Majoris. Whereas Lockyer* in his most recent paper "On the Chemical Classification of the Stars" (April, 1899), regards the so-called "Crucian" stars, as at a higher temperature than the "Rigelian" and "Cygnian," and indeed he regards Bellatrix "as a type of the hottest stars, exception being made of ζ Puppis."

Of the other lines recorded by Eder and Valenta† as due to silicon, 3905·4, 3862·5 and 3855·7 are present both in the spectra of the dissociated glass and in the high temperature spectrum of silicon obtained from the silicon tetrafluoride tube.

They are enhanced lines in the latter case, occurring together with Lockyer's enhanced lines in the absence of the three new silicon lines, but they lie outside the region measured by Scheiner in α Cygni, Sirius, and Rigel.

In the Harvard "Spectra of Bright Stars"‡ the two latter lines are however, specially noted in Rigel as 3863·2 and 3856·2 as "conspicuously strong in the ultra-violet," whilst all three are recorded (3905·6, 3863·2, 3856·2) in stars of Groops VI to VIII (Harvard), comprising α Cygni, Sirius, and Rigel. They would thus appear in these stars to accompany the enhanced silicon lines, specially noted by Lockyer, viz. 4128·6 and 4131·4.

The lines 3834·4 and 3836·7 recorded by Eder and Valenta are not present in any of the photographs of silicon spectra, and may possibly be due to impurities.

The lines 3795·9 and 3791·1 recorded by Eder and Valenta are present in all the silicon photographs, but do not become enhanced at high temperatures. There is, however, a third line, approximately λ 3807, not recorded by them, but which appears in all the photographs of silicon spectra. It is stronger than 3795·9 and 3791·1, and does not become enhanced with high temperature. All three lines accompany the three new silicon lines in ε Canis Majoris.

"A Note on the Electrical Resistivity of Electrolytic Nickel."

By J. A. Fleming, M.A., D.Sc., F.R.S., Professor of Electrical Engineering, University College, London. Received November 21,—Read December 14, 1899.

The numerical values assigned by various experimentalists for the mass or volume electrical resistivity of certain metals differ very considerably. Some metals are without much difficulty prepared as often

* 'Roy. Soc. Proc.,' vol. 65, No. 416, p. 189.

† Watts's 'Index of Spectra.'

‡ 'Harvard Annals,' vol. 28, Part I, Table 7, p. 23.

as required in a state of such chemical purity, and brought so easily into similar physical conditions as to annealing and density, that determinations made by different observers of their resistivity or specific electrical resistance are nearly identical.

Matthiessen's long-accepted value* for the mass resistivity of copper in the form of hard-drawn wire, viz., 0·14493 standard ohm per metre-gramme, was substantially confirmed by the more recent work of Mr. T. C. Fitzpatrick.† Even the purest electrolytic copper now obtainable in an annealed condition does not show an electric conductivity more than 3 per cent. greater than that of a similar character prepared thirty-five years ago by Matthiessen.

In a research carried out in the years 1892 and 1893 by the author in conjunction with Professor Dewar, careful redeterminations were made of the volume-resistivity at 0° C. of all ordinary metals, taken for the most part in an annealed condition and in a state of great chemical purity.

The values so obtained for the electrical volume-resistivity of silver, copper, gold, aluminium, zinc, platinum, tin, lead, magnesium, and iron agreed fairly well with the values given by Matthiessen, and quoted in most of the treatises on electricity. The resistivity of cadmium, as given by us was, however, considerably larger than that usually stated, although our sample of cadmium was very carefully prepared.

In the case of nickel, the purest nickel we were able to obtain was that prepared from nickel-carbonyl. Dr. Ludwig Mond, F.R.S., was so kind as to furnish us with two tubes of this nickel. It was found, however, to be too brittle to draw into wire, and the operation of melting it would have most certainly introduced impurities. Accordingly, the nickel tube was cut up in the lathe into a spiral, and a resistance coil formed with it which could be used for taking the resistivity ratios at different temperatures, but which was not sufficiently uniform in dimensions to permit its volume-resistivity to be calculated. Hence, in our published results, we took the volume-resistivity of this nickel at 0° C. to be 12,320 C.G.S. units, which is the value given by Everett, said to be derived from Matthiessen's experiments, and simply calculated the resistivity at other temperatures from the experiments given by our own observations with the Mond nickel. About a year ago, however, Mr. J. W. Swan, F.R.S., sent me a sample of nickel wire which he had prepared electrolytically from a hot solution of very carefully purified nickelous chloride. The electrolytic metal was annealed by heating in an atmosphere of hydrogen, after having been drawn into wire through a die.

The nickel wire so prepared and annealed is as soft as a silver wire.

* See 'B.A. Report,' 1864, or 'Phil. Mag.,' 1865.

† See 'B.A. Report,' Leeds, 1890, or 'Electrician,' vol. 25, p. 608, 1890.

It had a fairly uniform diameter of about 0·01 inch, and a length of nearly 250 cm.

The mean diameter of this wire was taken with the micrometer microscope at regular intervals of centimetres with the following results:—

Diametral Measurements of Nickel Wire, as read by Microscope at regular Intervals of about 5 cm.

Obs.	Diameter (inches).	Obs.	Diameter (inches).
1	0·0097	26	0·0100
2	0·0097	27	0·0096
3	0·00975	28	0·0098
4	0·0107	29	0·0093
5	0·0100	30	0·0099
6	0·0098	31	0·0102
7	0·0100	32	0·0098
8	0·01015	33	0·00975
9	0·01015	34	0·0095
10	0·0100	35	0·0098
11	0·0098	36	0·00985
12	0·0100	37	0·00965
13	0·01015	38	0·0098
14	0·0099	39	0·00985
15	0·0101	40	0·0101
16	0·0099	41	0·0096
17	0·0099	42	0·0094
18	0·01005	43	0·0098
19	0·0097	44	0·0098
20	0·0098	45	0·00995
21	0·0098	46	0·0098
22	0·00985	47	0·0098
23	0·0101	48	0·0096
24	0·0100	49	0·0099
25	0·01005	50	0·0101

The mean diameter of the wire, as obtained from the above fifty readings, was 0·00985 inch. This was checked by taking the density of the wire with all the usual precautions for obtaining a correct value.

The length, weight in air, and weight in water were determined to be as follows:—

Length of the wire	246·98 cm.
Weight in air	1·1163 grammes.
Weight in water at 18° C. + suspension...	1·00175 ,,
Weight of suspension	0·1000 ,,
Weight of wire at 18° C. in water	0·99175 ,,

From the above observations the density was found to be 8·96 at

18° C. The mean diameter calculated from the length and density is then 0·00997 inch. Hence we have—

Mean diameter from micrometer measurement .... 0·00985 inch.
Mean diameter by specific gravity and length measurement... 0·00997 „

The mean of both means is 0·00991 inch = 0·02567 cm. This last number was taken as the value of the mean diameter.

The nickel wire was then soldered to thick copper leading-in wires, and wound on a frame of a kind suitable for immersion in liquid air.

A description of this particular kind of resistance coil, which has proved itself to be exceedingly suitable for low temperature work, was given in a paper describing the result of numerous observations on the resistivity of metals at low temperatures, published by Professor Dewar and the present author in 1893.*

A coil having been thus constructed, its resistance was taken at various temperatures in a bath of paraffin oil, and the results are as shown in the table below. The temperature of the bath was measured

Observations on the Resistance of Electrolytic Nickel Wire.

Obs.	Total resistance of nickel wire.	Platinum temperature, *pt.*	Centigrade temperature, C.	Volume resistivity in C.G.S. units.
1	3·4284	1·057	1·232	6974
2	3·7563	18·489	18·29	7641
3	3·9470	28·676	28·32	8029
4	4·1109	36·959	36·51	8363
5	4·3506	48·740	48·21	8850
6	4·5679	58·773	58·23	9292
7	4·5778	59·315	58·78	9312
8	4·7493	67·384	66·85	9661
9	5·0403	80·550	80·11	10253
10	5·2018	88·587	88·25	10582
11	5·3000	93·544	93·29	10782
12	5·3882	95·731	94·88	10961
13	5·2379	89·289	88·97	10655
14	5·0094	78·482	78·02	10190
15	4·7273	66·700	66·17	9616
16	4·5260	57·151	56·61	9207
17	4·3586	48·704	48·18	8865
18	4·1323	37·906	37·44	8406
19	3·9620	31·226	30·83	8060
20	3·8112	21·550	21·30	7753
21	3·4318	2·205	2·35	6981
22	2·090	−80·72	−78·2	4251
23	0·710	−196·89	−182·5	1444

* See 'Phil. Mag.,' September 1893, p. 279, "On the Resistance of Metals and Alloys at Temperatures approaching the Absolute Zero."

at the same time by means of a platinum thermometer (P_1) used in previous researches.

The conversion of the platinum temperatures into centigrade temperatures was effected by means of a table drawn up Mr. J. Hamilton Dickson* for this thermometer.

The measurements of the resistance at low temperatures (−78·2° and −182·5°) was obtained by measuring the coil in liquid air and melting CO_2 at the Royal Institution Laboratories, by kind permission of Professor Dewar.

The total resistance of the nickel calculated from the above observations is set out in the form of a curve (fig. 1), having resistance as ordinates and temperature as abscissæ.

The curves are given both for temperature in centigrade degrees and temperature in platinum degrees. The curve shows that the resistance is falling steadily downwards to a zero value as the absolute zero of temperature is approached.

In fig. 2 the portion of the curve between 0° C. and 100° C. is shown in an enlarged scale. In fig. 3 the volume-resistivity is set out in terms of temperature.

The results show that the volume-resistivity or resistance per centimetre-cube of this electrolytic nickel at 0° C. is **6935** C.G.S. units. The average temperature coefficient between 0° C. and 100° C. is 0·00618.

The above observations indicate that this electrolytic nickel, as prepared by Mr. Swan, has an exceedingly different and much lower resistivity than that employed for test by Matthiessen thirty-five years ago.

The value of the mean temperature-coefficient of the nickel used in the experiments of Fleming and Dewar in 1893, and prepared by Dr. Ludwig Mond, was 0·00622† between 0° C. and 100° C. It is clear therefore that some extraordinary electrical difference exists between nickel as it can now be produced electrolytically and nickel as it was produced by Matthiessen for his experiments.

It would be interesting to ascertain if any specimen of nickel known to have been used by Matthiessen for his experiments still exists, and if so, to discover the nature of the impurity (if impurity was present), or at least the physical difference, which caused his nickel to have nearly double the electrical resistivity of that which can now be produced.

I desire to record my thanks to Mr. J. E. Petavel and to Mr. A. Blok for assistance in these experiments.

* 'Phil. Mag.,' June, 1898.

† 'Phil. Mag.,' September, 1893.

FIG. 1.—Temperature-resistance Curve for Electrolytic Nickel Wire.

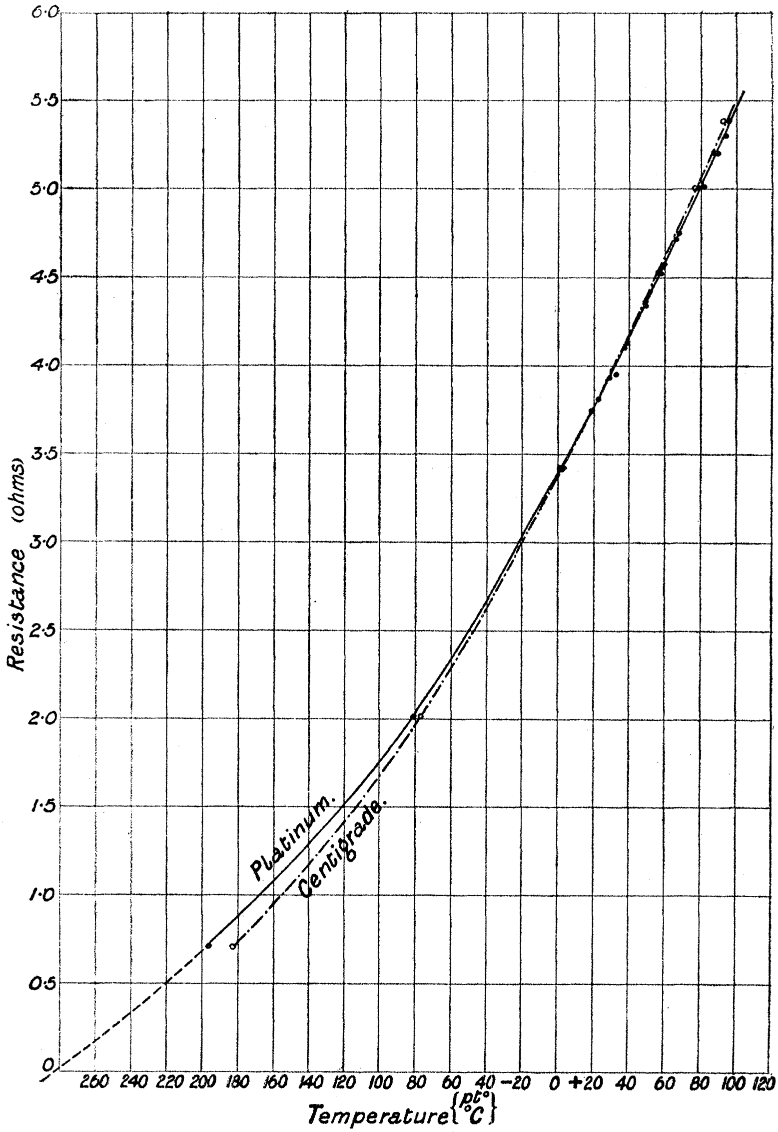


Fig. 2.—Temperature-resistance Curve for Swan's Electrolytic Nickel Wire (Range, 0—100° C.)

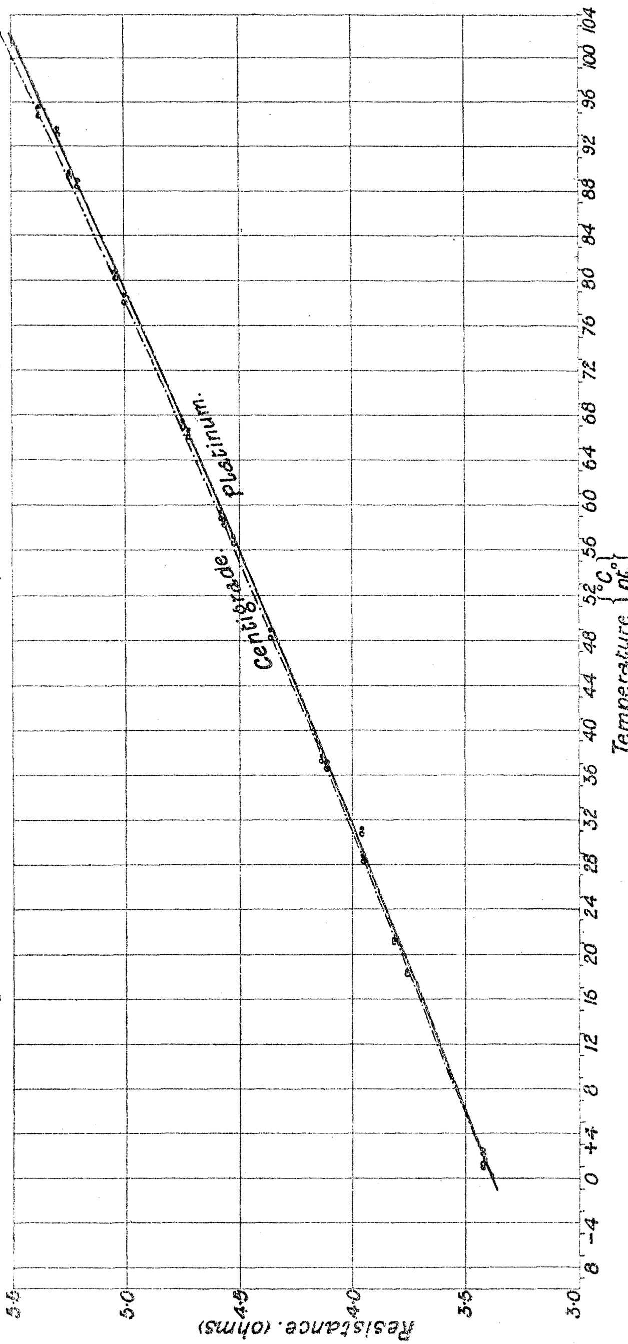
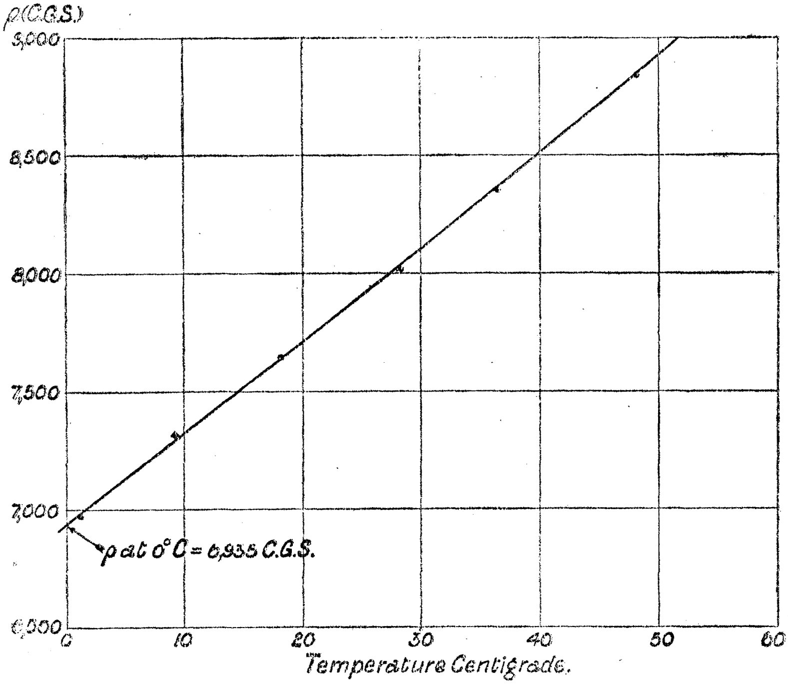


FIG. 3.—Electrolytic Nickel Wire (Curve to obtain ρ at 0° C.)



Note added December 6, 1899.—Since writing the above short paper, I have discovered in a paper by Messrs. A. Matthiessen and C. Vogt,* a reference to the sample of nickel with which the present accepted figure for its resistivity was evidently obtained.

This paper is entitled "On the influence of Temperature on the Electric Conducting Power of Iron and Thallium," and its title would not lead a reader to look in it for a reference to the resistivity of nickel.

Messrs. Matthiessen and Vogt therein state that samples of supposed chemically pure nickel and cobalt wires prepared by M. Deville were given to them by M. Wöhler. They measured the resistivity of these samples, but they state that their electrical behaviour gave them reason to believe that this nickel and cobalt were not pure. They give the electrical conductivity of the nickel as 13·11 at 0° C. taking hard drawn silver at 0° C. as 100.

Hence if hard drawn silver has a volume resistivity of 1620 C.G.S. units at 0° C., it follows that Matthiessen and Vogt's value for the resistivity of their sample of nickel would be 12,357 C.G.S. units at

* 'Phil. Trans. Roy. Soc.,' 1863, p. 384.

0° C., which is a number very close to that usually given in tables of electrical specific resistance.*

Matthiessen and Vogt state in this paper, that they hope to be able to prepare pure nickel electrolytically, and obtain a value for its electrical resistivity. I have been unable to discover, however, that they ever carried out their intention. At any rate, the number which they give for the electrical volume resistivity of this nickel of the purity of which they evidently had suspicions, has been accepted for the last thirty-six years as the true value.

"Observations on the Morphology of the Blastomycetes found in Carcinomata." By KEITH W. MONSARRAT, M.B., F.R.C.S.E. Communicated by Professor SHERRINGTON, F.R.S. Received November 22,—Read December 14, 1899.

(From the Pathological Laboratory of University College, Liverpool.)

(Abstract.)

This research was undertaken in order to confirm if possible the observations of Sanfelice, Roncali, and others, on the presence of organisms of the order Blastomycetes in carcinomata, and to study the morphology of the same. The observations have been arranged under four headings :—

1. Isolation by culture.
2. Staining reactions.
3. Histology.
4. Tissue reactions following inoculation.

1. *Isolation by Culture.*—The tumours examined were carcinomata of the breast and uterus; incisions were made with a sterilised knife and scrapings from the edges of these inseminated on to media. Many kinds of media were tried, but a result was obtained only on glucose agar. Wort agar and wort bouillon were subsequently used for sub-cultures; on both the organism grows readily aërobically at 37° C. Sub-cultures on neutral gelatine appear as pale yellow slow-growing colonies without liquefaction of the medium. On neutral agar the colonies have a more marked yellow tinge; they do not appear until

* The numerical values of the specific resistance of nickel given in various tables by different authors are not quite identical, and yet all so far found are stated to be derived from Matthiessen's experiments. Thus, Everett ('C.G.S. System of Units,' 1891 ed.) gives 12,320 C.G.S. units at 0° C. as the value. Landolt and Börnstein give one value equivalent to 12,757 at 0° C. from the ratio of conductivity of nickel to that of mercury, and another equivalent to 12,014 at 0° C., derived from the ratio of the conductivities of hard drawn silver to that of nickel.