Coincident with the opening of the newly found nickel deposits of Sudbury was the discovery of nickel steel. In 1889, James Riley, of Glasgow, established the fact that a small proportion of nickel greatly increased the strength of steel. Up to this time, nickel had played a very minor part among the metals, but Riley's discovery lifted it to a place of much importance, and quickly led to an increased demand which the Sudbury deposits were in a position to supply, and which greatly hastened their development. A special application of nickel steel was in the manufacture of armour plates for battleships. The United States government of the day was quick to realize the importance of nickel steel armour plates, and its large requirements put the industry at Sudbury on its feet. Undoubtedly, however, the future of nickel steel is an industrial one.

After the present devastating war is ended, the work of reconstruction will begin, and in this it is certain nickel steel will play a worthy and important part. For large bridges, locomotive and automobile parts, marine shafts and boiler tubing for everything, in short, where steel is required to be both strong and light, nickel would seem to be almost indispensable. Other uses there are for nickel, such as in electroplating, in cupro-nickel, nickel silver, coinage, etc., but these, while not unimportant, do not now, and are not in the future, likely to require much metal, compared with nickel steel. Even the war, while diverting nickel as well as almost everything else for the time being to purposes of destruction, is making the industrial world more familiar with the advantages of nickel steel, and will probably conduce to a greater demand than ever before.

Alloyed with Steel.

There are several other metals which, when alloyed with steel, exercise a beneficial effect comparable to that of nickel; among them, tungsten, manganese, vanadium, chromium, molybdenum. But the supply of most, if not all of these is scanty and precarious. The difficulty of obtaining sufficient quantities of manganese since the war broke out, is well known, and the scarcity of tungsten has led to molybdenum being used in its place. But most deposits of molybdenite, the principal ore of this metal, are pocketty, and of comparatively small extent. It would seem that nature was in a niggard mood when she provided these beneficiators of steel.

This scarcity is not so marked in the case of nickel, which indeed occurs abundantly—more abundantly than copper—as a constituent of the solid crust of the earth, but only here and there is it sufficiently concentrated to furnish workable deposits. In one or two localities, for instance, in the island of Cuba, nickel occurs on a really important scale, but in such a form—namely, accompanied by chromium in an earthy iron ore of low metallic contents, as to make its commercial extraction or utilization somewhat difficult. It is less easy to make a product of uniform composition from a natural alloy of this kind than from the necessary materials in separate form, since in the latter case the proper proportions are more readily obtained and controlled. But so far the largest and best deposits from which nickel as such can be extracted are those of the Sudbury district of Ontario. Here large masses of pyrrhotite mixed with chalcopyrite are found, containing on an average about 3 per cent. of nickel and 1.5 per cent. of copper.

In Four Localities.

From four separate and distinct localities in Ontario nickel in commercial quantities has been obtained. The earliest of these was Silver Islet, a tiny speck off the north shore of Lake Superior. The chief metal of this mine was silver, but with it were associated also nickel and cobalt. In 1874—43 years ago—a shipment of nickel and cobalt in the form of speiss, mattes and oxide, was made to Schneeburg, in Saxony, for which, reckoning also the silver which was left in these materials, some $30,000 was obtained. It must be remembered that at that time nickel was worth about $3 and cobalt about $4 a pound.

The second area was that of Sudbury, now by far the most important source of production in the world. The third nickel-bearing locality was Cobalt, so-called from the metal of that name, whose rose-pink arsenate colored the rocks alongside the Timiskaming and Northern Ontario Railway Company's right-of-way near Lake Timiskaming, and attracted the attention of the woodrangers and workmen when the railway was being built in 1903. The assemblage of minerals at Cobalt was almost precisely the same as at Silver Islet—silver, cobalt, nickel and arsenic. The nickel contents in both cases were small, yet from the Cobalt silver ores have been taken nickel amounting to about 4,000 tons in all, and from these ores was made the first metallic nickel refined in Ontario.

In the township of Dundonald about 130 miles northeast of Sudbury, the fourth nickel deposit was discovered. A prospector, named Alexander Kelso, who read the government reports, noted that the surveyor in laying out the township of Dundonald had observed a strong local deflection of the needle, and being a man of intelligence, examined the spot and found the disturbance due to a body of pyrrhotite carrying nickel and copper. This, it will be observed, was the Creighton mine case over again, except that the information contained in the government blue books was made use of. This mine is called the Alexo, and it has for several years yielded 10,000 or 12,000 tons of ore averaging over 4 per cent. of nickel and about 1 per cent. of copper.

Two Distinct Types.

These four nickel areas are of two distinct types: Silver Islet and Cobalt being alike in their mineral constituents, while the Sudbury and Alexo deposits closely resemble each other. In the first two the ore is essentially one of silver, accompanied by the arsenides of nickel and cobalt. In the second, the chief component is pyrrhotite with which are associated nickel and copper sulphides. But Sudbury far surpasses the other three in size and importance.

Two operating companies work the mines of Sudbury—the Canadian Copper Company and the Mond Nickel Company, the former an American, and the latter an English concern. The seat of the former is Copper Cliffe, and of the latter Coniston. The copper company treats about 1,300,000 tons of ore yearly and the Mond company over 300,000 tons. Both are excellent samples of the modern, large-scale mining company, whose works and equipment are of the most approved type.

The process of treating the ore is interesting. After being raised from the mine and washed, it is roasted in huge heaps in the open air to drive off the sulphur, which, according to the Nickel Commission, escapes from the heaps, and also from the smelter and refinery stacks, in quantities equivalent to one million tons of sulphuric acid per annum. The roasted ore is smelted in an ordinary blast-furnace to a low grade matte, and the latter is then blown to a Bessemer matte, containing about 80 per cent. of nickel plus copper. This matte is exported to New Jersey and Wales for the final separation of the metals. The International Nickel Company, with which the Canadian Copper Company is associated, is erecting a large refinery at Port Colborne, Ontario, which it is expected will shortly go into operation, with a capacity of 7,500 tons of refined nickel per annum. The Mond Company's refining is all done at Clydach in Wales, where metallic nickel and sulphate of copper are made. A third company, the British-America Nickel Corporation, is opening a large deposit of ore at the Murray mine, and will build a smelter and refinery there also. This company has the financial backing of the British government. The output of the Sudbury mines for 1917 was about the same as for 1916, or, say, 41,500 tons of nickel and 21,250 tons of copper, the value of which, in the matte form, was about $30,050,000. Both metals, owing to war demands, are higher in price than for years.

Other Countries' Deposits.

The other main source of the world's supply of nickel is the island of New Caledonia, some three days' voyage by steamer from Sydney, Australia. The New Caledonia ores are of an entirely different character from those of Sudbury, being for the most part of an earthy, laterite nature. They carry a higher percentage of nickel, but no copper. No refining is done on the island, the ores being exported as such, or as matte, principally to Britain and France, but also to a smaller extent to the United States, for refinement. These deposits for a long time dominated the nickel market, but their output now is less than one-third that of the Sudbury mines. For instance, during the five years, 1911-1915, New Caledonia turned out 39,607 tons of nickel, while Ontario produced 121,106 tons. Since 1915, the production of New Caledonia has not increased, while that of Ontario has gone up more than 20 per cent.

Norway also has nickel-copper deposits of the Sudbury type, but the ores are poorer both in nickel and copper. The war demand has brought about an increase in the Norwegian production which, however, is less than 1,000 tons per annum. Most of it has found its way to Germany, but of late this export trade has been much curtailed