to take out all the carbon, and then to restore the amount required for the grade of steel sought. But it is not easy to take out the carbon completely without encountering a new difficulty. Namely, when the carbon is nearly gone, the oxygen of the blast begins to act upon the iron itself, forming oxide of iron; and this substance existing in the mass of molten iron, even in extremely small quantity, deprives it of homogeneity and renders it liable to brake under the hammer at red heat, or as the iron masters say "makes it red-short." Now to cure this red-shortness, and at the same time to recarbonize the melted wrought-iron, a compound of iron, manganese and carbon, called *Spiegeleisen* or specular iron, from its brilliant luster and large mirror-like crystalline faces, is added to the bath before casting. The manganese is supposed to unite with the oxygen of the iron oxide just referred to, and to pass as oxide of manganese into the slag which floats on the bath, while the carbon unites with the iron in the bath to form steel.

Now the Bessemer operation, thus sketched, is simpler, quicker and applicable to larger quantities at once than puddling. There are in fact but three reasons which occur to us why the product should not be as cheap as that of the puddling furnace. 1. The latter will successfully treat sorts of pig iron which cannot be used in the Bessemer converter; and these sorts are (partly for that reason) cheaper than the "Bessemer pigs." 2 The Bessemer process involves a large loss of iron. 3. It requires very expensive "plant" or machinery, the interest on the cost of which is to be assessed upon the product. Nevertheless, the statement hinted at the commencement of this article is scarcely premature Steel rails, acknowledged to be in all respects superior to iron ones, can be produced at a cost which is rapidly approximating that of iron. The "rail of the future" will be steel!

Yet it is not likely that any more Bessemer works will be erected in this country. For a rival process — the only one, so far, which is worthy of that name—is coming into favor, and already in England, and on the Continent, puts its product into the market on equal terms. We refer to the Martin process of manufacturing steel on the open hearth of a Siemens reverberatory furnace. Here the decarbonization of the pig-iron is effected by the reactions, upon the molten bath, of wrought-iron or ore and of the furnace-flame. The operation is slower and more completely under control than that of the Bessemer method; and the ease and regularity with which any desired grade of steel can be produced has led to the employment of this method for some purposes to which the Bessemer is less adapted—for instance, the manufacture of boiler-plate, machine and tool steel, &c. But the gradual perfection of the arrangements and manipulations of the Martin system, in such works as those of Siemens in Great Britain, Martin in France, and also the establishment at Terre Noire in the South of France, has brought about a competition between Bessemer and Martin steel on the chosen ground of the former, namely, the manufacture of rails.

One of the advantages of the Martin process in this competition seems to be its capacity of employing old iron rails (usually containing phosphorus) in making new steel rails. It does not appear that the treatment eliminates the phosporous but, on the contrary, that a steel is produced containing more phosphorous than was hitherto supposed consistent with tenacity. The secret is asserted to lie in the reduction of the quantity of carbon in proportion as that of phosphorus is increased, or, as it has been expressed, in the substitution of phosphorus for carbon as a "steelifying agent." Phosphorus has been universally regarded as the great foe of the steel manufacturer; and if by this means it can be utilized as an ally, a very large amount of material will be rendered available for making steel; and the transformation of thousands of miles of iron tracks on the railroads of the world into tracks of steel will be greatly facilitated. It must be added that engineers and metallurgists are still doubtful about "phosphorus-steel rail though the reports concerning their use in France for a year or two past have been generally favorable.

The decisive effect produced by minute proportions of a substance like phosphorus in combination with iron may be seen in the fact that one-tenth of one per cent. of it is considered all that ordinary "carbon steels" will bear, while even the "phosphorous-steel," of which so much is said, never contains so much as half of one per cent., and usually, we are informed, the proportion of phosphorus in it is about 0.35 per cent.—that of carbon being perhaps 0.12 per cent.

THE EIGHTY-ONE TON GUN.

(*See illustration on page 301.*)

The sketch we give of "Boring the Trunnion Coil" is the last operation connected with the manufacture of the monster 81-ton gun We do not cast them, as Krupp does his famous steel weapons at Essen, but we build them up piece by piece In the first place, a long pillar of solid steel is obtained which, in the case of the 81-ton gun, alone cost £1600. This pillar is bored out to the proper diameter of the cannon, and the tube thus secured forms the centre of the gun. The next thing is to provide several wrought-iron cylinders to clasp this tube and strengthen it, and it is in the manufacture of these cylinders wherein lies the strength of our "Woolwich infants" A long bar of stout iron, sometimes 200 ft. in length, is put into a furnace of the same dimensions, and heated to redness; one end is then attached to a revolving iron pillar at the mouth of the furnace, and the pillar is set in motion, so that the heated iron bar gets wound round it in the form of a spiral Subsequently this spiral is slipped off the pillar, and is carried to a reverberatory furnace to be heated once more, but this time to a white heat In this condition the mass is brought under a huge steam-hammer and welded into a cylinder, in which form, after having been properly turned and bored, it is ready to slip on to the steel tube we first alluded to.

Two or three iron cylinders, or jackets, are usually placed around the steel tube in our big guns at the breech, where, of course, most strength is necessary, while one suffices for the muzzle, and this is the reason why our modern cannon have that humped-back appearance behind. The biggest cylinder is termed the "trunnion coil," for it carries with it the trunnions on which the gun rests when in its carriage. In the case of the 81-ton gun, the trunnion coil is of immense proportions, 6 ft. in height and 18 ft. in girth, and the finished gun will be 27 ft. long. Our illustration shows the last operation of all being performed—that of boring this cylinder inside to render it smooth, so that it may be easily slipped over the steel tube, or, rather, over the first iron jacket with which the steel tube is already surrounded The cylinder is made so that it is a trifle too small and will not slip over the tube; but it is heated to make it expand and in this condition it is easily fitted in its place, where it shrinks very tightly on cooling. In this very neat and simple manner are the guns at Woolwich now built up, and from the circumstance that the bore of the gun is made of hard steel, while the cylinders around are constructed of tough wrought iron, they may be relied upon for great strength and endurance.

It is anticipated that the 81-ton gun will be able to send a projectile through twenty inches of solid iron, or, in other words, through the sides of the strongest ironclad now built or building. For this purpose 300 lb. of gunpowder will be required, and a shot weighing half a ton.—*London Illustrated News.*

APPARATUS FOR PRODUCING GAS INSTANTANEOUSLY.

This apparatus consists of three vessels,—an air pump, a receiver, and a carborator. In the latter is enclosed the essence of the mineral which forms carborated air—that is to say, the air becomes instantaneously changed into lighting gas by escaping from the receiver and coming in contact with the mineral in the carborator. A few strokes of the pump is sufficient to send into the receiver enough air to make gas for an evening. On opening a tap the gas is conveyed to the different burners. Instantaneous gas thus made has an advantage over ordinary coal gas, of not only being nearly 100 per cent more economical, but its brilliancy is greater, and it burns with a steadier light, It is odourless, and does not injure gilding or picture frames, and is unattended with any danger

The price of an apparatus large enough to supply 10 burners is about $320 It is manufactured by Mr. Martin, 63, Rue de Molté (Château d'Eau), Paris.

COUGH.—Valerian root 5d.; snake root, 1d., Peruvian bark, 1d.; Spanish juice, 1d; peppermint, 2d. Boil the roots and juice in about a pint and a half of water down to a pint. When cold, bottle, and add the peppermint. Dose: A wine-glassful when the cough is troubles ... .