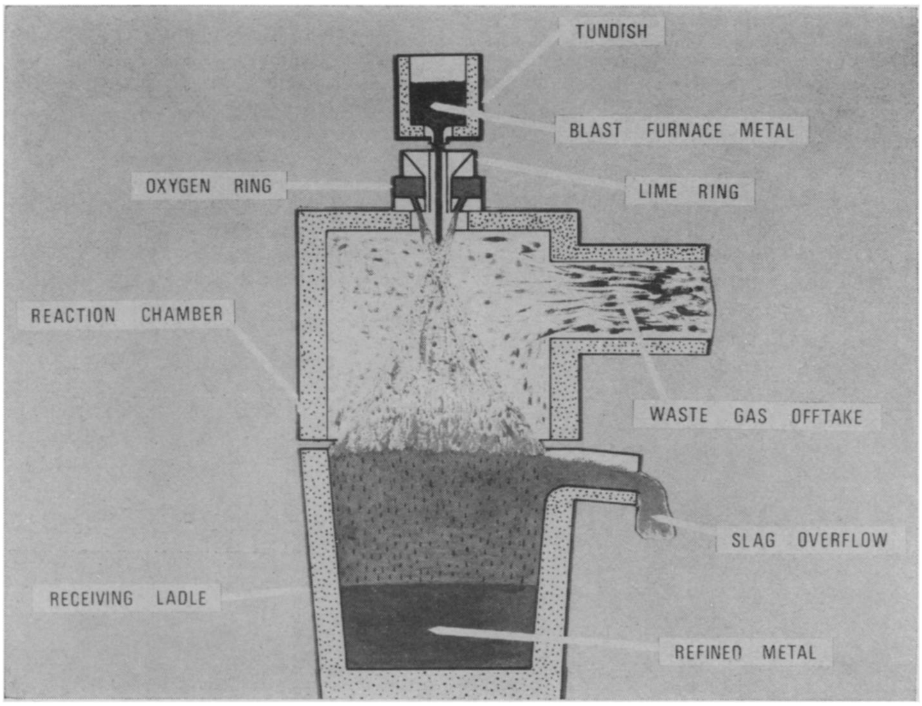

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Molten iron, blasted with oxygen, turns into a spray of steel.

Steelmaking in Midair

Spraying process promises cheaper production; U.S. firms watch warily.

by F. C. Livingstone

Seven years ago, the British Iron and Steel Research Association began a search for new methods of making refined iron. Four years later, it realized it had found, instead, a new, cheap, method of making steel.

The British believe their spray process is the most advanced in the world, requires less capital outlay than any other, and might revitalize the country's declining iron works. American steelmakers, watching carefully, say they see no real savings. Nevertheless, technicians from major United States corporations regularly fly the Atlantic to look for themselves.

In Britain, the process has stirred a political broth. The Millom Hematite Ore and Iron Co., which developed the first pilot plant on the BISRA model, was at first forbidden to expand its spray steelmaking by Britain's Iron and Steel Board, causing a national outcry. Now the board has discovered it had no power to forbid the Millom expansion, and the company can go ahead and invest $3 million of its own in the process.

Steel is basically iron with most of the carbon and other impurities removed. Usually this is done by forcing air up through the molten metal, allowing the carbon to burn away. In the new process, molten iron is sprayed into a chamber with a strong blast of pure oxygen. The metal droplets, the size of pinheads, offer an immense surface in relation to their volume, allowing the quick reduction of the carbon from iron's 2 to steel's 0.2 percent.

Since the basic reaction takes place in midair, there is no need for expensive refractory linings for the chamber, nor does the molten steel pick up impurities from the linings.

Because the temperature of the metal is raised to about 3,600 degrees F. a large proportion of scrap can be used.

The process is closely controlled by varying the oxygen flow, making it particularly suitable to control by computer.

In the BISRA experiments hot metal was made in the laboratory by melting pig iron in an arc furnace and then pouring from the ladle into a tundish (funnel), flow being regulated to maintain a constant head of metal. A half-inch diameter tundish nozzle and a nine-inch head of metal permitted a thruput rate of six long tons per hour.

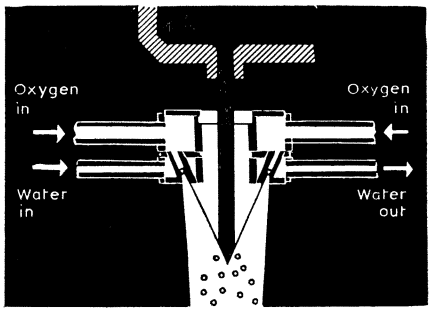
Lime, mixed with other fluxes to lower the melting point, was fed in at a predetermined rate together with oxygen, and the droplets of slag and metal fell into the receiving vessel.

The metal formed a pool below the foaming slag. When the level rose sufficiently, spent slag flowed away through an overflow.

At the end of the process, the refined metal was allowed to fall into a transfer ladle where alloys were added to produce steel of the required composition.

These initial experiments were limited by the size of the arc furnace, which could take about 1,350 pounds of metal.

Using hot metal containing 1.3 percent phosphorus, oxygen at a rate of 1,500 cubic feet per ton of hot metal and appropriate amounts of lime, about 35 percent of the phosphorus and 50 percent of the carbon could be removed. Using 0.2 percent phosphorus hot meal, a 75 percent removal was obtained, giving the final material a phosphorus content of about 0.05 percent. This was not considered acceptable since it was determined that the phosphorus content should not exceed 0.02 percent. A change in the flux ingredients achieved this, but the carbon content was still about 2 percent.



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Oxygen ring cooled by water jacket.

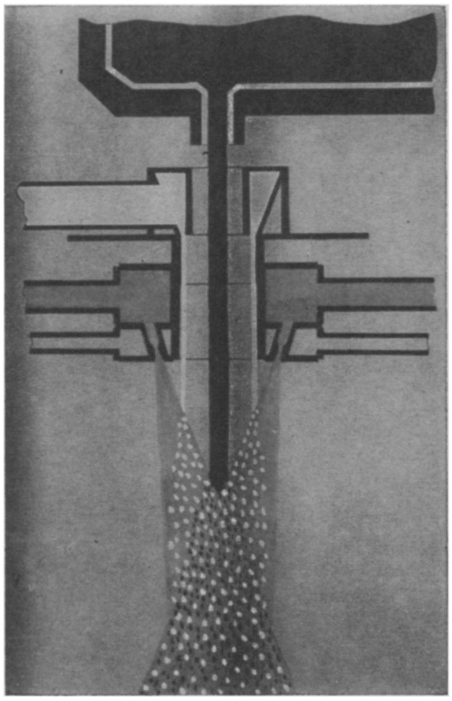
It appeared that this high carbon content was due to an inadequate nucleation of carbon monoxide. This was proved when the oxygen flow was increased to 1,800 cubic feet per ton of hot metal. The contents of the receiving ladle erupted violently, and the resulting metal contained 0.75 percent carbon.

Nucleating the refined metal with nitrogen bubbles reduced the violence of the reaction, but did not produce a sufficiently low carbon content.

This was due to the fact that although the receiving ladle was preheated, it was always colder than the metal, which would then be supersaturated with carbon monoxide.

This handicap was overcome by raising the initial temperature of the receiving ladle by gas preheat. After this, final carbon figures were of the order of 0.3 to 0.5 percent. By permanently increasing the oxygen rates to 1,800 cubic feet per ton, a metal containing less than 0.3 percent carbon was regularly obtained.

At the beginning of 1966, the Millom Hematite Ore and Iron Co. decided to adopt the process and designed a plant which would permit a throughput rate of 10 long tons per hour. The plant was ready for use by midsummer.



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Lower ring adds lime flux.

At Millom, the refined metal in the receiving ladle is transported to the foundry. The material can be cast into ingots, with alloy additions made to produce steel of the required specification. Alternatively, the metal can be used to produce a range of refined irons suitable for use in the foundry.

Unlike conventional processes, spray steelmaking can treat liquid iron as soon as it leaves the blast furnace. This eliminates the need for a separate steelmaking plant. When the blast furnace is tapped, the hot metal is diverted directly into the spray-steelmaking unit. Heat losses are thus kept to a minimum.

In the pilot plant at Millom it was found that there was a loss of about 8 percent of refined metal with the overflowing slag. In a full-scale plant, however, the slag could be kept in a receiving vessel and allowed to settle so that the metal could be recovered.

There has also been a certain amount of loss in the fumes produced. In the pilot plant an existing chimney was used to release the fumes to atmosphere. This could be corrected in a production plant by having a cleaning unit recover them. This material could then be mixed with lime as the fluxing medium.