it was this entanglement which eventually led to the abandoning of the looped field type of machine for the type where the material to be separated passes between the poles and through the magnetic field but once and in consequence escapes entanglement.

The freeing of material which had been attracted was at first secured by means of scrapers, and later by reducing the field at the point where the material was desired to be freed, but it is now generally obtained in the best machines by reversing the magnetism, producing a neutral point at which all material of whatever attractability is dropped. So well have the principles of the designs of a magnetic separator come to be understood that a difference of magnetic susceptibility now offers in many cases a cheaper way of concentrating minerals than the customary way of taking advantage of the difference in specific gravity.

From its highly attractable property and from its low value, which has ordinarily prevented any other method of concentration, iron ore has naturally been a special field for magnetic separation. This has been with two specific ends in view, one, the enrichment of a low grade of iron ore for the purpose of reducing the freight to a furnace and also the furnace cost of operation per unit of iron smelted. The other use has been to free iron from deleterious materials, such as tiatium, phosphorous and sulphur. Where these occur in separate crystals which can be liberated by crushing the iron ore, the resulting separation is one which frequently proves commercially feasible. In the case of sulphur the success depends on the fact that the sulphur compounds usually found in iron are either more or less magnetic than the iron oxides of the ore.

The separation of iron has divided practically into the separation of magnetites—that is, iron oxide, which is naturally magnetic and which can be picked up with an ordinary hand magnet -- and the hematites and limonites which are less magnetic, usually so feebly magnetic as not to be attracted by a hand magnet.

In the enrichment of hematites the question has divided into two different sorts of separation, one, the separation of high-grade hematites from sandstone in which they occur as a conglomerate, having been deposited as ditrital material from older iron beds along with the sand; the other, the separation of silicious material which was originally deposited at the same time as the iron and usually in the form of intimately entwined crystals.

The question of the physical condition of iron ore with reference to its impurities, is one of the more important in the magnetic concentration of such material. One of the first questions which are asked by a furnace man when approached on the subject of iron concentrates is "the amount of the fines." If it is necessary to crush the material to such fine sizes that most of it will blow out of the top when put into a furnace, the purchase of any considerable tonnage of such material is evidently a matter to be approached with caution. Briquetting has made material advances and large experiments are being carried on at present in the smelting of briquetted iron material. It should be noted that this matter of briquetting and the production of fines is entirely a question of the physical character of the ore. Magnetic separators now handle such feebly magnetic materials as hematite in chunks of practically any desired size, separators being constructed to concentrate material up to one inch in diameter. The cost of building and operating a separator increases about in proportion to the size of material which it is to handle. It is therefore a commercial matter as to whether the cost of briquetting, or the cost of concentrating at a larger size, out-weigh one another. Almost invariably it is cheaper to build a machine capable of handling larger size then it is to briquette, as in general briquetting costs more per ton than the cost of separation, including interest, depreciation and royalties on the separator when handling material as large as one inch in diameter.

In such a matter as the St. Lawrence iron sands, where the material is already crushed, and generally crushed even finer than enough to free it from the accompanying gangue, the question of briquetting is an important one and bears an aspect which should interest Canada with its water powers. The need of briquetting iron ore for use in a smelting furnace is brought about by the high pressure of the modern blast. If this blast could be eliminated, within certain limits it would be a matter of indifference as to whether the material was coarse or fine. It would still have to be granular enough to permit the escape of the gases generated in the smelting operation. Electric smelting provides the required condition that there need be no blast. The magnetites, being iron oxides, need only be mixed with carbon in the shape of any clean fuel, such as coke or charcoal, and subjected to the heat generated by an electric current, to have the carbon join with the oxygen of the magnetite and escape of carbon monoxide, leaving the iron to be tapped off in the form of pig. These St. Lawrence magnetites could probably be dredged up and concentrated wet into an iron ore of unusually high grade, and delivered in the Ottawa valley for a cost not to exceed one dollar per ton. This commercial utilization by means of magnetic separation would appear to offer the promise of a very considerable industry when taken in connection with smelting by means of the water power of the Dominion.

Of next importance (commercially) from the standpoint of magnetic separation is the separation of the mixed sulphides of lead, zinc and iron. This so-called "Leadville problem" has existed for many years. There was in this camp a large tonnage of zinc-lead ore which was too high in zinc to permit the lead furnace men treating it without getting into serious difficulty through the choking up of his stack from zinc accretions, and too high in lead and iron to permit the zinc smelter from treating it without the destruction of his retorts through slagging by lead and iron. The specific gravity of the zinc and iron was too close to permit of commercial water separation. Through zinc interests who were looking for an ad-