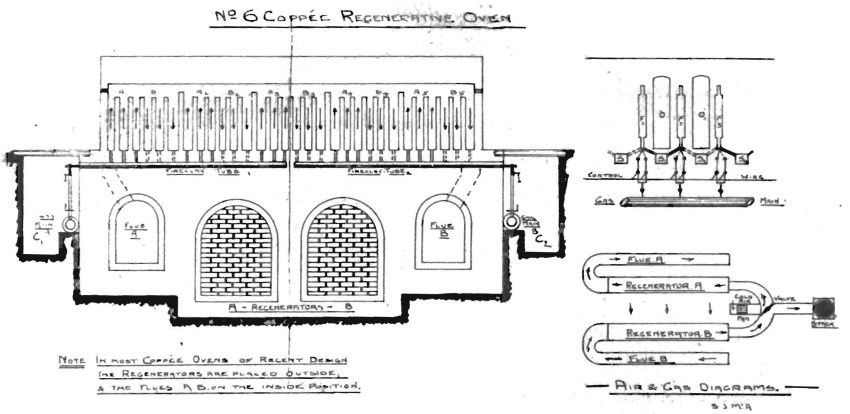
products follow the course of the arrows, then down and back through the sole into the corresponding main flue, the draught of the stack being designed for that purpose.

The small diagram illustrates the method of placing boilers for steam generation on plants of this type.

The Coppee Regenerative Oven.



A glance at accompanying Fig. 6 shows the ovens or coking chambers in the usual form, divided by partition walls containing the vertical heating flues; there being 10 sets of three uptakes, and marked "A," "B," to "A5, B5."

Under each oven there is a sole flue marked "S1, S2," etc., to which the verticals are connected alternately in sets of threes, as marked and shown, and each alternate sole flue is led into flues "A" and "B."

The gases for heating purposes come back in the divided mains "A" and "B" through "C1" and "C2," then up through the smaller tubes and three-way cocks into either one of the two holes through the fireclay distributing tubes or "cornue" bricks, there being two of these special tubes, each supplied with gas from either end, and,

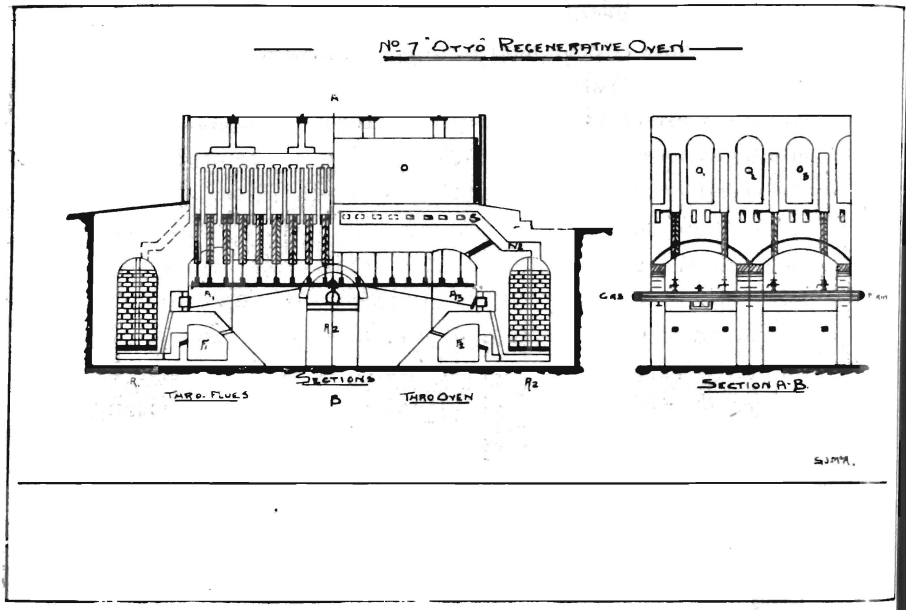
as shown, each three apertures correspond with each alternate set of three heating flues. The air necessary for the combustion of these gases is supplied by a fan, and can be controlled by dampers before admission to the combustion space—with the special cocks set one way the products of combustion pass up the flues "A" to "A5," and down the flues "B" to "B5," and away through the regenerator to the chimney. The system runs as set out by the special diagram, after a half-hour's course over the direction of the arrows as shown, the butterfly valves are reversed, together with the special gas cocks, thereby changing the courses of the gas and air, the valve and gas cocks being all actuated by the one lever action. One special feature of the ovens is the splendid arrangement of the heating flues, whereby each stream of the gases has only to cover one-tenth of the oven walls, whereas in many cases plants are designed where these products are carried a half, and even the full length of the oven, often showing an appreciable difference of temperature between the uptake and downcast flues.

The Fig. illustrating this form of oven shews the regenerators placed in the centre, with the collecting flues on the outside; in recently-designed plants, these positions are generally reversed.

The "Otto" Regenerative Oven.

As shown by Fig. 7, the "Otto" oven superstructure is supported longitudinally by three arches, "A," "A2," and "A3," all running full length of the settings, and transversely, also by arches as illustrated in section "A.B."

Through the gallery "A2" the gas main is conducted, and from this are led two small distributing tubes, to which is connected a burner for each vertical uptake,



these coming up flush with the flue bottoms. The air necessary for the combustion of these gases is drawn through the air ports (placed at definite intervals), up through the regenerators, and "gooseneck" N2, and into sole flues "S," there being two flues, each having ports connecting to half the number of uptakes.

Combustion having taken place, the products are conducted along the inspection flue, then down the verticals in the remaining half of the length, their course is then into and through the regenerator into main flue, either "F" or "F2," and away to the stack.

Like the air intakes, the ports leading from the regenerators into the main flues are at definitely close intervals.

In the waste-heat oven of this name there is only one main flue; naturally the regenerators are dispensed with, and the gas main is placed at the opposite end to the

main flue. On the gas distributing tubes under each side wall are placed the gas burners, but in this case of a bunsen type. The heating gases pass up the verticals along the inspection passage, then down a special flue into the main, and away to stack.

"Koppers" Regenerative Oven.

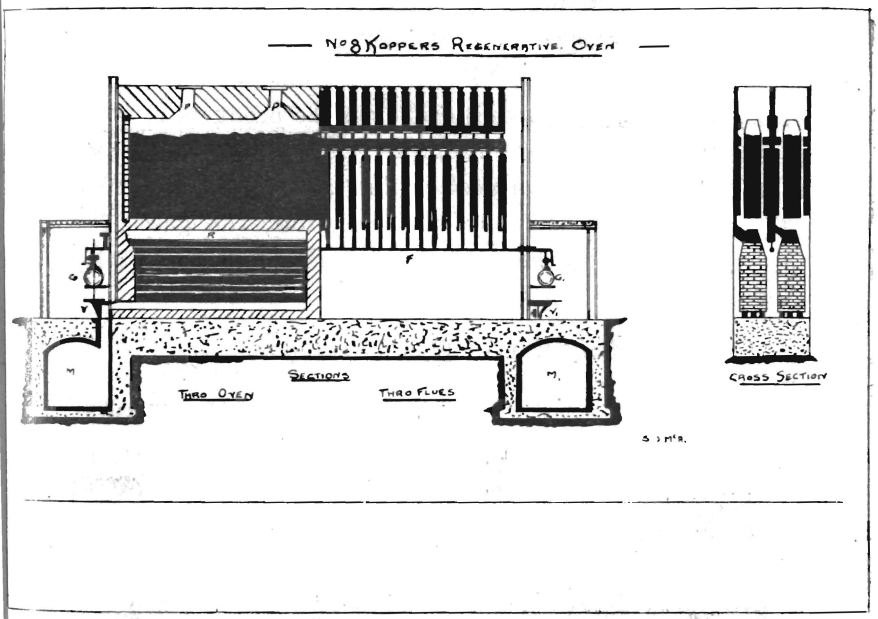


Fig. No. 8 shows the form of the "Koppers" regenerative oven. On first glance its simplicity of construction and the independent regenerator for each oven are points that interest most engineers.

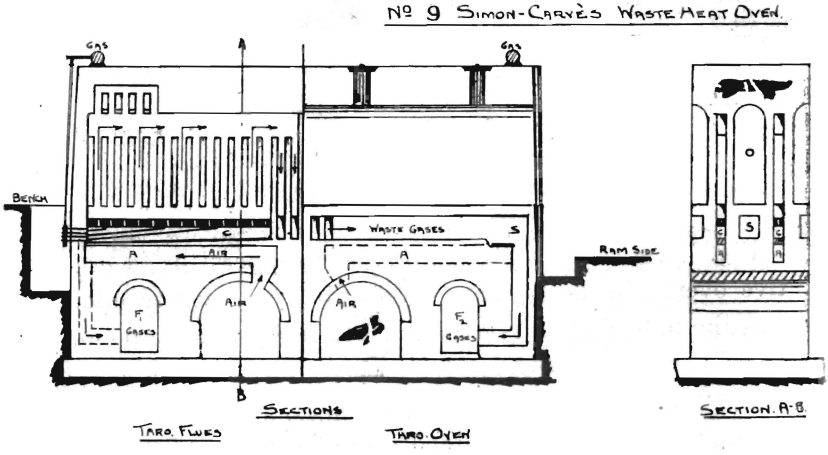
"M" and "M1" show the main flues, and "R" the regenerators, which are divided centrally by a strong partition wall, "G" and "G1" being the gas mains feeding the distributing tubes "F," these leading in turn to their respective uptakes.

The air is admitted by valves "V" or "V1," and leading under and through the regenerators travels by the

ports to points of combustion as shown. The period of combustion is again in this case carried out in half the flues, while the remaining half are carrying off the products of that action into the regenerators; thereby they dispensed with the greater part of their heat before being drawn into main flues "M" or "M1." This reversal system is, as with most of the other types, controlled from one point, either by lever or winch action on the control wires of all valves and dampers.

In the "Kopper" waste-heat oven the products of combustion are drawn up through 26 vertical flues, and passing along the usual inspection flue, are carried down by two large downcasts into the main flue, the gases for combustion hvaing been supplied at the opposite end by bunsens.

Simon-Carves Waste-Heat Oven.



In the Simon-Carves waste-heat oven the gases from the by-product plant are led back for oven heating purposes by the two gas mains, as shown on the section. They are led off from this main by smaller tubes into the chamber "C," which is divided into four separate ports,

each supplying three or four of the heating flues. The necessary air is drawn in through the galleries, and passes through the small passage "A" to the combustion chambers "C," the products then pass in an upward direction, heating the oven walls, along the top inspection flue to the two downcomers, from where they are led into the sole flues, shown as "S," and passing through the main flues "F1" or "F2," are drawn to the stack, this action being the same on either side of the partition wall; thus showing that the gases are not asked to do extra duty in passing from one extreme end to the other, this being practically the same merit shown in the case of the Coppee types.

The "Simon-Carves" regenerator is a type largely used. In general principle it varies very little from the "W-H" oven of that name, the air galleries becoming regenerators, and with the usual reversal of air and gases for recuperation purposes.

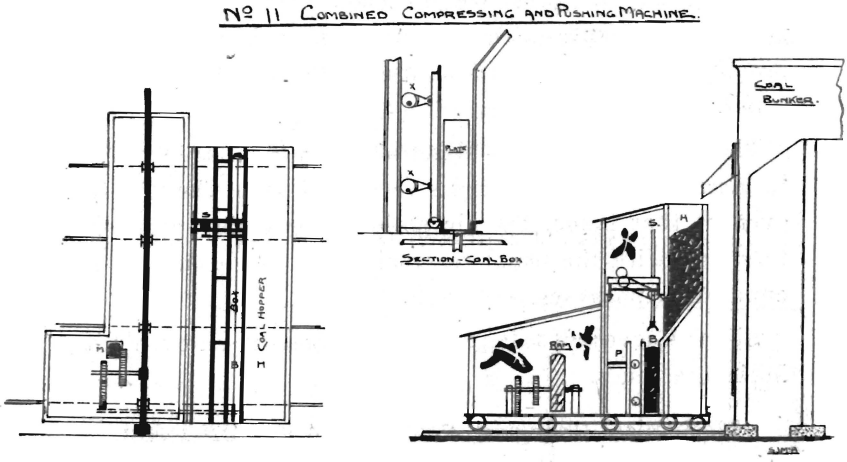
Simon-Carves also designed and construct an oven with horizontal flues.

Mechanical Charging, Pushing and Gas Off-Takes.

Fig. 10 not illustrated.

Almost invariably the coals for coking on English plants are dumped by mechanical tipplers into large underground boots, generally two in number, the first feeding the "carr" disintegrator, as shewn by Fig. 10. The crushing of coal by this machine is almost universal; its construction is simple, as shewn by cross section, there being four separate diameters of circular or square bars. The first and third of these run in a clockwise direction, and the second and fourth contra clockwise, each being driven by drive belts off their respective pulleys, "P1" and "P2." "B1" and "B2" being used purely for balancing effect. The coal coming in through a shute as illustrated,

falls on to the bars below, and the fact that they are travelling at 6000 feet per minute, and each set in an opposite direction, disintegrates the coal thoroughly, bringing it down to the required gauge of 3-16in. to 0in. Passing out the outlet into the elevator boot, the coal is picked up and lifted to the overhead bunkers, these being designed with sufficient headroom to permit the charging lorries to come under and fill their hoppers. (See Fig. 11.)



According to the requirements of the coke, and the nature of the coals in use, it is sometimes found necessary to form the whole charge into a solid block by ramming.

Fig. 11 shews diagramatically the machine for the purpose, H being the hopper, carrying several charges of coal. From H it is permitted to fill the ramming box B, which, when filled, is strongly compressed by the stamper or rammer S. On the completion of this operation, the eccentrics X-X are operated, thus drawing the side away, and giving sufficient clearance to permit the solid mass of coal to be hauled by means of steel rope and plates into the oven chamber.

After the coking period is completed, the same machine can discharge the oven, this time using the ram. The ram-head is a solid steel casting, and is attached to a long H section bar of strong type, and on the top side of it will be found a rack, into which is fitted a driving pinion driven through gearing from the motor M. The stamper S is also mechanically driven, in some cases hydraulically, and at others electrically, with a friction action.

Fig. 12 illustrates another method of charging ovens—that being the electric lorry. This machine is capable of carrying the full load of the oven, and by means of coal valves corresponding to the feeding holes H1, H2, H3. H4, the whole charge can be poured in quickly. For this operation both oven doors must be in position, and upon the coal reaching its approximate height, the leveller bar is inserted through the special doors contained within the oven door, and working backwards and forwards, levels the charge to its requisite height. This machine again has the ram attached for pushing the coke, and its cantilever arm, as shown, performs the duty of raising the oven doors on the ram side; the doors on the bench side are lifted and held up while "pushing" by the winch, as shown. The gases resultant from carbonization lead along the space between the coal charge and the soffit of the arch, then up through O to the ascension pipes, which conducts them to a common passage of light steel construction, known as the foul main, from where they are extracted by the exhauster vacuum.

Fig. 13 shews the method of ordinary hand lorry or "dandy" charging, T1, T2, T3 feeding their coal loads through H1, H2, H3 into oven.

The placing of the ascension pipe or gas uptake in this instance permits of two oven door winches, but only allows of three sets of tub rails.

One feature I have introduced in this diagram is the multiple main system, allowing in the case of B, the fume main, for the very early gases to be drawn away immediately to the stack. Some English districts compel the use of the idea.

"C" is the oven gas main which comes into operation in the extreme early and late periods of carbonization, and it conducts the gases to the benzol and ammonia plants, and they are then used for oven-heating purposes.

"D," the gas-lighting main, draws off the gas from the middle period. This portion of the gases is only put through the tar and ammonia extraction plant, thus leaving in the gas hydro-carbons that are high in illuminating values.

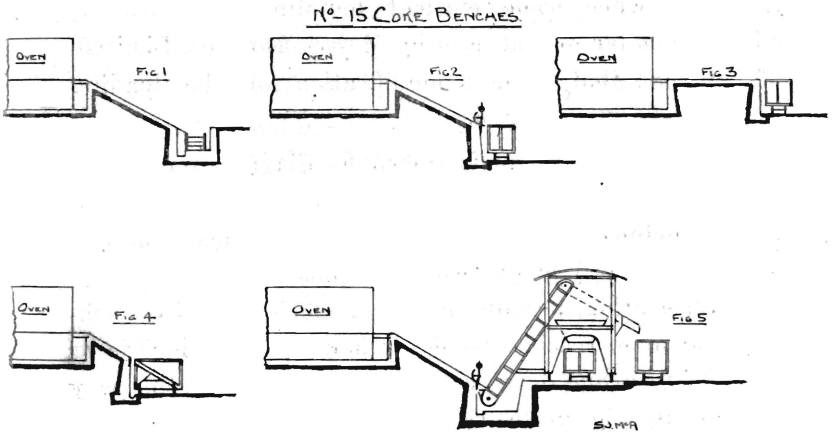
The above system is a favourite Continental type for works that are distributing rich gas for special lighting purposes.

Coke Quenching.

In Australia, most of the oven benches being horizontal, the hot coke is pushed out on to the paved floor and quenched by means of an ordinary hose pipe, and the incandescent coke thus served suffers greatly from oxidation before being thoroughly quenched, often giving rise to a dark colour in the product. Another unfortunate practice is the quenching of the coke inside the oven. The practice in the United Kingdom, where almost all benches are inclined, is to push the mass through a quencher similar in most cases to the photo., Fig. 14. In the use of this apparatus it is obvious that little air can gain access to the coke, owing to the side plates, and while in this position a thorough drenching takes place from water issuing from the perforations in the side and top tubes, at a pressure of about 60lbs. per square inch, and with care and thorough handling of the water and hood it

is possible to obtain coke equal in appearance to the best beehive product.

The Coke Oven Bench.



The coke bench plays a very important part in the efficient working of a modern plant.

On the attached sketch will be found five figures, each showing a different method. The type best adaptable can only be chosen on site conditions.

Fig. 1 illustrates a method very frequently used on plants situated on blast furnace sites, where the conveyor shown in the trough at the foot of the incline bench is kept running during "pushing" periods, and conveys the coke with one handling straight into the furnace hoppers.

Fig. 2 depicts a favourite English method, where the coke product has to be conducted some distance. At the foot of the incline will be noticed a retaining gate, the length of which may be equal to the length of the waggon. On the lifting of this gate the coke gravitates into the truck, or, as the author has seen, blast furnace buckets.

In Fig. 3 we have a method very seldom seen on modern oven structures, and never in Australia, except in two

cases. From a quenching and handling viewpoint this type carries serious disadvantages, but where a specially picked product is required, it is really to advantage, and then only when some efficient handling apparatus is adopted similar to that used by Messrs. Hoskins, Limited, of Lithgow, that being a modification of the loading machine shewn on Fig. 5.

The coke car system is shewn by diagram on Fig. 4. The truck or car bottom is set at an angle corresponding to the inclined bench (almost always 27 deg.), and is designed to carry about two oven "pushings." Its structure, all grating, permits of a very efficient final quenching, and upon receiving same is hauled up an incline or elevator to a high-level waggon station, and in this way minimising shunting work.

The loading machine shewn on Fig. 5 is largely used on the Continent, the original makers, Coppee Ltd., claiming some extraordinarily low working costs with its use.

Photo. 15A will shew better details.

Recovery of Coal By-Products.

This section of the paper could be extended indefinitely, the subject being of such importance that the author wonders at his audacity in attempting to prune his notes into such a concise form, and at the same time present a subject of general interest. Perusal of the leading gas journals of both England and America will prove the enormous possibilities and subjects underlying the above heading.

To shew the general retention of products, and the further rectification for the intermediates, the introduction of Table 4 will serve in a general sense to shew the results gained and the everyday uses of the products.

TABLE No. 4.

Coal and its Products.

Product.	Fractionated to—	Upon further Fractionation.	Commercial Uses.
Gas	Waste heat ...	...	Steam Power
			,, ,,
	Surplus Gas ...	...	Gas Engines
			,, Lighting
Tar	Dehydrated Tar	...	Macadam, Paints
	Ammoniacal liq.	...	See Ammonia
	Light Oils ...	Crude Benzol ..	See Benzol
	Middle Oils ..	Carbolic Acid-	Disinfectants, Dyes
		Piric Acid ...	& Explosives, Drugs (Aspirin, phenacetine)
		Cresylic Acid ...	Disinfectants
		Napthaline ..	Dyes, Explosives
	Heavy Oils ...	Creosote Oil ...	Preservative, Fuel Oil
		Napthaline ...	Dyes, Explosives
		Anthracene Oil	Lubricants
		Anthracene ...	Alizaren Dyes
	Pitch	...	Fuel Briquettes
			Paints and Varnish
Ammonia ...	Sulphate of Am-	...	Fertilisers
	Am. Chloride ...	Am. Carbonate	
	Concentrated	,, Chloride ...	
	liquor ...	Liquid Ammonia	Refrigeration
		Am. Nitrate ...	Explosives and Fertilisers
Crude Benzol	Washed benzol	Pure benzene ...	Nitro-benzenes, Explosives, Aniline Dyes, Perfumes, Drugs.
		Motor Spirit ...	
	Washed Toluol	Pure Toluol ...	Explosives, Toluol Dyes, Drugs (Saccharine)
	Solvent Naptha	...	Grease Extraction
	Washed Xylol...		Rubber Solvent
Sulphur Compounds ...	Sulphide Iron...	Sulphuric Acid	Sulphuric Acid
	Sulphur ...		Ammonium Sulphate
Cyanogen Compounds ...	Prussian Blue...	Pottasium Cyanide ...	

On most coals, if at all capable of being coked, and considering them equal, the question of Recovery v. Non-recovery is not fraught with many great difficulties.

Mr. Ernest Bury, M.Sc., of Skinningrove Steel Works, Durham, shews a fine example when quoting a case where