

which transforms the cotton into leather is capable of being tinted to any shade that may be wanted of red, green, brown, black, blue, yellow, etc., and that whatever are the ingredients of the composition no admixture of india-rubber or gutta percha forms part of it, inasmuch as the leather cloth, when complete, even when folded and exposed to considerable heat, is entirely free from the tendency to stickiness, which has been the great objection to all waterproof material."

#### REGENERATIVE GAS FURNACES.

Mr. C. W. Siemens read the following paper on these ingenious pieces of machinery, before the British Association:

The principle of the regenerative gas furnaces has already been explained to the scientific public, by Professor Faraday, in a lecture delivered by him at the Royal Institution in June, 1862. Its general construction and the history of its invention and gradual development form, moreover, the subject of a paper which was read by me in January, 1862, before the Institution of Mechanical Engineers. Since that period this principle of heating has been extensively applied in England, France, Germany, and other countries to glass-houses, for heating gas retorts and muffles for metallurgical purposes, for melting steel, and for puddling and welding iron. The ostensible object of this invention being to save fuel, it could hardly be expected that it would be favourably looked upon in this, the greatest coal-producing district of the whole world; but experience has proved that there are other advantages resulting from its application which, in the case of puddling and working iron, are even superior in value to mere saving of fuel in a money point of view. A diagram was exhibited representing a furnace for welding and working iron, and the gas-generator connected with it. The heated chamber is of the usual form, but instead of a fireplace there are four passages (two at each end of the chamber) leading downwards into four regenerators or chambers filled with loosely piled fire-bricks. The lower extremities of these four regenerator chambers communicate with two cast-iron reversing valves. The gas arriving from the producer through a pipe is directed by the valve into one regenerator or other according to the position of the valve. The gas then ascends through the one regenerator, where it takes up the heat previously deposited in the brickwork, and issues into the furnace at a point where it meets with a current of heated air arising from the second regenerator to effect its combustion. The products of combustion pass away through the opposite regenerator and the reversing valves into the chimney flue. The last named regenerators receive at this time the waste heat of the furnace, heated at their upper extremity to the temperature nearly of the furnace itself, but remaining comparatively cool towards the bottom. Every hour or half-hour the direction of the currents is reversed by a change of the valve lever, the heat before deposited in the one pair of regenerators is now communicated to the air and gas coming in, while the waste heat replenishes the second pair of regenerators. The gas producer consists of two inclined planes upon which the fuel descends, being gradually deprived in heating of its gaseous constituents, and finally burnt to car-

bonic oxide by the air entering through the grate at the bottom of the inclines. Water admitted at the bottom also assists in the decomposition of the ignited coke at the bottom, converting the same into carbonic oxide and hydrogen gas. The saving of fuel which has been effected by this arrangement amounts to from 40 to 50 per cent. In the application to reheating and puddling furnaces a saving of iron has been effected, owing to the mildness of the gas flame, of from 3 to 4 per cent. of the entire put in; the iron also welds more perfectly than it does in the ordinary furnaces. Smoke is entirely obviated. By another arrangement the regenerative principle has been applied also to coke ovens, the result being that the separation of the coke from its gaseous constituents is effected without losing the latter. In placing the coke ovens, constructed on this plan, near the works where the iron is puddled and reheated, the latter operation may be entirely effected by the gas generated in producing the coke necessary for the blast furnace in producing the pig iron. The gas resulting from the regenerative coke oven may be used to heat the blast, and boilers connected with the blast furnace. These latter improvements are now in course of being carried into effect on a large scale. The gas produced is of a very illuminating character, and may, it is repeated, be used for that purpose in preference to the hydrocarbon now manufactured for that purpose by a much more expensive process.

#### BOILER EXPLOSIONS.

The following communication on "Boiler Explosions," from the Astronomer Royal, was read at the meeting of the British Association:

In considering the cause of the extensive mischief done by the bursting of a high-pressure steam boiler, it is evident that the small quantity of steam contained in the steam-chamber has very little to do with it. That steam may immediately produce the rupture, but as soon as the rupture is made and some steam escapes, and the pressure on the water is diminished, a portion of the water is immediately converted into steam at a slightly lower temperature and lower pressure, and this in the same way is followed by other steam at still lower temperature and pressure, and so on until the temperature is reduced to 212 deg. Fahr. and the pressure to 0. Then there remains in the boiler a portion of water at the boiling point, the other portion having gone off in the shape of steam, of continually diminishing pressure. From this it is evident that the destructive energy of the steam, when a certain pressure is shown by the steam-gauge, is proportional to the quantity of water in the boiler. By the assistance of Professor Miller, of Cambridge, Messrs. Ransome, of Ipswich, and Mr. George Biddell, I have been able to obtain a result which I believe to be worthy of every confidence. I will first state as the immediate result of Mr. Biddle's experiments, that when there were in the boiler of a small locomotive 22 cubic feet of water, at the pressure of 60lb. to the square inch, and the fire was raked out and the steam was allowed gently to escape with perfect security against priming, the quantity of water which passed off before the pressure was reduced to 0 was 2 $\frac{1}{2}$  cubic feet, or one-eighth of the whole. In regard to the use made of Professor