The most important step in the development of the regenerative furnace has been the complete separation of the fire-place or gas producer from the heating chamber or furnace itself. When a uniform and sufficient supply of combustible gas is ensured, it can evidently be heated just like the air, by being passed through a separate regenerator before reaching the furnace, whereby its heating power is greatly increased. The difficulty of maintaining a uniform flame in the furnace is thereby certainly removed, and there is no longer any necessity for keeping the flame always in the same direction through the furnace, since the gas can be introduced with equal facility at each end of the heating chamber in turn, and the periodical change of direction of the flame through the furnace tends only to make the heat more uniform throughout; whereas in the previous plan of employing solid fuel for heating in the furnace, the relative position of the fire-place and heating chamber being fixed and unchangeable, required the direction of the flame to be kept always the same, unaltered by the reversal of currents through the regenerators. The new plan of a separate gas producer has now been successfully carried out in practice, and there are already a considerable number of the regenerative gas furnaces in satisfactory operation in this country and on the continent, applied to glass-houses, iron furnaces, &c. In the neighbourhood of Birmingham, at Messrs. Lloyd and Summerfield's glassworks, a flint-glass furnace constructed upon this plan has now been in continuous operation for nearly twelve months, and affords a good opportunity of ascertaining the consumption of fuel of the regenerative furnace as compared with the previous furnace performing the same work. At the glass-works of Messrs. Chance (Brothers) and Co., near Birmingham, the regenerative gas furnace has been under trial for the same length of time, and has latterly been adopted for the various purposes in crown and sheet glass making upon a very large scale. Messrs. James Russell and Sons, Crown Tube Works, Wednesbury, are also applying the furnace to the delicate operation of welding iron tubes, and, in a short time, will probably employ no solid fuel for any furnaces at their works. Another flint-glass furnace erected by Messrs. Osler in Birmingham, and several puddling furnaces erected by Messrs. Gibbs Brothers at Deepfields, and by Mr. Richard Smith at the Round Oak Iron Works, are amongst the latest applications of the regenerative gas furnace, the designs having in all cases been furnished by the writer, and carried out under his brother's immediate superintendence.

The gas producers are entirely separate from the furnace where the heat is required, and are made sufficient in number and capacity to supply several furnaces. The fuel, which may be of the poorest description, such as slack, coke dust, lignite, or peat, is supplied at intervals of from six to eight hours through covered holes, and descends gradually on an inclined plane, which is set at an inclination of from 45° to 60°, according to the nature of the fuel used. The upper portion of the incline is made solid, being formed of iron plates covered with fire-brick; but the lower portion is an open grate, formed of horizontal flat steps. At the foot of the grate is a covered water trough, filled with water up to a constant level from the small feeding cistern, supplied by a water pipe with a ball tap. The large opening under the water trough is convenient for drawing out clinkers, which generally collect at that point. Small stoppered holes at the front and top of the producer are provided to allow of putting in an iron bar occasionally to break up the mass of fuel and detach clinkers from the side walls. Each producer is made large enough to hold about ten tons of fuel in a low incandescent state, and is capable of converting about two tons of it daily into a combustible gas, which passes off through an opening into the main gas flue leading to the furnaces.

The action of the gas producer in working is as follows:—The fuel descending slowly on the solid portion of the inclined plane, becomes heated and parts with its volatile constituents, the hydrocarbon gases, water, ammonia, and some carbonic acid, which are the same as would be evolved from it in a gas retort. There now remains from 60 to 70 per cent. of purely carbonaceous matter to be disposed of, which is accomplished by the slow current of air entering through the grate producing regular combustion immediately upon the grate; but the carbonic acid thereby produced, having to pass slowly on through a layer of incandescent fuel, from three to four feet thick, takes up another equivalent of carbon, and the carbonic oxide thus formed passes off with the other combustible gases to the furnace. For every cubic foot of combustible carbonic oxide thus produced, taking the atmosphere to consist of one-fifth part by volume of oxygen and four-fifths of nitrogen, two cubic feet of incombustible nitrogen pass also through the grate, tending greatly to diminish the richness or heating power of the gas. Not all the carbonaceous portion of the fuel is, however, volatilised on such disadvantageous terms; for the water trough at the foot of the grate, absorbing the spare heat from the fire, emits steam through the small holes under the lid; and each cubic foot of steam in traversing the layer of from three to four feet of incandescent fuel is decomposed into a mixture consisting of one cubic foot of hydrogen, and nearly an equal volume of carbonic oxide, with a variable small proportion of carbonic acid. Thus, one cubic foot of steam yields as much inflammable gas as five cubic feet of atmospheric air; but the one operation is dependent upon the other, inasmuch as the passage of air through the fire is attended with the generation of heat, whereas the production of the water gases, as well as the evolution of the hydrocarbons, is carried on at the expense of heat. The generation of steam in the water trough being dependent on the amount of heat in the fire, regulates itself naturally to the requirements, and the total production of combustible gases varies with the admission of air. And since the admission of air into the grate depends in its turn upon the withdrawal of the gases evolved in the producer, the production of the gases is entirely regulated by the demand for them. The production of gas may even be arrested entirely for twelve hours without deranging the producer, which will begin work again as soon as the gas valve of the furnace is reopened, since the mass of fuel and brickwork retain sufficient heat to keep up a dull red heat in the producer during that interval. The gas is, however, of a more uniform