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GERMAN GRAPHITISING FURNACES AT MEITINGEN

(Siemens Plania)

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BRITISH INTELLIGENCE OBJECTIVES SUB-COMMITTEE

LONDON—H.M. STATIONERY OFFICE

GERMAN GRAPHITISING FURNACES AT MEITINGEN (SIEMENS PLANIA).

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PERSONNEL OF TEAM.

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1. OBJECT OF VISIT.

The Siemens Plania Graphitising Factory at Meitingen (Bavaria), which is 18 Km. North of Augsburg on the road to Donauwörth, was visited on 18th September, 1945. It is normally concerned solely with the graphitising of amorphous carbons from Siemens Plania's Carbon Factories (and on occasions from Griesheim I.G.F.), and the subsequent machining operations.

2. INTRODUCTION.

The target was included in the list for the Team inspecting Aluminium Reduction Factories, in the belief that amorphous carbons used in that industry were made there. It was found that, in fact, Meitingen only graphitised, and that their sole connection with the aluminium industry lay in the supply of the circular cathodes used for the super-purity aluminium furnaces operating on the three-layer process, and on rare occasions also of some rectangular blocks for the ordinary reduction furnace cathodes.

The members of this Team did not feel themselves qualified to undertake a critical investigation of the graphitising process, but as they were on the spot they took the opportunity to make a fairly brief inspection of the Factory and to obtain some details of furnace construction and operation. We did not inspect the machining shop.

No graphitising was being carried out at the time of the visit, but a start had just been made, on instructions from the Occupying Authorities, with some jobbing work in their machine shops.

3. PERSONNEL INTERVIEWED.

Dr. Minstring (Manager); Herr Gerhard (Production Superintendent); Dr. Hubmann (Electrical Engineer).

4. BOMB DAMAGE.

There was no damage whatever from bombing. (It may be worth mentioning here that this was the only Factory we had seen where foreign workers had not at the time of the collapse broken out into an orgy of petty damage and looting. There had been no damage either by military operations or personnel).

5. GENERAL DESCRIPTION OF FACTORY.

Meitingen was chosen for its proximity to the new Lech Hydro-electric Station. At that time power development was apparently ahead of consumption, and tariffs described as "favourable" were being offered to attract orders. It appeared that later, when the demands for power grew, the tariffs hardened considerably, and the Management complained about the prices they had to pay for power for their latest extensions.

The Works were first built in 1926 with small furnaces of 12-ton capacity, giving an annual production of 6,000 tons. Progressive additions were made, so that by 1939 the output was 10,000 tons. During the war there were further extensions, though the full programme was not completed at the time of the collapse. The output planned was 25,000 tons per annum; the peak rate reached was 15,000 tons per annum. The latest developments used furnaces with a capacity of 60 tons, taking up to 7,500 KW. each.

The great bulk of their production went to the steel industry, which explains their expansion in recent years. The largest size of carbon which they graphitise was given as 500 mm. square, i.e. about 20", but we cannot see why there should be this limit, and this may refer to their capacity for machining operations afterwards.

We did not study the lay-out of the Works, but there is plenty of room, with good access. In addition to the Furnace Houses, there was a Machine Shop for turning and threading finished electrodes. We did not visit this, nor did we visit the Laboratory.

6. POWER SUPPLY.

Power comes in at 11,000 volts from the Lech Power Station. There is also a connection to the Grid. The total consumption at the Factory was given as 9,000,000 KWH. per month. There are a number of individual transformers, and each of the large furnaces has one to itself. These operate from a single phase, to deliver up to 50,000 amps at 50/150 volts, with 32 tappings for regulation. The nature of the process calls for careful juggling to balance the demand on the three phases, which can only be done by operating several furnaces simultaneously.

7. FURNACE DETAILS.

(a). General Construction. The details of their latest furnaces are indicated in the attached diagrammatic sketch. They are installed in a building about 200' long x 90' wide, composed of one main central Bay and an Annexe at either side. The furnaces are arranged at right angles to the length of the building, off-centre, so that one end of a furnace is close to the wall of an Annexe, and there is a wide gangway down past the other end. They are served by a heavy overhead crane. There are about 12 furnaces.

The furnace proper consists of two end walls, and a floor built up in a pit to the level of the shop floor.

The end walls are built of fire-brick 7' high, 12' wide, and about 3' thick. There is a clear space between them of about 60', which is the effective length of the furnace. These end walls are reinforced with buck-stays. They are pierced by six square graphite conductors of 300 mm. (say, 12") side, which project into the furnace for a distance measured at 32 cm. (12"), and outwards a somewhat smaller distance. These six conductors are arranged in two columns of three at a distance between centres of about 7', though this was not measured exactly.

Contact at the outside is made through side plates of copper held by hollow water-cooled clamp plates, with a hollow bolt through each electrode to pull up the connections. These bolts are water-cooled. Water connections are by rubber tubing, the three electrodes at each side being in series.

This arrangement is repeated at the other end of the furnace, so that there are six carbons leading in and six leading out.

The current is supplied through aluminium conductors feeding the carbons at either end. At one end the lead out to the transformers is short, but that from the other has to traverse the length of the furnace. The traverse is made through aluminium conductors made in channel section. There are nine for the lead each side, supported on insulated stands, and the whole can readily be dismantled when the furnace is being charged or discharged. These conductors are arranged to cross each other so as to ensure even distribution of the current between them.

As an experiment, they have varied the construction of some of their end walls and incorporated for the greater part of the inner face graphite slabs instead of fire-brick.

These graphite slabs have a depth of about 1' each. We were told that there was a backing of graphite powder for another foot, leaving a foot of the ordinary outside fire-brick. We were told that this experiment was very successful.

A lot of emphasis was laid on the construction of the floor of the furnace. This was made by excavating a pit, about 4' deep and 15' wide for the full length of 60' between walls, in the Furnace Room floor. This pit is built up with fire-bricks to a depth of about ten courses and also lined with about 18" of fire-brick, so that at this stage of construction there is a "bath" in the floor about 18" deep and of the same width as the end walls. A layer of about 2" of sawdust is laid on this. They use this material quite a lot, and say that it has the virtue of minimising sticking. By this we take it that the charcoal formed and left by coking forms a useful physical separation between the fire-brick and the packing powder which follows. Above the sawdust there is a layer of about 12" of pulverised carborundum (q.v.), and on this again about 8" of their packing powder (q.v.).

The bed thus formed is, after settlement and the first heating, roughly level with the floor of the building, but after several rounds growth and distortion affect it. The bottom needs partial or full renewal every two or three years.

This bottom and the end walls really constitute the only permanent parts of the furnace.

The charge of carbons to be graphitised is built up in layers on this prepared bottom for the full length between the walls, with fillings of packing powder. When the greater part of the charge has been built, side walls formed of heavy buttresses of a special concrete carborundum heat-resisting mixture, which they make themselves, are placed along both sides. These buttresses have cast-in eyes at the top to facilitate cranage. It was pointed out that at the temperatures reached in the furnaces, given as 3,000°C., the packing flows like water, but that when cooling starts, after power has been switched off, it binds again so that the furnace side walls can be removed to increase cooling.

When the charge has been built up to the top of the side walls, the furnace is covered with slabs of rough carborundum. (Reference to this material is made later in this Report).

The above describes the construction of their large 60-ton furnaces. The older, smaller ones are built in a generally similar fashion. They were described as having a capacity of 10 to 15 tons.

(b). Packing Powder. Their special packing powder is a prominent feature in the construction and operation of their furnaces. It consists of coke, sawdust, quartz-sand, and graphite.

Gas coke is used - ash content immaterial. It is ground to about 15/20 mm. maximum size in a jaw-crusher; very roughly dried, when necessary, in a coal-fired "Didier" vertical furnace; further crushed in a roll-crusher to 5 mm. maximum; and then bunkered. Other bunkers contain an ordinary quartz-sand, and sawdust, whose anti-sticking virtues were again emphasised when the packing-powder plant was being inspected. These three ingredients are mixed in a simple "Draise" mixer consisting of a horizontal pan with a vertical axis, in the proportion, by weight, of about 90% coke; 5% sand; and 5% sawdust. We were told that if too much sand is used the mixture binds; if too little is used the "walls collapse", i.e. presumably, the mix does not bind at all when heated.

To secure conductivity at the start of each cycle, graphite is added to the packing powder. This graphite is obtained from scrap, turnings, etc. The proportion added varies from 1:3 up to 1:1 according to the size of the articles to be graphitised. They told us that small articles need more graphite in their packing powder than large ones, and that for very small articles indeed they use 100% graphite dust for their packing powder. This graphite is mixed with the other three ingredients in the same "Draise" mixer.

In the Furnace Room the packing powder is at present handled by grab. There was a suction plant, which, they say, had worked well, but during the war they were unable to obtain spare parts and had had to abandon its use.

(c). Carborundum. Mention has already been made of carborundum. This we understand as a rather loose description of the product that is obtained when the packing powder has been through the furnace cycle two or three times. There will obviously be pretty heavy oxidation of the carbon, and the presence of the silica will explain the formation of an impure carborundum.

In effect, it can be said that the silicon in the packing powder remains as the coke is being consumed. The actual consumption of coke seems to be fairly heavy, as their formal Return to the Military Government shows the need of about 500 tons of "mine coke" to match 1,500 tons of raw electrodes, i.e. a consumption of about 33%.

Big lumps of carborundum, when they cannot be used for the covers to the furnaces already mentioned, are broken up and re-ground in a special hammer mill to bean size, for use in rebuilding the furnace bottoms.

8. <u>OPERATION OF FURNACE.</u>

(a). <u>Load characteristics</u>. We were told that the cycle from cold to cold - i.e. empty to empty - is about ten days.

When the furnace charge has been built up and covered, as already described, and the bus-bar connections made good, a load of 1,200 KW. is applied. During the first nine hours this load is increased to 2,000 KW., and then from hour to hour in steps of 200/300 KW. to build up to a total of 7,500 KW.

The total time under power was given as from 40/70 hours, depending on the size and quality of the carbons to be graphitised. (This is for the large furnace. The graphitising time for the small ones was given as 12/20 hours).

We were told also that the total energy consumption was as follows:-

For the old small furnaces pre-war, working on "good material" ... ... 3.5 KWH per Kg.
-do- -do- -do- using "poor material" ... ...6.5 KWH per Kg.
For the new modern furnaces, working, of course, on present-day "poor material" ... ... 5.0 KWH per Kg.

We were not able to ascertain how they determine when graphitising is complete, but, in view of the temperatures reached and the impossibility of getting samples, it must be an empirical question decided by experience. The main concern, of course, when power is switched off, is to cool the furnace down as quickly as possible without undue oxidation. (They do not appear to have any particular cooling fans, but allow for natural convection through the roof, assisted by the earliest possible removal of the side walls of the furnaces).

Frequent reference was made to "good material" and "poor material". By this was implied material which graphitised easily, and therefore did not take an undue amount of power, as opposed to material which took a lot of power to graphitise it. It was clear that during the war the electrodes which they received had been made from raw materials which were less easy to graphitise. We did not hear of any scientific expert at Meitingen with whom to discuss this question, and we have an idea that the science of the process was concentrated at the Siemens Plania Head Office, and that the Management at Meitingen were the practical people. During a conversation with Dr. Hubmann we mentioned the effect of iron or other catalyst in minute quantities on speeding up graphitisation. He agreed to that, but implied that it was not a matter on which they had much knowledge. They just had to do the best they could with the carbons which they received.

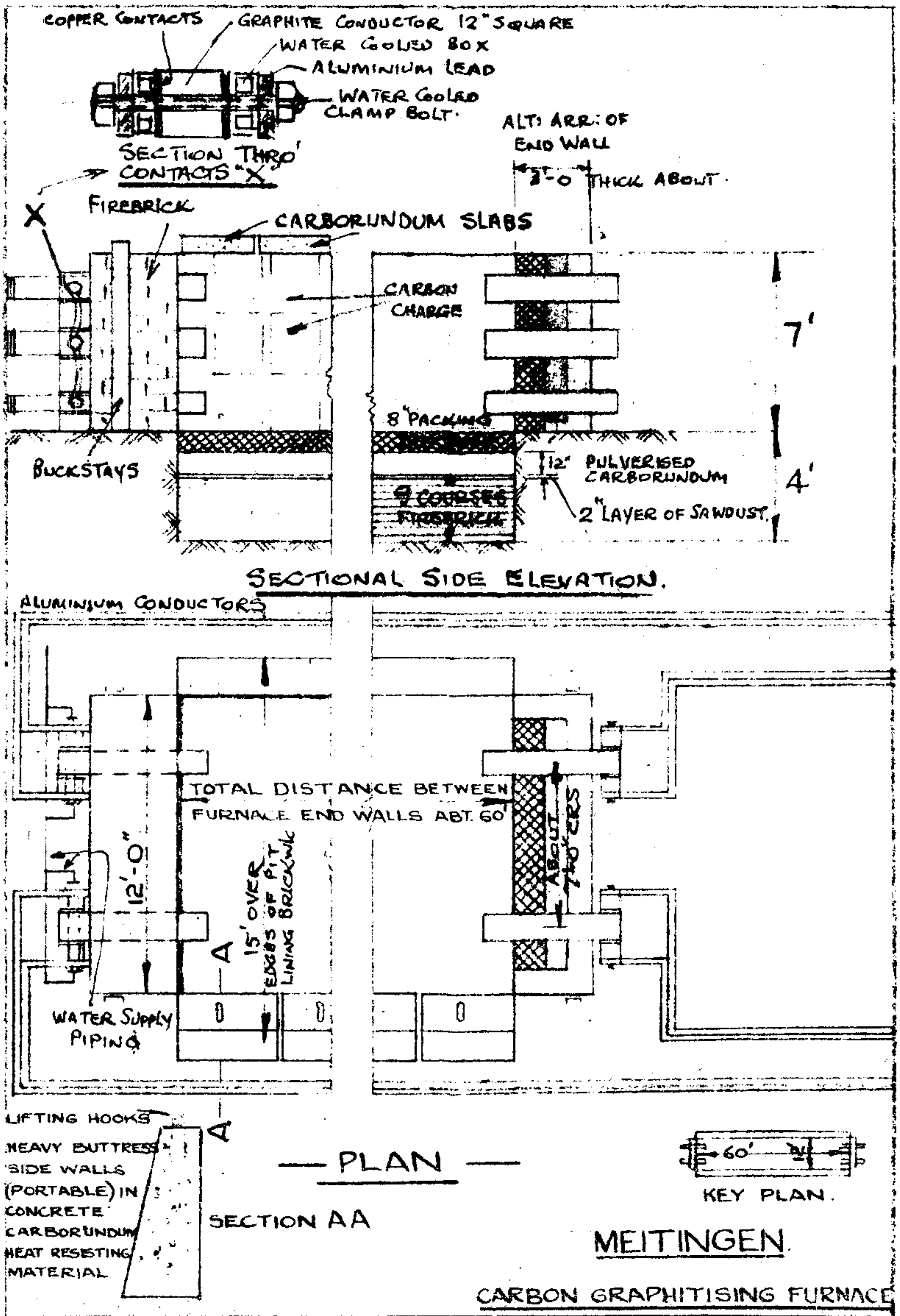
(b). Labour. The total labour employed at the Works, including administration, was 350. The great majority of these were paid on piece-work.

Basic wages had not altered since before the war, the prices of materials having been controlled by the Reich to prevent justification for wage increases. At the beginning of the war continuous shift work, which had previously called for 48 hours per week, was put up to 56, the change-overs being achieved on Sundays by 12-hour shifts for two Sundays out of three.

As far as Meitingen was concerned, this applied only to Power House Attendants and the like, since the bulk of the work was done during the day under piece-work conditions. The average earnings of piece-workers were given as 50 M. per week. At Meitingen, as at other places, there seems to have been far less of a differential for specialised jobs, and the chief attraction to people engaged on heavy and hot jobs seems to have been the privilege of buying increased rations. It was freely admitted that the work of charging and discharging furnaces was extremely hot, arduous, and dirty. They had about 100 Russian P.O.W.'s on this work. They were all Officers from a nearby camp.

(c). Costs. We were told that the cost of graphitising was 25/40 M. per 100 Kg., depending upon the size. This excluded machining costs and covered only the graphitising.

When the Factory was first built power was charged at 1.5 Pf. per KWH., which they considered good. Although they had long-term contracts for this, these did not cover the extensions, for which the tariff was progressively increased, and at the time of the shut-down the average cost for power over the Factory had risen to "between 2.5 and 2.8 Pf. per KWH". On the power consumption already calculated, the cost of power per 100 Kg. would come to 10/14 M.


COPPER CONTACTS
GRAPHITE CONDUCTOR 12" SQUARE
WATER COOLED BOX
ALUMINIUM LEAD
WATER COOLED CLAMP BOLT.
SECTION THRO' CONTACTS "X"
ALT: ARR: OF END WALL
3'-0" THICK ABOUT
X
FIREBRICK
CARBORUNDUM SLABS
CARBON CHARGE
7'
8" PACKING
BUCKSTAYS
12" PULVERISED CARBORUNDUM
4'
9 COURSES FIREBRICK
2" LAYER OF SAWDUST.
SECTIONAL SIDE ELEVATION.
ALUMINIUM CONDUCTORS
TOTAL DISTANCE BETWEEN FURNACE END WALLS ABT. 60'
12'-0"
15' OVER EDGES OF PIT LINING BRICKWK
ABOUT 7'-0" CRS
A
WATER SUPPLY PIPING
LIFTING HOOKS
HEAVY BUTTRESS
SIDE WALLS (PORTABLE) IN CONCRETE
CARBORUNDUM HEAT RESISTING MATERIAL
A
SECTION AA
PLAN
60'
KEY PLAN.
MEITINGEN.
CARBON GRAPHITISING FURNACE