

It must be remembered that the method of working a Mond producer may vary under varying conditions, and that ammonia recovery can only be profitably undertaken on large plants using about 150 tons of fuel per week. Moreover, the excessive use of steam under such conditions involves the production of a gas rich in carbon dioxide and hydrogen, but poor in carbon monoxide, and, for furnace purposes generally, this is not so efficient a gas as one richer in carbon monoxide, and poorer in carbon dioxide and hydrogen.

The composition of producer gas varies with the fuel used, form of producer, amount of steam, etc., the following table giving the composition of gas produced from various fuels:—

Fuel used.	Nitrogen.	Carbonic Oxide.	Carbonic Anhydride.	Hydrogen.
Wood . . . . .	53·2 to 55·5	21·2 to 34·5	11·6 to 22·0	0·7 to 1·3
Charcoal . . . . .	64·9	34·1	0·8	0·2
Peat . . . . .	63·1	22·4	14·0	0·5
Coke . . . . .	64·8	33·8	1·3	0·1

The following table gives typical analyses from the producers considered in this chapter:—

	Siemens.	Wilson.	Mond.
Carbonic oxide . . . . .	24·8	23·4	11·0
Marsh gas . . . . .	2·3	2·9	2·0
Olefiant gas . . . . .	...	0·4	...
Hydrogen . . . . .	8·7	12·0	29·0
Carbonic anhydride . . . . .	4·8	5·1	16·0
Nitrogen . . . . .	59·6	56·2	42·0
Percentage of combustible gas . . . . .	35·8	38·7	42·0

**Water-gas.**<sup>1</sup>—As has already been shown, when steam is decomposed by incandescent carbon, a mixture of hydrogen and carbon monoxide is obtained. This mixture is called water-gas, and has many valuable applications in metallurgical practice.

The reaction is endothermic; and unless heat is supplied from an outside source, the incandescent carbon is rapidly cooled and the reaction ceases. In practice, the gas is made in the following

<sup>1</sup> See *Mineral Industry* for 1900, vol. ix. p. 148.

manner:—An iron cylinder is lined with fire-brick and provided with the necessary apparatus for introducing the coke. When this has been lighted, a current of air is forced in until the mass is brought to a high temperature. The blast is then stopped, the charging aperture is closed, and a jet of steam is passed through the incandescent carbon. The steam is decomposed; its oxygen burns the carbon into carbonic oxide, setting free the hydrogen. The resulting mixture has equal vols. of hydrogen and of carbonic oxide, the weights being as 2 to 28.

There are two distinct modes of procedure for heating up the carbon; in the first, air is blown through as in ordinary gas producer practice, the producer gas thus formed being utilised; the second method is to blow air through under greater pressure, in which case the fuel is completely burnt to carbon dioxide, and about three times the heat developed as in the previous case, whereby the mass of carbon is brought to the incandescent state in a much shorter time. Thus, instead of converting part of the fuel into producer gas, and utilising the heat units contained in this by burning it in another furnace, the whole of the heat units developed from complete combustion of carbon to carbonic dioxide are developed *in situ* in the producer itself, and are thus available for the dissociation of a greater quantity of water and production of a larger quantity of water-gas from a given unit of fuel. This method, devised by Dellwik and Fleischer, has the additional advantage that only one combustible gas is made; as the products of combustion from injecting air, being carbon dioxide and nitrogen, are of no value, they are consequently allowed to escape directly into the air, and the plant is not complicated by having a gas-holder to receive the combustible producer gas produced during the first operation, as in the ordinary process.

Fig. 145 illustrates the latest form of the Dellwik-Fleischer Producer, in which A is the generator, fitted with fire-bars near the bottom, and lined with fire-brick, B is the blast-pipe which admits the air-blast below the fire-grate, C and C' are gas outlets, the upper one, C, being in use when the steam is admitted at the bottom, and the lower one, C', not seen in the sketch, being in use when the steam is admitted at the top; D is the stack for the outlet of waste gases during the heating up with air, this also shows the charging arrangement; E represents the interlocking valve gearing used for reversing the direction of the steam and the water-gas at intervals; F is the steam superheater, from which two conducting pipes enter the generator, one near C and the other near C'; G is the scrubber, through which the water-gas passes on its way to the gas-holder H; I is the blower and engine. In use, the steam is alternately blown in at the top and bottom, the water-gas being drawn off at the bottom or top as the case may be.

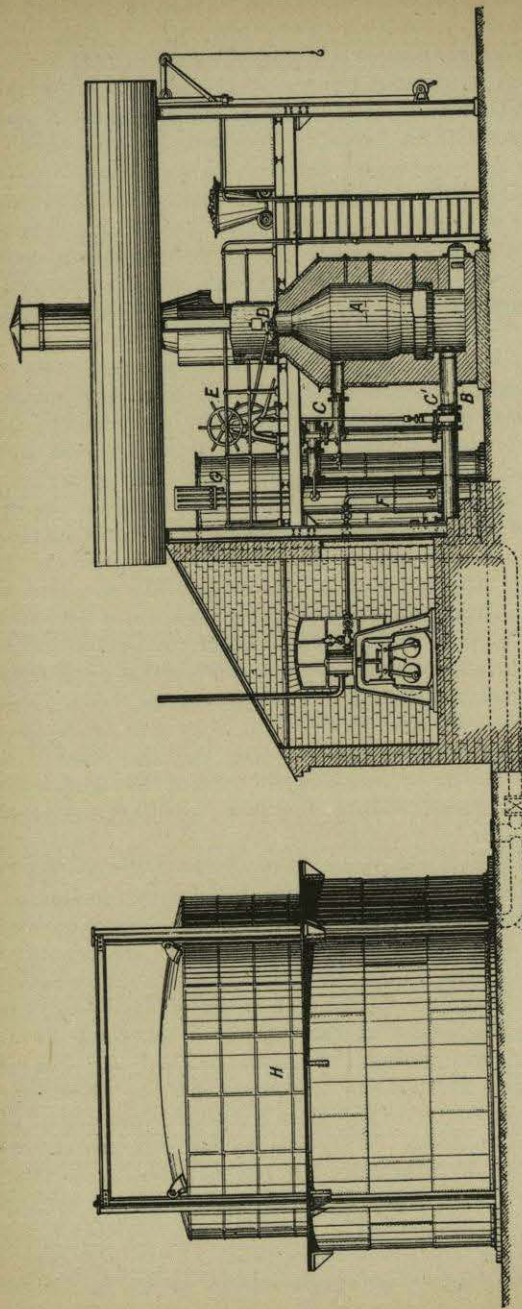


FIG. 145.—The Dellwik-Fleischer Water-Gas Plant. A, generator; B, blast inlet; C, C', gas outlets (the lower, C', behind the blast pipe); D, stack and charging valve; E, interlocking valve; F, steam superheater; G, scrubber; H, gas-holder; I, blower and engine.

Water-gas has approximately the following composition:—

CO	. . . . .	39.6
H	. . . . .	50.8
CH <sub>4</sub>	. . . . .	0.9
CO <sub>2</sub>	. . . . .	4.7
O	. . . . .	0.2
N	. . . . .	3.8

**Blast-furnace Gases.**—In 1814 Aubertot first used the waste gases of blast furnaces for roasting ore, burning lime, and similar purposes, and these gases are now largely used when a very high and uniform temperature is not required. The chief uses are for heating the hot-blast stoves (which are used in turn for pre-heating the blast for the furnaces) for raising steam, and for calcining and roasting ores. The composition of the waste gases varies with the fuel used in the blast furnace, and the following table gives typical examples:—

	N.	CO.	CO <sub>2</sub> .	CH <sub>4</sub> .	H.	C <sub>2</sub> H <sub>4</sub> .
Charcoal . .	59.7-63.4	20.2-29.6	5.9-19.4	0.3-1.0	0.1-0.4	...
Coke . . . .	64.4	34.6	0.9	...	0.1	...
Coal . . . .	56.3	21.5	15.2	4.2	1.0	1.8

It will be noticed that these gases are very similar to poor producer gas, the chief difference being the much smaller percentage of hydrogen. Great strides have been made in recent years in the use of these waste gases in gas engines.<sup>1</sup> The chief difficulty<sup>2</sup> formerly met with was the removal of the dust present, but several successful devices have now been designed, and there is no doubt that a great future lies before the use of the immense quantities of these waste gases annually produced for the direct production of power in gas engines. As the mechanical difficulties with large gas engines have been gradually overcome the size of these has been increased. At many works engines of from 700 to 1000 horse-power are now installed for operating the blowing engines, and where steelworks have a large blast-furnace plant attached the gas produced is more than is required for this purpose; the surplus is used for gas engines to generate electricity at a central station, for use in various ways in connection with the steel plant, in some cases the rolling mills being electrically driven.

<sup>1</sup> *Journ. Iron and Steel Inst.*, 1899, No. 1, p. 130; 1900, No. 1, p. 109; 1901, No. 2, p. 149; 1906, No. 3, pp. 16, 36, 141.

<sup>2</sup> *Journ. Iron and Steel Inst.*, 1905, No. 1, p. 321.