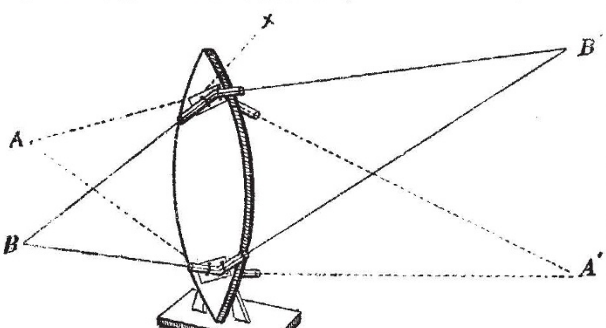
masterly essays upon these and others to the Linnean Society. His treatises on the Leguminosæ are no less exhaustive and valuable; and there is not a temperate or tropical region of the globe whose floras have not been largely elucidated by him. It may safely be affirmed that for variety and extent of good work of the kind he had no superior. The distinctive qualities of his descriptions are—scientific accuracy, good arrangement, precision of language, lucidity, and the discarding of what is superfluous. In these respects he has had no superior since the days of Linnæus and Robert Brown, and he has left no equal except Asa Gray.

Of his amiable disposition, and his sterling qualities of head and heart, it is impossible to speak too highly: though cold in manner and excessively shy in disposition, he was the kindest of helpmates and most disinterested of labourers for others.

Of recognition by foreign Academies Bentham had his full share, including that of Corresponding Member of the Institute of France. His election into the Royal Society was not till late (1862). It should have been in 1829, when he was proposed by R. Brown, and at his recommendation withdrawn, along with other scientific candidates, who thus showed their dissatisfaction at the Society's election of a Royal Duke to the President's chair. He, however, received the Royal Medal of the Society, and in 1878, on the completion of the Australian flora, the Secretary of State for the Colonies, unsolicited, recommended him to Her Majesty for the Companionship of the Order of St. Michael and St. George.

A MODEL LENS FOR USE IN CLASS DEMONSTRATIONS

In using diagrams or models as aids in teaching, this question constantly arises—How far may we represent Nature diagrammatically without producing in the mind of a student one-sided and false impressions? I have myself endeavoured to follow this rule: that, if a complicated object or phenomenon is to be studied, we may simplify this, and bring out many salient features, with a diagrammatic representation; this must, however, only be looked upon as a stepping-stone to a more complete study of the object or phenomenon itself. The



model of a lens to be described I have found of much service in lecturing, antecedent to a demonstration of the passage of luminous rays through actual lenses.

This model may be constructed out of the simplest materials, and should cost but two or three shillings. It consists of a piece of deal board cut in the shape of the cross-section of a biconvex lens, and fixed to a stand of wood (see diagram). Four small squares of board, *x*, are fixed in the positions indicated, two on either side of the lens. Glass tubes bent at obtuse angles are fixed to these by staples, and can rotate with them on the screws by means of which the squares are fixed to the lens. Two pieces of string to represent visual rays are then passed through the tubes A A′ and B B′. The theory of the use of this model will be at once apparent. A ray of light passing through a lens of a given curvature and density will practically (this is not absolutely true) be bent at a given angle, whatever be the direction of the ray, so long as it passes through the same part of the lens. In the model this constant degree of bending is given to the string—representing the ray of light—by the bent tubes. These, rotating on the lens, allow one diagrammatically to represent the rays passing through it in any desired direction.

Taking the string B B′, for example, and holding it at these two points in the two hands, and keeping the string taut, it will be found that in shifting the point B—representing a luminous point—in any direction, B′ will shift until it occupies the position of the corresponding focus. By shifting the string it is possible to demonstrate the focal points of parallel, diverging, and converging rays, either parallel to the axis of the lens, or on secondary axes. Then, by using at the same time the string fixed to the other side of the lens A A′, the formation of an image may be shown. Grasping with the two hands A and B, an assistant holding A′ and B′, it will be seen how by this lens an inverted image is produced. Bring the points A and B nearer the lens, keeping them, however, at the same distance apart, and the points A′ and B′ will recede from the lens and from each other, showing how the image of the nearer object is formed farther away from the lens, and is larger in size. On the other hand, if A and B be pulled away from the lens, A′ and B′ approximate to it and to one another.

In working the model the squares should rotate easily, and the strings must always be held taut. For lecture-room purposes the lens should be about two feet high, and the strings may be coloured. On the same principle I have constructed models of other lenses or lens combinations.

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THE ELECTRICAL EXHIBITION AT PHILADELPHIA

[FROM A CORRESPONDENT]

To one who has visited the various electrical exhibitions held in recent years in the chief European cities, the Exhibition now open in the city of Philadelphia might seem a little disappointing from the absence of novelty in the exhibits, though replete with objects of interest for all to whom this class of show is not familiar. As might be expected, the strong point of the Philadelphia show is electric lighting; and the building—a temporary structure erected close to the depot of the Pennsylvania Railroad Company on the west bank of the Schuylkill—presents both interiorly and exteriorly a blaze of light. The array of dynamo-machines is remarkably complete. Edison leads the way with a variety of machines, including one "Jumbo," of the same type as, but rather smaller than, the pair of machines in use at the Holborn Viaduct lighting station. There are also a large number of Weston's machines, and a very valuable exhibit by the Thomson-Houston Company. The machines of the latter company are quite unique amongst dynamos; one of them can maintain sixty arc lights on one circuit, though there are but three coils on its armature. Other dynamos are shown by Ball, Hockhausen, Van Depoele, and McTighe. There are several excellent arc lamps, possessing novelty, however, in matters of detail only. A great show of incandescent lamps is made by the Edison Company, and also by the Weston Company. The latter has some remarkable lamps with filaments sixteen inches in length prepared from a new parchment-like substance, of which samples are shown. These lamps are from 100 to 200 reputed candle-power.

Electric motors are exhibited by several inventors.

The little Griscom motor and the Cleveland motor are of course present, driving sewing-machines and fans. Edison contributes also some small motors of excellent finish. Amongst larger machines there is one by Daft and one by Elihu Thomson. But by far the most important of all exhibits of this class is that of Mr. F. J. Sprague, which shows a very great advance on anything hitherto accomplished. Mr. Sprague appears to have succeeded in producing a motor which runs at a uniform speed whatever its load. It is employed in driving a small loom.

In telephones there is not much new. The Clay Telephone Company exhibits its system, with a remarkably simple and efficient receiving instrument. Beyond this there is absolutely nothing new. The chief interest centres on the historic exhibitions of Elisha Gray, Graham Bell, A. E. Dolbear, and Van der Weyde. The remarkable telephones of Daniel Drawbaugh are not yet exhibited to public gaze on account of pending legal proceedings.

In telegraphy the sole novelty is the marvellous multiplex telegraph of Delaney, based upon the principle of La Cour's "phonic wheel," and capable of transmitting seventy separate messages simultaneously through a single wire.

Passing on to other exhibits, it should be mentioned how Messrs. J. W. Queen and Co. display a very large collection of imported apparatus, including the finest instruments of Elliott Brothers, Carpentier, Breguet, Hartmann, and Edelmann. Some excellent measuring-instruments by the Electric Apparatus Company of Troy, N.Y., are also shown. A collection of a curious and instructive nature was exhibited by the U.S. Patent Office, consisting of the historic models sent by inventors. Here may be seen the original Edison telephone, the original Brush dynamo, the original Edison lamp, and many other similar objects, including many old forms of electric motor dating from the years 1840-50. A special effort has also been made to get together a complete modern library of books bearing on the science of electricity. Some six thousand volumes have in this manner been procured, and form a valuable collection.

The Franklin Institute of Philadelphia, which has organised this Exhibition, must be congratulated on the energy and enterprise which it has put forth. It would be impossible to get together a collection of apparatus more thoroughly representative of the solid progress made in electro-technics on the American continent. Though the Exhibition is yet far from complete, it has become much more so since its opening on September 2. It will remain open until October 11.

A NEW APPLICATION OF INDIA-RUBBER[1]

IF iron takes the lead among articles of modern industry in the extent and number of its applications, it yet falls short of india-rubber in their variety. This latter article, indeed, promises soon to attain a universal diffusion. Its industrial career, though little more than just begun, already outstrips that of most substances that were first in the field.

The mere enumeration of its qualities would suffice to account for the diversity of its applications. It possesses so great an elasticity that by this quality alone it adapts itself to a thousand different uses—brace-bands, garters, sides of boots, &c.

Observe how, if not the lightest, india-rubber is at least the most powerful reservoir of mechanical energy known. It lends itself most readily to the restitution, under the form of mechanical labour, of the energy imparted to it by tension, and this restitution may be effected with remarkable quickness. It is owing to the relative lightness of india-rubber considered as an accumulator of energy, and, above all, to its power, that the exactness of the principle of "heavier than air" may be demonstrated on a small scale.

From an electrical point of view, india rubber acts as a better insulator than gutta-percha, and is, indeed, one of the best insulating bodies known. At the same time that its specific inductive capacity is weaker than that of gutta-percha, it does not become plastic at a moderate temperature. These properties render it an excellent insulator in electrical applications: submarine and subterranean telegraphy, electric light, transmission of force, &c. While it insulates better than gutta-percha, the conductor, where india-rubber is used, does not run the risk of being put out of centre, as is the case sometimes with gutta-percha.

India-rubber is known to oxidise under exposure to air and light; above all, under alternations of dryness and damp. By subjecting it, however, to a special operation, called vulcanisation, a product is obtained which maintains its flexibility at low temperatures, resists heat much better, does not oxidise in air, and absorbs less water. It is especially under the form of vulcanised india-rubber that its applications are numerous.

FIG. 1.—Position in which household utensils furnished with india-rubber may be placed without falling.

There is, finally, a third form of india-rubber, no less useful, that of ebonite, or hardened india-rubber, a form which combines with its lightness and great electrical resistance, the further advantage of resisting acids, and which is therefore exclusively employed when vessels for the electric pile or other reservoirs of a light and not readily brittle character are wanted. Like a new Proteus, india-rubber is thus seen to adjust itself to the ever more numerous and pressing demands of modern industry.

To turn now to the new, curious, and original application an idea of which it is the object of this notice to convey. The aim of the inventor, whose name unfortunately has not reached us, has been to take advantage of the great mutual adherence of a soft and a hard body. It is by the utilisation of this relation that the inventor has originated quite a series of household objects in earthen-

[1] From *La Nature.*