as a practical method of identification or as an intellectual exercise is open to question; we are inclined to think that it is neither the one nor the other, and that the table should only be consulted when the group character of the compound has been definitely ascertained.

The fact that the book is written by a native of Bengal and printed by a Calcutta firm explains the occasional lapses in English, which is by no means to the discredit of either publisher or author; but it does not excuse the far too numerous mistakes in the spelling of chemical names. It is unfortunate that the volume has not been read in proof by someone conversant with the language.

J. B. C.

OUR BOOKSHELF.

The Callendar Steam Tables. By Prof. H. L. Callendar. Pp. 39. (London: Edward Arnold, 1915.) Price 3s. net.

In his Royal Society paper in 1900 and in his article on Vaporisation in the "Encyclopædia Britannica" of 1902, Prof. Callendar showed the use of a simple empirical formula connecting the pressure, density, and temperature of steam. If his formula is correct, it is possible to tabulate all the properties of steam required in engineering calculations in such ways that the numbers are more consistent with one another than any hitherto published. Mollier, of Dresden, published tables and corresponding curves calculated by this method, and these were republished in England by Ewing in 1910. Messrs. Smith and Warren calculated and published tables which were discussed in NATURE of April 3, 1913. We then gave reasons for the suggestion that perhaps such experimental results as were available scarcely justified the use of the Callendar method, in spite of the fact that Prof. Callendar is undoubtedly the highest authority on this subject. He now says that these tables form part of a larger work entitled "Properties of Steam," in which the theory of steam and experimental methods of investigation are more fully discussed and illustrated.

For the present we may, perhaps, assume that, for moderate pressures and temperatures, these tables are more correct than any hitherto published, and if this is so their value to the steam engineer cannot be over-praised. They give pound Centigrade and also pound Fahrenheit units, with pressures in pounds per square inch, volumes in cubic feet per pound, as well as kilogram Centigrade units, with pressures in kilos per square cm. and volumes in cubic metres per kilo. Table II. is the most important; it gives volume, entropy, temperature, and total heat in terms of pressure. Tables IV., V., VI., and VII. give the total heat, volume, entropy, and Gibbs's potential of super-heated and super-saturated steam. The diagram which accompanies the tables has been arranged for interesting graphical calculation. From this description steam

engineers will see that, in addition to what is due for his engine experiments in Montreal, they owe the author a second deep debt of gratitude. The gas and petrol engine engineers also owe him a large debt. We do not think that there is any case of an experimental physicist since Regnault's time doing even half as much service to engineering.

J. P.

The Star Pocket-book, or How to Find your Way at Night by the Stars. By R. Weatherhead. Second impression. Pp. 92. (London: Longmans, Green and Co., 1915.) Price 1s. net.

THIS little manual not only provides an easy means of becoming familiar with the chief constellations and individual stars, but also shows how this knowledge may be made practically useful in the determination of position and direction during night marches. The book contains several useful tables giving among other details the time of year when certain stars transit at midnight, the highest altitudes of stars in various latitudes, and pairs of bright stars which transit at the same time. These simul-transit pairs, when vertical, mark the meridian, and also serve as pointers to a celestial pole. The new issue of the book includes some additional notes on the use of the stars as direction and time finders; and it should be found particularly helpful to soldiers and scouts at the present time.

The Cambridge Pocket Diary, 1915-1916. Pp. xv+255. (Cambridge: At the University Press, 1915.) Price 1s. net.

READERS whose work is connected with schools and colleges will find the arrangement of this attractively produced pocket diary very convenient. Beginning in the middle of September, it enables one to start a new diary at the commencement of the academic year. The miscellaneous information provided is intended primarily for members of the University of Cambridge.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

The Manganese Ore Requirements of Germany.

IN a letter, under the above title, published in NATURE of October 14, Dr. Leigh Fermor dissents from the conclusion reached in my article of July 15 on munition metals that the enemy countries can produce sufficient manganese for their steel manufacture requirements without having recourse to imports, and gives it as his opinion that they are likely to be seriously hampered by a shortage of manganese ore as soon as their accumulated stocks have been used. His conclusions are as follows:—

"(a) That on the outbreak of war the Teutonic Powers had no great accumulated stocks of manganese ore, perhaps a maximum of 200,000 tons; (b) that, assuming war conditions necessitate a maintenance of the iron and steel industries of those two countries at

a peace standard, about 600,000 tons of ore a year must be obtained from fresh sources to replace imports in time of peace; (c) that, allowing that the Teutonic Powers might succeed in increasing their internal production by 100,000 tons, and obtain 50,000 tons of manganese ore from Turkey, if the Allied Fleets could prevent all manganese ore from outside from reaching Germany and Austria, these countries would be faced with a shortage of 250,000 tons of manganese ore in the first year of the war, and with a shortage of 450,000 tons per year afterwards, increased to 500,000 tons per annum once the Dardanelles are forced.

"The Germans will doubtless find means of dispensing with the use of manganese ore as much as possible, and they may devise methods of utilising the manganese silicate, rhodonite, of which they appear to possess a considerable quantity; but it seems inevitable that the shortage of manganese ore, once it is felt, will hamper seriously the German iron and steel industries."

Dr. Fermor's conclusions, if correct, would mean that the German production of iron and steel must have been seriously diminished in the first year of the war, and that this diminution will be very greatly accentuated in succeeding years. Before producing evidence on this point which will, I think, be found to be decisive as to the issue between Dr. Fermor and myself, I should like to explain the reasons for the conclusion with regard to manganese at which I arrived in my article of July 15.

That article dealt with ten munition metals, and it was not possible within its limits to give more than a concise survey of the evidence bearing on each particular metal. I may say, however, that the detailed evidence which is so clearly and ably presented by Dr. Fermor with regard to manganese was available to and was considered by me, and that, excluding for the moment his brief reference to manganiferous iron ore, if this were all the evidence which had to be taken into consideration, I should have drawn the same conclusion as he has done—i.e., that the enemy countries, and in particular Germany, could not supply their manganese ore requirements from internal resources.¹ There is, however, another factor which appeared to me on examination to be not only important, but vital. Dr. Fermor has also considered it, but evidently dismissed it as unimportant when he writes:—"I must note that in making the above calculations I have excluded figures for manganiferous iron ores from both the German and the world's figures as confusing the issue." It is with this factor that I must deal, for I came to the conclusion that it was decisive.

Although Germany prior to the war was a large and regular importer of manganese ores, she was by no means insensible of the technical value of her own deposits of manganiferous iron ores as a source of supply of manganese for steel production. In support of this assertion, it will be sufficient if I quote the following sentence from an article by Dr. Scheffer, of Dortmund,² which, it will be observed, was published shortly before the outbreak of war:—"Die Mehrzahl der Arbeiten die sich mit Manganerzen und Deutschlands Versorgung mit diesem Rohstoff befasst, beschäftigen sich nur mit der Manganversorgung Deutschlands aus dem Ausland ohne dabei zu berücksichtigen dass zur Erzeugung einer Reihe mangan-

haltiger Roheisensorten auch Eisenerze mit einem entsprechend niedrigeren Mangangehalt verwendet werden können und dass diese manganhaltigen Eisenerze im Inlande in grossen Mengen gefördert werden."³

Germany's production of manganese and manganiferous iron ores for the years 1908-1911, taken from Scheffer's paper, is appended in the following table:—

—	1909 Metric	1909 Metric tons	1910 Metric tons	1911 Metric tons
(a) Manganese ores (above 30 per cent. Mn) ...	392	474	166	177
(b) Manganiferous brown iron ores (30-12 per cent. Mn) ...	279,611	266,685	266,825	288,049
(c) Manganiferous brown iron ores (<12-2 per cent. Mn) ...	2,274,702	2,393,479	2,634,451	2,791,923

The main source of the home supply is the Siegerland.

The figures show that while the output of manganese ores is infinitesimal, there has been a large and almost steady output of the higher grade manganiferous iron ore, and a decided increase in the very large production of low-grade ore, the total output being in 1911 more than 3,000,000 tons. Calculation of the manganese tonnages of (b) and (c) gives the following figures for 1911:—

(b) Mean value of 21 per cent. Mn gives ...	Tons 60,490
(c) Mean value of 6 per cent. ⁴ Mn gives ...	167,515
Total ...	228,005

Taking now the German steel production in 1913, the figures are as follows:—

Total steel produced ...	Tons = 18,960,000 ⁵
Steel exported ...	= 4,300,000
Home consumption of steel ...	= 14,660,000

Assuming an average manganese percentage of 0.75 in the finished steel, this will absorb

Amount available ...	Tons 109,942 = 228,005
Excess ...	118,063

From this it is clear that the tonnage of manganese contained in the ore as mined is *more than double that required to be present in the finished steel*. The excess would be available for deoxidising the fluid steel if it could be applied in a suitable form. Even here, however, it would not all be lost, for in 1911 the German blast-furnaces smelted more than 662,000 tons of manganiferous slag from open-hearth and puddling furnaces. With these facts before me, I had to consider whether the German manganiferous iron ores could be made available for steel manufacture in

³ In the above article ores containing more than 30 per cent. of manganese are regarded as "manganese ores," while those containing both iron and manganese, the latter being present to the extent of anything between 2 and 30 per cent., are regarded as manganiferous iron ores. They contain technical values both in iron and manganese. The mineralogical concept of manganese and manganiferous iron ores is different; but we are only concerned with the metallurgical use of the terms.

⁴ This is rather less than the mean value, but the estimate is purposely made conservative.

⁵ Dr. Fermor gives this as 19.29 million tons in his first table, but this is the total *iron* production.

¹ I am much obliged to Dr. Fermor for his explanation of the figures of American production, which is perfectly correct, for the information he gives of the mineralogical composition of the Indian ores, and for pointing out my omission of the Brazilian manganese ores.

² *Stahl und Eisen*, July 23, 1914, pp. 1246-1254. Other articles are published in "Glückauf," 1913.

place of the customary ferromanganese or silico-spiegel. It has to be borne in mind that whereas in peace time in any given case that particular process holds the field which happens to be the cheapest, this is not the dominating consideration in war. If a commodity is essential for war purposes, and if the raw materials are available, it must be produced, *whatever it costs*. This being so, it appeared to me that while considerable departures would have to be made from ordinary practice, there was no insuperable difficulty in the technical problem of smelting the manganiferous iron ores in such a way as to render them available for steel production. It would not be advisable at the present time to say what my reasons were for coming to this conclusion, but I think my view would be supported by steel metallurgists generally.

Germany, however, has another source of manganese, the mineral rhodonite, which corresponds when pure to MnSiO_3 . From this can be produced various grades of manganese silicon alloys by reduction in the electric furnace, as the following analyses show⁶ :—

	No. 1. Per cent.	No. 2. Per cent.	No. 3. Per cent.
Manganese	74.2	70.3	55.0
Silicon	24.1	24.6	24.1
Iron	0.77	3.8	19.0

These products have the advantage over ferromanganese of being low in carbon, and yet possess a strong deoxidising power. Their use is specially advantageous in incorporating both manganese and silicon in steel. I was not able to obtain any figures showing the extent to which Germany was manufacturing these alloys before the war, but it appeared to me to be very probable—indeed, almost certain—that a considerable production, for which preparation would have been made, was to be expected in war time. Taking these facts into consideration, the conclusion appeared to me to be warranted that the German miners and metallurgists would, under the stimulus of necessity, be able to render their country independent of the import of manganese ores, and I therefore placed manganese in the category of metals that Germany would be able to produce from internal resources.

Dr. Fermor has come to the opposite conclusion. Much the same view was stated, though even more strongly, by a writer in the *Times* early in the spring of this year, who predicted that, owing to deficiencies in manganese supply, the German steel industry would collapse in June, 1915. Fortunately, the issue between Dr. Fermor and myself can be settled by what is, after all, the most satisfactory method, viz., the appeal to facts. I will give them briefly. The source of my information is the "Statistik des Vereins Deutscher Eisen und Stahl Industrieller," published in *Stahl und Eisen* (August 5 and September 23, 1915). There is, in my opinion, no reason for regarding the figures as incorrect. They are published in the official technical organ of the German iron and steel industry. They contain evidence of the setback caused to that industry by the outbreak of war, evidence which is supplemented in an article by Dr. Schrödter frankly admitting the difficulties with which it has had to contend,⁷ and they show that those difficulties have been successfully surmounted.

Statistics of production of the various types of steel in each district are given, and may be consulted by those interested. For my purpose, however, it is

sufficient to quote the monthly output of cast iron and steel from the outbreak of war for a whole year :—

Month	Cast iron Metric tons	Steel Metric tons
August, 1914	586,661	567,610
September	580,087	660,615
October	729,822	900,227
November	788,956	892,814
December	854,186	928,294
January, 1915	874,133	963,790
February	803,623	946,191
March	938,438	1,098,311
April	938,679	1,012,334
May	985,963	1,044,107
June	989,877	1,080,786
July	1,047,503	1,138,478

These figures tell their own tale, and require but little comment. Confining our attention to steel production, the output for August, 1914, the first month of the war, was only 36 per cent. of the average yield in peace time—very little more than one-third. It appears to have taken the Germans only two months to overcome their technical difficulties, as is evident from the October figures, which represent an enormous increase over those of August—rather more than 50 per cent. Apart from slight fluctuations, the figures thereafter show a steady increase, until those of the last month of the war are more than double those of the first month, and represent a rate of production rather above 72 per cent. of the peace rate. There are no signs here of an expiring industry; on the contrary, I venture to think that an unprejudiced examination of the figures shows us that it has been getting month by month into a stronger position. It may be urged that a drop of 28 per cent. represents a not unimportant shortage. But I must point out that this is calculated on the total production in peace time, when, as in 1913, 22.6 per cent. was exported. This condition no longer holds. Subtracting this amount, we obtain a difference of only 5.4 per cent. between the peace and war figures of production; in a few months this will have vanished if war requirements demand it. I estimate that before the end of this year Germany will be producing steel at the rate of between 14,000,000 and 15,000,000 tons per annum, and that that rate can be increased if necessary.

The foregoing is an achievement to which I, for one, cannot refrain from paying my tribute of admiration, even though I ventured to predict it. It is in the fullest sense of the phrase an important technical success for German metallurgists. How has it been done? Dr. Schrödter will not say. What he does say is :—"Die Erzeugung unserer jetzt auf heimische Rohstoffe angewiesenen Eisenindustrie ist so gross dass sie nicht nur alle Anforderungen von Landheer und Flotte erfüllt, sondern auch die notwendigen laufenden Mengen an Eisen für Friedenszwecke und darüber hinaus bis zu einem gewissen Grade den Bedarf für unsere benachbarten neutralen Länder zu liefern vermag. Diese erfreuliche Tatsache ist offenkundig. Wie wir uns in unseren Rohstoffen decken ist unser und unserer Metallurgen Geheimnis das wir der verbündeten Welt unserer Feinde preiszugeben natürlich keinen Anlass haben."

I think, however, there can be little doubt that the utilisation of the German manganiferous iron ores supplies the answer.

Austria has also surmounted her technical difficulties in steel production.⁸ Her output is very much

⁶ Bureau of Mines, U.S.A., Bulletin 77, pp. 145-46.

⁷ "Die Eisenindustrie im ersten Kriegs Jahr," pp. 798-800.

⁸ *Stahl und Eisen*, 1914, pp. 818-19.

smaller than that of Germany, but is still by no means unimportant. The figures are as follows:—

	Tons
Production between August 1, 1913, and May 31, 1914	=819,000
Production between August 1, 1914, and May 31, 1915	=727,500
Difference	91,500

Of this drop of 91,500 tons, no fewer than 49,700 tons occurred in the first month of the war, and the following figures show that her present rate of production is greater than in the corresponding months of 1914:—

	1914 Metric tons	1915 Metric tons
January	78,300	79,100
February	80,000	84,500
March	107,800	110,500
April	94,100	99,000
May	95,500	80,800

(The diminution in May, 1915, was caused by the opening of hostilities between Italy and Austria.) I have quoted the Austrian figures (which do not include Hungarian production) because in the article by Dr. Kestranek, of Vienna, from which they are taken, there is a direct reference to manganese and steel production. It is as follows:—"Die Stahlwerke Oesterreichs vermöchten die volle Höhe ihrer normalen Erzeugung zu erreichen und zu erhalten, trotz der Knappheit mancher für die Stahlerzeugung notwendige Stoffe. Man lernte rasch mit dem Verfügbaren hauszuhalten, für das Ersetzbare Ersatz zu finden, und alle im Lande vorhandenen bisher unbeachteten oder nicht voll ausgenutzten Hilfsquellen zu erschliessen. So wurde Beispielsweise die für die Stahlerzeugung heute als unentbehrlich angesehene Legierung des Ferromangans, zu deren Erzeugung man fast ausschliesslich auf die Verwendung der kaukasischen Manganerze angewiesen schien, sichergestellt durch die ökonomischen Verbrauch der noch vorhandenen grossen Vorräte an fremdländischen Manganerzen und durch Heranziehung der im Inlande befindlichen Lagerstätten von solchen Erzen."

It is clear from this that the Austrians had accumulated pre-war stocks of manganese ore, and that they have succeeded in utilising their native manganiferous ores.

To sum up. Unless the evidence I have brought forward is untrustworthy—and I see no reason to doubt the figures of production, which bear ample witness to the setback both to the German and the Austrian iron and steel industries caused by the outbreak of war, which was followed by a remarkable recovery in the case of Germany (only two months later), and which has been well maintained, and indeed improved upon, during the succeeding months—then the conclusion appears to me to be fully warranted that Germany has succeeded in rendering herself independent of external supplies of manganese. According to Dr. Schrödter she is, in addition to supplying her own needs, exporting steel to her neutral neighbours.

Austria has been aided by her stocks of imported manganese ore, but has also been successful in utilising her own deposits.

So far from the figures of production showing a decline, which would certainly have set in by now if the shortage of manganiferous ore predicted by Dr. Fermor were correct, they bear witness to a remarkable degree of vitality and expansion in German steel production.

I wish to acknowledge my great indebtedness to Mr. G. C. Lloyd, the secretary of the Iron and Steel

Institute, for the help he has given me in obtaining the figures of German and Austrian steel production that I have quoted.

H. C. H. CARPENTER.
Royal School of Mines, South Kensington, S.W.,
October 23.

The Government Scheme for the Organisation and Development of Scientific and Industrial Research.

THE proposal to establish a permanent State-aided organisation for the promotion of scientific research, with a view to its applications to trade and industry, is a most hopeful sign of the times, and will be welcomed in principle by scientific workers generally. But, inasmuch as any such scheme necessarily implies a certain amount of State control and direction of scientific research, and, ultimately also, of the large body of scientific workers who will be brought within its ambit, there are certain important matters to be considered and settled in principle at the outset, if the scheme is to be as fruitful and successful as it ought to be. I venture, therefore, in the spirit of a friendly critic and well-wisher to the scheme, to submit to your readers the following paragraphs embodying some of the points which seem to me to need very careful consideration, in order that the freedom and interests of individual scientific workers shall be sufficiently safeguarded and conserved.

(1) In my opinion what is most needful in this country for the development of scientific research in relation to industry is a central fund for the subsidising of a *limited* number of important lines of investigation, initiated and carried out by scientific workers and technologists of repute, who are, or have been, sufficiently in touch with practical affairs as to have acquired at first-hand a real knowledge of industrial conditions and of the economic factors which will necessarily come into play in connection with any new development. Such proposals might be initiated either by individuals so qualified, or by any group or association of such individuals, and such persons should have a strong (if not a majority) representation upon any Advisory Council or Committee appointed either to select or recommend suitable subjects for investigation, or to advise in connection with the prosecution of any investigation so selected.

(2) The selection of a particular line of research should be governed by three considerations mainly:—

(a) Its importance and practicability as directly bearing either upon the development or revival of national industries, and particularly of those which, although producing essential commodities (e.g. synthetic dyes or optical glass), have through past neglect become localised abroad, or which may conceivably be threatened in the near future, or upon questions pertaining to the future better utilisation of national resources of raw materials (e.g. coal and its by-products).

(b) The probability of there being a successful issue of the investigation within a reasonable time.

(c) The fact that its inauguration and continuous successful prosecution would involve expenditure beyond the financial resources either of an individual investigator (even though he may be aided by grants from the existing research funds of scientific and technical societies), or of the institution in, or in connection with, which he may be working.

(3) Broadly speaking, there are three distinct classes of investigation which would come within the above category, namely:—

(a) Investigations with the object of establishing new or more accurate scientific data, or methods, involved in the design of industrial appliances or plant, or in the daily scientific control and supervision of important manufacturing processes.