manufacture of the rheostats, they hope to retain and extend the markets opened to them by the temporary paralysis of German export trade. Messrs. Isenthal also inform us that they find "by careful organisation, by manufacturing the component parts of these rheostats in very large quantities, *i.e.* practically making the whole rheostat except the winding in very large quantities," the instruments do lend themselves to mass production. Before the war they did not consider themselves justified in incurring the expense and work required for such methods of manufacture, and therefore purchased the apparatus from abroad. But they add:—"The closing of our relations with the central Continent has given just that impetus which was needed for us to set aside *ordinary* commercial considerations, hence our present facilities for manufacturing this apparatus."

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES.—Mars, now nearly as bright as Sirius, will be in opposition early on Friday. Jupiter and Venus, so conspicuous in the western twilight, reach conjunction about 3 a.m. on February 14. Their nearest approach takes place earlier, about midnight, Venus being 26′ S. Even at 7.30 p.m., February 13, they will be only 32′ apart. The moon occults a 3·2 mag. star, *e* Geminorum, on February 14. As seen from Greenwich disappearance occurs at 11h. 3m. The moon is in conjunction with Neptune on the evening of February 16 at 6h. 24m. Geocentrically the planet will be 1° 2′ S. Comet 1915*e* (Taylor) can still be glimpsed with a 3-in., but is not a suitable object for such a small aperture. The following positions are from a continuation of the Copenhagen ephemeris for Greenwich midnight:—

		h. m. s.		° ′
Feb. 11	...	5 30 22	...	+24 21·3
15	...	36 45	...	25 39·0
19	...	43 48	...	26 50·8

SHIFTS OF WAVE-LENGTHS.—Modern measurement of wave-lengths, in striving successfully after an accurate third decimal figure, has begun to detect all kinds of causes that result in wave-length alterations. In solar spectroscopy, in addition to the well-known pressure and motion effects, the recondite theory of relativity and the ubiquitous anomalous dispersion championed by Freundlich and Julius respectively have afforded explanations of the observed displacements. In the one case it is an intense gravitational field that is adduced as competent; in the other the mutual effect of neighbouring lines. In the laboratory length of arc, its internal pressure, distance from pole, impurities, change of electrical conditions, have been described as the source of displacement by Royds, Albrecht, St. John, Burns, and Bilham. The latter, working in Prof. Fowler's laboratory at South Kensington, has now studied the special case where the adventitious element itself gives rise to strong lines (*Astrophysical Journal*, December, 1915). A number of iron lines in the regions of H and K were measured in the spectrum given by a carbon arc fed with Fe filings, and also when the arc was fed with a mixture of filings and calcium chloride, the calcium lines being measured in both cases. The results obtained in this very interesting research indicate that some lines are susceptible, whilst others have constant wave-lengths. The K line of calcium is found to differ by 0·008 Å. in the two sources. One hesitates to think of the array of conditions it will become necessary to introduce into the specification of standard lines.

FURNACE SPECTRA OF COBALT AND NICKEL.—To the metals (Fe, Ti, V, and Cr) whereof the electric furnace spectra have already been investigated in such painstaking and accurate manner by Dr. King, must now be added Co and Ni (*Astrophysical Journal*, vol. xlii., No 4). Fourteen pages are given up to tabular matter similar to that for the elements previously studied. Attention may be directed to some results of an unexpected character; thus not only is the violet end found relatively rich in lines, but all the enhanced lines of cobalt (except only λλ 3878·90 and 3904·23) in the region of shorter wave-lengths than λ 4077·56 have been classified as furnace lines. Another peculiarity is the fact that each of the classes I., II., and III. contain some lines that attain a maximum in the furnace and are weaker in the arc, thus affording, as regards the lines of Class III. A, a group of lines special, perhaps, to a range of temperature of some 500° C.—a feature worthy of further attention.

THE ELECTRO-THERMIC SMELTING OF IRON ORES.

THE rapid growth of the application of the electric furnace to the metallurgy of iron and steel is certainly the most noteworthy feature of the development of this industry during the last decade. Ten years ago "electric steel" was largely a novelty. To-day there is scarcely a branch of this highly diversified and complex industry in which electrothermic heating has failed to secure a footing and to justify itself. This progress is all the more remarkable when it is remembered that the steel manufacturing industry "owing to its age and importance, and also to the capital invested in it, is one of the most conservative and settled of all industries."[1]

The earliest uses to which electric furnaces were applied were to the production of (1) ferro-alloys, containing iron, carbon, and such elements as tungsten, molybdenum, vanadium, etc., which indeed cannot be made in fuel-fired furnaces; and (2) of the highest classes of carbon and alloy tool steels, where they competed successfully with crucible furnace products. Having "made good" up to this point, they were next developed, not in direct competition with Bessemer and open-hearth furnaces, but as important adjuncts to them, and within the last seven years a great variety of products—*e.g.*, gun, tyre, and axle steel, wire and plate billets, and rail and girder steel—are manufactured with their aid. Such processes may be classed as electrothermic refining, for they take the metal as delivered by the Bessemer or open-hearth furnace, and, owing to their high temperature and more neutral atmosphere, permit the formation of refractory basic and even reducing slags, *e.g.*, calcium carbide, which carry the refining of the steel to a further stage, and produce a purer and more trustworthy metal. Especially has this been the case with the manufacture of rail steel in Germany and America, where it has been found that the trustworthiness of the steel is so much increased by electrothermic refining that the railway companies are willing to pay considerably more for rails produced in this way. Mention must also be made of the application of the electric furnace to the production of mild steel castings—always a difficult operation—where a very fluid metal can be obtained, and a better separation of gaseous and other impurities. Heroult[2] recently quoted instances in which it had been found to be unnecessary to anneal such materials at all, since their properties were fully as good as those of the best rolled mild steel made in

[1] "Electrothermal Methods of Iron and Steel Production." By J. B. C. Kershaw, p. 3.
[2] Transactions of the Eighth International Congress of Applied Chemistry. New York. September, 1912.