fulfil, namely, (1) to determine the maximum, as well as the mean stress, on the material tested; (2) to be easily adapted to specimens of varying diameters; (3) to be easily adapted to specimens of varying length; (4) to measure accurately strains of at least one hundred-thousandth part of an inch; (5) to be of reasonable expense. The results of a large number of tests made with the instrument are given. These tend to prove that copper, aluminium, and other non-ferrous metals have very varying elastic properties, and it is consequently impossible to establish any definite law for elastic failure. It appears, however, that elastic failure always does take place according to a law which approximates closely to the maximum shear-stress theory.

In an article on the development of modern road surfaces in the Journal of the Franklin Institute for October, Mr. W. H. Fulweiler divides the methods of applying tar into three general heads:—(*a*) Brushing with a hot coating of coal-tar and dusting it lightly with sand; in general use in France. (*b*) Painting the surface by machine and dusting with sand; in general use in England. (*c*) Coating the surface with a fairly heavy coating of hot tar or tar compounds, and then covering with a light coat of screening, the surface being finally rolled. The latter is the general system adopted in America, and seems to be better adapted to the rougher surface of American roads. A refined grade of tar, considerably heavier than that used in France or England, is used, having more body and greater binding properties, and the coating applied is about twice as heavy. A light coating of clean gravel or fine stone chips is then put on instead of sand and rolled, thus renewing the wearing surface and filling the voids better than can be done by the use of sand. The treatment produces deeper penetration and more lasting effect, and succeeds best on macadam roads. It is practically mud-proof, absolutely free from road dust, apparently proof against very heavy motor traffic, and is the most satisfactory for American conditions. The cost is higher than that of the French and English methods.

An interesting pamphlet dealing with water-hammer in steam pipes has been issued by Mr. C. E. Stromeyer, chief engineer of the Manchester Steam Users' Association. According to the Board of Trade reports, water-hammer has been the cause of about 120 steam-pipe explosions. Mr. Stromeyer finds that nearly one-half of these have been due to the absence of drain-cocks on steam pipes, or to their injudicious use. A large number, chiefly on steamers, have been produced by admitting steam into pipes containing water. Others have occurred when water was admitted into steam pipes, or when steam condensed in them. Steam being admitted through valves on which water was resting, injudicious opening of valves having steam and water on both sides, and injudicious manipulations of steam valves, whereby plugs of water have been set in motion, have all contributed to swell the total of explosions. Mr. Stromeyer considers it inadvisable to lay down at present definite rules for the design of pipe arrangements in general, having been led to this conclusion by the fact that draining arrangements, designed to obviate explosions, have caused the majority of accidents, and also because in many cases of complicated pipe arrangements the water-hammer may often be attributed to any of the above-mentioned causes. Mr. Stromeyer complains of the insufficiency of the official reports of explosions having given him much difficulty in arriving at definite conclusions.

Mr. W. B. Clive, of the University Tutorial Press, Ltd., has published a second edition of "First Stage Sound, Light and Heat." The book has been revised and rewritten by Dr. R. W. Stewart, who has introduced a course of experimental work. The price of the book is 2*s*.

In connection with the Winnipeg meeting of the British Association last August, the *Manitoba Free Press* published a series of illustrated biographical sketches of the president, Sir Joseph Thomson, F.R.S., the presidents of the sections, the evening lecturers, and the general officers of the association. These biographies have now been re-issued in pamphlet form at the price of 50 cents. Copies of the booklet can be obtained from Mr. A. V. Thomas, c/o *Manitoba Free Press*, Winnipeg, at 7½*d*. each.

We have received a copy of the second part of vol. xiii. of the Transactions of the Leicester Literary and Philosophical Society. The booklet contains abstracts of lectures delivered before the society, the report of the council, and the annual reports of the sections of the society presented at the annual general meeting in May. The report states that the balance of the fund raised in connection with the visit to Leicester, in 1907, of the British Association has been voted to the council of the society for investment as the nucleus of a fund, the interest accruing from which is to be devoted in a manner to be decided by the council, annually, or at such times as the council may determine, to the development of local scientific knowledge, including that bearing upon the industries of the town. A cheque for 80*l*. has been received, and the council has appointed a special committee to consider and report as to the best means of applying the money in furtherance of the object intended.

OUR ASTRONOMICAL COLUMN.

Astronomical Occurrences in November:—

Nov. 11. 10h. 27m. Mercury in conjunction with the Moon. (Mercury 1° 21′ S.).
16. 16h. 27m. Venus in conjunction with the Moon. (Venus 0° 6′ S.).
,, 19h. 0m. Vesta in conjunction with the Moon. (Vesta 1° 15′ N.).
17. 5h. 39m. Uranus in conjunction with the Moon. (Uranus 3° 0′ N.).
22. 10h. 11m. Mars in conjunction with the Moon. (Mars 4° 26′ N.).
23. 13h. 15m. Venus in conjunction with Uranus. (Venus 2° 33′ S.).
,, 14h. 53m. Saturn in conjunction with the Moon. (Saturn 1° 32′ N.).
,, 7h. 39m. Minimum of Algol (β Persei).
26. 20h. 55m. Eclipse of the Moon, partly visible at Greenwich.
,, 4h. 28m. Minimum of Algol.
29. 23h. 22m. Neptune in conjunction with the Moon. (Neptune 4° 14′ S.)

Re-discovery of Winnecke's Comet (1909*d*).—A telegram from the Kiel Centralstelle announces that Winnecke's comet was re-discovered at the La Plata Observatory, Argentina, on October 31. Its position on that date at 8h. 14·1m. (La Plata M.T.) was 17h. 11m. 51·6s., −27° 18′ 43″, and its magnitude was about 10·0; this position lies a little to the south-west of θ Ophiuchi. According to Prof. Hillebrand's elements, the perihelion passage took place on October 4·0 (G.M.T.).

Halley's Comet.—According to a note in the November number of the *Observatory*, Halley's comet is steadily increasing in brightness, and ten minutes' exposure, presumably with the Greenwich 30-inch reflector, gives a strong image. Reproductions of photographs are given in the *Observatory* (Greenwich, September 23), *Knowledge*, and the *Astrophysical Journal* (Yerkes Observatory, September 16, 17, 24, and 26). The *Observatory* (No. 415, p. 435) also gives an ephemeris for April and May, 1910, the time of perihelion passage being taken as April 19·65

G.M.T. From this we see that the nearest approach to the earth should occur on May 20, the distance then being 14·3 million miles. The revised elements indicate that the comet should transit the sun's disc on May 18d. 14h., but the transit will, of course, be invisible in Europe. It appears possible that, at that time, the comet's tail may extend beyond the earth and be visible in the midnight sky.

From observations made with the 40-inch Yerkes telescope Prof. Barnard concludes that the comet is brightening rapidly, and was not fainter than magnitude 13·5 on October 17–19; the diameter was estimated at 15″, the comet being a little brighter towards the centre.

The Astronomischen Gesellschaft prize has now been definitely awarded (*Astronomische Nachrichten*, No. 4366) to Messrs. Cowell and Crommelin.

SATURN.—A telegram from the Flagstaff Observatory announces that the lacings crossing Saturn's equatorial bright belt, detected at that observatory, have now been photographed there (Circular No. 114, Kiel Centralstelle).

MERCURY.—From the careful study of some twenty photographs, taken at the Massegros Observatory during the elongation of September last, M. Jarry-Desloges arrives at the conclusion that the rotation period of Mercury coincides with the period of revolution. The photographs show a number of details (*Astronomische Nachrichten*, No. 4366, p. 375, November 1).

THE "FLASH" SPECTRUM WITHOUT AN ECLIPSE.—Yet another important development in solar spectroscopy emanates from Mount Wilson, Messrs. Hale and Adams, in No. 3, vol. xxx., of the *Astrophysical Journal*, describing the apparatus and method whereby they have succeeded in photographing the bright-line spectrum of the lower chromosphere without waiting for a total eclipse. With their apparatus such photographs may now be obtained at any time when the sun is observable.

After describing the previous attempts to attain this end, made at Kenwood, Yerkes, and Meudon, they give a brief description of the additions to the 30-foot spectrograph which enabled them to accomplish it.

The main difficulty in such photography is to keep the solar image exactly tangential to the slit, but they have overcome this by fitting a slipping-plate over the slit-plate. This slipping-plate is moved, parallel to the slit-plate, by a fine screw, and carries a right-angled prism which reflects the image of the limb on to a second, similar, prism fixed in front of the slit so as to reflect the rays between the slit jaws. The observer watches the spectrum, and by moving the slipping-plate preserves the tangential position, which gives the "flash" spectrum, throughout the exposure. The tower telescope gives a solar image of 6·7 inches diameter, and a grating having 568 lines per mm. on a ruled surface 49 mm. by 82 mm. is employed; better results are anticipated when the new 150-foot tower telescope becomes available. At present provisional wave-lengths are given for 124 "flash" lines, which are tabulated to show coincidences with Rowland's solar lines and with the eclipse lines observed by Evershed, Frost, Jewell, and Lockyer, respectively. The deviation of the wave-lengths of these lines from those given by Rowland for the corresponding solar lines is less than the probable error of measurement; if the bright lines of the "flash" spectrum were due to anomalous refraction at the sun's edge, as suggested by Julius, the two sets of wave-lengths should differ considerably.

SEARCH-EPHEMERIS FOR GIACOBINI'S COMET, 1896 V.—A revised set of elements for the comet discovered by Giacobini on September 4, 1896, is published by that observer in No. 4364 of the *Astronomische Nachrichten*, and gives the probable date of perihelion passage as December 19, 1909.

Three search-ephemerides are also given, one assuming that perihelion will occur on December 19·364, the others for ten days before and after, respectively. The position for November 4 is $\alpha = 18h.\ 13{\cdot}1m.$, $\delta = 15^\circ\ 1'$ S., and the brightness is given as 0·58, unity being about equivalent to magnitude 12·0. The southerly declination and comparative faintness of the object render it unlikely that the comet will be observable, if found, except by the largest instruments.

THE UPPER AIR.[1]

THE past decade has been very fruitful in the investigation of the upper air. By the use of kites sufficient results have been obtained to furnish a tolerably complete knowledge of the variation in the meteorological elements up to a height of 2 km., while registering balloons have furnished information regarding the distribution of temperature up to heights of 15–20 km. The results of the Berlin manned balloon ascents were arranged and discussed very fully ten years ago, but no such comprehensive discussion of the much more numerous kite and registering balloon ascents has yet been attempted. The present report deals with the instruments and methods of investigation, and with the results for temperature and for wind.

The most important series of the earlier ascents with manned balloons was that made by Glaisher in 1860–70. Unfortunately, he was led to believe that artificial ventilation of the thermometers was unnecessary, with the result that his observations at great altitudes are untrustworthy. In the series of ascents made from Berlin in 1888–95, observations made with careful ventilation proved beyond doubt that large errors would arise in the absence of proper ventilation, and that Glaisher's results were almost certainly affected by such errors.

The following table shows the nature of the errors, and incidentally furnishes a comparison with one of the earlier *ballon-sonde* ascents :—

Height, metres	Fall of temperature °C. per 1000 metres		July 31, 1901	
	Glaisher	Berson	Berson and Süring	Ballon-sonde
0–1000	7·5	5·0	7·2	8·3
1000–2000	6·5	5·0	6·8	6·1
2000–3000	5·0	5·4	3·7	4·2
3000–4000	4·2	5·3	5·2	5·1
4000–5000	3·8	6·4	7·4	5·7
5000–6000	3·2	6·9	5·5	6·3
6000–7000	3·0	6·6	7·2	4·7
7000–8000	2·0	7·0	7·2	7·6
8000–9000	1·8	9·0	3·6	7·1

Temperature observations in manned balloons are now usually taken with an Assmann's aspirator, in which a ventilating current of about 4 m.p.s. is forced by a fan through a polished tube containing the thermometer and screening it from radiation.

The instruments used with registering balloons are of two types. In the large type the record is made on a metal or photographic sheet, covered with lamp-black, and wrapped round a revolving cylinder driven by a clock. Pressure, temperature, and humidity are recorded by separate pens. The barometer is a Bourdon tube or an aneroid, the thermometer some form of bimetallic instrument, and the hygrometer a bundle of hairs. In the small type the temperature record is traced on a cylinder or plate, which is itself moved at right angles to the direction of motion of the temperature lever by the changes of pressure. The temperature and pressure are then given by the ordinates and abscissæ of the trace obtained. The advantage of this arrangement is that no clock is required, and the instrument can be made much lighter and is more easily tested. The loss of the humidity trace is unimportant, because the hygrometric records at low temperatures are very untrustworthy, and the observations in the lower layers can be made with kites or manned balloons.

The instruments used with kites are similar to the *ballon-sonde* instruments of the larger type, but they have an arrangement for recording wind velocity. In the Dines instrument the records are traced on a flat, circular sheet of cardboard rotated by means of a clock and resting on a wooden tray beneath which the instruments are placed.

The *ballon-sonde* instruments are tested either (1) by keeping the thermometer at ordinary atmospheric pressure in testing for temperature, and the barometer at ordinary temperatures in testing for pressure, or (2) by testing the thermometer through the temperature range at different pressures and the barometer through the pressure range at

[1] Report on the Present State of our Knowledge of the Upper Atmosphere as obtained by the use of Kites, Balloons, and Pilot Balloons." Report of the Committee, consisting of Messrs. E. Gold and W. A. Harwood, presented at the Winnipeg meeting of the British Association, 1909.