to extend. Thus, there is no place where pressure gauges or steam indicators can be tested. It is intended to take up this work, and for this purpose a mercury pressure column is being erected.

Again, there are the ordinary gauges in use in nearly every engineering shop. These, in the first instance, have probably come from Whitworth's, or nowadays, I fear, from Messrs. Pratt and Whitney or Browne and Sharpe, of America. They were probably very accurate when new, but they wear, and it is only in comparatively few large shops that means exist for measuring the error and for determining whether the gauge ought to be rejected or not. Hence arise difficulties of all kinds. Standardisation of work is impossible.

In another direction a wide field is offered in the calibration and standardisation of glass measuring vessels of all kinds, flasks, burettes, pipettes, &c., used by chemists and others. At the request of the Board of Agriculture we have already arranged for the standardisation of the glass vessels used in the Babcock method of measuring the butter fat in milk, and in a few months many of these have passed through our hands. We are now being asked to arrange for testing the apparatus for the Gerber and Leffman-Beam methods, and this we have promised to do when we are settled at Bushy. Telescopes, opera-glasses, sextants, and other optical appliances, are already tested at Kew, but this work can, and will, be extended. Photographic lenses are now examined by eye; a photographic test will be added, and I trust the whole may be made more useful to photographers.

I look to the cooperation of the Optical Society to advise how we may be of service to them in testing spectacles, microscope lenses and the like. The magnetic testing of specimens of iron and steel, again, offers a fertile field for inquiry. If more subjects are needed it is sufficient to turn over the pages of the evidence given before Lord Rayleigh's Commission, or to look to the reports which have been prepared by various bodies of experts for the executive committee.

In electrical matters there are questions relating to the fundamental units on which, in Mr. Trotter's opinion, we may help the officials of the Board of Trade. Standards of capacity are wanted; those belonging to the British Association will be deposited at the Laboratory. Standards of electromagnetic induction are desirable; questions continually arise with regard to new forms of cells other than the standard Clark cell, and in a host of other ways work will be found.

I have gone almost too much into detail. It has been my wish to state in general terms the aims of the Laboratory to make the advance of physical science more readily available for the needs of the nation, and then to illustrate the way in which it is intended to attain those aims. I trust I may have shown that the National Physical Laboratory is an institution which may deservedly claim the cordial support of all who are interested in real progress.