	Swedish Iron.	O. H. Soft Steel.	Rail Steel.	Cast Iron.	Dbl. Refined Electrolytic Iron.
Carbon	0.10	0.15	0.60	3.75	0.00
Silica	0.10	0.15	0.20	2.00	0.002
Sulphur	0.01	0.05	0.05	0.01	0.003
Phosphorus ..	0.02	0.06	0.10	0.50	0.003
Manganese ...	0.10	0.75	0.80	0.50	0.02

In the above table are listed the impurities usually found in commercial steels, in such quantities as are desired for the particular service required of the steel, or as a necessary accompaniment of the process of manufacture. Carbon belongs in the first class and may thus be considered as a useful element; of the remainder, sulphur and phosphorus are decidedly injurious and their elimination is sought as far as may be practicable; while silicon and manganese are necessary additions because of their indirect influence on certain harmful constituents. The generally listed analyses make no mention of the gases occluded in the steels, particularly nitrogen and oxygen. Yet the vital influences of these elements have recently been recognized and they may be considered as the cause of the marked differences, hitherto unexplained, in Bessemer and open hearth steels of seemingly identical composition.

Of the enormous number of tests of the physical quality of steels, practically all have been made up of materials whose properties may have been influenced by the above mentioned impurities. In the newer field of alloy steels, it is especially true that the effect of the additional element, such as nickel, manganese, silicon, chromium, tungsten, molybdenum, vanadium, etc., is very markedly influenced by slight amounts of impurities, carbon in particular. It may truthfully be said, therefore, that an investigation starting with essentially pure iron as a basis, might branch out into any channel, no matter how thoroughly it has apparently been covered before, without in reality repeating the previous work.

A most promising field was the study of the alloy steels. As may be readily seen, with the vast field opened up, one person could do but little more than scratch the surface, especially in view of the numerous difficulties arising, when the work was first begun, to keep the alloy during melting free from contamination from the furnace gases and from the impurities of the crucible. The electric furnace and magnesia crucible were found to be the best solution of the problem.

It is not the purpose of this article to enumerate the various alloys made up or the nature of the tests; its object is rather to discuss the probable usefulness of the development of the electrolytic refining of iron from the general results of the investigation. It is sufficient to say that most of the earlier work consisted in the preparation of alloys and in testing them for various properties. The scope of the work may be summed up as follows:—(1) the influences of the alloying elements in varying proportions, in the absence of carbon and particularly the sulphur, phosphorus, and manganese accompanying ordinary materials—(2) the testing of alloys which may not have been feasible previously, because of the detrimental effect of the general impurities, particularly carbon, on the nature of the alloy formed—(3) the correlation of the several properties observed, with the hope that it might aid in interpreting the inner make-up of the materials.

In general, electrolytic iron can hardly be expected to take a conspicuous place in steel for ordinary purposes, since the properties would have to be very greatly superior to those of the less pure metals of otherwise identical composition to warrant its use, as the cost of the refining operation is necessarily high. As far as structural materials are concerned, the carbon is a beneficial agent, permitting one to vary the strength, ductility and elasticity of the alloy according to the nature of the service required; the great advantage of the electrolytic iron comes in enabling a closer regulation of the properties to be made because of the absence of the other detrimental impurities, particularly sulphur, phosphorus and oxides.

Conspicuous results may be cited in the copper steels where in the absence of carbon, copper is seen to be a beneficial agent, and not the extremely deleterious one indicated by tests upon steels of the usual holding of carbon. Again, in those materials used for their magnetic properties, small amounts of impurities, especially carbon, are injurious, and alloys made with electrolytic iron as a base material showed a higher permeability than those of corresponding additions to commercial iron.

There are many special fields of usefulness, however, where the primary cost of the material is a secondary consideration if the resultant properties are of sufficient merit.

Pure iron is a factor in the commercial world only indirectly because of the elimination of the customary impurities, as sulphur and phosphorus; manganese, and carbon in particular, can hardly be classed as such. The great measure of its utility will rest in the elimination of the variables incident to the use of customary stock as a basis for a high grade, uniform product.

EXPERIMENTS ON THE USE OF PYRITIC RESIDUES.*

In Italy experiments have been carried out by Carcano for the production of pig iron from pyrites residues. Purifying, enrichment, and agglomeration are necessary to prepare pyrites residues for treatment in the blast-furnace. The material often carries more than 4 per cent.

The residues treated by Carcano in the electric furnace contained:

Silica	From 7.9 to 12.25 per cent.
Iron	From 47.0 to 60.3 per cent.
Alumina	From 6.9 to 18.80 per cent.
Sulphur	From 2.01 to 4.25 per cent.

The residues were charged in their powdery condition. It was endeavored to work with the most basic slag possible, with a certain percentage of manganese, so as to ensure a sufficiently strong desulphurizing effect. Generally, manganese is found to be a satisfactory desulphurizer. In the experiments raw material containing up to 4.25 per cent. sulphur yielded a pig iron running between 0.015 and 0.058 per cent. sulphur in the presence of from 2.17 to 2.54 per cent. manganese. Various types of electric furnace of different powers were used. The furnace tried by Carcano in 1908, which gave the most favorable results, was of a capacity varying from 200 to 300 horse-power. It was a closed furnace with neutral hearth supplied with single-phase or three-phase current with automatic charging, and with recovery of the carbon monoxide evolved during the reactions. That gas was used to prevent deoxidation of the pyrites residues. The energy consumption per ton of pig produced averaged 2,100 kilowatt hours in a furnace of 180 kilowatts and using residues containing 50 to 55 per cent. of iron in the form of ferrous oxide. The lower ends of the vertical electrodes rested on the slag, so that the furnace worked as a surface resist-

*Abstracted from a paper on The Application of Electricity in the Metallurgical Industry of Italy, by R. Catani.