presence of oxides in the form of pits and films, and in almost all cases in which a test bar failed under a load less than 35,000 lb. per sq. in., the failure was traced to these oxides of tin and zinc.

AT the end of last year the important plumbago mining industry in Ceylon was suffering very severely from the loss of the German and Belgian markets and from other causes connected with the war, and steps were taken by the Imperial Institute to induce users of plumbago in the United Kingdom to buy the whole of their supplies from Ceylon instead of partly from Ceylon and partly from foreign countries as previously. Recent statistics indicate that progress has already been made in this direction, for it is significant that the percentage of Ceylon plumbago exported to the United Kingdom during the first ten months of the present year is considerably greater than in 1913. Moreover, the total exports to this country from January to October this year are more than double those of the corresponding months in 1914, and, in addition, Russia is a large new purchaser. The most important use of plumbago is in the manufacture of steel works crucibles, which are required to resist the effects of great variations of temperature; and it is gratifying to know that a source within the British Empire is available to supply the demands of our munitions works for these articles.

THE Cambridge University Press will publish very shortly a supplementary volume of Scientific Papers by Sir George Darwin. It will be edited by F. J. M. Stratton and J. Jackson, and contain lectures on Hill's lunar theory, a paper on periodic orbits, the inaugural lecture delivered in 1883 on the author's election to the Plumian professorship at Cambridge, and an address to the International Congress of Mathematicians in 1912. In addition, the volume will include memoirs of Sir George Darwin by, respectively, Sir Francis Darwin, on his life apart from his scientific work, and Prof. E. W. Brown on Darwin as astronomer, mathematician, and teacher.

OUR ASTRONOMICAL COLUMN.

o CETI.—The maximum of this star is not "due" until January 8, 1916, but strict regularity is not a feature of its light curve, and it has already reached 3·0 magnitude (December 16), being only slightly less than α Ceti (2·7 mag.), and is thus a full magnitude brighter than at the last maximum. The present apparition strongly recalls that of December, 1906.

COMET 1915*e* (TAYLOR).—Since this comet was observed at Washington many observers have managed to find it. An observation made with the 10-in. refractor at the Hill Observatory on Thursday, December 16, 13h., gave the following approximate position, R.A. 5h. 16·7m., declination $+2^\circ\ 13'$, whence it appears that the daily movement is accelerating. As the comet is evidently approaching, increasing in brightness and very favourably placed for observation, it may be expected to become a fairly conspicuous object.

From observations made on December 6 at Washington, and on December 9 and 12 at Copenhagen, Messrs. Braae and Fischer-Petersen have calculated the following orbit and ephemeris:—

$$T = 1916 \text{ Feb. } 26{\cdot}426 \text{ t.m.B.}$$

$$\left.\begin{aligned} \omega &= 18^\circ\ 27'\ 38'' \\ \Omega &= 107^\circ\ 6'\ 55'' \\ i &= 21^\circ\ 52'\ 59'' \end{aligned}\right\} 1915{\cdot}0$$

$$\log q = 0{\cdot}19358$$

		R. A. h. m. s.		δ
Dec. 25	...	5 11 1	...	$+5^\circ\ 7'{\cdot}6$
29	...	8 34	...	6 40·3
Jan. 2	...	6 22	...	8 21·8

The comet's distance from the sun diminishes from 172 to 160 million miles between December 13 and January 2, and it comes about ten million miles nearer the earth in the same time. On December 12 it is stated to have been of about the eleventh magnitude.

GEMINID METEOR SHOWER.—Mr. Denning sends the following notes of observations of this shower:—Mrs. Fiammetta Wilson, observing from Wokingham, on December 11, 6h. 30m., to midnight, saw thirty-seven meteors, of which nearly one-half were Geminids, from a radiant at $109^\circ+32^\circ$. On December 11 thirty-two meteors were seen before midnight, and a very distinct radiant was found at $117^\circ+31^\circ$.

Miss A. G. Cook observed the shower from Stowmarket on December 11 until interrupted by clouds at 10.30. The radiant was at $109^\circ+33^\circ$.

Mr. T. Hargreaves, at Eton, watched for meteors on the evenings of December 11, 12, and 13, and morning of 14, and recorded forty , of which about eight, seen from 12h. 28m. to 13h. 16m. on December 13, were Geminids with a radiant at $111^\circ+30^\circ$.

Mr. Denning, at Bristol, looked out on December 12, 15h. 30m. to 18h., and in about $1\frac{3}{4}$ hours of that interval saw twenty-five meteors, 18 per cent. of which were from a double radiant at $110^\circ+33^\circ$ and $118^\circ+32^\circ$. Clouds prevented observation on December 13 and 14, but on December 15, 15h. 40m. to 16h. 10m., thirteen meteors were counted. Not a single Geminid was seen; the shower appeared to be over.

On December 15, 8h. 23m., a fireball was seen from Bristol falling low in due north, path about $207^\circ+53^\circ$ to $210^\circ+47^\circ$. It must have been a splendid object from the north of England and south of Scotland.

Judging from the results of the foregoing and some other observations, it seems certain that the display was not above the normal character. Moonlight, however, partially interfered, and several cloudy nights at the most important period prevented efforts to corroborate the easterly motion of the radiant.

NOTES ON VARIABLE STARS.—A sudden maximum of UV Persei was observed by E. Hartwig (*Astronomische Nachrichten*, 4815) on September 2, the star reaching 11 mag., although less than 13–14 mag. on August 28. On September 4 it was again invisible. This fleeting illumination was also observed by Prof. A. A. Nijland (*Astronomische Nachrichten*, 4818), who reports that the star could not be found on August 31. On September 3 it was as bright as the comparison star, but the following night had vanished. The previous maximum occurred on June 19, 1914—*i.e.* 434 days earlier.

Some interest attaches to a new variable star, 4, 1915 Orionis (1900, 4h. 58m. 46s., $-4^\circ\ 20{\cdot}8'$), discovered by Mr. J. Voûte, who, seizing a fortuitous opportunity, observed it passing through an extraordinary fluctuation of light last September (*Astronomische Nachrichten*, 4821). Estimated magnitudes were:—

1915	Sept. 12	8·5 mag.	Sept. 28	7·12 mag.
	Sept. 23	6·4 mag.	Oct. 4	8·3 mag.

The variability of RU Cassiopeiæ and the neighbouring star, P.D. 695, was not supported by photographic measures recently published by Dr.

Münch. The visual observations made by von Guthnick during the summer of 1911 (*Astronomische Nachrichten,* 4818) show that the average amplitude of the light curve is 0·25 mag. in each case, and the periods are just about one day. With magnitudes about 5·8 and spectra of the usual advanced helium type (B8–B9) either would supply the Ottawa observers with just the stiff kind of spectroscopic problem they seem to revel in.

The light curve of a new Algol star, 3, 1915 Coronæ (BD+30°, 2688, 9·1 mag.) has been published by von Cuno Hoffmeister (*Astronomische Nachrichten,* 4821) who first detected its variability during August, 1914. A series of observations, including fifteen minima, gives the following elements:—Period, 17h. 26m. 4·18s.; normal magnitude, 9·28; minima, 9·76; duration of phase, 4·3 hours.

A TUNGSTEN ARC LAMP.

A NEW and extremely interesting development of the nitrogen- or argon-filled electric lamp is described in a paper by Messrs. E. A. Gimingham and S. R. Mullard in the Journal of the Institution of Electrical Engineers for December 1. The lamp is the result of experiments started in 1913 in the Edison and Swan United Electric Light Co.'s laboratory. Instead of the light being emitted by an incandescent spiralised filament of tungsten, it is given out by an actual arc between tungsten electrodes.

The first problem to be solved was, of course, to strike the arc. In the first forms of lamp, two tungsten electrodes were normally in contact, and an expansion strip consisting of a strip of molybdenum, to one side of which was welded a thin strip of copper, was fixed to one of the electrodes. This strip was heated by a spiral filament of tungsten, in series with the electrodes. It was found, however, that the electrodes were frequently partially fused together, so that the expansion strip failed to separate them, in addition to which a certain amount of spluttering occurred, which shortened the life of the lamp. To overcome this defect, an entirely different method was employed, enabling the arc to be struck between fixed electrodes consisting of two small globules of tungsten. A tungsten filament was made to glow close to the electrodes, and ionised the gas between them. This made the gas conducting. The ionising filament was connected in parallel with the arc circuit, and was connected up for a few seconds only by means of a switch, and then disconnected as soon as the arc was properly struck.

In continuous-current lamps, however, difficulty was experienced in inducing the arc to leave the filament and pass to the negative electrode. The heat of the arc, moreover, destroyed the ionising properties of the filament. To cure this, two expedients were adopted. First of all, instead of a simple tungsten filament, it was found that better ionising properties could be obtained from a mixture of tungsten with zirconia, yttria, thoria, and other refractory oxides, and that, in addition, such a filament had a longer life. Secondly, the use of the expansion strip was reverted to for the purpose of moving the positive electrode along, after the arc had been struck, to another part of the filament, which acts as the negative electrode, and saves the central part of the latter (opposite to which the positive electrode returns when the lamp is switched off) from being rendered inactive.

Such a lamp is shown diagrammatically in Fig. 1. The current first passes through the circuit A and the filament BB′, while at the same time there is the full potential difference of the mains between the tungsten globule, E, and the filament. The gas in this gap is ionised, and the arc strikes. As the main current then passes through the relay C, this is actuated, and breaks the ioniser circuit. Meantime the heat from the arc causes the expansion strip F to warp, and moves E further along the filament.

Alternate methods, used for lamps of higher candle-power, are to arrange the ionising filament and the electrode, so that, after striking, the arc rises away from the active part of the filament, or to employ two electrodes and a change-over switch. In the latter case, the arc is first struck between the filament (connected to the negative pole) and the smaller electrode as anode, and as soon as the latter becomes brightly incandescent, the filament is switched off and the polarity changed, so that the arc is formed between a larger positive electrode and the smaller one, which is now negative.

The efficiency of the lamp, for a life of a few hundred hours, is in the order of ½ watt per c.p., and the intrinsic brilliancy of the light source about 10,000 c.p. per sq. in. Spectrum analysis shows perfect continuity and strength over the whole visible spectrum, and at the same time richness in the ultra-violet.

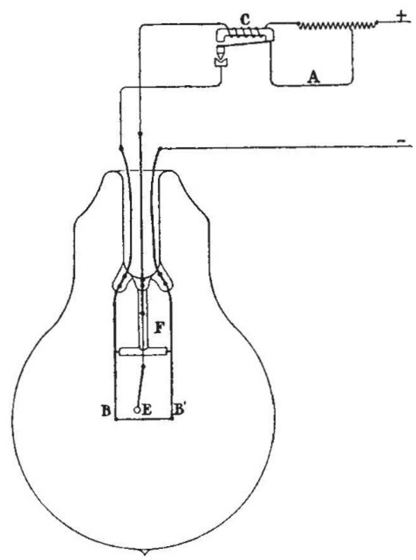

FIG. 1.

One of the immediate applications of the new lamp is for projection purposes, and the manufacturers have already placed on the market a practical form of lantern lamp, with a resistance arranged so that it may be set for any voltage. This lamp is simply started by means of a push switch, which closes the ioniser circuit, and is to be released as soon as the arc is struck. In its smaller sizes the lamp will doubtless displace entirely the Nernst filament which, in spite of its disadvantages owing to the negative temperature coefficient rendering it very sensitive to pressure variations, has been used very largely for small projectors, surgical examination lamps, etc., and has remained popular until the stock of the German Nernst burners in this country at the outbreak of the war became exhausted. For photographic enlargement lamps it should also have a useful field, and, ultimately, as a substitute for arc lamps for kinema theatres, and the internal lighting of shops and large buildings. The spectrum shows that it should be invaluable for colour matching.