

pieces were prepared for the determination of the refractive properties of the glasses.

The three open and three complete rings were examined in plane polarised light for strain. The examination showed that in both rings of the French glass, and in the open ring from the German lamp chimney, the amount of strain was negligible. In the unbroken ring from the German chimney there was very decided strain. Strain was also present in both rings of the "Durax" glass, the unbroken ring of this material showing much more pronounced strain than any of the other rings. The appearance presented by the rings when examined in the dark field is a very strong and sharp black circular line in the middle of the glass with a decided black cross upon it, and the rest of the ring either white or milky.

The character of the strain present in the unbroken ring from the German chimney was determined by distorting the ring into an elliptical form by compression between two points at opposite ends of a diameter of the ring inclined at 45° to the plane of polarisation. By this means the milkiness could be made to disappear entirely from the regions about the diametrical plane perpendicular to the line of compression, but the strain in the neighbourhood of the points of compression was increased. This shows that the strain is relieved by an increase in the curvature, and augmented by a reduction in the curvature; in other words, the inner layers of the ring are in a state of tension, and the outer layers in a state of compression. The fact that in the open ring the strain throughout is practically entirely relieved suggests that these chimneys are made in one operation, and not by the combination of layers of material at different temperatures. It is evident that with the distribution of strain in the cold state indicated above, the chimney will tend to be relieved of strain when there is a radial temperature gradient throughout its substance with the outer surface cooler than the inner surface.

With the "Durax" tubing there is in neither ring freedom from strain. In the open ring the strain becomes worse on altering the curvature in either direction. Perhaps this indicates that the tube is built up of layers of the same or different materials, but brought together with one layer decidedly cooler than another. The presence of a thin white band in the substance of the glass may also indicate that the tube has been built up in the way suggested. An examination of all the rings in ordinary light showed the presence of striæ likely to prevent the formation of really sharp spectrum lines in the determination of their refractive properties. This expectation was fully borne out by the appearance of the lines in the refractometer. No indication was obtained that any tube consisted of more than one type of glass, but the want of sharpness in the lines was sufficient to obscure the difference between glasses of very nearly identical optical properties. The results obtained in these measurements are as follows:—

	n_D	$n_C - n_F$	ν
German chimney ...	1.4795	0.00729	65.8
French chimney ...	1.5748	0.01313	43.8
"Durax" combustion tubing ...	1.5156	—	—

The optical glasses which resemble the above in refractive properties are, for the German chimney one of the new "Fluor Crowns," for the French chimney a light flint, and for the "Durax" tubing a hard crown.

Experiments were made to determine possible variations in the strained condition of lamp chimneys due to internal heating and resulting temperature gradient across the glass.

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Coils of wire were wound round a cylindrical metal core, the whole enclosed in asbestos paper and fitted closely (without mechanical strain) into the ring of the chimney examined. A thermo-couple was introduced between the lagging and the glass to enable the temperature of the latter to be determined on the passage of a current through the heating coil.

French Chimney.—This was initially when cool without strain. On heating up strain was found to develop progressively as the temperature rose, and there is no evidence that at any temperature the strain declines to a minimum again.

German Chimney.—When cool and at uniform temperature this showed very decided strain in the shape of a central ring and cross. On heating up the ring the strain was relieved, but the glass is never entirely freed from the strain as evidenced by a complete absence of the stauoscopic figure. The tendency is rather for the central dark ring to move outwards and to be replaced eventually by another ring moving out from the inner surface of the glass ring. There is nevertheless a decided minimum effect, *i.e.* minimum strain, obtained when the temperature of the inner surface of the glass ring is about $150^\circ \text{C.} (\pm 20^\circ)$. The temperature gradient across the glass is such that in the steady state the temperature of the outer surface of the lamp, corresponding with the above internal temperature, is roughly 70° , within the same limits of accuracy. Excessive heating above these limits results merely in producing a more pronounced strain.

A further chemical analysis of the inner layers confirmed the view that the German miner's lamp chimney is of a single material.

The incandescent lamp chimneys are very thin and optical examination is not possible, but it appears fairly certain that in their case also the extra strength is attained by some process whereby the outside is chilled before the interior cools down. It seems possible also that the extra heat-resisting qualities of certain beakers, flasks, etc., of German glass may be due to the converse process, the interior being chilled previously to the exterior. All these glasses appear to be of the borosilicate type, such as is used for the well-known thermometer glass 59^{III}, but with somewhat more boric anhydride; the chemical glass contains zinc oxide, which is absent from the thermometer glass.

As already stated, the object of these notes is to put such information as is available before English manufacturers in the hopes of encouraging some of them to take up the manufacture of some of these glasses.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. R. TRAVERS SMITH has been appointed to the chair of materia medica, therapeutics, and pharmacology in the school of surgery of the Royal College of Surgeons in Ireland.

THE will of the late Mr. W. E. Allen, chairman of Messrs. Edgar Allen and Co., Ltd., of the Imperial Steel Works, Sheffield, who died in January last, provides that two-fifths of the residue of his property after the payment of numerous bequests to charities and employees, shall be given to the University of Sheffield, to be applied as to 5000*l.* to the Applied Science Department, and as to the balance, in the discretion of the University Council, in founding Edgar Allen scholarships or exhibitions for students of that University, of whom one-half shall be sons of workmen earning daily or weekly wages or foremen of workmen or managers. The gross value of the

estate was 271,068*l.*, and about 150,000*l.* is devoted to bequests for charities and employees.

THE annual gathering of the South-Western Polytechnic was held on Friday, March 12. The chair was taken by Archdeacon Bevan, and Mrs. Hayes Fisher distributed the certificates and prizes. The report of the principal showed that the chief feature of the session 1913-14 was the large number of scholarships gained by the past and present evening students. These scholarships included a Beit fellowship, the research studentship at Emmanuel College, Cambridge, a science scholarship and an art scholarship given by the London County Council. Amongst the degrees gained in London University were three D.Sc. degrees in chemistry. The principal also directed attention to the large number of present and past members of the institute who were serving with the forces. A vote of thanks was proposed by the Mayor of Chelsea, Principal Hudson, of St. Mark's College, and was seconded by Mr. J. B. Coleman, who gave some account of the present condition of chemical industries and of what the chemical department of the institute was doing to help those industries.

THE steady progress of education, and especially of scientific education, in India, has frequently been noticed in these columns, and we are glad to see confirmatory evidence in the *Presidency College Magazine*, issued from the Presidency College, Calcutta, and edited by Mr. Joges Chandra Chakravarti. The magazine contains some interesting papers and notes, and prominent among them is an article on Prof. H. E. Armstrong's visit to Calcutta as reader in chemistry to the University, when he delivered a course of five lectures. There is also a review of "Forty Years of Progress of Chemistry at the Presidency College," by Dr. P. C. Ray, showing how a school of chemical research is being gradually built up, of which Dr. Ray himself is the leader. A very appreciative obituary notice of Prof. J. A. Cunningham, who was professor of chemistry at the Presidency College from 1906-9 is given. Further, a series of notices of eminent Presidency College men is published, and the subject of the article in this number is Sir Asutosh Mookerjee, lately Vice-Chancellor of the University, who has done much for Indian education.

THE number of undergraduates in residence at Oxford and Cambridge, as stated in a note on March 4 (p. 24) is almost exactly one-third that of a year ago, the other two-thirds—about 2000 from each University—being on active service with the Army or Navy. According to the *Kreuz-Zeitung* there are upon the books of the twenty-two German universities—the twenty-second university being that of Frankfurt a/M., opened in October last—for the winter semester, including those at the front, 52,504 students, of whom 4000 are women, as against 59,600 and 3700 respectively last year. On leave—i.e. on military service—there are 29,882 students, including 300 women, mostly students of medicine. There are present in the universities 18,922 men and about 3700 women. Of those present, 1500, including several hundred women, are foreigners. The number of students on military service is, however, larger than appears from these statistics, since the Technical High Schools have not been taken into account. The real number is only obtained by subtracting from last year's number of German men students those of this semester, which gives about 32,000 students in the field. This does not even include those called to arms after the closing of the statistics. Their number is at least one-third of those present, so that the number

of students under arms must be raised by a further 6300. Seventy-five per cent. of the German students are therefore in the field. Of the German students of Technical High Schools about 80 per cent. are in the army.

THE War Office gives notice that an Army entrance examination will be held on June 29 next. At this examination there will be open to competition:—(a) Not fewer than 125 cadetships at the Royal Military Academy, Woolwich (for the Royal Artillery and Royal Engineers); (b) not fewer than 300 cadetships at the Royal Military College, Sandhurst (for the Cavalry, Foot Guards, Infantry, and Army Service Corps). The competition will be conducted in accordance with the regulations issued in November, 1911, except that no oral or practical tests will be included in the examination. To be eligible to compete for admission to the academy, a candidate's age must be such that he will have attained the age of 16½, and will not have attained the age of 25, on July 1, 1915. To be eligible to compete for admission to the college, a candidate's age must be such that he will have attained the age of 17, and will not have attained the age of 25, on that date. The contributions usually paid by parents of cadets will be dispensed with in the case of candidates admitted as a result of this examination. This will not affect the payment of 35*l.* required for the provision of uniform, books, etc. A sum not exceeding 3*s.* a day will be contributed from Army funds towards the cost of each cadet's messing, washing, and contingencies. Camp kits are issued in kind at the academy or college. Outfit allowance of 50*l.*, from which the cost of the camp kit will be deducted, is issuable to cadets on appointment to commissions. A limited number of cadetships in the Royal Navy and supplementary first appointments in the Royal Marines will also be open to competition.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 4.—Sir William Crookes, president, in the chair.—Prof. W. A. Bone, Prof. H. L. Callendar, and H. J. Yates: A bolometric method of determining the efficiency of radiating bodies. In view of the increasing uses of incandescent surfaces in heating operations of all kinds, the authors have investigated, as a scientific problem, the measurement of radiant efficiencies of such surfaces, by a bolometric method, which can be standardised by direct comparison with a radio-balance, and which the authors propose to substitute for the existing *water-radiometer-cum-thermopile* method (known as the "Leeds method") used hitherto. The paper describes the construction and use of a new bolometer, specially designed for the purposes in view, in which the radiation from an incandescent surface, falling on a blackened coil of platinum wire, can be determined in absolute units for the increase in the electrical resistance of the receiving coil, the area of which is sufficiently small to allow of the instrument being standardised from a source of known intensity. And, by way of example, the application of the method to the measurement of both the absolute radiation of a gas fire and its "distribution factor," is described and discussed.—E. Chappell: The simplification of the arithmetical processes of involution and evolution. An arithmetical process can be said to be completely simplified when it is reduced to either addition or subtraction. The invention of logarithms completely simplified multiplication and division, but involution and evolution were only replaced by multiplication and division, so that these processes may still be laborious even with the use of logarithms. The paper describes