B. Butterworth .

B.I.O.S. FINAL REPORT No. 473

ITEM No. 22

THE MANUFACTURE OF HEAVY CLAY PRODUCTS IN GERMANY

BRITISH INTELLIGENCE OBJECTIVES

SUB-COMMITTEE

LONDON—H.M. STATIONERY OFFICE

THE MANUFACTURE OF HEAVY CLAY PRODUCTS IN GERMANY

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THE MANUFACTURE OF HEAVY CLAY PRODUCTS IN GERMANY.

INTRODUCTION.

1. The mission's field of interest was understood to be the manufacture of heavy clay productions for use in building, including the design of clayworking machinery and the design and quality of products. The terms of reference were to make an exploratory survey of possible sources of information - works, institutions or individuals - with a view to determining whether such targets might usefully be examined in detail at a later date. An endeavour was therefore made to reach as many targets as possible in the time available, and inspections were confined to essentials in each case.

2. The following 22 targets were visited between 13th and 28th August, 1945:-

CLAYWORKS.

1.	Schütte A.G., Heisterholz, nr. Petershagen, Westphalia.	Roofing tiles.
2.	Vereinigte Burscheid-Hilgener Ziegel-und Klinker-Werke,G.m.b.H. Hilgen, nr. Düsseldorf.	Klinker and common bricks.
3.	Didierwerke A.G., Nieder Dollendorf, nr.Bonn.	Refractories.
4.	Jakob Kalscheuer G.m.b.H., Frechen, nr. Cologne.	Salt-glazed stoneware pipes.
5.	Servais - Werke A.G., Witterschlick, nr.Bonn.	Klinker floor-tiles, glazed wall-tiles and refractories. (At time of visit roofing tiles only).
6.	Rheinische Chamotte & Dinaswerke, Mehlem, nr.Bonn.	Refractories.
7.	Westdeutsche Ziegelwerke A.G., Rödelheim, Frankfurt-on-Main.	Common and facing bricks and hollow blocks.

22/2844	8.	Deutsche Steinzeugwarenfabrik, Friedrichsfeld, Mannheim.	Salt-glazed stoneware pipes, chemical stoneware and agricultural drain-pipes.
22/3245	9.	Tonwarenindustrie Wiesloch A.G., Wiesloch, Baden.	Roofing tiles, common bricks and hollow blocks.
22/3246	10.	Ziegelwerke Mühlacker K.G.a.A., Mühlacker, Württemburg.	Roofing tiles and common bricks.
22/3247	11.	Ziegelwerke Ludwigsburg A.G., Ludwigsburg, Württemburg.	Roofing tiles.
22/3248	12.	Wilhelm Gail'sche Tonwerke A.G., Giessen, Hesse.	Klinker and acid-resisting bricks and tiles and glazed wall-tiles and blocks.
22/705a	13.	Dachziegelwerke Ergoldsbach A.G., Ergoldsbach, Bavaria.	Roofing tiles and building bricks.
22/705	14.	Dachziegelwerke Ergoldsbach A.G., Neufahrn, Bavaria.	Roofing tiles and drain tiles.
22/3249	15.	Dampfziegelei Hans Adam, Argelsried, nr. Munich.	Common bricks (perforated).
22/3250	16.	Aktien-Ziegelei München, Unterföhring, nr. Munich.	Common and klinker bricks and klinker wall and floor tiles.

CLAYWORKING MACHINERY WORKS.

22/744	17.	Eisen-und Hartgusswerk Concordia G.m.b.H., Hameln (on the Weser)	Grinding and extrusion machinery and machinery for other industries.
22/1527	18.	C.Keller & Co., Laggenbeck, Westphalia.	Cutting-off, conveying and drying systems.
22/1526	19.	Berger & Co. G.m.b.H., Bergisch Gladbach, nr. Cologne.	Grinding, mixing, pressing and cutting-off plant and machinery for other industries.

GENERAL IMPRESSIONS.

5. Full data on the German heavy clay industry are not available, and it is not certain, therefore, that the clayworks seen were representative of either average or best practice in the country. There was evidence, however, in several cases (e.g. Nos.1, 4, 7 and 13) that the works inspected was the largest and most modern of a local group, and it was apparent in other cases that products of the very highest quality were being, or could be, made (e.g. Nos. 1, 5, 8 and 12). In the case of Nos.9 and 10 it is known that the control lies in the hands of Ludowici, whose works at Jockgrim * is understood to be an outstanding example of roofing-tile production by modern mechanised methods. It is felt, therefore, that while possibly all the most modern examples were not included, a reasonable number of works employing average to good German practice were seen.

6. The outstanding impression obtained was that a German clayworks is designed at the outset to a plan, for a definite output, and for a particular method of operation, and that it is housed in a substantial permanent building with all parts under cover and with convenient circulation and access provided. Where additions to the buildings are necessary they are generally carried out in harmony with the original plan.

7. The amount of mechanical conveyance employed was also found to be outstanding. Belt or trough conveyors were used for the clay, and mono-rail or Keller systems for the green articles. Small four-wheel bogies running on the rails laid down around the kiln for the Keller system were often used for drawing. The general impression was of capital willingly expended in the economy of labour.

8. The fundamental difference from British practice, however, which affected both layout and mechanisation, was that drying was carried out in multi-storey buildings over the kilns. This was found to be the general practice in the works visited, which were up to 50 years old, but there was evidence that in the most modern German practice Keller dryers at ground level were preferred.

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* This works is described in Musterbetriebe Deutscher Wirtschaft Dachziegel-und-Hohlstein-Industrie Carl Ludowici, K.G. a.A., Falzziegelwerke Jockgrim (Rheinpfalz) published by J.J.Arnd, Leipzig, C.1.

20.	Karl Händle & Söhne Muhlacker, Württemburg.	A wide range of plant for clayworking.

MISCELLANEOUS.

21.	H. Moeller A.G., Unna, nr. Dortmund.	Manufacturers of electric switch-gear, including ceramic parts.
22.	Fritz Scheibler, 187, Koenigstrasse, Wuppertal (Elberfeld.)	Expert on kieselguhr and its use in filters and filter-aid.

3. In Appendix II these targets are described individually in so far as they come within the team's scope. Targets 3, 6, 21 and 22 proved to be outside the team's field altogether. They are not described further in this report, but such information as was obtained from them has been passed separately to the appropriate authorities.

4. The targets actually visited constitute a final selection from a much larger number considered by the team in planning its itinerary. Many were eliminated at the outset because they could clearly not be covered in a tour of two or three weeks and because they appeared to be the least promising. Three targets had to be abandoned during the tour because they could not be located, and several others because the difficulties and delays in arranging transport made it impossible to reach them. It was particularly regretted that the team was not able, for this last reason, to enter the French zone, where it was intended to visit, amongst others, the Ludowici tile works at Jockgrim. The team did not enter the Russian zone.

9. A further notable point was that in many of the works visited the clay was very thoroughly prepared and unusually large storage accommodation was provided for souring.

10. Keller cutting-off and handling plants were almost universal in the works visited. These machines are probably unique in design and finish, but they are well-known outside Germany and do not call for further comment at this stage. The general finish of the other examples of German clayworking machinery seen appeared to be excellent.

11. The great majority of roofing tiles seen in Germany were single-lap clay tiles. Both single and double-roll patterns were common All the plain tiles seen were flat, without camber, and larger than our standard plain tiles. Both single-lap and plain tiles were mainly of uniform red colour, and no multi-coloured, sanded, or coloured sanded tiles of the types known in this country were observed. The types of tile made probably had some bearing on the consistent use of continuous kilns, mainly zig-zag, at the works visited.

RECOMMENDATIONS

12. It is strongly recommended that British clayworking machinery manufacturers should have an opportunity of sending representatives to study German plant. From the inspections made it is thought that the works of Keller (No.18), Berger (No.19) and Händle (No.20) would prove of considerable interest as would those of some other machinery makers whose products were seen in use. The names of these makers, and descriptions of the points to which attention is particularly drawn in connection with plant generally, are given in the sections which follow and summarised in Appendix I.

13. It is recommended that consideration should be given to the desirability of examining more fully the firing of klinker bricks, more particularly those of blue and brindled colour. It is though that the practice at Unterföhring (No.16), where a continuous gas-fired chamber kiln was used (see paragraphs 73 and 74) might be of interest to the manufacturers of blue engineering bricks in this country.

14. It is not considered that information of practical value would be obtained from more detailed study of aspects of the German heavy clay industries not covered by the two foregoing recommendations. Practice at most German works, as noted in paragraph 8, differs fundamentally from British, and its methods for the most part would not be applicable without acceptance of the basic principle of drying over kilns.

WORKS LAYOUT

15. In almost every works examined the whole, including kilns, was enclosed within a common building several (usually 3 to 6) storeys high. In one section of the building was the making plant and at one or both sides of this the kilns and drying sheds. The kilns were on the ground floor and the coal charging floor to the kiln formed the first floor. On the floors above this were the dryers, which might be either of the Keller chamber type or sheds fitted with wooden racks and shelves. Where Keller dryers were used they were usually on either one or two floors above the kiln, but where open-rack drying sheds were employed there might be as many as four floors of these above the kiln. With this layout the heat rising naturally from the kiln could be utilized in heating the dryers immediately above. At practically every works hot air was drawn off by fan from chambers being emptied or from cooling chambers on the kiln and delivered through sheet-metal ducting to the dryers above. Ine one particular case the fan and ducting were insulated. In the case of Keller chamber dryers about one-third of the heat required for drying was stated to be obtained in this way. The remaining heat required for drying was usually obtained from exhaust steam, or maybe in some Keller installations from a hot-water circulating system with coke-fired hot-water heater. A good example of the typical German layout was seen at Unterföhring (No.16) where one long building, mainly three storeys high, housed seven continuous kilns situated in line end to end with Keller dryers over the kilns. Illustrations of this works and of Heisterholz (No.1) are given in Figs. 1 and 2 respectively. Another example (not visited) is shown in Fig.3.

16. Most works had a central boiler and power-house, the steam being used to generate electricity to drive the plant, and the exhaust steam being used for drying. Making machinery was not driven direct by steam engine as in Britain, but individual electric motors were provided at the different plant units. Advantage was taken of this at some works to use grid electricity in summer to drive the plant when heat from the kilns was sufficient for drying during hot weather, and to revert to the works' own power-house plant in winter, when large quantities of exhaust steam, and possibly some live steam, were required for drying. At a few of the works purchased electricity was used to drive the plant. In such cases the Keller dryers were usually heated by hot water on the recirculatory system with a coke-fired water heater, together with the usual hot air drawn from the kiln.

17. The works were of medium size. Those producing roofing tiles had outputs varying from 8 to 22 million pieces (consisting of interlocking tiles, plain tiles and in some cases bricks). The interlocking tiles weighed about 2.7 tons and the plain tiles about 1.8 tons per 1,000 (roughly 6 lb. and 4 lb. each) and their weights were thus of the order of brick weights. Works making bricks only or mainly had annual outputs of 7 to 30 million brick-equivalents.

18. From observation and from information received at various works it appeared that the stiff-plastic and semi-dry processes are not used for building-brick production in Germany, and that there is nothing there comparable with the Fletton production in this country.

MECHANISATION AND CLAYWORKING MACHINERY

GENERAL

19. An example of a works manufacturing common bricks solely which can be used to illustrate the degree of mechanisation is Target No.15 (Argelsried). This works made perforated bricks larger than standard size, the output being about 7,000,000 brick-equivalents in 11 months. (The works closed down each January on account of the weather). This is an output of about 150,000 per week, the number of employees being 25 to 28, not including office staff. Keller fully-automatic plant was used, and it was stated that the output was limited by the kiln, the machine working only about 40 hours per week. The total labour works out at about 8 man-hours per 1,000, made up approximately as follows:-

	No. men	Hrs/wk.	Man Hrs./1,000
Overburden	1	48	0.31
Excavator driver	1	48	0.31
Tending excavator	1	48	0.31
Cleaning up	1	48	0.31
Filling wagons with coke	1	48	0.31
Haulage	1	48	0.31
Feeding	1	40	0.26
Die man	1	40	0.26
Transport to dryer	2	40	0.52
Transport from dryer	2	40	0.52

	No. men	Hrs/wk.	Man Hrs./1,000
Setting	4	48	1.23
Drawing and loading	4	48	1.23
Burners	3	56	1.08
Kiln wickets, pallets	1	48	0.31
Fitter	1	48	0.31
Foreman	1	48	0.31

20. Excepting on the works in the Munich area, considerable attention was given to the preparation of the clay, and unusually large storage accommodation was provided for souring. At Heisterholz (No.1) the clay was dry-ground and screened (about 16 wires to the inch). It passed through two trough mixers in series, part of the water only being added in the first. Steel band conveyors took it to the souring bins, where after standing for some three weeks it was picked up on to a second steel band conveyor beneath the floor and passed through a combined mixer and feeder to the pug.

21. De-airing pugs were not extensively used for brick and tile production, only one being seen on the works visited.

22. The dies seen were not of exceptional design. Brick dies were of laminated steel and usually water-lubricated. Tile dies for the manufacture of flat tiles were simple square-cut orifices in a steel plate. No attempt was made to shape the spacer behind the die to the flow of the clay.

SPECIAL FEATURES AND UNUSUAL MACHINES.

Grinding Pans

23. The majority of grinding pans were under-driven, and on over-driven pans the bevel crown-wheel was inverted so that dust and dirt did not collect on the teeth. It was noted that the grinding pans seen at Heisterholz (No.1) and made by Händle were of simple design and unusually well constructed for ease in carrying out maintenance work.

Conveyors

24. A steel trough conveyor of neat design was seen at Hilgen (No.2) and at Unterföhring (No.16). The maker was Raupach. It consisted of a series of semi-cylindrical troughs carried on two chains, the length of link of the chain being equal to the width of the trough. The chain pivots consisted of long cylindrical rods common to both chains, and the troughs were rolled over these rods so that gaps did not occure when the conveyor went over the end pulleys. The arrangement is illustrated in Figure 4.

Presses

25. Berger (No.19) made a small moveable electrically-driven press which has no British equivalent. One was seen at Nieder Dollendorf (No.3). It stood on a four-wheeled trolley about 4ft. 6 in. x 3ft. 6 in., and was said to have an output of about 800 pieces per hour. It is illustrated in Figure 5.

Pugs

26. German pugs tended to be augers rather than pugs in the sense accepted in this country, most of the working of the material being done in other machines prior to extrusion. Double-bladed wing knives were standard. These knives had renewable edges, and were of a design which eliminated the central boss or torpedo head. Händle's pugs appeared to be of good design and should be further investigated. Most of the pugs seen were equipped with the usual single roll for feeding, but the manufacturers' catalogues showed other devices which might have advantages. A pug with paddle - type feeder, manufactured by Rieter, is illustrated in Fig. 6.

De-airing Pugs.

27. British de-airing pugs usually consist of two pugs one above the other, whereas the customary German arrangement was to have both pugs on the same shaft, thus eliminating gearing. Raupach was stated to have a pug of this type. The Berger design was without the first or shredding pug (See Fig. 7). It resembled an ordinary pug, but there was a pair of feeding rolls in which the shredding and seal were obtained.

Mixers and Feeders.

28. A point of particular interest in the design of mixers and feeders was that certain of them were designed to combine mixing and feeding in the same machine.

29. On the brickworks at Unterführing (No.16) and Argelsried (No.15), the plant included rotary feeders by Rieter, of Constance. This feeder, which is illustrated in Fig. 8, consisted of a cylinder about 6 ft. in diameter and 4-5 ft. deep, with its axis vertical. There was a central vertical shaft which carried at its bottom end two curved arms or paddles which both mixed the material and pushed it outwards so that it passed through a gap between the bottom of the cylinder and its walls. At the second of these two works, coke was added to the clay in the proportion of one wagon of coke to seven of clay, and this device was apparently capable of giving the necessary mixing, as the rest of the plant consisted merely of rolls and pug.

30. At Heisterholz, Schütte had designed a combined mixer and feeder for plastic material taken from souring store. A fixed cylinder about 8 ft. in diameter and 3 ft. high had a bottom which rotated intermittently, i.e. in frequent small adjustable movements similar to the action of a coal feeding device for kilns. The plastic clay was fed into the trough so formed and built up into a layer about 3 ft. thick. This layer rotated through about 120°, when it passed under a roller which reduced its thickness to about 2 ft. It then came up against a radial worm which cut it off and fed it outwards. The worm was not a complete spiral, but was composed of knives almost forming such a spiral. This device, which was called a "rundbeschicker", (round feeder") was constructed by Eisenwerke Weserhütte, at Bad Oeynhausen.

31. At Witterschlick (No.5) there was installed a mixer made by Eirich, Hardheim, Nordbaden, which could be alternatively described as a wet pan. The pan itself, about 10 ft. in diameter, was underdriven, and supported over it were two vertical overdriven shafts situated on a diameter about half-way between the centre and edge of the pan. These two shafts carried at their bottom cranked mixer bars, and at each end of these bars was a small roller about 1 ft. 9 in. diameter and 7 in. wide. In operation the pan revolved in the usual manner while the four small rollers described a planetary motion.

32. At Witterschlick and at Giessen (No.12) the plant included a machine termed a "rasplar" ("shredder" or "grater") made by Groke of Merseburg, Leipzig. Its purpose was to divide the plastic clay into a large number of small pieces. It consisted of a vertical cylindrical drum perforated with a large number of holes about $\frac{1}{2}$ in. diameter. Clay fed in at the top was forced through these perforations and collected on a rotating table underneath, from which it was ploughed off.

Miscellaneous.

33. The general finish of clayworking machines seen was excellent, the surface of castings, for example, being very good.

34. No information was obtained on the use of alloy steels in clayworking machinery in Germany.

35. It was stated by Händle that he did not know of any machine produced in Germany or elsewhere that would make hollow blocks with one end solid. He understood that experiments had been carried out, but not on a commercial scale.

36. The works at Argelsried (No.15) made a brick with 95 perforations. The design of this die should be of interest.

DRYING.

37. With very few exceptions, the dryers seen were in multi-storied buildings over the kilns in the Continental tradition. The dryers either were on the Keller system or consisted of wooden racks with natural air circulation assisted in some cases by steam or hot air from the kiln. The outstanding general feature of these dryers was their size, drying times being long and 6 - 8 days not unusual. Neufahrn (No.14), for instance, for an output of about 21,000,000 tiles per year, there was a Keller dryer with 128 chambers on two floors over the kilns. At Unterfohring (No.16) there was a Keller dryer of 121 chambers on a single floor, extending in one line over two kilns and three gas ovens, built end to end. At Ergoldsbach (No.13) most of the drying was done in a wooden rack dryer of four storeys, but there were also a single-storey rack dryer and a 27-chamber Keller dryer.

38. At Heisterholz (No.1) there were two interesting dryers. The first was a mechanised rack dryer, in which the tiles were carried on pallets in large steel frames, some 10 ft. by 4 ft. 6 in. hung from angle-irons in the roof in a large open space over one of the kilns. Warm air rising from the kiln was exhausted by fans above. The salient feature of the installation, its mechanisation, would not be applicable to any other type of dryer. In the other dryer, which was also over a kiln, the tiles were carried on pallets supported on sloping racks so arranged that dry tiles could be removed individually by hand from the lower end of the slope for loading on a mono-rail conveyer. As each pallet was removed those above it slid down one place, leaving room for a further wet tile at the top. Warm air rising from the kilns was exhausted by fans above.

39. The Director of the works at Ludwigsburg (No. 11) was designing a hot-air chamber dryer using Keller handling devices. In an attempt to reduce the loss of thermal efficiency which occurs in such a dryer when the articles are nearly dry, and to avoid other recognised weaknesses of this type of dryer, he was proposing to adopt a two-chamber system, recirculating air from one chamber through another more recently filled.

40. At Argelsried (No. 15) the Keller high-pressure hot water system was a pump-circulated open system, a pressure of two atmospheres being maintained by its installation in a high building. The boiler was thermostatically controlled to work at a temperature of 90° to 100°C.

41. At Wiesloch (No. 9) the waste gases from the boiler were passed into a Keller dryer, a practice which is generally deprecated on account of the consequent damage to the dryer structure.

42. In general the dryers designed by Keller use hot air from the kiln and a subsidiary source of bottom heat, either steam or hot water, the latter being preferred by the designers. Keller does not build tunnel dryers, nor chamber dryers operated on hot air alone, nor does he recommend the installation of his standard type in cases where the articles can safely be dried in less than 48 hours. It was stated that one-third of the heat required for drying could be obtained from the kiln, and that a brick containing 800 gm. of water would need in addition to the hot air 1,000 kilo-cal. of heat in coal. This is a coal consumption of about 3.3 cwt. per 1,000, a figure which is roughly of the order of those given for boiler consumption on some of the works.

43. There is, however, some doubt about the actual thermal efficiency of the Keller installation. At its face value, the statement made means an efficiency of about 30 per cent., which is a reasonably high claim, but not excessive. The weight of 800 gms. (1.75 lbs), however, is probably the weight of water originally in the brick, and since it is not customary to dry right out (in this country, at any rate) this is not necessarily the weight of water removed in the drying. If the statement is taken to mean that an article originally containing 800 gm. of water requires the given quantity of heat for its normal drying (in which it will probably lose not much more than one pound) the efficiency is of the order of 20%, which is not high. The alternative interpretation, namely that the article could be dried right out with this amount of heat, is viewed with some suspicion, as the thermal efficiency of a chamber dryer decreases considerably when the articles are nearly dry. It is regretted that on none of the works visited could any actual data be obtained, both because of the practice of combining these dryers with natural ones over kilns, and through lack of knowledge on the part of the management (in many cases, now) of the weight of water actually evaporated. It can only be stated that, probably owing to the practice of utilising natural

drying and the whole of the heat rising from the kiln, coal consumptions for power and drying were in general low. Climate and cost of timber make this practice impossible in the British Isles. According to information obtained at Wiesloch and Ludwigsburg the latest German trend is towards dryers at ground level, which is British practice.

44. The party was informed that there was no German who had made a study of the technical aspects of drying and who was accepted as an authority on the subject. This, and various small points such as a longer time of drying on one works in a Keller than by natural drying, and an expressed preference on another for natural drying over the Keller, leads to the conclusion that the firm of Keller are content with their virtual monopoly, and that there is comparatively little new or important to be learnt in this sphere. The Keller system of mechanical handling, which is the crux of the Keller dryer, is already well known in this country.

45. Only two tunnel dryers were seen on the works visited. The first at Witterschlick (No.5) was a short plain tunnel operated on hot air and of poor design. The second, at Mühlacker (No.10) was of conventional design with hot air admitted at one end and steam pipes along the bottom. Two good features were noted; the length was ample (over 150 ft.) and the tunnels were low (about 4 ft. 6 in.).

46. A somewhat unusual method of drying stoneware pipes and chemical stoneware was seen at Friedrichsfeld (No. 8). Immediately over a group of 12 intermittent kilns there were two drying and moulding floors. All drying was effected by (a) the heat rising naturally from the kilns and warming the floor of the shed immediately above and (b) hot air drawn off from the cooling kilns. Large metal hoods were provided over the wickets on each kiln, from which two metal ducts about 18 in. in diameter connected into rectangular concrete stacks about 2 ft. 6 in. - 3 ft. square rising up through the two drying sheds above. On each floor, openings about 2 ft. 6 in. square were provided in the stacks, and by means of flap dampers immediately over the openings the hot gases, rising naturally up the stack when the wicket was broken down, were diverted into the drying sheds. No other source of heat, such as steam, was used. Drying conditions presumably varied considerably from time to time and from place to place on the floor according to which and how many kilns were firing and cooling.

KILNS AND FIRING

GENERAL

The kilns seen were for the most part not new, many having been built between about 1890 and 1912, with a few more modern. The most recent was that at Witterschlick (No.5), erected in 1938. Tables summarising the data on kilns and firing are given in Appendices III and IV.

THE FIRING OF COMMON BRICKS AND ROOFING TILES

Types of Kiln

Zig-zag kilns were used at five of the six roofing tile works visited. Each works had two or three such kilns operating into stacks 130 - 200 ft. high, assisted in each case by a fan. These kilns had 16 - 24 chambers, except at Wiesloch (No. 9) where zig-zag kilns with 28 and 32 chambers, each with two firing circuits, were employed. In the zig-zag kilns, adjacent chambers generally were joined by a right-angled connection of the same cross-section as the chambers themselves, the junctions of the crowns being mitred. In the 32-chamber kiln at Wiesloch, however, the crowns of the chambers continued through to the end wall and the connections were made by short arched tunnels which, being of narrow and lower cross-section, did not penetrate the chamber arches appreciably. This construction should be cheaper than the normal method with mitred junction.

Barrel-arch kilns of the Hoffmann top-fired type were used for roofing tiles at Heisterholz and for common bricks at other works. They were all plain in section and without drop arches. At Heisterholz there were 3 plain barrel-arch kilns with 18 chambers and a stack 148 ft. high assisted by a fan. For the firing of common bricks 1 - 3 plain barrel-arch kilns were employed at the works visited, with stacks 115 - 150 ft. high and no fans. These kilns had 16 - 20 chambers.

Kilns were substantially constructed and generally appeared to be in very good condition, having no cracked brickwork, etc., On all kilns the main flue was situated in the middle wall, with dampers operated from the coal charging floor. In most cases the dampers were operated by hand-wheel in conjunction with a screw thread on the damper rod. At Heisterholz conical dampers with metal-to-metal seating as well as a sand seal were employed.

Extraction of Hot Air.

51. A noticeable feature of the kilns was that use was not made, as in Britain, of hot-air flues built within the kiln structure for the transfer of hot air from the back cooling chambers to the drying chambers; instead, provision was made for drawing off hot air from either emptying or cooling chambers by fan and ducting to the dryers. In the zig-zag kilns hot-air offtakes were generally provided in the middle wall for each chamber, which connected into the main hot-air flue also situated in the centre wall of th kiln. At Mühlacker (No. 10) a portable wrought-iron tube, with small offtakes connecting into the main hot-air flue and to one row of feed-holes, was used on the kiln top to extract hot air from a given chamber. By means of a fan on the centre top of the kiln, hot air was withdrawn from this flue and transferred by sheet-metal ducting to the dryers. Where Keller dryers were employed, this ducting travelled beneath the ends of the battery of dryers with small uptakes, each with valve control, leading into the base of the dryer chambers. With barrel-arch kilns hot-air flues built right round the outside or at either side of the top of the kiln just below firing-floor level were mainly employed, connections from the main hot-air flue to the chambers being made by metal goosenecks to 12 to 15 in. diameter holes in the crowns of the chambers or by sheet metal troughs which covered one or more rows of feedholes. At Heisterholz the hot-air extraction system consisted of overhead metal ducting with down-comers over each chamber; the latter could be connected when required to a metal trough which was of such a size as to cover 2 rows of 4 feedholes. As with the zig-zag kilns a fan was used to extract the hot air from the kiln and forward it to the dryer. The fans used were stated to be mainly of 8 - 10 H.P.

52. At Hilgen (No. 2) a coke furnace at one end of the kiln could be connected through a ring flue (beneath the charging floor) and a sheet metal duct to any chamber for assistance in drying the bricks in winter.

Wickets

53. A feature of the kilns was the care taken to seal the wickets to prevent air-leakage. This was probably necessary because of the high draughts employed. The normal method was to build two wickets each $4\frac{1}{2}$ in. thick and clayed over and separated by a space of about 15 in. In one case brown paper was pasted over the outer wicket wall, whilst at another works a sheet-metal door clayed round the edges was used. At all works wickets were small, e.g. 3 ft. to 3 ft. 9 in. wide and 5 ft. 6 in. high.

Setting of Roofing Tiles.

Two main types of tile were made - (a) the large interlocking tile of various designs and weight about 6 lb., and (b) the plain tile, which was flat, with one end rounded, size 7 x 15 in. and weight about 4 lb.

For plain tiles the general practice was to set two or three courses of fired bricks at the base of the chamber (header bricks 9 in. high crossed by a flat stretcher, so forming base flues about 8 x 9 in. size) and to build charge-shafts of bricks below the feedholes. Above the brick footings plain tiles were set on edge in pitches across the chamber, each pitch of tiles touching the previous one. These pitches were 9 - 10 courses of tiles high according to the internal height of the chamber, and each course, except the top three, was separated from the one above either by flat waste tiles or by 1 in. thick fired bricks. The tiles within the courses were set on edge in pairs back to back, so that adjacent pairs of tiles were spaced nib distance, $\frac{3}{4}$ in. apart. This setting is illustrated in Figure 9.

At Heisterholz, where interlocking tiles were produced, a box method of setting was employed. Footings consisted of one course of bricks on edge crossed by large fireclay covers set flat. Above this, compartments about 18 in. long by 10 in. high, and holding 11 interlocking tiles on edge, were formed by making use of special side supports and two circular bars made of heavily grogged fireclay. The bars were $2\frac{1}{2}$ in. in diameter by 20 in. long and fitted into two circular depressions in the top of the side supports, so that when supported between adjacent side-pieces each formed the base of the compartment above. The side supports, which were placed on edge about 18 in. apart, were $2\frac{1}{4}$ in. thick, 13 in. high and 15 in. long. The face of the setting therefore consisted of a number of boxes or compartments 18 in. long and 10 in. high. The tiles were approximately 16 in. long and 9 in. high. These were set in double pitches, across the width of the chamber, each double pitch being separated by a space of 6 in. The normal feed-holes to the chamber, of which there were 4 per row with rows spaced 39 in. apart, fed direct to the space between the double pitches. To improve the uniformity of firing, extra rows of feed-holes had recently been provided, with 3 holes per row, placed mid-way between the original feed rows. These additional rows fed coal direct to the top of the setting. The coal was hand-fed to the kiln at this works. The setting is illustrated in Figure 10.

Transfer to and from Kiln.

57. Generally the Keller system of handling the dried bricks and tiles was employed. In most cases rail tracks were provided down both sides of the kiln with turntables at the wickets, and on these rails four-wheeled iron trucks were hand-pushed direct into the chambers to the setting face. In a few cases, however, three-wheeled rubber-tyred trucks were used, the surrounds to the kilns being concreted for smooth running. Wickets were of small size, so that the small type Keller trucks were utilised.

58. Drawing of fired goods was by barrow (iron-wheeled) or by the same trucks as were used for setting.

Rates of Fire Travel.

59. The zig-zag kilns used for firing roofing tiles were mainly of normal internal cross-section, about 8 ft. wide and 7 ft. 9 in. - 8 ft. high, with 3 feedholes per row. One kiln with 28 chambers was larger (9 ft. wide and 7 ft. 9 in. high) and one with 16 - 24 chambers smaller (6 ft. wide and 7 ft. 3 in. high). On the kilns with 16 - 24 chambers, the circuit of the kiln could be travelled in 7 - 10 days, rates of fire travel being of the order of 60 - 80 ft. per day. At Ludwigsburg (No. 11), where 16-chamber kilns of small section had been employed, together with a high draught of about 4 in. w.g., rates up to 90 ft. per day had been obtained, and the circuit of the kiln traversed in 5 days. With the kilns with 28 and 32 chambers, each with 2 firing circuits, rates of fire travel of 40 to 50 ft. per day were attained with each fire. The tiles burned in these kilns were made by the plastic process (extruded and wire-cut in the case of plain tiles and formed in the revolver press in the case of interlocking tiles). They had thus been well dried prior to setting in the kiln, and this must have had a considerable influence on the rates of travel attained.

60. The barrel-arch kilns used for firing bricks were of medium cross section, varying from 8 ft. 9 in. wide by 7 ft. high to 13 ft. 6 in. wide by 8 ft. 6 in. high. Rates of fire travel varied from 20 ft. to 40 ft. per day; for common bricks the circuit of 16- to 20-chamber kilns were traversed in 7 to 8 days. The kilns were operated on stack draught only. In comparing these rates of travel with British practice, which includes the stiff-plastic and semi-dry processes, it must be remembered that the German bricks, being wire-cut, were dried before setting.

61. With high draught and high rates of travel the tendency is usually for the bottoms of the setting to be hard or overfired However, in the German works visited the tops generally appeared to be the harder fired. This was probably brought about by topping over the charge shafts, which was a general practice even although mechanical feeders were used. No residues of unburnt fuel were observed amongst the fired goods in chambers being drawn.

Temperature of Firing.

62. Roofing tiles and common bricks were fired at temperatures of 900° - 1,000°C. For klinker bricks the temperature was higher. Common red klinkers were fired at one works at 1,060° - 1,120°C. in a barrel-arch kiln, and blue and red klinkers at another works at 1,230° - 1,250°C. in a Mendheim gas-fired continuous chamber kiln.

Fuel Consumption.

63. Fuel consumption figures were generally difficult to obtain with any degree of accuracy. There was the further difficulty that at the roofing-tile works a variety of products were made, such as plain and interlocking tiles, ridges, etc. and bricks. Thus it is difficult to give a fuel consumption figure except per 1,000 articles produced. On this basis the total fuel consumption (for making, drying and firing) varied from 5 -.7 cwt. per 1,000 articles. At Neufahrn (No. 14) where only tiles were made, the consumption per 1,000 articles was 2.8 cwt. on the kiln and 3.8 cwt. on the boiler, giving a total of 6.6 cwt. At Ergoldsbach (No. 13) the figures were respectively 2.1 cwt. (kiln), 2.7 cwt. (boiler) and 4.8 cwt. (total). Interlocking tiles weighed about 2.7 tons per 1,000 and plain tiles about 1.8 tons per 1,000. Taking an average weight of 2.5 tons per 1,000 articles, the total fuel consumption would vary from 2.0 to 2.8 cwt. coal per ton of fired goods.

64. In the case of common bricks the consumptions were rather lower. At Rödelheim (No. 7), where the yearly output was 12 million bricks, of which two-thirds were of facing quality, the total fuel consumption was stated to be 4.9 cwt. per 1,000 bricks, made up of 2.9 cwt. on the kiln and 2.0 cwt. on the boiler. At the small but efficient works at Argelsried (No. 15) the total fuel consumption per 1,000 bricks was 3.8 cwt. of solid fuel and 18 to 20 units of electricity. At this works fine coke was added to the clay at the rotary feeder to the making plant in the proportion of 1 wagon of coke dust to 7 wagons of clay. The solid fuel consumption comprised 0.7 cwt. coarse coke for drying, 1.7 cwt. of fine coal for firing the kiln and 1.4 cwt. of fine coke added to the clay.

65. Considering that the clays contained very little carbonaceous matter, the total fuel consumptions at all these works were very good.

The Use of Mechanical Stokers.

66. Mechanical stokers appeared, in contrast to British practice, to be largely used in Germany, practically all the works visited having them installed on their continuous top-fired kilns. The advantages claimed for them were mostly in respect of uniformity of firing and quality of product, but fuel saving may also have had a bearing on their use since the clays employed at these works generally contained little carbonaceous matter and fuel had to be brought long distances.

67. The Schag type feeder, made by Ingenieur Gairing Maschinenfabrik G.m.b.H., Riedlingen, Württemburg, was the one most generally used; it was seen at 7 works. These feeders consisted of a cylindrical container with a rotating disc at the base driven by a ratchet on the outside. For the purpose of varying the rate of feed, the number of ratchet teeth engaged at each stoke could be altered and there was an adjustable shutter above the delivery opening from the disc where the fuel was discharged from the cylinder into the side vertical downtake placed over the feedhole. The battery of feeders was operated by a $\frac{1}{2}$-1 H.P. motor, driving a series of rocker arms positioned over the kiln top; metal rods from the overhead rocker rods operated the ratchets on the side of the feeders. A sliding cover allowed inspection of the heat beneath the feedholes whilst the stoker was in position and working.

68. The feeder made by Schumann of Pforzheim, near Karlsruhe, is noteworthy because of its light and simple construction. It consisted of a small rectangular cast-iron coal container, which was unusually thin (about 1/8 in. - 3/16 in. thick), connected to a cylindrical worm barrel at the base. The screw feeder was driven by a ratchet arrangement on the outside at one end of the barrel, the coal being discharged into the vertical downtake which was placed over the feedhole. The feeder is illustrated in Fig. 11.

69. It was stated at Rodelheim that Heinrich Klaustermaier of Osnabrück manufactured a pneumatically operated feeder. A ½-H.P. electrically-driven compressor supplied air to a pipe over the kiln top. Rubber tube connections were made from this pipe to the feeders. At the feeder the compressed air acted upon a membrane which caused an eccentric to move backwards and forwards and so feed the coal. It was stated that feeders of this kind had been installed at a works near London in 1936. Subsequent enquiry confirmed this but showed that the feeders had proved unsatisfactory and their use had been discontinued.

70. Other makers of stokers used on the Continent were stated to be (a) Rieter and (b) Rutz, both of Constance.

Coal Handling to the Kilns

71. Although German works generally had only 1-3 kilns, the methods of coal handling to the kiln tops were of interest. The more general system was by means of a wooden ramp at one end of the kiln or battern or kilns, up which side-tipping wagons of coal were hauled by rope and electrically-driven winch. The wagons were then either tipped and the fule hand-barrowed to the required position on the kiln top, or alternatively the rail tracks were continued from the ramp laong the sides of the charging floor where the coal was tipped in the firing zone. Another method employed was to raise the coal to charging-floor level by elevator and then barrow the fuel to the required position.

72. At the Hilgen (No.2), with only two barrel-arch kilns, a mono rail system was used. From the rail wagons the coal was discharged into a hopper from which it was elevated to a bunker on the kiln top midway between the two kilns. Here the coal was shovelled into tubs with capacities of 1-2 cwt., which were hand-pushed on the overhead mono-rail which travelled round the outer side of the top of each kiln.

THE FIRING OF KLINKER BRICKS

73. Bricks stated to be klinker bricks were produced at a few of the works visited. Many were of a red or reddish-brown colour, but there were considerable variations in colour and texture, and at Giessen (No.12) there were klinker bricks of a white colour. Only at Unterfohring (No.16) did the klinker bricks or tiles resemble to some extent our blue engineering bricks.

Klinker bricks were generally burned in normal barrel-arch kilns, the hardest fired bricks being obtained from the upper portion of the kiln. At Unterführing, Mendheim gas-fired continuous chamber kilns, with comparatively small chambers (12 ft. 9 in. by 9 ft. 6 in. by 6 ft. 6 in. high, capacity 4,000 bricks) were used. There were three such kilns, each with 14 chambers and fired with producer gas. Each kiln had its own gas producer which was of the suction type operated by the draught of the kiln. A new pressure producer plant was being installed by Messrs. Klokner, Humboldt and Deutz, of Kalk, Cologne, fitted with mechanical ashing device and tangential dust separator, which would be capable of supplying all three kilns. The blueing was carried out by operating under reducing conditions for the last 3 hours of firing of each chamber. The clay was stated to have a high iron content, the colour of the product being obtained naturally during the firing, without the help of additions to the body. Some 40 per cent. of the goods produced were blues (blued right through) the remainder being brindles, browns and reds. Usually the aim was to produce blue goods, but at the time of the visit the demand was for reds. Some further study of the firing of klinker bricks, more particularly those of blue and brindled colour, might be of service to the manufacturers of blue engineering bricks in this country.

THE FIRING OF SALT-GLAZED PIPES AND CHEMICAL STONEWARE

75. In the two works visited making salt-glazed pipes, Frechen (No.4) and Friedrichsfeld (No. 8), rectangular down-draught intermittent kilns of normal type with perforated (holey boy) floors were used, several kilns being connected to one large stack, of height 120 to 150 ft. approximately. In both cases stepped grate fire-holes of large width, 2 ft., were provided on the kilns, the coal being fed to a metal hopper attached to the front of the top fire-hole opening, and extending its full width.

76. The kilns used at Friedrichsfeld for the firing of salt-glazed chemical stoneware were large, internal dimensions being 12 ft. high, 40 ft. long and 16 ft. 9 in. between flash walls. These kilns had six fireholes of the above type each side, and a large wicket at one end 8 ft. wide by 12 ft. high. The firing cycle for chemical stoneware was 3 weeks and the firing time 110 hours. The maximum temperature was 1,200°C.

77. At both works the kilns were constructed on the ground floor within buildings with the sheds for drying and hand-making or moulding on the floors above. From the evidence of the dark colour of the glaze and of the body of the pipes and chemical stoneware it appeared that reducing conditions of firing had been applied.

78. No case was met of the firing of pipes in continuous kilns, but during discussion at one brickworks it was stated that pipes were fired in this way, such pipes being sprayed or dipped before setting in the kiln so that salting was not required.

THE FIRING OF WALL-TILES.

79. At Witterschlick (No. 5) the car tunnel kiln, which at the time of the visit was being used uneconomically for the firing of roofing tiles, had many features of interest.

80. The kiln was built in 1938 by Volmer, Heimsoth and Dressler of Hanover. It was 245 ft. long with cross section above car deck level 3 ft. 10 in. wide by 4 ft. 6 in. high. Firing was with raw, hot producer gas. The producer was hand-fed with brown coal briquettes of size about 3 in. in diameter by 1½ in. deep, and was provided with mechanical grate and an automatic gas-pressure regulator. The steam for admixture to the air blast for blowing the producer was generated in a small vertical boiler. This was fired with gas from the producer via one gas pipe and four refractory burner blocks in the centre base of the boiler. The hot gas, after passing through a tangential dust separator, at a temperature stated to be 240°C., travelled through overhead ducting from which five downtakes led to the five burners on each side of the kiln. Each of these downtakes was provided with a water seal at the base for the collection of tar. From each downtake a right-angle connection took off just above the tar seal, which connected, via another pipe at right angles, to the burner in the side of the kiln. A screw-down gate-valve was provided in the first offtake from the main downtake and provision was made for cleaning or poking out the offtake pipes and burners, hinged doors with screw fasteners at the end opposite the hinge being fitted to each pipe. By shutting the burner valve each burner and its connecting pipes could be cleaned individually of any tar or coke accummulations while the kiln was working. Two burners on each side entered the kiln walls at an angle and fired into the muffle chambers down the sides of the kiln. The other three burners on each side fired direct into the kiln; these only were being used for the direct firing of roofing tiles.

81. Another special feature was the provision of a vertical metal tube recuperator in the preheating zone on each side of the kiln. Cold air, blown by fan through these recuperators, was preheated to a temperature of 450°C. and passed through flues in the brickwork to the front of the burners.

82. Hollow walls and false crown were provided in the cooling zone, the coal air entering through a number of openings in the side walls of the kiln, each controlled by a metal slide. The resulting hot air was drawn off by fan and sent via ducting to the open rack drying shed situated immediately above the kiln. In addition, openings about 12 in. by 6 in. were provided in the floor of the drying shed whereby hot air rising from the kiln structure passed through the floor into the drying room by natural updraught.

83. Draught was obtained by a stack 160 ft. high, an automatic damper control being fitted which was adjusted to give a suction of 2.4 mm. at the exhaust dampers. This would be particularly useful in windy weather.

84. The kiln was fully instrumented, panels being provided with temperature, gas pressure and draught indicators and recorders supplied by Schaffer and Budenberg, of Magdeburg.

PRODUCTS.

85. The number of works visited was not large enough to permit generalisations about the quality of German heavy clay products, particularly as no samples were tested. Opinions were thus based on visual examination, but a few observations of general interest may nevertheless be offered.

BRICKS

86. The only brickmaking process used at the works visited was the wire-cut. During the tour there was ample opportunity for study of the materials and methods which had been used in the construction of buildings. The impression obtained in this way confirmed the view that wire-cut bricks at least formed a much larger proportion of the total output in Germany than in Britain. The majority were ordinary solid wire-cuts, but there were some hllow bricks, extruded endwise with two square holes running through them. The finish of the bricks was generally of a similar standard to wire-cut bricks made in Britain. It may, however, be remarked that the finish of brickwork seemed to be generally poorer. In work that was not of the first importance excess mortar was left protruding from the joints without being struck off, whilst at other points joints were not filled.

ROOFING TILES

87. The great majority of roofing tiles seen in Germany were single-lap clay tiles. Both single- and double-roll patterns were common. The pitch of roofs generally was steep, and in dwellings a large roof often came down to first floor level, with one or two storeys in the roof. Nevertheless these single-lap tiles were occasionally used at quite low pitches without any underfelt and they appeared to be satisfactory. This result would appear to depend upon the elaborate design of the interlock and the accuracy of manufacture . The regularity of shape and size owed much to the great care exercised in preparing the clay, especially the thorough mixing followed by wet storage that seemed to be usual. Double grooves at both side and head of the tiles were general whatever the form of the upper surface, and were even applied by one firm to a tile very similar in pattern to an English pantile. A few of the designs are illustrated in Fig. 12, including the "pantile" referred to. A study of catalogues obtained from the manufacturers showed that the special problems arising with certain designs of tile in making satisfactory connections at ridges, eaves, verges, gables and projections had been considered and special tiles devised for their positions. Certain of these special tiles are illustrated in Fig. 13. Designs of ventilator roofing tiles were also illustrated and some of these are reproduced in Fig. 14.

88. All the plain tiles seen were flat, without camber, and larger than our standard plain tiles. Both single-lap and plain tiles were mainly of uniform red colour, and no multi-coloured, sanded or coloured sanded tiles of the types known in this country were observed.

FLOOR-TILES, QUARRIES AND ACID-PROOF TILES

89. Red and cream floor tiles from Witterschlick (No. 5), dust pressed in a hydraulic machine in sizes up to 6 in. x 6 in. and thicknesses up to 1 in, were true in shape and very well vitrified though coarser in texture than the normal British floor tile. Quarries and acid-proof tiles from Heisterholz and Giessen (Nos. 1 and 12) were generally extruded from a hollow-block type of die and wire-cut to length. They were dried and fired as blocks, being finally split into tiles along grooves scored in the clay by projections on the die. Only such pieces as cove angles were pressed. Sizes ranged up to 10 in. x 5 in. and 1 in. thick. The resulting products, while neither so true in shape nor so smooth in texture as pressed quarries, made a good durable surface which looked well when used with the wide joint usual with this type of work in Germany.

FAIENCE AND TERRA COTTA.

90. Carefully finished faience and terra cotta, purpose-made to architects' drawings for each individual building, appeared to be almost unknown in Germany, apart from a few decorative plaques and lumps of rather heavy statuary. Considerable use was made of tiling, both glazed and unglazed, of standard shapes and sizes up to 10 in. x 5 in., for street kiosks, shop surrounds and railway station entrances. The tiles were usuall set with the longest dimension vertical, using wide straight joints to hide the imperfections of the extruded tile, and the general effect was pleasing. Unglazed tiling, of which the products of Heisterholz were typical, was usually of red, brown or blue brindled colour. Glazed tiling as made at Giessen (No. 12) normally carried a transparent glaze on a cream-coloured body.

SALT-GLAZED STONEWARE PIPES AND CHEMICAL STONEWARE.

91. The products seen at Frechen and Friedrichsfeld (Nos. 4 and 8) were all of high quality with a dense vitreous body covered by a good salt glaze. Designs and patterns of the finished article differed only in detail from the comparable British practice, but standardisation and rationalisation appeared to have progressed further than in Britain.

GLAZED FINISHES.

92. The chief chemist at Hesterholz provided interesting information about terra sigillata ware. He showed fragments of Greek terra sigillata as well as specimens made from the Heisterholz clay, which illustrated four alternative finishes, each burnt at a range of different temperatures. These were:

(i) Glazed finish (Glasur)
(ii) Sintered slip finish (Sinter-engobe)
(iii) Slip finish (Engobe)
(iv) Terra sigillata

The distinction between (iii) and (iv) was that the engobe consisted of the whole clay, whilst the terra sigillata was done with a specially prepared suspension of colloidal clay from which all coarse material had been removed by 24 hours sedimentation. The suspension, which had a specific gravity of 1.2, was peptized with 0.4 per cent. NaOH and stabilised with 0.8 per cent. humic acid. This process is the subject of British Patent No. 460556. The best burning temperature for the Heisterholz clay was stated to be 900°- 1000°C. For further information about terra sigillata ware reference should be made to a paper by A. Möser in T.I.Z. 62(2), 1938.

THE TESTING OF PRODUCTS.

3. The works laboratory at Heisterholz was housed in premises which seemed extensive for this type of laboratory, and was well equipped with small machines for preparation of clays and experimental blocks. There were three small furnaces, one fired by coal, one by oil, and one (the smallest) electrically. There was also a press for determining crushing strengths of bricks. This was done on 4 cm. cubes cut from the bricks - the capacity of the press did not allow of the use of the German standard 5 cm. cubes. In peace-time it had been standard practice to determine soluble salts twice a month. The standard German freezing test (25 cycles of freezing to - 15° C.) had also been used, though it was stated that the tiles made at Heisterholz did not fail in frost. The chief chemist was aware that if a saturated tile is immersed in petroleum and frozen it undergoes an expansion but does not break.

APPENDIX I

LIST OF CLAYWORKING MACHINERY MANUFACTURERS MENTIONED IN THE REPORT BUT NOT VISITED.

	Name and Address	Products Mentioned	Paragraph Reference
1.	R. Raupach, G.m.b.H., Görlitz, Silesia.	Extrusion plant, conveyors etc.	24, 27.
2.	Rieter, Constance.	Pugs, rotary feeders, mechanical stokers.	26, 29, 70.
3.	Eisenwerke Weserhütte, Bad Oeynhausen.	"Round feeder".	30.
4.	Eirich, Hardheim, Nordbaden.	Mixer/wet pan.	31.
5.	Groke, Merseburg, nr. Leipzig.	"Shredder" or "grater"	32.
6.	Ingenieur Gairing Maschinenfabrik, G.m.b.H. Riedlingen, Württemburg.	Mechanical stokers.	67.
7.	Schumann, Pforzheim, nr. Karlsruhe.	Mechanical stokers.	68.
8.	Heinrich Klaustermaier, Osnabrück.	Mechanical stokers.	69.
9.	Rutz, Constance.	Mechanical stokers.	70.
10.	Klokner, Humboldt & Deutz, Kalk, Cologne.	Producer-plant.	74.

APPENDIX II.

DESCRIPTION OF TARGETS.

TARGET NO.1: SCHUTTE A.G.,

Heisterholz, Nr. Petershagen, Westphalia.

(Map reference: G.S.G.S. 4346 - L53/RW8419)

Visited on 14th August, 1945 by the full team.

Activities

Manufacture of clay interlocking roofing tiles.
Manufacture of klinker bricks, discontinued at time of visit.

General Description

The target was one of four clayworks operated by the same company. It was the chief and most modern of the four, and had the head office and laboratory. It was about 30 years old. The other works were as follows:-

No.2 Works at Heisterholz, about ½-mile N.N.E. of No.1.
No.3 Works at Holtrup (on the Weser)
No.4 Works at Dehme (on the Weser).

The target was not damaged. The manufacturing process was as follows:-

Clay - Mild shale.
Claygetting - Multibucket excavator working intermittently.
Transport to works - Locos and railway trucks.
Preparation and storage of clay - Box feeder to 2 underdriven perforated pans (11 ft. diameter); elevated to 8 piano-wire screens (about 16 wires to the inch); 2 trough mixers (some water added in each ; steel band to 2 storage bins (3-4 weeks capacity); clay retrieved at bottom of bins; slat conveyor to circular mixer-feeder (see paragraph 30); pugmill.

Making - (a) Interlocking tiles - Pugmill extruding 8 circular rolls; automatic cutter; transport band to presses.
(b) Pantiles - Pugmill and Keller automatic tile-cutter.
Drying - Mono-rail conveyor to dryers; all drying in racks over kilns (see paragraph 38).
Dipping - Some of the tiles dipped before burning.
Burning - Mono-rail conveyor and 3-wheel trucks to three top-fired barrel-arch kilns (only two working at time of visit); hand firing; drawing by rubber-tyred wheelbarrows.
Power - Electricity partly from grid and partly made in works.

Production
(all figures per year)

	Pre-War	Wartime	At time of visit
No. 1 Works	8,000,000 tiles	12,500,000 tiles	5,000,000 tiles
No. 2 Works	12,500,000 klinker bricks etc.		Nil
No. 3 Works	5,000,000 klinker bricks	Nil	Nil
No. 4 Works	7,500,000 klinker bricks	Nil	Nil

Key Personnel.

Interviewed	Not Interviewed
Christian Heuer, Technical Director.	Ernst Rauch, Chairman of Directors.
Theoder Schumann, Chief Chemist.	Heinrich Kaiser, Sales Director.
Ernst Pfifke, Engineer.	Ernst Nordmann, Prokurist.

Number of Employees.

	Pre-war	At time of visit
No. 1 Works	About 350 men	225 men
No. 2 Works	" 150 "	nil
No. 3 Works	" 65 "	nil
No. 4 Works	" 80 - 90 "	54 "

Comments.

The target was considered to be a good example of standard German practice. The lay-out of the works was on factory lines, with compact planning of dryers above kilns and good circulation. Items of particular note were:

(a) perforated pans (see paragraph 23),
(b) rotary (see paragraph 30),
(c) pugmill,
(d) close spacing of feedholes in kilns,
(e) methods of setting tiles in dryers and kilns (see paragraph 56).

TARGET NO. 2. VEREINIGTE BURSCHEID - HILGENER ZIEGEL - UND KLINKER-WERKE, G.m.b.H., Hilgen, nr. Düsseldorf.
(Map reference: G.S.G.S.4346 - K52/WF6078

Visited on 17th August, 1945 by the full team.

Activities.

Manufacture of klinker and common bricks, discontinued at time of visit.

General Description.

The works was built in 1898 with one kiln, and a second kiln was added in 1912. The works was practically undamaged. The manufacturing process was as follows:-

Clay - Hard shale.
Claygetting - Blasting and hand-getting.
Preparation of clay - Jaw crusher and dry pan; wet pan; trough mixer; smooth rolls; Raupach pugmill.
Making - Pugmill and Keller semi-automatic cutter.
Drying - Keller-type handling plant to 41-chamber Keller-type dryer over one kiln.
Burning - 2 top-fired barrel-arch kilns, with 18 to 20 chambers respectively; natural draught; automatic stokers used in front of fires and hand-firing behind; mono-rail coal conveyor on top of kiln.
Working hours - 50 hours per week.

Production

Normal pre-war production - 8-8,500,000 klinker and common bricks per year.
In full production until September, 1944.
Half production until March, 1945, when the works closed.

Key Personnel

Interviewed	Not Interviewed
Wilhelm Schmul, Works Manager.	Heinrich Becker, Managing Director.

Number of Employees.

For full pre-war production: 65 employees.

Comments

The target was considered to be an old-fashioned works of moderate efficiency and the bricks produced were not of exceptional quality.

TARGET No.4: JAKOB KALSCHEUER, G.m.b.H.,
Frechen, nr. Cologne.

(Map reference: G.S.G.S.4346 - K51/WF3557)

Visited on 18th August, 1945 by the full team.

Activities

Manufacture of salt-glazed stoneware pipes, discontinued in 1943 and not resumed up to time of visit. Faience was formerly made.

General Description

The target was stated to be the largest works of a group of 12 in the district, all producing stoneware pipes before the war but closed at the time of the visit. The target was practically undamaged.

Numbers of Employees

1927 - 90 employees
1938 - 60 employees

Comments

The works was considered to be old-fasioned, but was in reasonably good condition

TARGET NO. 5: SERVAIS-WERKE, A.G.,
Witterschlick, nr. Bonn.
(Map reference: G.S.G.S. 4346 - K51/WF5033)

Visited on 18th August, 1945 by the full team.

Activities

Manufacture of roofing tiles (a comparatively recent development). Manufacture of klinker floor-tiles, glazed wall-tiles and refractories, all discontinued at time of visit.

General description

The buildings housing the refractories department had been completely destroyed in the war, but the plant had been saved. There was also considerable damage in other parts of the works. The process was as follows:-

Clay - Kaolin for wall-tiles from Seok, Bohemia.
Clay for white floor-tiles from Coblenz district.
Clay for red floor-tiles from pit near works.
Clay for roofing tiles from pit near works.
Preparation of clay - Mixer/wet pan; "raeplar" ("shredder" or "grater") (see paragraphs 31 and 32).
Making - (a) Wall-tiles - Hydraulic presses by Lacis of Trier, each with an output of 1,000 tiles per hour, 4 tiles being pressed at a time.
(b) Roofing tiles - Mock-up press with output of about 500 per hour.
Drying - Tunnel dryer and rack dryer.
Burning - Car-tunnel kiln built by Volmer, Heimsoth and Dressler of Hanover in 1938. For a full description see paragraphs 79 - 84.

Production

A rate of about 1,250,000 roofing tiles per year at time of visit, on a mock-up press. It was stated that with a permanent press the production would be about doubled without increase of labour.

Key Personnel

Interviewed	Not Interviewed.
Philipp Servais, Prokurist.	Willy Haas, Managing Director. Adolf Horbach, Prokurist. Wilhelm Mehr, Works Manager.

Numbers of Employees

Pre-war	-	450
Wartime	-	200
At time of visit	-	80

Comments.

The target was essentially a wall- and floor-tile works, and on account of the unsuitability of the tunnel kiln for burning roofing tiles it was working very inefficiently at the time of the visit. It was estimated that the coal consumption for roofing tiles was about twice that of an efficient works.

TARGET NO. 7: WESTDEUTSCHE ZIEGELWERKE A.G.,
Rödelheim, Frankfurt-on-Main.

(Map reference: G.S.G.S.4346 - L51/WM6271)

Visited on 20th August, 1945 by the full team.

Activities.

Manufacture of common and facing bricks and hollow blocks (discontinued owing to destruction of works).
Excavation of sand and gravel.
Formerly manufacture of precast concrete slabs.

General Description

The target was stated to have been the largest of 18 brickworks round Frankfurt, the aggregate capacity of which had been 50 million bricks per year. It had been bombed in March 1944 and the buildings, with the exception of one kiln, were almost completely destroyed. The company was stated to be owned by Frankfurt City Council. The process had been as follows:-

Clay - Loess.
Transport to works - Single-rope haulage.
Preparation of clay - Box feeder; wet pan; 1 pair rolls; pugmill.
Making - Keller plant.
Drying - Keller dryer over 18-chamber kiln; rack-dryer over 16-chamber kiln.
Burning - (i) 18-chamber top-fired barrel-arch kiln built in 1905.
(ii) 16-chamber top-fired barrel-arch kiln built in 1907.
Automatic stokers used; unorthodox firing methods.
Working hours - 60 hours per week.

Production

Pre-war - 12 million pieces per year, made up approximately of:
8 million facing bricks,
4 million common bricks and hollow blocks.
Wartime - 11 million pieces.

Key Personnel.

Interviewed.	Not Interviewed
Hans Täubner, Works Manager.	Dr. Lingnay, Herr Burggral, Joint Managing Directors.

Numbers of Employees.

Pre-war and wartime - 60.

TARGET NO.8: DEUTSCHE STEINZEUGWARENFABRIK
Friedrichsfeld, Mannheim.
(Map reference: G.S.G.S. 4346 - I.50/WR6093)

Visited on 22nd August, 1945 by the full team.

Activities.

Manufacture of salt-glazed sanitary pipes, chemical stoneware and agricultural drain-pipes.

General Description.

15 - 20 per cent. (by value) of the target had been destroyed by artillery action. The works had 54 rectangular downdraught intermittent kilns, grouped together in buildings, with sufficient space around the kilns for coaling, firing and access to the wickets for drawing and setting. The kilns are described more fully in paragraphs 75 and 76. Immediately above the kilns were two floors on which both pipes and chemical ware were moulded and dried. Vertical de-airing extrusion machines made by Raupach were used for pipes. Drying was effected by heat from the kilns transmitted through the floors, and by hot air drawn off from cooling kilns. The drying floors are described more fully in 46. The body of the stoneware pipes consisted of a local stoneware clay and grog, and the methods of preparation were orthodox.

Key Personnel.

Interviewed	Not Interviewed
Erich Baltzer, Head of Chemical Department	Chl. Kammerscheid, Managing Director.
Heinrich Buselmaier, Works Chemist.	Adam Uhrig, General Manager
	Kurt Schwenzer, Secretary
	Hans Herz, Head of Sanitary Pipe Department
	Herm. Friedel, Chief Buyer
	Theo Heidinger, Works Manager.

Numbers of Employees

Pre-war - 900 - 1,000 employed in quarry, works and office, slightly more than half of these being in the chemical department.

Wartime - Similar total number, but about two-thirds in the chemical department.

At time of visit - 160, of whom about half were repairing war damage.

TARGET NO.9: TONARENINDUSTRIE WIESLOCK A.G.,

Wiesloch, Baden.

(Map reference: G.S.G.S. 4346 - L50/WR6878)

Visited 22nd August, 1945 by S.B. Stedham, B. Butterworth, H.H.Lacey, A. Miller and E. Rowden.

Activities.

Manufacture of clay interlocking roofing tiles in a wide variety of designs, common bricks and hollow walling blocks, all discontinued at time of the visit.

General Description.

The target had been about 2/3 destroyed by bombing in March 1945 and was still in this condition and inactive at the time of the visit. It had been built in 1916, and the manufacturing process had been as follows:-

Clay - Heavy "bergton", mixed with loam and barium carbonate.

Claygetting - 2 multi-bucket excavators made by Weserhütte, Bad Oeynhausen.

Transport to works - Endless chain.

Preparation and storage of clay - Clay soured and stored in separate building; box feeders to 3 wet pans; fine rolls; pugmill.

Making - (a) Tiles - Clot extrusion machine; clots by conveyor belt to 8 tile presses and 5 tile extrusion machines.
(b) Bricks - Raupach de-airing machine.

Drying - (a) Tiles - Dryers over Kilns 1 and 2; 22 - chamber Keller dryer on ground floor adjacent to Kiln 3, heated by a boiler and by h. air from Kiln 3.
(b) Bricks - 17-chamber Keller dryer on ground floor adjacent to Kiln 2, heated by waste gases from boiler.

Burning - 3 zig-zag kilns:

1 - built 1916; 28 chambers; 2 fires
2 - built 1916; 32 chambers; 2 fires
3 - built 1939; 16 chambers; 1 fire; space to extend to 20 chambers.

Production

Pre-war with 3 kilns - 17,000,000 roofing tiles
3,000,000 3-hole wire-cut common bricks.
A few hollow blocks.
1944 - 7,000,000 roofing tiles.

Key Personnel

Interviewed

Karl Wagner, Director
Friedrich Felderhaff, Engineer

Ludowice was stated to have a controlling interest in the company.

Numbers of Employees

Pre-war - 340
At time of visit - 61, including 7 foremen.

Comments.

The works was considered to be well laid out and efficient in operation.

TARGET NO.10: ZIEGELWERK MÜHLACKER K.G.a.A.

MÜHLACKER, WÜRTTEMBURG.

(Map reference: G.S.G.S. - L49/WR8140)

Visited on 23rd August, 1945 by the full team.

Activities.

Manufacture of clay roofing tiles, plain and interlocking, in a wide variety of designs, and a few common bricks.

General Description.

The target had been partly destroyed by bombing.

One kiln out of three was in operation at the time of the visit, and reconstruction of the works appeared to be making good progress. The works had been built in 1898, and the manufacturing process had been as follows:-

Claygetting - Multi-bucket excavators.

Transport to works - Jubilee trucks and electric loco.

Preparation and storage of clay - Box feeder to perforated pan; large smooth rolls; overhead conveyor to storage bin about 270 ft. long and 70 ft. wide; holding 1-2 months supply of clay; retrieved by multi-bucket excavator; single-rope haulage to mixers and rolls; pugmill.

Making - Clot extension machine; tile presses.

Drying - Keller dryers for tiles.
Tunnel dryer for bricks.

Burning - 3 zig-zag kilns:

1 - built 1898; 16 chambers; used for bricks; damaged and not in use.
2 - built 1898; 20 chambers; used for tiles; damaged and not in use.
3 - built 1907; 20 chambers; used for tiles; in use.

Mechanical stokers used on all kilns.

Production

Pre-war - about 10,000,000 pieces per year, comprising interlocking and plain roofing tiles and bricks.

At time of visit - about 2,500,000 plain tiles per year.

Key Personnel.

Interviewed	Not Interviewed
Ernst Waidner, Managing Director	Emil Keuthe, Director.
	Albert Feinauer, Engineer.

Ludowici was stated to have a controlling interest in the comapny.

Numbers of Employees

Pre-war - 300-350
At time of visit - 84.

TARGET NO.11: ZIEGELWERKE LUDWIGSBURG A.G.,
Ludwigsburg, Württemburg

(Map reference: G.S.G.S. 4346 - L49/WS0733)

Visited on 23rd August, 1945 by the full team.

Activities.

Manufacture of clay interlocking and plain roofing tiles, discontinued at time of visit.

General Description.

The target had been almost completely destroyed by bombing in February 1944, and was still in this condition and inactive at the time of the visit. It was stated that the company had a second works at Fellbach. Plans were being worked out for reconstruction of the target, and the following particulars were obtained of the former process and the new porposals:-

Clay - Reddish, loamy

Drying - Dryers over kilns and on ground floor, and an open shed for specials.
For the new works a Keller dryer over one kiln and a hot-air chamber dryer on the ground floor were proposed (see paragraph 39).

Burning - Two 16-chamber zig-zag kilns; mechanical stokers.

Production.

Pre-war - 9 - 10,000,000 pieces per year, comprising:

6,000,000 interlocking tiles
3 -4,000,000 plain tiles.

Wartime - about 2/3 of pre-ware production.

The production at the Fellbach works was stated to be about 6,000,000 bricks per year.

Key Personnel.

Interviewed: Karl Frank, Director.

Numbers of Employees.

Pre-war - 180 employees, including 50 women.

At Fellbach, pre-war - 100 employees, including 25 women.

TARGET No.12: WILHELM GAIL'SCHE TONWERKE A.G.,

Giessen, Hesse.

(Map reference: G.S.G.S. 4346 - L51/WG6719)

Visited on 24th August, 1945 by the full team.

Activities.

Manufacture of klinker and acid-resisting bricks and tiles, glazed wall-tiles, and partition blocks, (glazed both sides), all discontinued at time of visit.

General Description

The target consisted of two works about ¼-mile apart. Both had been partly destroyed by bombing in December 1944 and March 1945 and were inactive at the time of the visit. They were stated to be similar to one another as regards process and output. The process at No.2 works, which had been built in 1890, was as follows

Clay - White-burning stoneware clay, 15ft. face.
Claygetting - By hand, probably selected.

Preparation and storage of clay - Three wagons clay mixed with one wagon grog and one wagon sand in box feeder (grog previously passed through stonebreaker and continuous ball-mill); "rasplar" ("shredder" or "grater") (see paragraph 32) rolls; pugmill.
Clay for products other than bricks through storage bin.

Making - Raupach and other extrusion machines (not de-airing)
Hydraulic press for specials made by Hirsch and Frank.

Drying - Keller elevator to dryers over kilns.

Burning - (a) One top-fired barrel-arch kiln; central stack 100 to 120 ft. high; 16 chambers, each holding 15,000 tile-equivalents in a mixed setting; drop arches; firing klinker and acid-resisting bricks and tiles at 1,200°C.; 14 days to go round kiln circuit.

(b) Six intermittent rectangular down-draught muffle kilns; coal-fired; three grates per side; 4,000 to 6,000 pieces per muffle; firing glazed tiles and partition blocks (once-fired) to 1,200°C.; 4 to 6 days from setting to drawing.

Production

Prewar and wartime 25 - 30,000 tons per year from both works.

Key Personnel

Interviewed	Not Interviewed
Albert Jung, Proprietor.	Georg Gail, Proprietor and Chairman. Willmar Kause, Works Manager. Georg Hofmann, Technical Adviser.

Numbers of Employees.

Preware and wartime - 250 men, about half in each works.

At time of visit - 20 men.

TARGET NO.13: DACHZIEGELWERKE ERGOLDSBACH A.G.,

Ergoldsbach, Bavaria.

(Map reference: G.S.G.S. 4346 - M49/WU2921)

Visited on 27th August,1945 by H.H. Macey, E. Loewy and E.Rowden.

Activities

Manufacture of clay roofing tiles, plain and interlocking in a wide variety of designs, and building bricks, all almost completely discontinued at time of visit.

General Description

The target was the main works of three operated by the same company. The others were at Neufahrn (Target No. 14) and Straubing. The target was undamaged. The process was as follows:-

Clay - 80 per cent. local loam or loess, lacking in plasticity, mixed with 20 per cent. white clay ("tegel") obtained at Schwandorf, 45 km. away, as the overburden from opencast coal working.

Preparation of clay - Box feeders; wet pan; belt conveyor to one pair rolls; Raupach pugmill (not de-airing).

Making - (a) Interlocking tiles - Clot extrusion machine; belt conveyor to five presses.
(b) Plain tiles - Extrusion machine with cutter, made by Georg Willy.

Drying - (a) Interlocking tiles - Keller elevators, one from each pair of presses to Keller dryer.
(b) Plain tiles - mono-rail conveyor to;
(i) 27-chamber Keller dryer over 20-chamber kiln, heated by exhaust and live steam and warm air rising naturally from top of kiln,
(ii) open rack dryer over an old kiln, heated by hot air from drawing chambers on 20-chamber kiln,
(iii) four open rack dryers, one on each of the four storeys above the 24-chamber kiln, heated as follows:-

1st shed - mainly steam to gilled pipes, but also heat rising from kiln.
2nd shed - hot air extracted by fan from drawing chambers of kiln below.
3rd and 4th sheds - heat rising from the sheds below.

Burning - Two zig-zag kilns, one of 24 chambers and one of 20 chambers; each kiln served by separate stack assisted by a fan; Schag-type mechanical stokers on both kilns.

Working hours - 48 hours per week.

Production

Pre-war (1936) - Approximately 22,000,000 pieces per year, comprising:-

10,000,000 plain tiles
3,500,000 interlocking tiles
5,600,000 special interlocking tiles
300,000 ridge tiles
2,500,000 bricks

Wartime - 70 - 75 per cent. of prewar production.

Key Personnel.

Max Schrommer, Managing Director.
Georg Maier, Deputy Managing Director.

Numbers of Employees

Prewar (1936) and wartime - 22- employees, including 70 - 80 women.

At time of visit - 25 employees.

TARGET NO. 14: DACHZIEGELWERKE ERGOLDSBACH A.G.

Neufahrn, Bavaria.

(Map reference: G.S.G.S. 4346 - M49/WU2725)
Visited on 27th August, 1945 by H.H. Macey, E. Loewy and E. Rowden.

Activities

Manufacture of clay roofing tiles, plain and interlocking in a wide variety of designs, and drain tiles, all discontinued at time of visit.

General Description

The target was undamaged. The process was as follows:-

Clay - As at Target No. 13.

Preparation of clay "

Making - "

Drying - Two Keller dryers, each with 64 chambers, on two floors, over the kilns. The Keller dryers on the floor immediately over the kilns were heated by hot air from the drawing chambers on the kilns, and by exhuast steam and possibly some live steam at night. The dryers on the top floor were heated by exhaust and live steam only.

Burning - Two 17-chamber zig-zag kilns; both kilns served by a single stack, assisted by a fan; Schag mechanical stokers on both kilns.

Power - One water-tube boiler, chain-grate fired and fitted with economiser and superheater.

Two engines:-

1. Main engine - single cylinder horizontal engine with special valves, heavy flywheel and belt drive to a 256 KW alternator; all exhaust to dryers.

2. Subsidiary engine for night use - small steam turbine; exhaust and some live steam to dryers.

Working hours - 48 hours per week.

Production

Prewar (1938) - approximately 21,000,000 pieces, comprising:-

12,200,000 plain tiles
8,300,000 interlocking tiles
300,000 ridge tiles
375,000 drain tiles

Wartime - 70-75 per cent. of prewar production.

Key Personnel

Max Schrommer, Managing Director.
Georg Maier, Deputy Managing Director.

Numbers of Employees.

Prewar (1938) and wartime - 240 employees, including 80-90 women.

At time of visit - 10 employees.

TARGET NO.15: DAMPFZIEGELEI HANS ADAM

Argelsried, nr. Munich.

(Map reference: G.S.G.S.4346 - M49/WY6651)
Visited on 28th August, 1945 by H.H. Macey, E. Loewy and E. Rowden.

Activities.

Manufacture of perforated common bricks, discontinued at time of visit.

General Description

The target was undamaged. The manufacturing process was follows:-

Claygetting - Multi-bucket excavator on rails in base of quarry.

Transport to works - Jubilee trucks hauled by winch.
Preparation of clay - Rotary feeder; one pair of rolls; Rieter pugmill; waste from dryer passed through disintegrator and added to clay when it is too wet.

Making - Keller fully-automatic cutting-off plant.

Drying - Keller fully-automatic handling plant to 27-chamber Keller dryer over kiln, heated by hot-water pipes and by hot air from the kiln. A small cylindrical hot-water heater, fired from the top with coke of 3-4 in. size and provided with an automatic thermostatic control at the primary air supply to the grate was situated on the ground floor. An electric pump circulated the water at a temperature of 95-100°C. through the pipes in the dryer and back to the heater.

Burning - One 20-chamber top-fired barrel-arch kiln with round ends; total holding capacity 140,000 standard 6.5 cm. bricks; stack 45 metres (148 feet) high; hot air drawn off from back cooling chambers by a 7 H.P. fan and passed into the base of the Keller dryers above; Schag mechanical stokers.

Working hours - 48 hours per week, but the making plant, since its capacity exceeds that of the kiln, is operated about 1½ hours less per day, say about 40 hours per week. The whole plant is shut down for one month each January when there is snow in the quarry, and during this time the machinery is overhauled.

Power - All purchased electricity.

Production

Prewar (1938) -

Over-size perforated common bricks (12 x 25 x 9.5 cm., with 95 holes)	Equivalent of 7,180,000 standard-size bricks per year.
Standard size perforated common bricks (12 x 25 x 6.5cm. with 28 holes) (made to special order only)	
Solid common bricks (made to special order only)	

Wartime (1944) - Equivalent of 6,135,000 standard-size Bricks.

Key Personnel

Interviewed	Not Interviewed
Arnulf Sohler, Manager	Hans Adam, Proprieter.

Number of Employees

Prewar (1938) - 25 - 28 operatives
2 office staff.

Comments

The works appeared to be very efficient (see paragraph 19) Although the clay received little treatment the products appeared to be of good quality. It was noted, however, that the Keller cutter made two unpleasant marks on one face of each brick.

TARGET NO.16: AKTIEN-ZIEGELEI MÜNCHEN

Unterföhring, nr. Munich

(Map reference: G.S.G.S. 4346 - M49/WY9163)
Visited on 28th August, 1945 by H.H.Macey, E.Lowry and E.Rowden.

Activities.

Manufacture of common and klinker bricks and klinker wall and floor tiles, all discontinued at time of visit.

General Description

The target was undamaged. The manufacturing process was as follows:-

Clay - Alluvial

Preparation of clay - Boxfeeder to pan; Rieter round feeder to one pair of rolls, Rieter pugmills.
(The above plant in duplicate.

Making - (a) Bricks - Pugmills; Keller fully-automatic cutting-off plant.

(b) Klinker tiles - Lacis hand-controlled hydraulic presses.

Drying - (i) 121-chamber Keller dryer on floor above the three gas-fired kilns and two of the 16-chamber barrel-arch kilns, heated by live steam and hot air drawn off from the cooling zone of the various kilns.
(ii) Open-shed rack dryer, 4 storeys high over the third 16-chamber barrel-arch kiln , heated by live steam and warm air rising naturally from the top of the kiln.
(iii) Rack dryer around the 12-chamber kiln.

Burning - (a) Common bricks - Four plain barrel-arch kilns, three with 16 chambers and one with 12 chambers; two 16-chamber kilns shared one stack; the other two kilns each with own stack; the 12-chamber kiln not used much except during the summer; Schag mechanical stokers normally used, but worn out during the war and hand-feeding adopted.

(b) Klinker bricks and floor tiles - Three 14 - chamber Mendheim continuous chamber kilns, fired with producer gas; chambers small, each holding 4,000 bricks; each kiln provided with its own producer, of suction type, operated by the draught on the kiln; producers coal-fired and gas produced passed direct through underground flues to the kilns; four gas valves per chamber; new pressure-type gas producer, mechanically operated and provided with a dust separator, being installed to operate the three kilns; firing temperature 1,230° - 1,250°C; reducing conditions employed for about the last three hours of firing; only about 40 per cent. of the products blue, the remainder brindled brown or red; the 12-chamber kiln merely roofed over; the other six kilns built end to end, forming with the dryers over a single long building mainly three storeys high. (See Fig. 1.)

Power

All purchased electricity; boiler only provides steam for drying.

Production

The works was destroyed by fire in 1935 and was modernised to give a production of 30 - 35 million pieces.

Prewar (1938) - 28,200,000 pieces per year, comprising:-

16,000,000 bricks
10,500,000 klinker bricks and specials
2,500,000 tiles

Wartime (1944) - 15,800,000 pieces

Key Personnel

Interviewed	Not Interviewed
Max Kühbandner, Shop Manager	Wilhelm Siekman, Chairman
Karl Denkinger, Book-keeper.	Gerhard Illig, Works Manager
	Hans Barth, Transport Manager
	Josef Linseisen, Engineer.

Number of Employees

Prewar (1938) - 206, including 42 women
Wartime (1944) - 182, including 24 women
At time of visit - about 40 men (making green bricks).

TARGET NO. 17: EISEN-UND HARTGUSSWERK

"CONCORDIA" G.m.b.H.

Hameln (on the Weser)

(Map reference: G.S.G.S. 4346 - L53/RC 1391)
Visited 13th August, 1945 by G.N.Hodson, B.Butterworth, E.Loewy, H.H. Macey and S.B. Stedham.

Activities

Main: Manufacture of polished squeezing rolls in chilled cast iron for rubber, paper, sheet-metal and other industries.

Subsidiary: Grinding and extrusion machinery for plastic clay processes (not de-airing)

General Description

The target was 70 per cent. operable, the machine-shop having been damaged.

Production

Production as a whole had slightly decreased during the war. No clayworking machinery had been made during the war, but production was being resumed at the time of the visit.

Key Personnel

Interviewed: Dr. Ing. Krause, General Manager.
Herr Festing, Chief Engineer.

Numbers of Employees

Pre-war and wartime - 250 - 300 men.

Comments

The clayworking machinery generally was of the type familiar in Britain, but there were a few details in design differing slightly from British practice.

TARGET No.18: C. KELLER & CO.
Laggenbeck, Westphalia.

(Map reference: G.S.G.S. 4346 - K53/RW0307)
Visited on 14th August, 1945 by the full team.

Activities.

Design and assembly of brickmaking machinery incorporating patent systems for cutting-off, handling, conveying and drying.

General Description

The target was undamaged. During the war the production of brickmaking machinery had been reduced to about one-third of its prewar volume, and the remainder of the capacity of the works had been taken up by armament production. The machine-shop was equipped with modern medium-sized automatic and plain lathes and gear-cutting and grinding machinery, and it appeared that it could be used for any accurate repetition work.

Brickmaking plant seen in course of manufacture included:

Roofing-tile cutters,
Small automatic cutters (Kleinautomat) for bricks,
Fully automatic cutters (Fullautomat) for bricks,
Finger cars,
Kiln trolleys,
Transfer cars.

For description of Keller's work in connection with dryers see paragraph 42 - 44.

The firm's plant and systems are well known in this country. Their British agents before the war were M. Steenbrugge and Company.

It was stated that Keller was negotiating with R. Raupach G.m.b.H., of Görlitz for rights to manufacture the latter's patents for heavy brickmaking plant.

Key Personnel

Interviewed	Not Interviewed
Joseph Keller, Aloys Keller, Joint General Managers	Heinrich Laube, Manager Hermann Prange, Wilhelm Deuper, Designers.

Number of Employees

Prewar - 220 employees
Wartime- 300 employees, including 75 Russian prisoners of war and 100 women.
At time of visit - 200 employees.

Comments

The products seen and the equipment and general condition of the works suggested precision rather than heavy work.

It is recommended that a team representing British clayworking machinery manufacturers should visit this target, and it is suggested that they should consider the removal of examples of the various cutting machines.

TARGET NO.19: BERGER & CO. G.m.b.H.

Bergisch Gladbach, nr. Cologne

(Map reference: G.S.G.S. 4346 - K51/WF5765)
Visited on 17th August, 1945 by the full team.

Activities.

Manufacture of:

Clayworking machinery,
Presses for various industries,
Grinding machinery,
Sand-blasting machinery for foundries etc.,
Machinery for screening and cleaning or crushing, masonry rubble from bombed buildings.

(All the above, except the rubble machinery, made also at Merseburg)

All production discontined at time of visit, awaiting permission to restart.

General Description.

The target was the larger of the two works operated by the same company. The other works was at Merseburg, near Leipsig. The target had been bombed and was only 50-60 per cent operative on the basis of numbers of employees. Since 1942 the company had been producing parts for tanks and guns.

Key Personnel

Interviewed	Not Interviewed
O.H. Brandi, Managing Director.	At Bergisch Gladbach: Erich Malchow, Sales Manager Hermann Sers, Production Manager At Merseburg Johann Kleuser, representing Managing Director. Rudolf Schulze, Sales Manager. Otto Herrich, Production Manager.

Numbers of Employees

	Bergisch Gladbach	Merseburg
Pre-war	400 - 500	150
Wartime	350	150
At time of visit	60	20

Comments.

The machine-tools generally were of good quality. Products of particular interest were (a) a moveable electrically driven press (see paragraph 25) and a de-airing pug (see paragraph 27).

It is recommended that a team representing British claymaking machinery manufactures should visit this target.

TARGET NO. 20: KARL HÄNDLE & SÖHNE.

Mühlacker, Württemburg

(Map reference: G.S.G.S. 4346 - L49/WR8139)
Visited on 23rd August, 1945 by the full team.

Activities.

Manufacture of brick-and tile-making machinery for the following parts of the process:

Preparation of clay,
Extrusion and de-airing,
Pressing (of tiles) (No hydraulic presses),
Feeding (of clay),
Conveying,
Automatic stoking,
Manufacture of castings for other industries.

All production discontinued at time of visit, awaiting permission to restart.

General Description.

The buildings had been damaged to the extent of about 10 per cent. but no plant had been damaged. About 80 per cent. of the company's hand tools and instruments were stated to have been taken by the French Forces.

The company's products were stated to be in use all over Germany on clays all kinds, and in other parts of the world, including England. The company's British agents had been the Pragos Engineering Co. Ltd.

Key Personnel

Interviewed	Not Interviewed.
Dr. Georg Händle	Karl Händle
Richard Händle	

Numbers of Employees.

Prewar - 280 employees
Wartime - 280, of whom about two-thirds were on armament work.
At time of visit - 80, largely on maintenance and bomb repair work.

Comments.

It was considered that the company had a good machine-shop and a good series of designs for clayworking machinery (see paragraph 23 and 26).

APPENDIX III

SUMMARY OF PRODUCTION AND FUEL CONSUMPTION FIGURES

(a) WORKS MANUFACTURING MAINLY ROOFING TILES.

Target Number and Name	Production per Year	Fuel Consumption per Year (metric tonnes)	Type and Number of Kilns	Number of Chambers	Firing Temperature (° C.)	Approximate Fuel Consumption per 1000 Articles (cwt.) Kiln	Boiler	Dryer	Total	Electricity Purchased per 1,000 Articles.
1. Heisterholz	8,000,000 tiles	Variable according to whether power taken from grid or generated at works. In summer taken from grid: in wirter power station used with exhaust for drying.	3 barrel-arch top-fired	18	950-960	4.5	?	-	?	?
9. Wiesloch	17,000,000 roofing tiles 3,000,000 bricks 20,000,000	Coal to boilers. 1,100-1,320 Coal to kilns: 4,200 Total 5,400-5,640 Coke to 1 dryer: 480	3 zig-zag	(1) 28 (2 fires) (2) 32 (2 fires) (3) 16	960	4.2	1.2	0.5	5.9-6.1	-
10. Mühlacker	10,000,000 flat and interlocking tiles and bricks	Coal to kilns and power house (Plant badly damaged)	3 zig-zag	2 of 20 chambers for tiles, 1 of 16 chambers for bricks.	980-1000	?	?	-	6-7# doubtful	-
11. Ludwigsburg	6,000,000 interlocking tiles 3-4,000,000 plain tiles 9-10,000,000	Coal to kilns and power house (Plant badly damaged)	2 zig-zag	16 + 16	990	?	?	-	?	-
13. Ergoldsbach	10,000,000 plain tiles 3,500,000 interlocking tiles 3,600,000 special interlocking 300,000 ridge tiles 2,500,000 bricks 21,900,000	Boiler: 3,000 Kilns: 2,300 5,300	2 zig-zag	20 + 24	900 - 1,000	2.1	2.7	-	4.9	-
14. Neufahrn	12,200,000 plain tiles 8,300,000 interlocking tiles 300,000 ridge tiles 375,000 drain tiles 21,175,000	Boiler 4,000 (Poor quality) Kilns: 3,000 7,000	2 zig-zag	17 + 17	880-900	2.8	3.8	-	6.6	-
	(b) WORKS MANUFACTURING BRICKS									
2. Hilgen	8-8,500,000 klinker and common bricks	Coal to kilns and boiler 3,840 Lignite for drying on kiln 240 4,080	2 barrel-arch top-fired	18 + 20	1,060-1,120	Approx.5 cwt. coal + 0.6 cwt. lignite.	?	-	10.2	-
7. Rödelheim	12,000,000 bricks (facing mainly and commons and hollow blocks)		2 barrel-arch top-fired	16 + 18	900	2.9	2.0	-	4.9	-
8. Argelsried	Equivalent of 7,150,000 bricks (perforated)	Coke to dryers 240 Fine coal to kiln 600 Fine coke to clay 500 1,340 Electricity 132,000-143,000 K.W.h.	1 barrel-arch top-fired	20	940-960	1.7 1.4 3.1	-	0.7	3.7	18.4-20.0 K.W.h.
15. Unterföhring	16,000,000 bricks 10,000,000 clinker bricks and specials 2,500,000 clinker tiles 29,000,000	Kilns 10,800 Boiler (drying only) 1,500 12,300 Electricity 650,000 K.W.h. Diesel oil 154,000 lb.	4 barrel-arch top-fired for bricks, 3 Hendheim chamber continuous kilns, producer-gas-fired.	3 of 16 chambers 1 of 12 " # 3 of 14 " # Not used much	800-1,000 1,230-1,250	7.5	-	1.0	8.5	22.4 K.W.h. + 5.3 lb. diesel oil.

APPENDIX IV.

DIMENSIONS OF KILNS

(a) KILNS USED FOR FIRING ROOFING TILES

Target Number and Name	Type of Kiln	Number	Chambers Width (ft.ins.)	Chambers Height (ft.ins.)	Approximate length if Fire Circuit (ft.)	Time to Travel round Kiln (days)	Approximate Rate of Travel (ft. per day)	Draught In front of Fires (in.w.g.)	Draught At Fan or Stack (in w.g.)	Stack Height (ft.)	Fan	Remarks
1. Heisterholz	Barrel-arch top-fired.	18	10' 10"	7'6"	410	6½	63	0.43	0.87	148	Fan	
9. Wiesloch	Zig-zag	28 ✱ 32 ✱ 16	9' 0" ? 8'0"	7'9" ? 7'9"	670 700 326	14 - 15 18 8 - 9	48 40 36 - 40			164 131	Fan Fan -	✱ Two firing circuits both kilns and boiler into one stack.
10. Mühlacker	Zig-zag	20 20 16	7'9"	7'9"		7 - 10				50 - 60	Fan 8-10 H.P. Fan do Fan do.	
11. Ludwigsburg	Zig-zag	16 16	7'3" 5'11"	7'7" 7'3"	435 407	(min) 32 (max)✱ 62(av) 67 (max)✱ 98(av)		3.1	4.0	197	Fan (50 H.P.)	✱ Once did 24 chambers per week.
13. Ergoldsbach	Zig-zag	20 24	8'0" 7'3"	8'0" 7'8"	612 610 (approx.)	7 - 10 7 - 9	61 - 87 (max) 65 - 87 (max)			131 148	Fan Fan (10 H.P.)	
14. Neufahrn	Zig-zag	17 17	8'3" 8'3"	8'3" 8'3"	560 560	7 - 8.2 7 - 8.2	68 - 80 (max) 68 - 80 (max)		1.57 1.57	295	Fan (20 H.P.)	

(b) KILNS USED FOR FIRING BRICKS

2. Hilgen	Barrel-arch top-fired	18	10'6"	8'0"	279	14	20		0.78 - 0.87	148	-	
		20	13'6"	8'6"	361	21	17		1.0	197	-	
7. Rödelheim	do.	18	13'1" ✱	7'10½" ✱	197	7	28 39 (max)			135	-	Can go round kiln in 5 days.
		16	9'10" ✱	9'2" ✱	180	77	26			115	-	✱ Figures open to some doubt.
15. Argelsried	do.	20	8'9"	7'0"	280	7 - 8	35 - 40			150		Kiln capacity 140,000 bricks.
16. Unterföhring	do.	16 16 16 12	12'0"	8'3"	256	8	32			148 ✱ 148 130	- - -	✱ Two kilns into one stack.

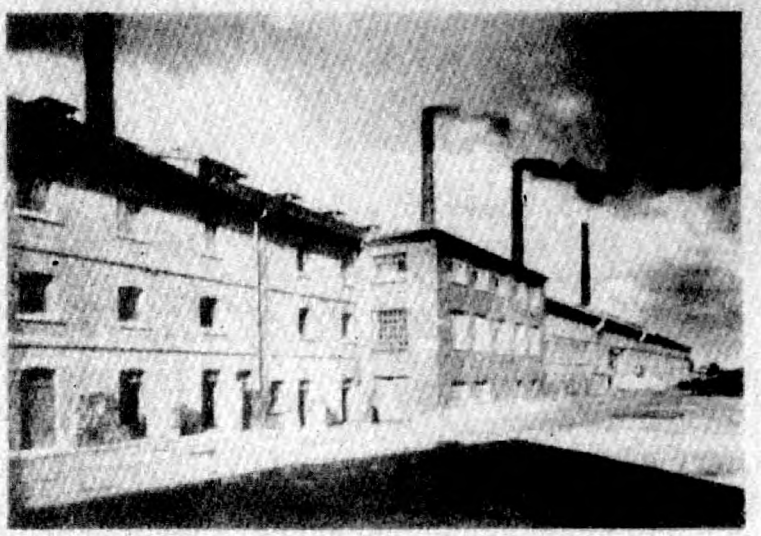


Fig. 1. View of Target No. 14. (Unterföhring) showing buildings housing kilns and dryers.

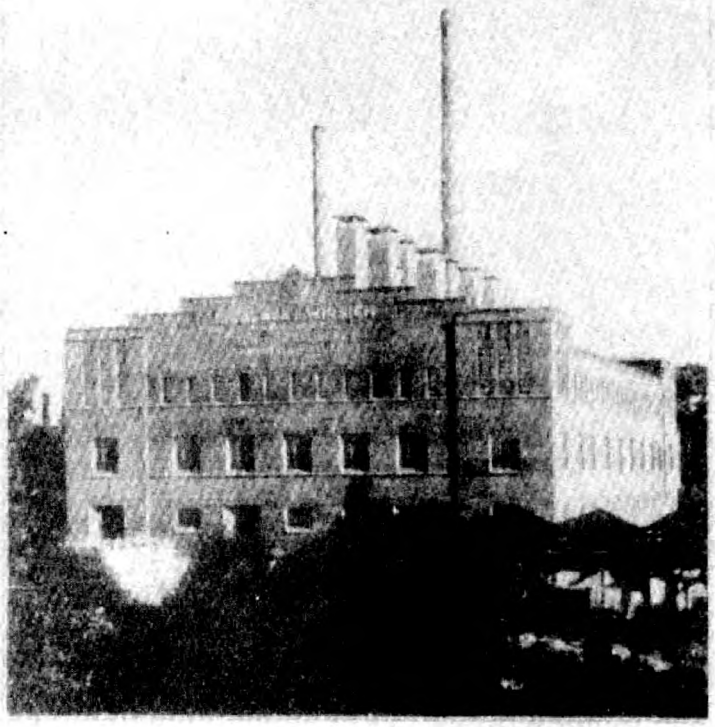


Fig. 3. Example of German clayworks design. The building shown contains a kiln with Keller dryers above.

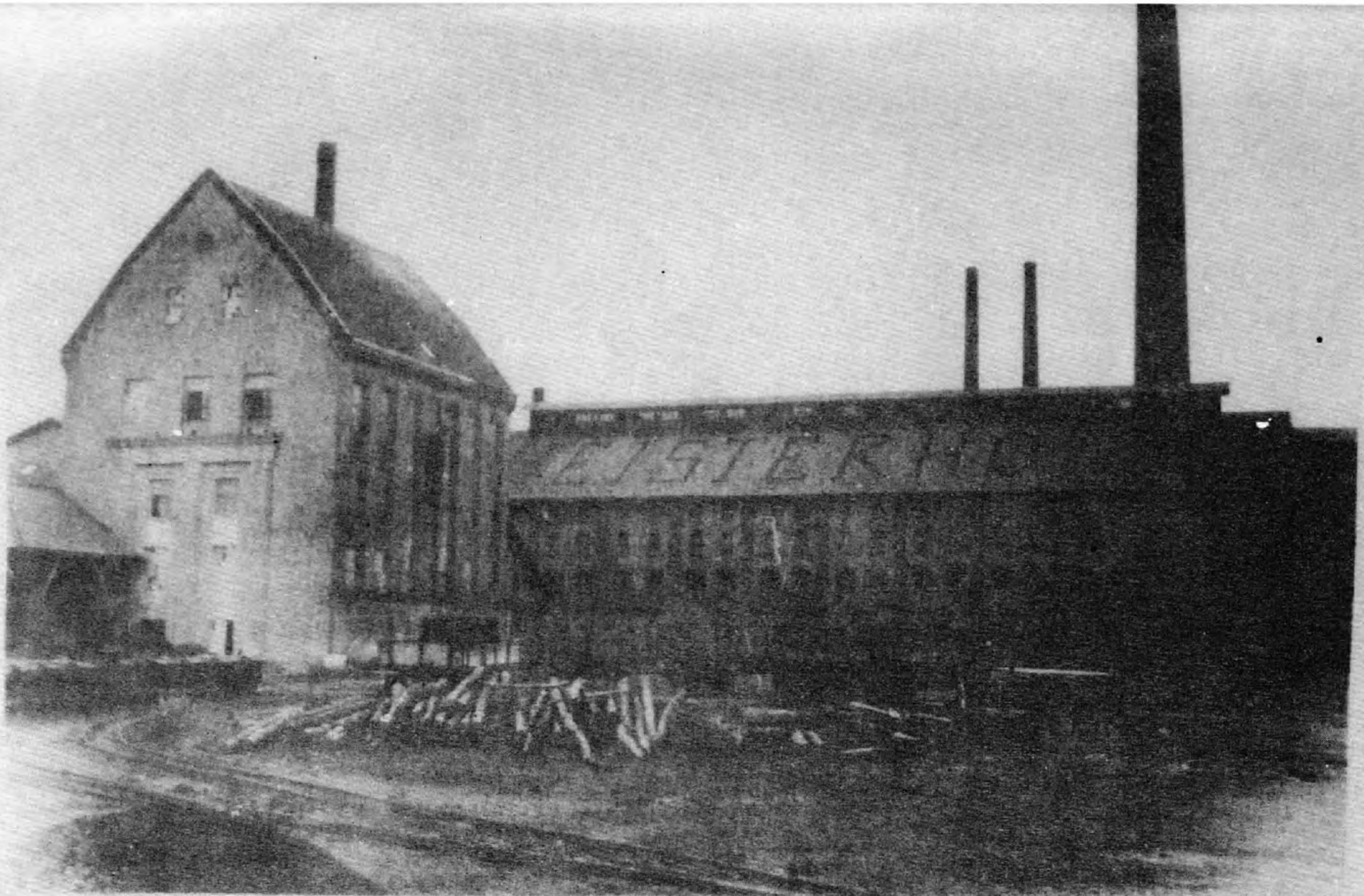
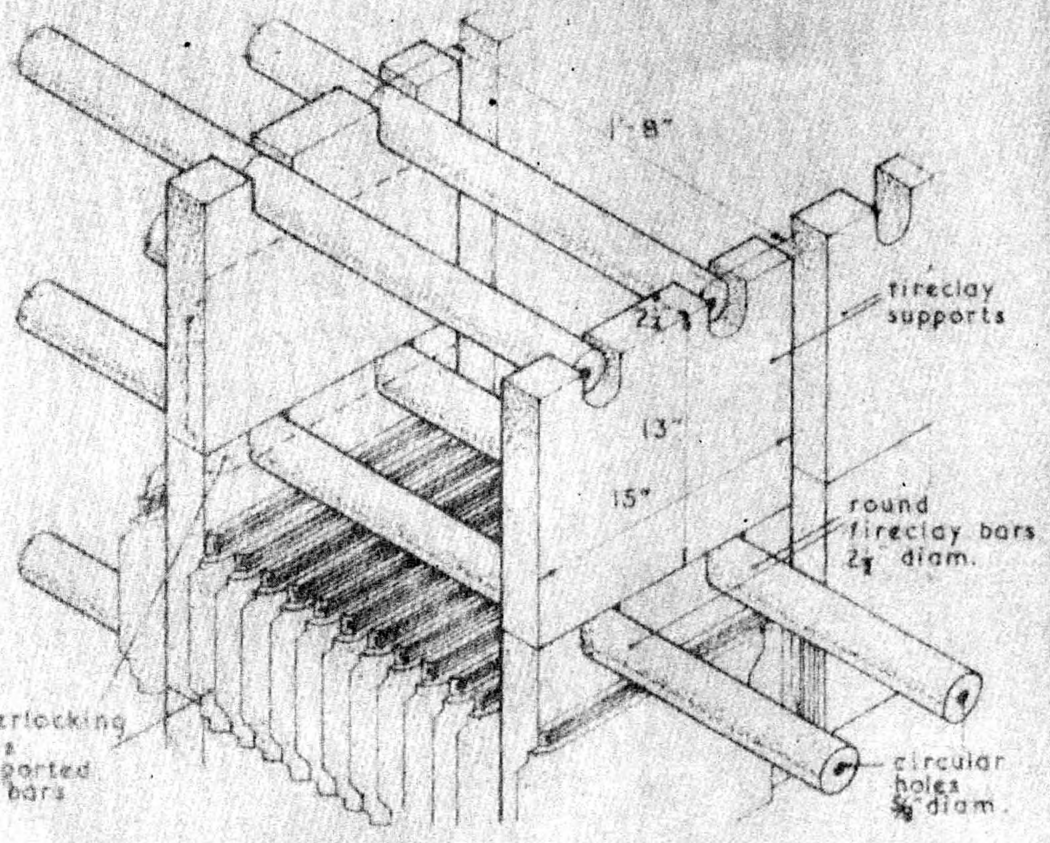


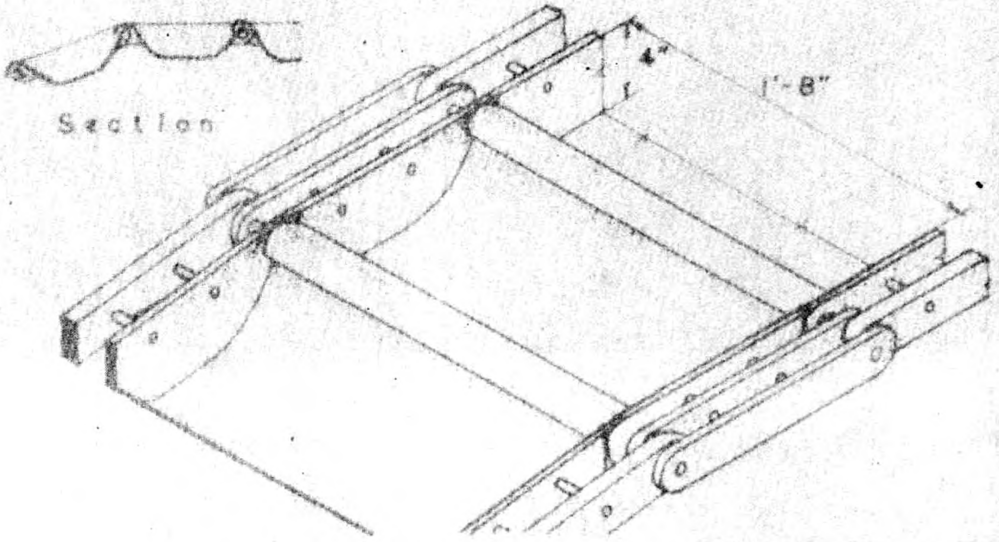
Fig. 2. View of Target No. 1. (Heisterholz) showing machine-shop (on left), and building housing a kiln and dryer (on right).

FIG. 10. METHOD OF SETTING EMPLOYED AT HEISTERHOLZ FOR ROOFING TILES



Isometric View of Setting

FIG. 4 STEEL TROUGH CONVEYOR MADE BY R RAUPACH



Isometric View

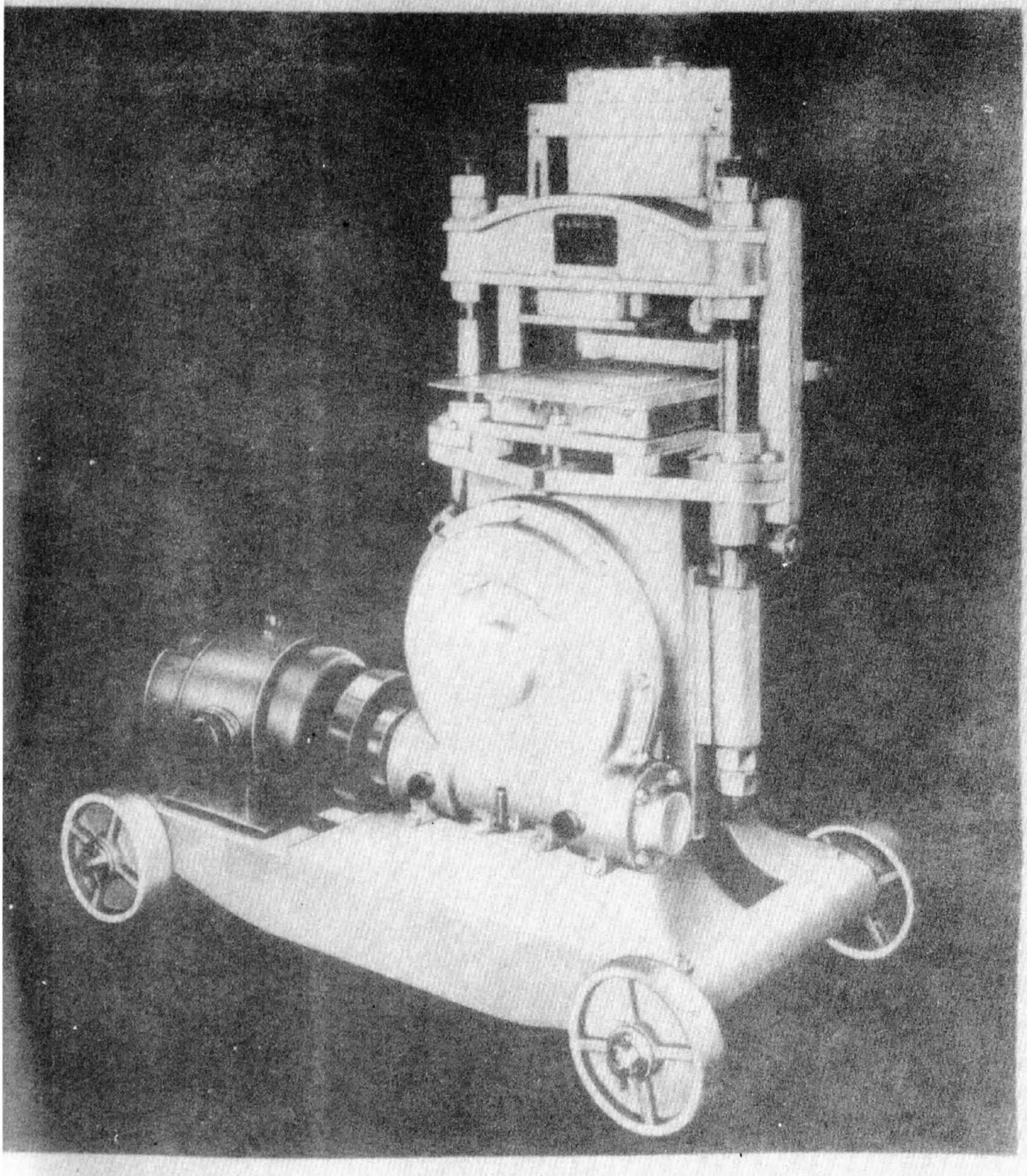


Fig. 5. Moveable electrically-driven press made by Berger and Cº

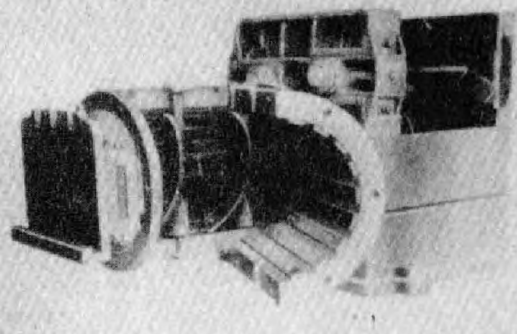


Fig. 6. Pug with paddle-type feeder, made by Rieter.

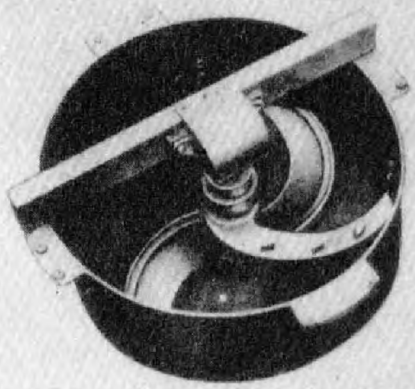


Fig. 8. Rotary feeder, made by Rieter.

Fig. 11. Mechanical kiln-feeder, made by Schumann.

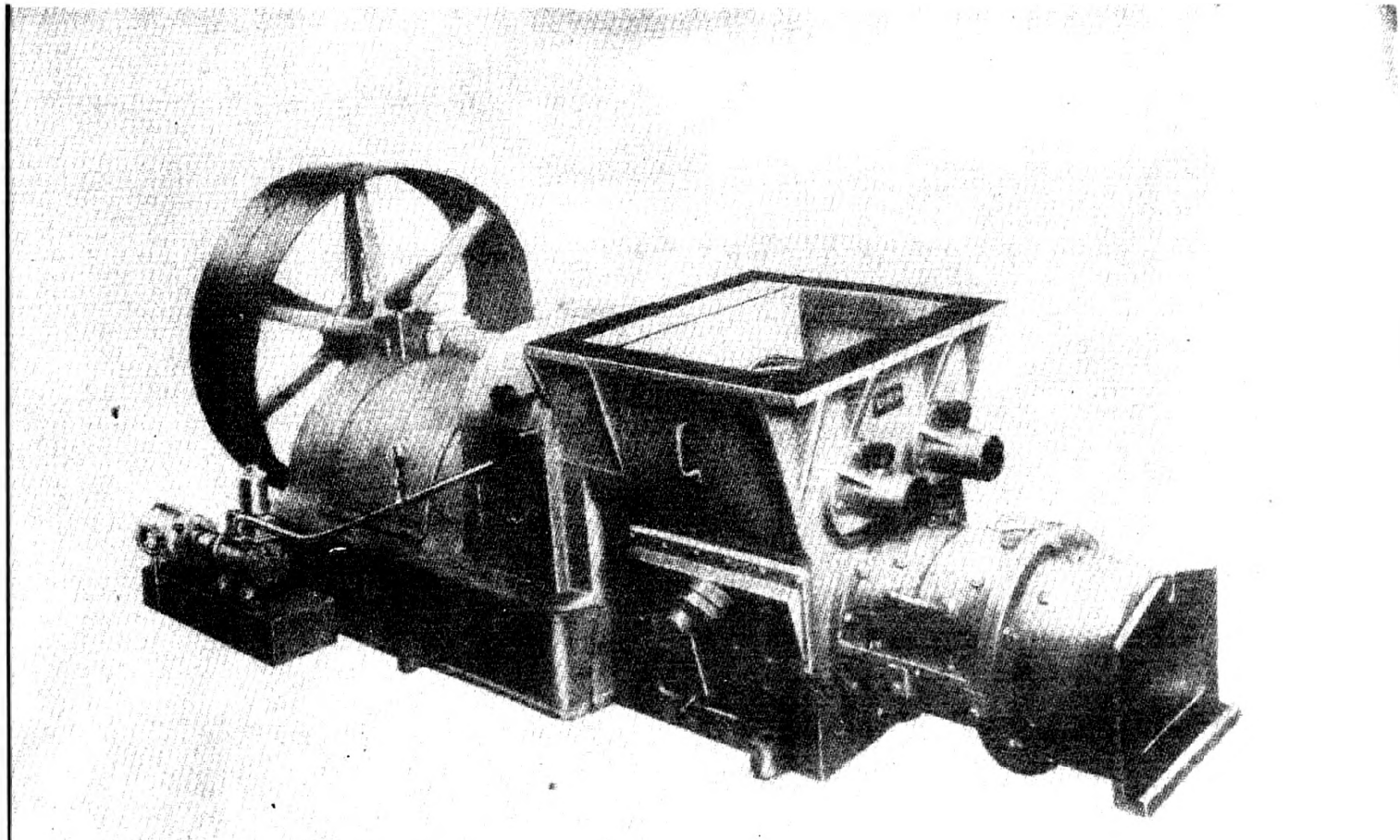
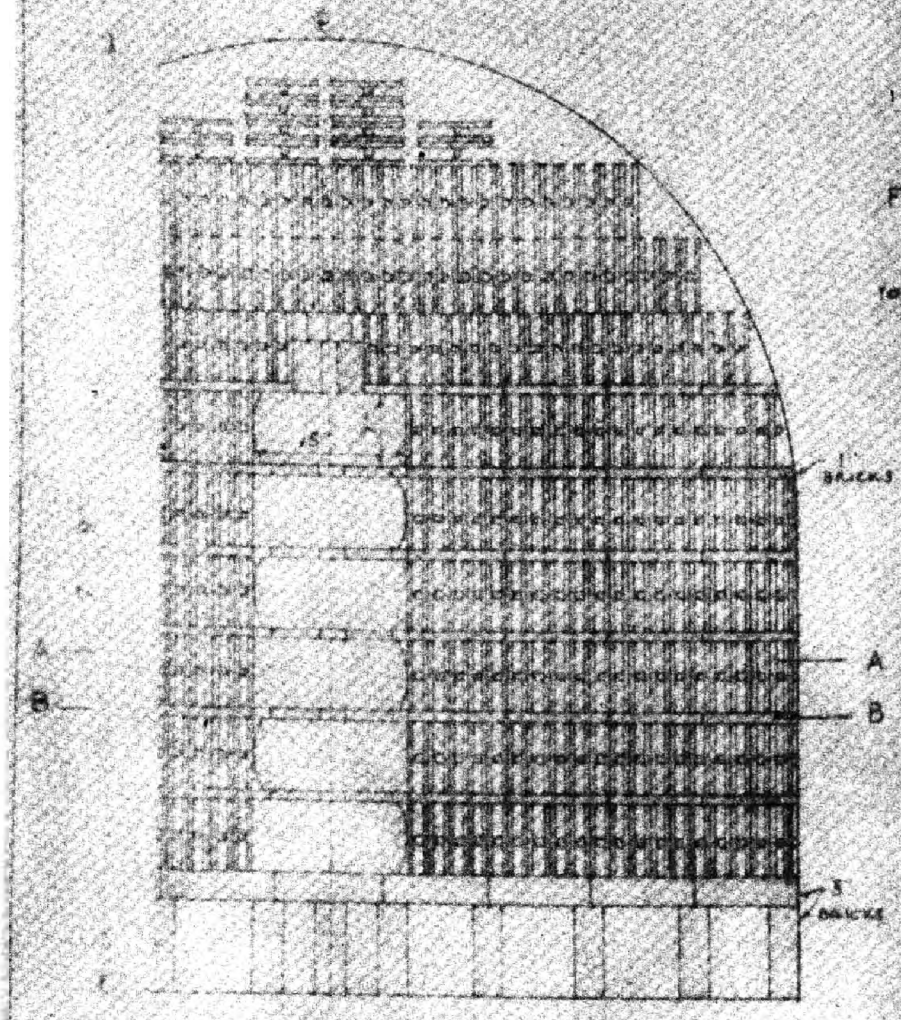
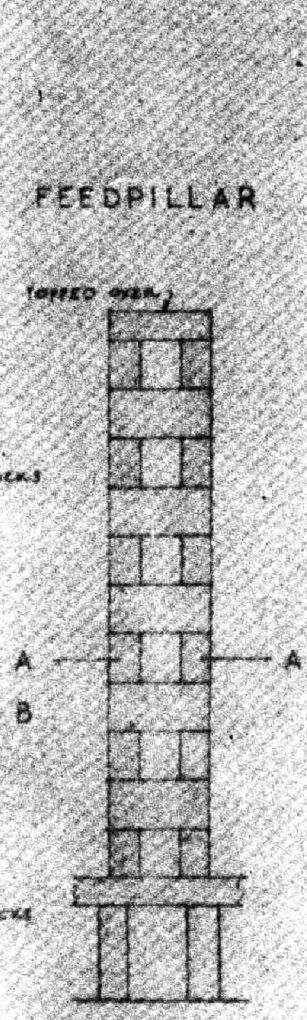
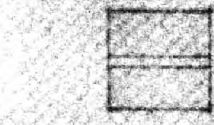


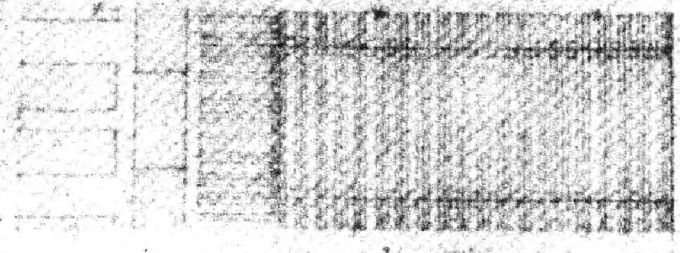
Fig. 7. De-airing pug made by Berger

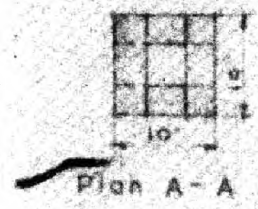
FIG 9 NORMAL GERMAN SETTING FOR PLAIN ROOFING TILES






Plan of Top





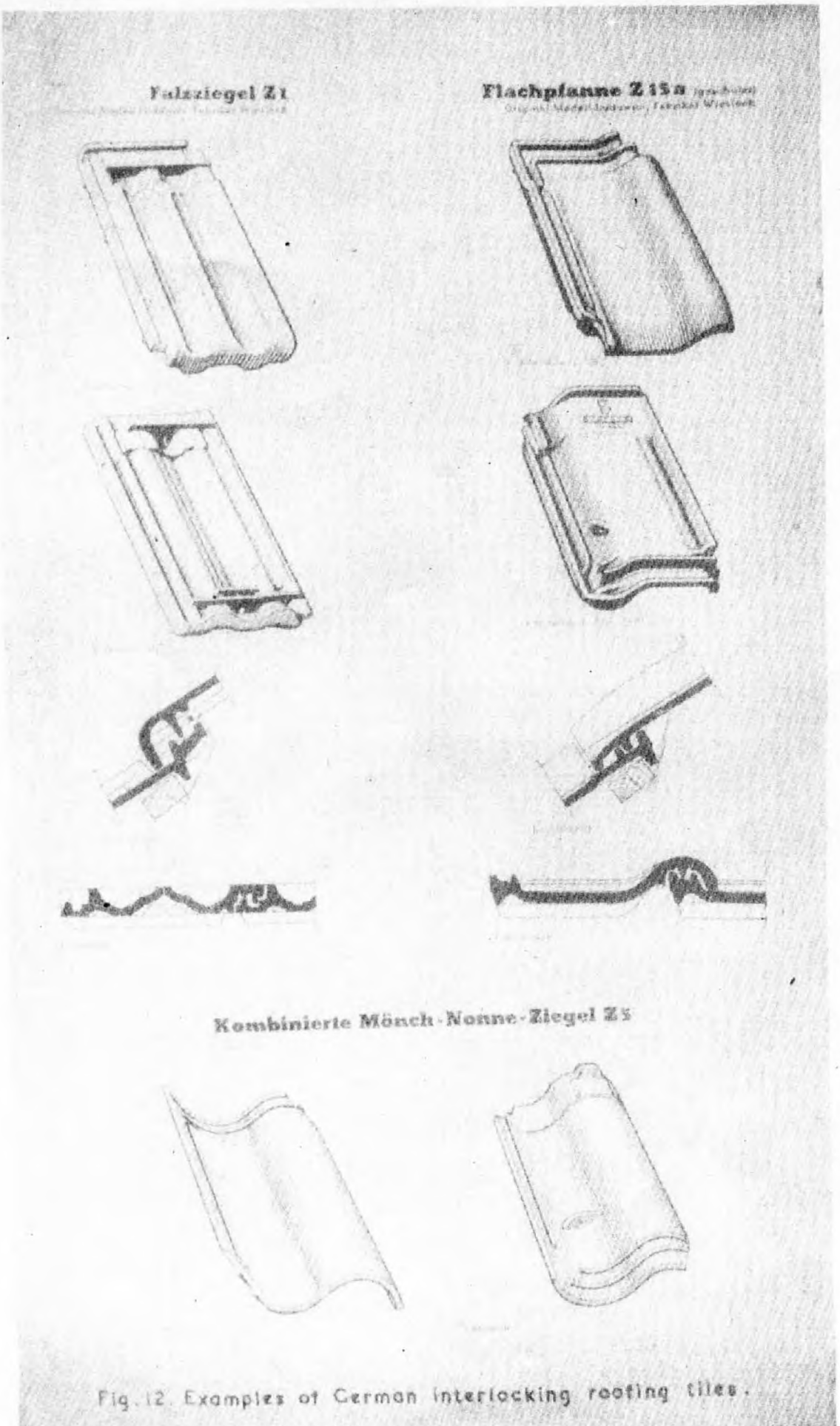


Fig. 12. Examples of German interlocking roofing tiles.

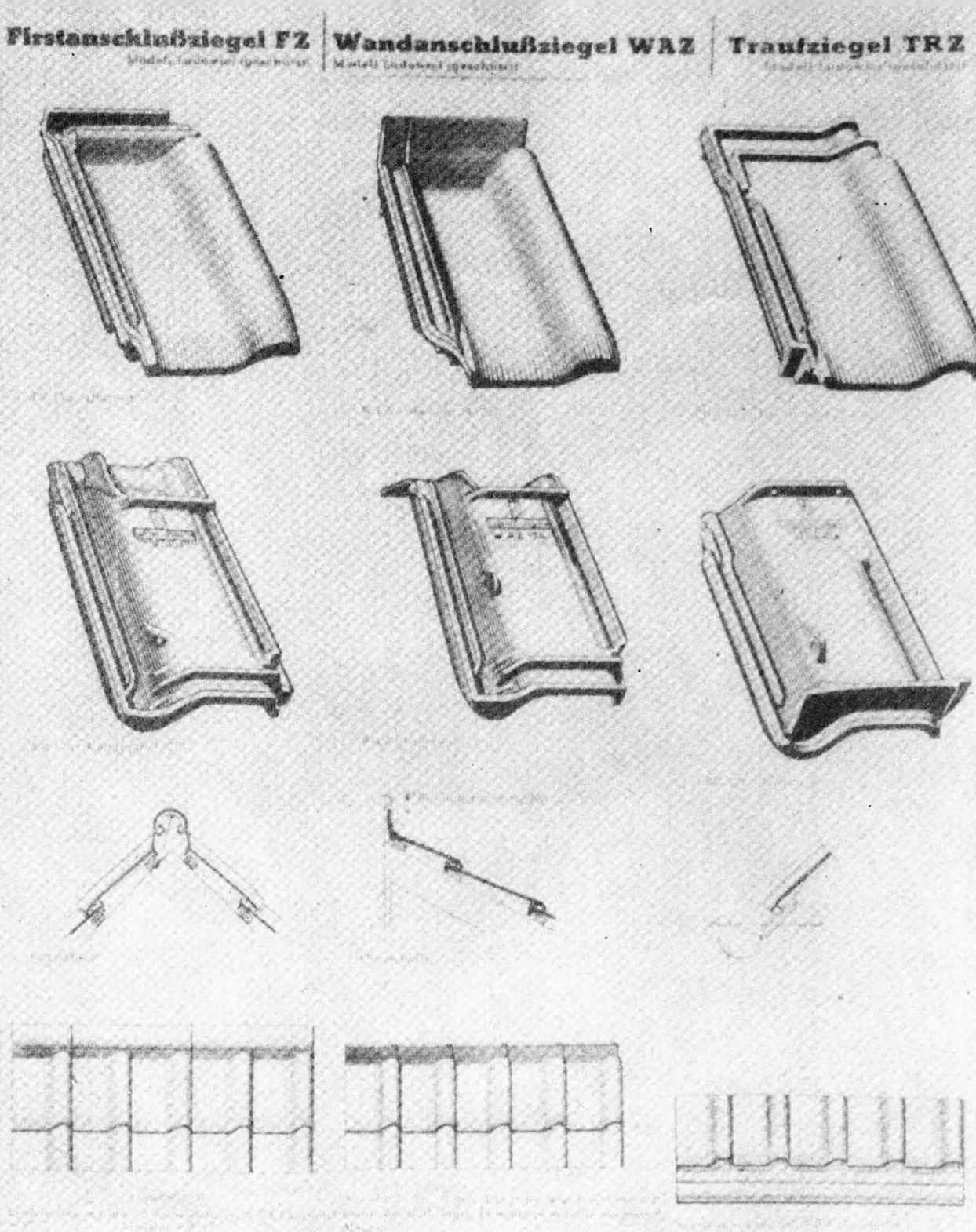
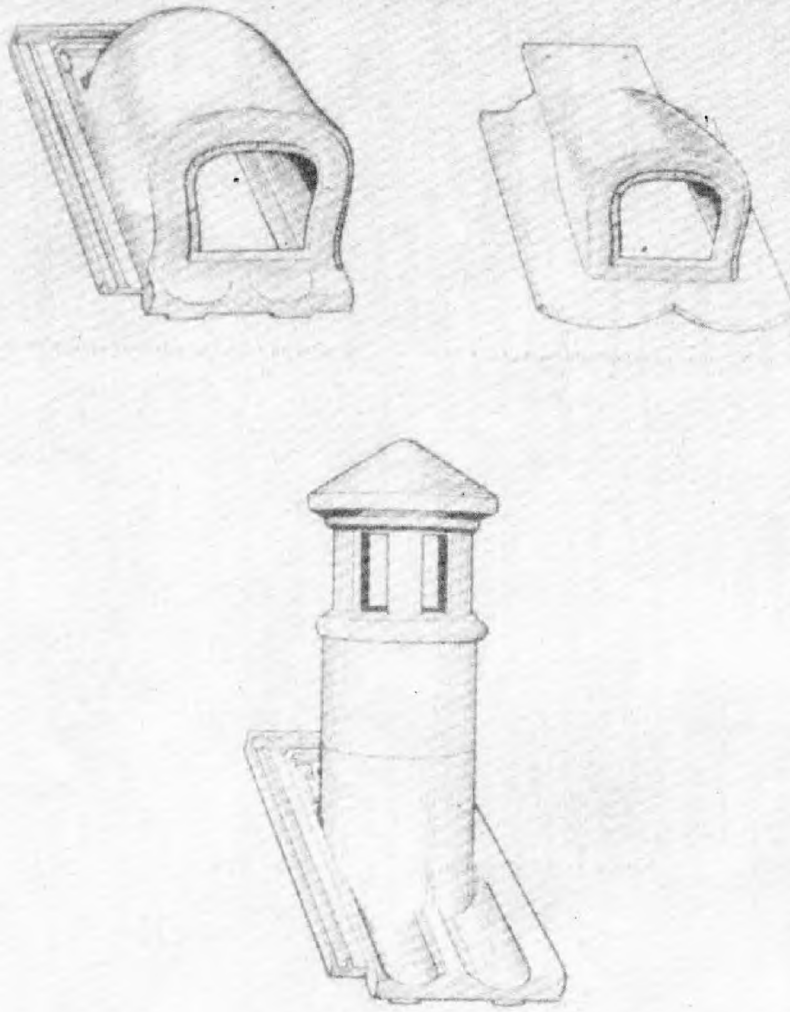


Fig 13 Examples of German special roofing tiles for use with tiles of the type of Z (5.6) (see Fig 12)



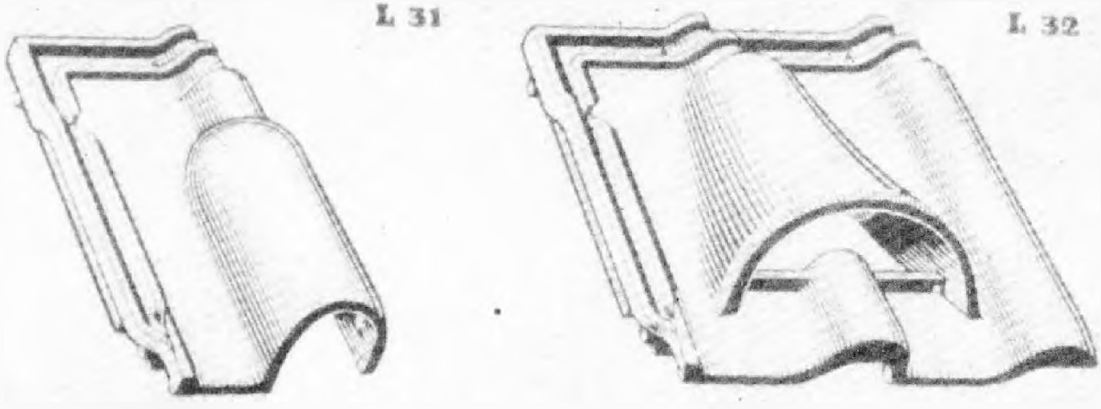


Fig 14 Examples of German ventilator tiles

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