BREWERY
HISTORY

Brewery History (2013) **153**, 48-65

GERMAN BREWING INDUSTRY - PART I

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The following piece, to be serialised over three issues, is one of a number of reports produced by the British Intelligence Objectives Sub-Committee (B.I.O.S.), a body whose purpose was to gather and publish information about German and Japanese technology after World War Two. This particular report was the work of six men, Col. J. H. Porter, Mr. A. Clark Doull, Dr J. Todd, Mr F.E. Lorenz, Mr G. Osgood M.A. and Dr L.R. Bishop.

The party's head was James Herbert Porter (1892 - 1973). His father, John Herbert Porter, who, together with his grandfather, James, formed the brewing company of James Porter & Son and established the Dale Brewery, Burton on Trent around 1875. The younger James began his brewing career in 1909, but this was interrupted by World War I. After war's end he returned to the industry as Assistant Brewer at Newcastle Breweries Ltd. It was here that Porter, together with the firm's chief chemist, Archie Jones, helped create Newcastle Brown Ale. In 1928, a year after the beer's launch and possibly due to its success, he was promoted to Head Brewer. He went on to become Managing Director in 1931, Vice-Chairman in 1953 and Chairman in 1955. When the brewery merged with Scottish Breweries in 1960 he became Vice-Chairman of the Group and later Vice-President.

The second member of the party, Alexander Clark Doull (1899 - 1964), also came from a brewing family, beginning his career under his father, John Doull, at Archibald Campbell, Hope & King Ltd., Edinburgh. In 1919 he became Assistant Brewer at Newcastle Breweries Ltd. before moving to McLennan & Urquhart Ltd., Dalkeith in 1921 to take up the position of Head Brewer. In 1926 Clark Doull became Head Brewer at George Younger & Son Ltd., Alloa where he remained until his retirement in 1962. In addition to becoming Director of the Alloa firm he also served on the board of R. Fenwick & Co. Ltd., Sunderland.

Unfortunately there appears to be little mention of the party's third member, Dr J. Todd, apart from the fact that he was an Associate of the Royal Institute of Chemistry and worked for Guinness.

Mr F.E. Lorenz (1890-1959) was born in Czechoslovakia and educated at the Weihenstepban Technical High School. After a period in the brewing industry he joined his family's malting business, Klatscher and Lorenz. His 30 year's working on the Continent ended when Hitler invaded Czechoslovakia and he moved to the U.K. Lorenz continued in the malting trade and, due to his proficiency with languages, played a significant role in its expansion overseas.

Mr G. Osgood is the other member of the group about whom little information seems to exist. Like Todd he was also an Associate of the Royal Institute of Chemistry. Osgood wrote a number of papers on bottling and was elected a life member of the Institute of Brewing in 1984.

The final member of the party, Dr Laurence Robert Bishop (1904 - 1988), was, according to Ray Anderson in his Brewers and Distillers by Profession (2012)*, 'one of the most versatile, accomplished and influential research scientists ever associated with brewing in Britain' (p.148). His career began at the Rothamsted Experimental Station in 1927 and lasted for over 50 years. One of Bishop's most significant contributions to brewing was to devise a system of continuous fermentation which implemented by Watney Mann in the 1960s.*

Tim Holt

Overall report on the German brewing industry

The party to investigate the Brewing Industry was sponsored by the Ministry of Food and Sent by the Brewers' Society. It consisted of Col. J.H. Porter D.S.O. (leader), Mr. A. Clark Doull, Dr. J. Todd, Mr. F. E. Lorenz, Mr. G. Osgood M.A. and Dr. L.R. Bishop.

During the twenty-one days available the party travelled about 2500 miles by car in the British and American zones and in Berlin, during July 1946. The Ruhr was not visited as it was thought to be too badly damaged. Otherwise, by direct visits and by enquiry into conditions in other breweries and maltings, the two zones were fairly well covered. During the trip, visits were made to nine breweries, four maltings, four research stations and four consultant and other firms connected with brewing. Owing to travel and other difficulties the party was unable to visit Austria, Czechoslovakia or the French Zone of Germany.

The information acquired has been presented in B.I.O.S. report No. 1512 under the headings of the targets visited. In the present report an attempt has been made to rearrange and collate the extensive information obtained under the heading of separate subjects, and at the same time to take advantage of the matter contained in other official reports, particularly that given by the Allied Brewery Traders investigation (B.I.O.S. Report No. 733), so as to present a connected account of such matters in the German Brewing Industry as seem of interest or advantage to the Brewing Industry of this country. Most of the information comes from B.I.O.S. Report No. 1512. When obtained from other sources it is noted in brackets at the end of the statement.

Organisation of the German brewing industry

Before the war the Brewing Industry in Bavaria was organised into two groups, the Brauverband (roughly equivalent to the Brewers' Society) and the Brauwirtschaftband (Brewing Economic Group). The latter had been responsible for the allocations of materials to breweries during the shortages immediately before and during the war.

The organisation of training and research had been in the hands of three institutes. These were supported by the State and by brewery subscriptions on a barrelage basis. This is dealt with in more detail later in the paper.

The pay of brewery workers was based on a scale fixed by law in 1932, and provided for wages of foremen and workers in town and country breweries. This scale had been retained and was still in operation at the time of the visit. It is shown in the following table giving the pay in Reichmarks:-

	Berlin and Ruhr.	Other Districts.
Unskilled men	46 - 70	41 - 65
Skilled men	52 - 75	47 - 70
Foremen	57 - 80	52 - 75

The tax on beer was levied by the Government on the monthly returns furnished by the gateman of each brewery who was required to record quantities of beer passing out of the brewery.

Organisation of teaching and research institutes

Before the war three main centres existed for the acquisition and promulgation of knowledge of brewing - the Versuchs und Lehranstalt (V.L.B.) in Berlin mainly for Northern Germany, the Weihenstephan University Technical College at Freising and the Brewing Research Station at Munich for Bavaria. The latter had been destroyed by bombing and the staff dispersed. The heads of the other two had been replaced by Non-Nazis. Otherwise the staffs were substantially the same, apart from normal changes and retirements and the reinstatement of two members at Weihenstephan dismissed by the Nazis.

The V.L.B. is a department of Berlin University. The ground and buildings were supplied by the State and funds were provided by voluntary subscriptions from the breweries on a barrelage basis, further funds being obtained by charges for analysis of samples and consultation fees. It appeared to be taking no active part in research and teaching, which can be attributed to the extensive damage it had suffered and to the isolation of Berlin imposed by the zonal system.

Weihenstephan Agricultural College was stated in one American Report to "contain the largest collection of German Agricultural experts outside jail" (F.I.A.T. 492.). It is housed in a fine old Augustinian monastry (provided by the Bavarian Government) at Freising, twenty miles north east of Munich, and is supported by the Bavarian State but most of the finances come from sales of beer and from consultation and student fees. Eighty students were there at the time of the visit, but an increase to the pre-war level of 100 - 200 students was anticipated.

Maltings, breweries and the brewing process

The main new developments encountered during the visit were in the production of very weak beers to meet war-time exigencies and in the production of beer substitutes. These topics are considered later. The main features of the planning and layout of the maltings and breweries visited were not such as to call for special comment; while the brewing process traditionally associated with continental beers and described in the textbooks was closely followed everywhere. As the Continental lager process of brewing differs in many respects from the British top fermentation system, many parts of the German process have no direct bearing on the operations followed in Britain.

Consequently the chief interest devolves on details of plant and treatment at the various stages of the process where the two systems are similar. While, on the research side, investigations had been restricted to the severely practical and there is little or no fundamental work to report.

Barleys

Little breeding work had taken place and many older strains of barley had been lost under the Nazi regime. Isaria is still a popular barley although the straw is not strong and it is known to have a tendency to give turbid worts. Two new varieties had been bred and tested. Haha (a Hanna x Hadostreng cross) was reported to give good results on good soil. Haisa (a Hanna x Isaria cross) was agreed to be the best for yield, quality and strength of straw.

To those who have not encountered it before, the primitive state of German agriculture comes as a great surprise. Ploughing is often by oxen and much of the land is sown in narrow strip cultivations. Such tractors as were seen appeared clumsy. Harvesting is often by scythe or even by sickle although a considerable proportion is harvested by reaper binder. Only one make of combined harvester exists (the Claas) and only one example was seen working during the whole of the trip, which took place during harvest time. The rather interesting features of this machine have been studied in this country by the National Institute of Agricultural Engineering.

From the foregoing it will be apparent that barley is chiefly threshed out of barn and so no new requirements for storage space have arisen in Germany as there has been negligible mechanization of harvesting. In the climate of Germany, barleys are usually harvested with 15 to 18~n of moisture and can usually be preserved without the use of grain driers. As a result these had only been installed for barley in connection with a few large grain stores built for the Army. On the other hand the usual moisture content is just high enough to be potentially dangerous and the use of aerated silos had been developed as a means of added safety. To obtain satisfactory aeration, which needs a relatively short air path, various elaborate devices have been installed. These are described by Lüers in the *Journ. Inst. Brew.* 1938, p.257 and in B.I.O.S. reports Nos. 439 and 733. Because of the greater vagaries and dampness of our climate, aerated silos would appear to have restricted functions in Britain.

Some work, regarded as less advanced than our own, had gone on on the disinfection of grain from insects. This is also reported by E.A. Parkin and T.A. Oxley in B.I.O.S. Report No. 439. In brewing circles Leberle advised against the use of hydrocyanic acid gas and advocated ethylene oxide - CO_2 mixtures for fumigation (F.I.A.T. 492). Others advised immediate screening and steeping of infested samples. Granary weevil was mentioned as the chief pest; while rice weevil occurs sporadically, although summer temperatures in Southern Germany are high enough for it to spread in the field by flying.

The existence of dormancy in barley after harvest appeared to be recognised and was specifically men-

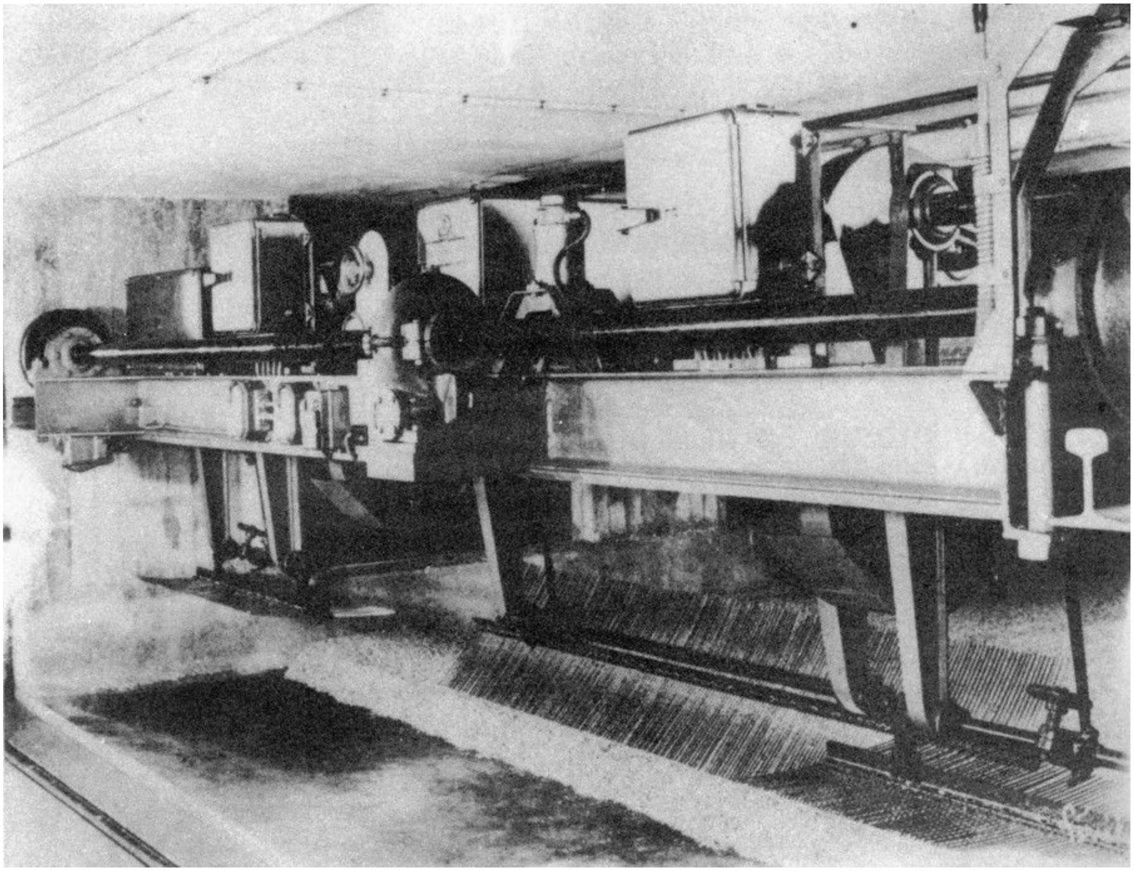

Figure 1. Maffei-Kraus rail-borne floor turner for maltings.

tioned as encountered in the malting of winter barley soon after harvest. Cure by storage for a few weeks after harvest before drying was advocated, from practical experience rather than scientific experiment.

Dr. Lakon at Hohenheim Agricultural College had developed a method of testing for the viability of cereals using first sodium selenite and later 2,3,5-triphenyl tetrasolium chloride. The latter method, which takes about eight hours, was reported to be adopted in south-west Germany and appears promising (F.I.A.T. 77 and B.I.O.S. 1512).

Malting

Nearly all types of maltings exist in Germany :- hand-worked floor maltings, mechanical floor maltings, box and drum maltings. The mechanical floor maltings were of the Maffei-Braus type (see B.I.O.S. Report No. 733 and and Fig. 1) and no example of a free-travelling floor turner was found in spite of careful search. However details and drawings of the "Schuster" free travelling turner were obtained from the makers (Anton Stainecker, Freising) and a good report was received of its use over a number of years in Czechoslovakia. (See Figure 2.)

The comparative merits of the different types employed were discussed with all competent authorities, of course, in connection with lager brewing. It may be said that brewers in general and the scientists of the V.L.B. favoured floor malt. This preference was difficult to define beyond statements that it was of better quality and more regular. The scientists at Reihenstephan favoured box malting and regarded the brewers' preference for floor malt as due to conservatism, but it must be recalled that the Kropf box system had been developed there. The V.L.B. had planned, but not carried out, comparative experiments to answer the question. The balance of opinion therefore appeared to favour floor malt for lager brewing, although the answer may be in some doubt. A number of breweries had embarked on the large capital expenditure required to construct the special maltings required for the Maffei-Kraus system of mechanical floor melting because of their preference for such malt. The detailed drawings of this system have been copied and brought to this country by the Allied Traders party.

The Maffei-Kraus and the box and drum systems involve a large capital expenditure but all authorities were agreed that, even with the low wage rates paid in

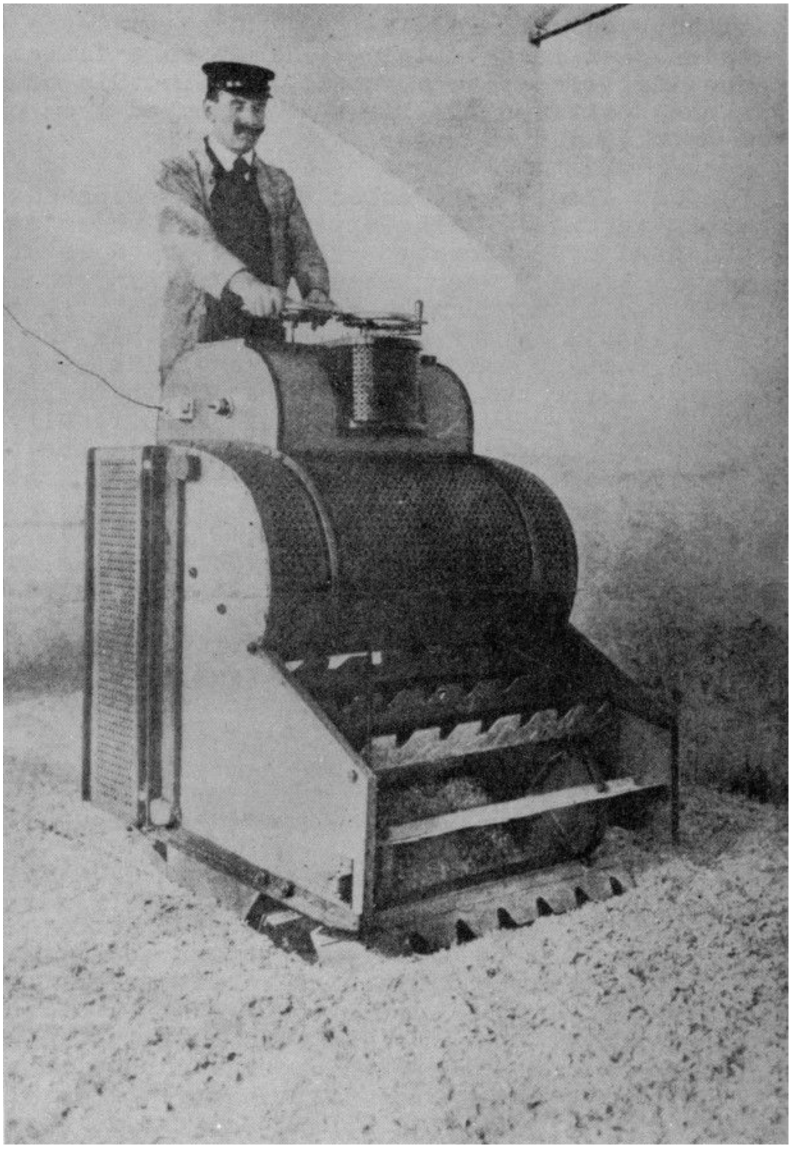

Figure 2. Schuster free-travelling floor turner for maltings.

Germany, the saving of cost over hand-made floor malt is considerable - one estimate put the cost of mechanically made malt at a quarter.

Among the malting plant and equipment much was encountered of usual design. Cisterns were usually conical and self-emptying. They were fitted with aerating pipes more commonly than in this country, and in some maltings the barley was pumped from one cistern to another during steeping.

The floors approached a square shape and were cement-surfaced. The appearance of these attracted a good deal of interest. That for instance at the Herford brewery was stated to be fifty years old and still had a smooth marble-like finish. After extensive enquiries it appeared

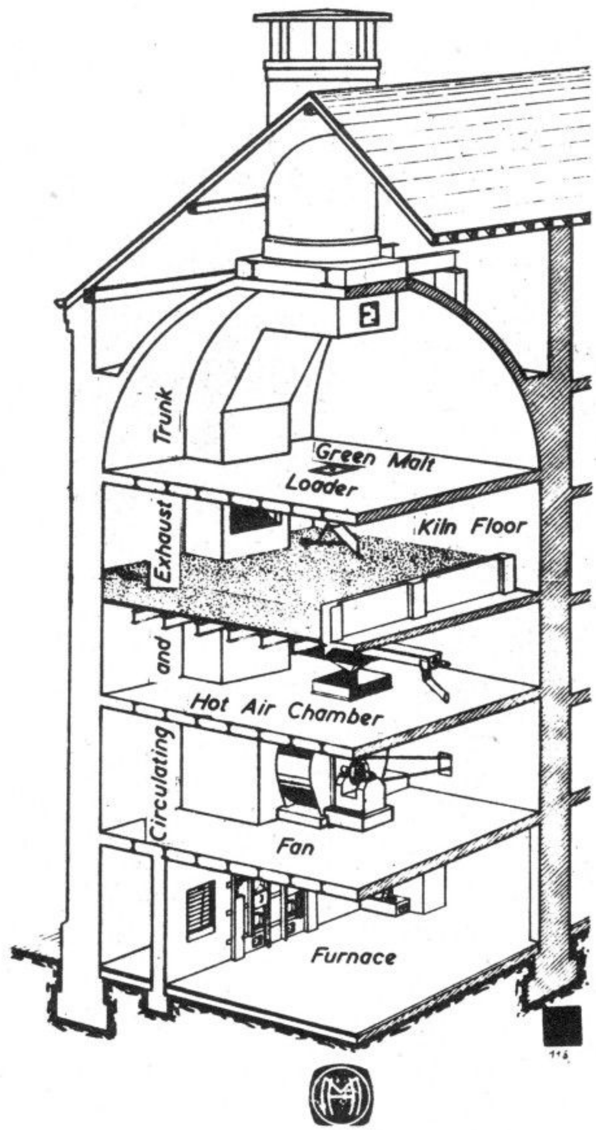

Figure 3. Muger air-circulating, deep-loading kiln.

probable that this was the product of two factors (a) the use of very fine sand in the surface layer and (b) good workmanship in the laying of the floors. The production of exceptionally hard floors by the incorporation of iron filings in the top layer and of still harder concrete by the use of stainless steel filings were mentioned.

Air conditioning as developed in this country was not met and appeared to be unknown but several rather more primitive types were met. The usual type consisted of finned pipes conveying chilled brine high up around the walls of the malting floor and fitted with a trough underneath to catch the drips. At the Herford brewery cooled air could be distributed above the floor by a herring-bone system of pipes, which could be controlled to open only over the region of the floor occupied by the piece. The system was non-return.

There is also a much wider range in type of kiln. Most floor kilns are of the two floor type. An interesting variation is that at the Herford Brewery where the kiln is circular although accommodated in a square building. A vertical shaft runs through the centre of the kiln and drives turners round on each floor through bevel gears. The floors are wedge wire and supported on steel strips on edge supported in turn by girders at right angles. This gives a very free flow to the floor. A slow speed fan is fitted and drying takes 48 hours (24 hours on each floor).

At the Kindl brewery there is a Topf vertical kiln design which saves space and the necessity for turners. The arrangement is similar to that in farm grain driers in that the malt travels downward between vertical perforated metal sheets and air is blown horizontally through. Each vertical malt compartment is divided horizontally into four with increasing temperatures downwards. Difficulties would appear likely as the malt dries and shrinks leaving a gap in the top of each compartment and as the dried rootlets tend to block the air flow through the malt. The party was assured that the kiln worked satisfactorily if a high power fan were used. If so it would appear wasteful of fuel.

One Berlin brewery had used vacuum drying drums but the system was not found satisfactory.

No Winkler kilns were inspected but similar single floor kilns for drying a deep load of malt were made by Topf of Erfurt and Mueger of Darmstadt. An example of the latter was seen at the V.L.B. where it was considered highly satisfactory. In this a large fan is mounted over the thermostatically controlled furnace to blow hot air through the malt. This is loaded 44 inches deep and in the curing stage the outlet from the kiln is closed and the hot air is recirculated to save fuel. The malt is dried to 3½% moisture in eighteen hours using normal lager finishing temperatures. (Figure 3.)

Special malts

Mannheim Proteolyt maltings were using Dixon's (British) patent process.

The Weyermann maltings at Bamberg were making four types of coloured malts which are added to lager beers in quantities up to 10% to give flavour and head retention.

The light and medium types are given a normal steeping and a 7 day germinating period in drums with a rise in temperature at the end to 70° - 75°F. to favour proteolytic action and so colour formation. The light malt is then saccharified in a roasting drum for 10 to 15 minutes at 140° - 150°F. and dried for twenty-four hours on a kiln. Colour 2 - 2.5° Lovibond.

The neat type is saccharified for 30-45 minutes at 140°F. and dried in the same drum at-200° - 250°F. Colour 4 - 5° Lovibond approx.

The darker type is treated similarly to the last except that it is dried at 300°F. Colour 18 - 20° Lovibond approx.

The darkest grade is germinated 4. to 5 days. After this it is hand-dried on a kiln for 24 hours at 124°F. and the rootlets are removed. It is then roasted by direct coke firing in revolving ball drum for 2 hours at 390°F. with additions of water through the hollow spindle at a rate of ¾ to 1 gallon per cwt at the halfway stage of roasting. After this the roasted salt is subjected to a secret treatment. This was discovered to be the treatment of large batches of about 10 tons in a revolving drum similar to a Galland drum first steaming for 1 hour and then drying for 3 hours at 170 - 175°F. This treatment appears to improve the flavour and appearance by glazing and debittering the malt. The colour is 16 - 17° Lovibond approx.

These Weyermann coloured malts were made in the usual way by high temperatures during the final curing stage of kilning. There is however a distinctly different way of producing highly coloured malts which may have advantages or distinct uses. In this at the end of flooring the malt is heaped and allowed to heat for one to two days. This treatment gives a high content of sugars and amino-acids and, as a result, the malts form a very high colour during the first stages of kilning. Such malts had been compared with normal Munich dark malts in a series of comparative brewing experiments by Fink and collaborators. In the early stages the Veers produced were stated to give remarkable fullness and roundness of flavour and the impression of a high original gravity. On long storage these distinctive characters disappeared.

Hops

A careful survey of the hop producing areas had been carried out with results in cwts produced which may be summarised in the following table:-

	1934 Crop	1943 Crop
Hallertau	69,000 cwts	107,000 cwts
Rheinpfals	1,000 "	500 "
Spalt	15,000 "	12,000 "
Tettnang	18,000 "	11,000 "
Hersbruck	18,000 "	7,500 "
Rotenburg-Weilderstadt	10,500 "	4,500 "
Jura	500 "	1,000 "
Baden	3,500 "	500 "
Aischgrund	1,000 "	-
	137,000 "	144,000 "

Thus the total crop remained in 1943 about the same as pre-war with local changes. Difficulties had arisen from lack of fuel for drying and from the zonal isolation.

In 1945 some 90% of the crop was exported to the U.S.A., Belgium, Holland and South America.

Prof. Raum reported that the varieties remaining in cultivation were Hallertau, Saaz (including Tetnang) and Spalt. The remaining ten or more varieties had been lost during the Nazi regime. A research station at Hüll in Bavaria was reported to be trying new types but was only just starting.

Spraying with Bordeaux mixture was used against downy mildew of hops (Peronospora). Power driven sprays were employed but machine pickers were not employed in Germany. Virus diseases in hops were not known or not recognised. Verticillium wilt was not known.

The usual artificial manures had been available and had been used in the larger gardens. In their smaller gardens the peasants used large quantities of farmyard manure on their hops and such was their enthusiasm they kept abnormally large herds of cattle to obtain sufficient supplies. The use of these large quantities of farmyard manure tended to produce a high yield of coarse hops of low quality.

Brewing water and treatment

The general impression gained was that water treatment is not in a very advanced state. Waters used varied between 10 and 20° German degrees of hardness (12 - 25 British degrees). These were usually carbonate waters and were often used without treatment. No case was encountered of the use of ion exchange resins, although these were under investigation at Munich just before the war.

This lack of treatment appeared to be partly due to German law which forbids acidification and partly to the influence of the late W. Windisch who had argued strongly that the best Pilsen type beer would be obtained by using distilled water, and, under his influence some brewers had actually installed plants to remove gypsum from their brewing waters. Recently the investigations

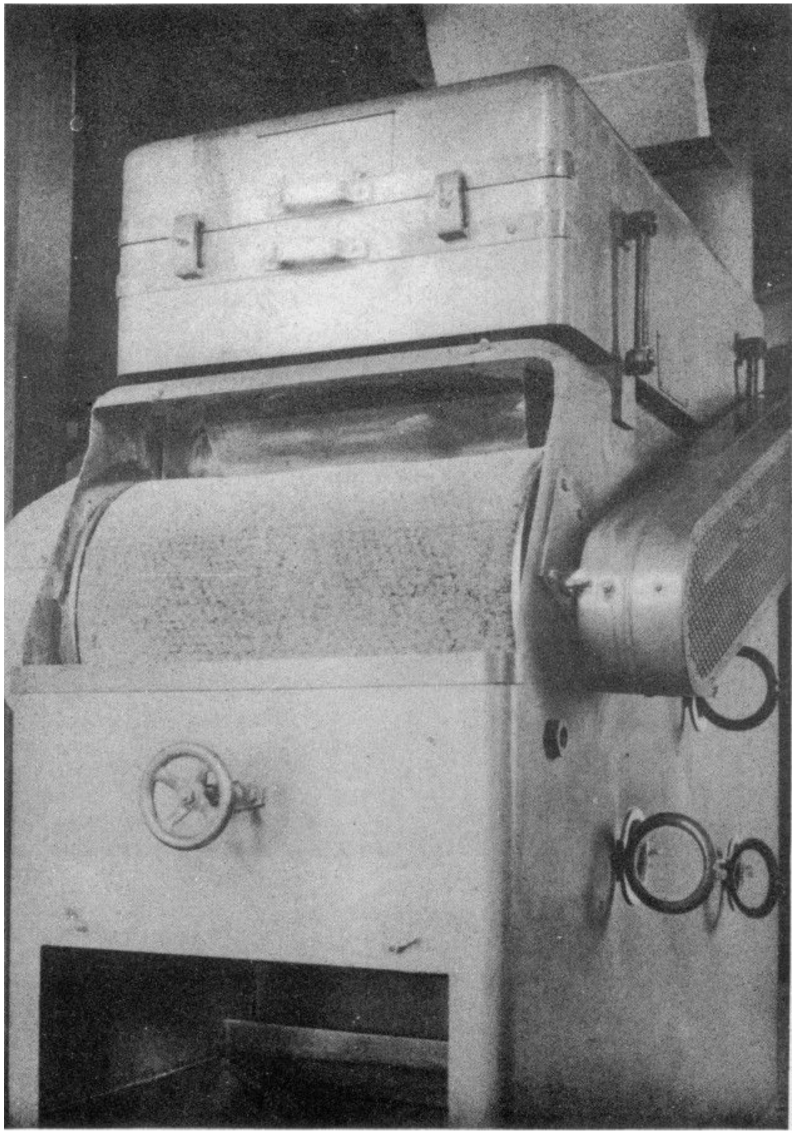

Figure 4. Malt polishing machine at the Herford Brewery.

of the V.L.B. have led them towards the view, already accepted for many years in brewing in this country, that gypsum in brewing water at least in moderate amounts is helpful to the taste and "body" of the beer. This is an improvement which is particularly felt in the weak beers in Germany today.

At one brewery the water was being treated against the danger of infection with "Micropur" which was understood to be a colloidal preparation of silver chloride.

Brewing

Cleaning and polishing malt

The facilities for cleaning and polishing malt were often good with clean rooms because the dust is sucked out and filtered through shaken bag filters in metal enclosed cabinets. In the Herford brewery an interesting machine was seen for cleaning and polishing malt by a revolving bristle brush. The general design is shown in the photo-

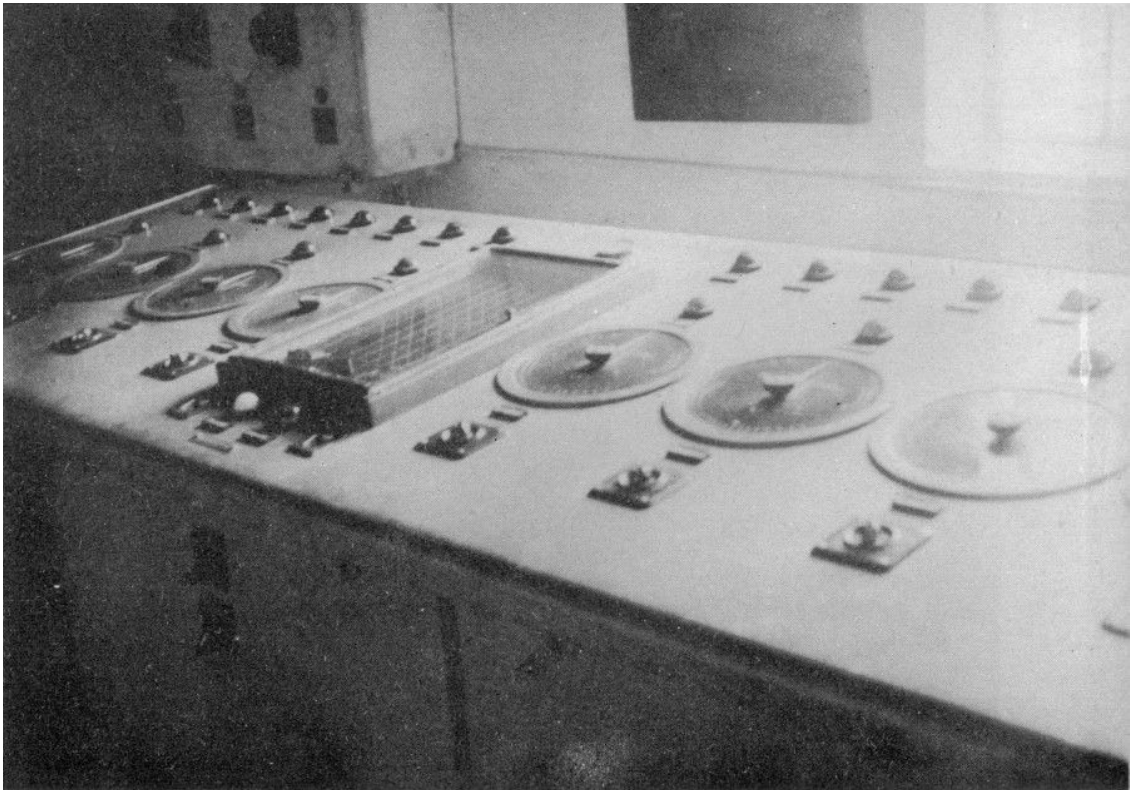

Figure 5a. Control panel for automatic grist blending from successive malt bins to malt mill.

graph. Machine drawings were not available as the machine had been made by Topf of Erfurt which has been reported as entirely dismantled by the Russians because this firm made the gas chambers used by the Nazis. (Figure 4.)

Blending of malts

An extremely interesting malt storage and grist blending plant was also seen at the Herford Brewery. The 16 bolted sheet iron malt bins hold a total of 1000 tons of malt. The bins are supported on girders in concrete bases carrying the weight independently of the old building. The malt is fed in and out pneumatically. The pneumatic feed out is to the automatic weigher above the malt mill. This feed out is controlled electrically from the weighing machine to a small glass-enclosed cabin with dials on which the quantities of malt to be taken are preselected from any eight of the 16 bins in an order which can also be chosen beforehand. On closing the switch the rest of the operations are carried out automatically. This was the only plant of its kind and installed just before the war by Topf of Erfurt so that the plans were not available. The three photographs give an idea of the arrangements. (Figures 5a, 5b and 5c.)

Malt mills

The malt mills seen were mostly by Seck. Their organisation had been taken over by M.I.A.G. in Brunswick who were engaged on the drawings for a new six roller mill.

Mashing and boiling plant

The plant for carrying out the mashing, boiling and sparging was in all cases of the conventional continen-

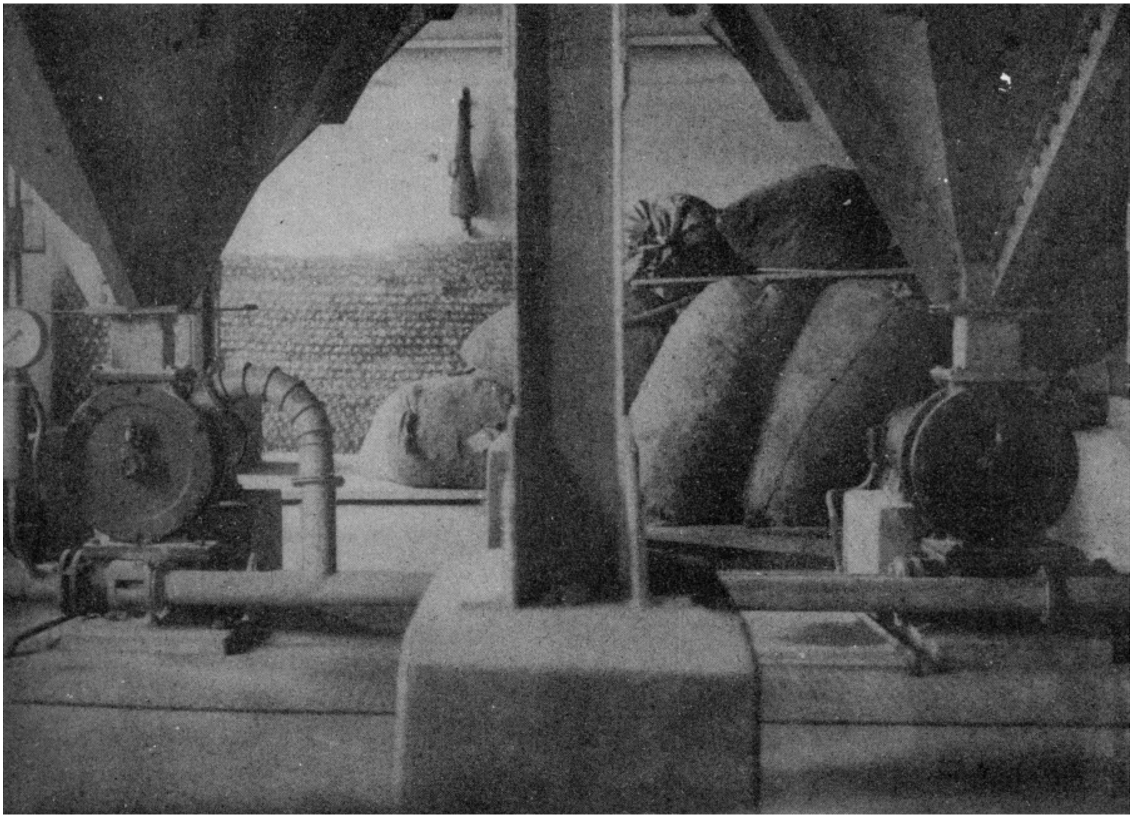

Figure 5b. Front view of controlled feeds from malt bins to pneumatic supply to malt mills.

tal pattern. In a number of instances - for instance the Humbser brewery in Fürth (Near Nuremburg) and the Bavaria St. Pauli brewery in Hamburg - great care and expense had been given to the design of the brewhouse and of the vessels, as is often the case in German breweries. The Kindl brewery brewhouse, the former showplace of the Berlin breweries, had been dismantled by the occupying power.

In many cases the wort then went to the large flat open coolers favoured by Continental brewers. These need great care to keep the bottoms exactly flat. One recommendation given was that their construction should be only undertaken by firms with experience who could provide special strengthening under the vessels, At another brewery the coolers were supported on jacks which could be exactly adjusted to distribute the load evenly and so avoid buckling.

Brewing for export beers

During the period between the two world wars the German breweries captured much of the world export market for beer and therefore careful enquiry was made into brewing methods and conditions.

Soon after the first war large profits were earned by one brewery which had freed itself from capital embarrassment during the inflation of the Mark. During the Nazi regime the exports had been maintained by underselling with the help of a subsidy amounting at times to a third of the cost. This export subsidy had been financed by a general tax on German manufacturers.

The grists used for these beers contained adjuncts to give clarity. The table gives details.

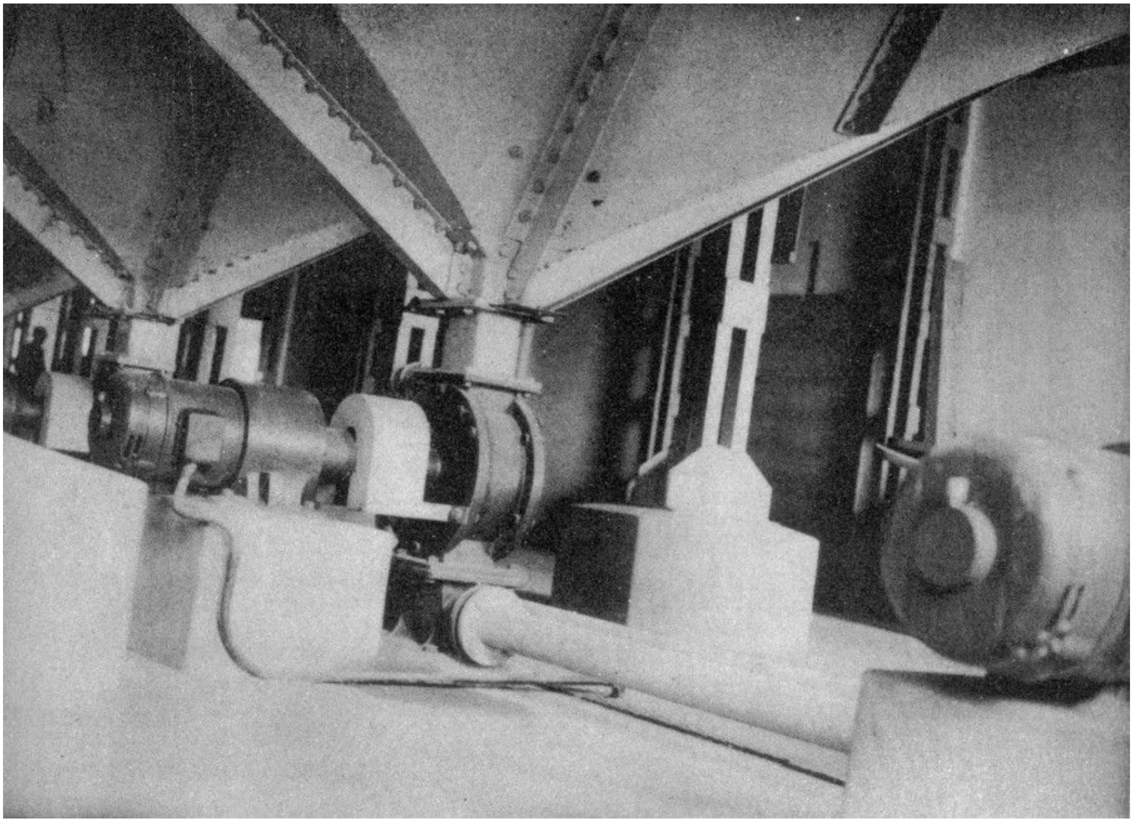

Figure 5c. Back view of controlled feeds from malt bins to pneumatic supply to malt mills.

BREWERY	ADJUNCTS	TREATMENT
Schultheiss Patzenhofer Berlin.	25% rice or 20% rice + 5% maize.	
Bavaria St. Pauli Hamburg.	5 to 7% rice.	Three mash with 2½ hours boil in open copper.
Bill Hamburg.	Rice up to 20% mashed separately and added after first stage.	Treatment with aluminium silicate see later.
Beck Bremen.	Sugar (quantity uncertain), (one brand rice).	Tannin treatment see later.

The export beers had special labels and some had metal foil cappings. One firm put the cappings on by machine and one by hand. The latter used the Jagenberg Corona labelling machine which put on front, back and neck labels at the same time. The pasteurisation of these beers is considered later.

Wort Refrigerators were of the vertical and plate cooler types and call for no special comment.

Fermenting vessels

Many kinds of fermenting vessel materials were seen, often several different kinds in one brewery, so that a good deal of information was obtained on the relative merits.

Generally the vessels were set in concrete surrounds swept up from the fermenting room floor and often tiled or painted on the outside, a construction which protects the racking cocks from drip. With metal fermenting vessels set in concrete special precautions have to be taken to insulate them from electrolytic action which would cause corrosion. To do this the outside of the vessel in many cases was treated with bitumen then fabric such as jute was bound round and again treated with bitumen. For more effective insulation the vessels are treated with bitumen and surfaced with cork blocks which in turn are coated with bitumen. Details of edge construction are given in the *Woch. f. Brau*. 1931, p.407 from which the following diagram has been copied.

For aluminium vessels the need for insulation is particularly great. The officials of the Schultheiss Patzenhofer brewery stated that they had aluminium

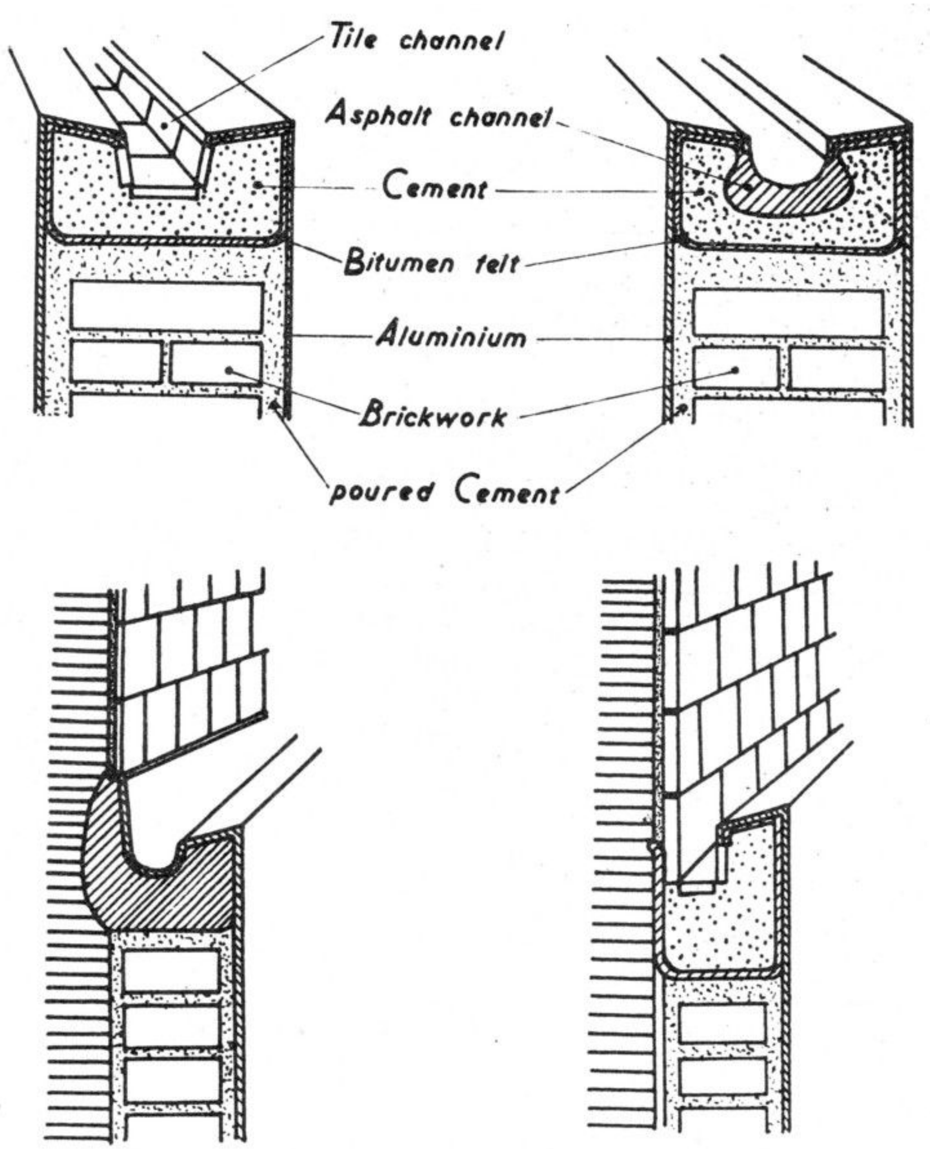

Figure 6. Details of construction of insulation for the edges aluminium fermenting vessels.

fermenting vessels mounted in eight inch cork blocks which had remained quite sound for thirty years. At the Kindl Brewery they mentioned that if electrolytic action is taking place in aluminium vessels it is easy to detect it because white crusts form in two or three hours on the pools of water left after washing down.

It is not generally recognised that stainless steel is liable to corrosion in a similar manner but it was learnt that these are preserved by similar treatments. In this case it was stated that four inches of cork is sufficient (with internal and external treatment with bitumen).

With Ebon vessels the concrete structure is of course directly faced with the material. The problem which is then liable to arise is that of hair cracks which develop as the result of settling or vibration. To prevent this the requirements are (a) a solid foundation from which to work (for instance one brewery was built on piles on marshy ground and concrete vessels had given much trouble) (b) an experienced firm to do the work. One brewer recommended that the contract for buildings and vessels should be given to one firm so that there should be no ambiguity who was to be blamed for any subsequent faults.

With glass lined vessels the main problem is to avoid damage from cracks due to blows. At the Bavaria St. Pauli brewery the men working in the vessels wore rubber boots and ladders were fitted with rubber "suckers" at the bottom and rubber protection at the top. The buckets were of aluminium with a heavy rubber flange to stand on. The thermometers floated on the beer on cork supports. With these precautions the brewer was well satisfied with glass-lined vessels. Such cracks as occurred were sealed with a cement sold for the purpose.

Generally however the preference among brewers was for stainless steel as the best material for use as fermenting vessels. The only objection raised was of course that of the high initial cost. The smooth finish to stainless steel was generally favoured and it was pointed out that this reduces the danger of corrosion and adhesion of beer stone.

Opinion on the optimum size for fermenting vessels favoured a maximum around 7 feet wort depth and 100 to 200 barrels capacity.

Cellarage

The lagering process was carried out usually in glass-lined tanks many of them horizontal cylinders to aid deposition.

Treatment to produce stable export beers had been developed in the years before the war. The Bill Brewery had formerly used 1/4 oz. of tannin and 1/8 oz. of pepsin per barrel but subsequently had changed to the use of aluminium silicate. In this process 1/3 oz. per barrel was stirred with a small quantity of beer and added to the full quantity in vertical settling tanks. After settling 8 - 10 days it was centrifuged, Seitz filtered and bottled. A 1070° beer treated in this way tasted very good and was entirely free from deposit after three years in bottle.

The Beck brewery used only 1/3 oz. of tannin per barrel with settling for a fortnight.

In the "Ersatz" drive beer pipes had been produced of glass and of plastics such as Vinidur (I.G. Farben), Mipolam and Plexiglas. In the latest types these withstood temperatures of 250°F.

Asphalt was recommended for cellar floors with the runways made of chequered iron plates standing on legs through the asphalt.

Filtration

Filtering was in some cases by Seitz filters and others by pulp filters. The Seitz firm gave details of the manufacture of their filter sheets. These were made of cellulose plus crushed and ground asbestos in proportions from 33% for EK special sterilizing sheets to 0% in 0/750 clarifying sheets (B.I.O.S. No. 733).

In the Bavaria St. Pauli brewery the pulp filters were back washed in situ by cold water to remove deposits and then with water at 112°F. The warm pulp was transferred to the pulp washers and heated to 185°F. for one hour without chemicals, cooled and rinsed. This pulp was stated to behave very favourably. Occasionally when very brown it was bleached with hypochlorite.

In the process patented by Dr. Pauly of the V.L.B., pulp is treated with bleaching powder and carbon dioxide passed in to liberate chlorine. Carbon dioxide imput is continued until the calcium carbonate is dissolved as bicarbonate when the products are washed out. This was claimed to give clean, sterile pulp with the minimum of water and labour.

Bottling

Generally bottling arrangements appeared backward compared with our own.

At one brewery the point was made that storage tank size should be adjusted to racking and bottling capacity, so that one (or more) tanks could be completely emptied in the course of a day.

At the Bavaria St. Pauli brewery bottling plant was sterilised by circulating 1% antiformin for two hours once a week followed by very thorough washing with water. At Weihenstephan 0.5 - 1% formalin was used and occasionally soda. Pipes were dismantled once in six months. At the Bill brewery crown corks were flamed to sterilise them.

Maximum temperatures for pasteurisation were similar in the different breweries. The conditions used may be summarised in the table.

BREWERY	HEATING	HOLDING	COOLING
Schultheiss Patzenhofer.	60 mins.	60 mins. at 150°-154°F.	40-50 mins. down to 104°F.
Bavaria St. Pauli			
Pale beer	90 mins.	25 mins. at 154° -158° F.	30 mins. to 60-65°F.
Bill			
Large botts.	90 mins.	25 mins. at 150° F.	30 mins. to 65°F.
Small botts.	90 mins.	25 mins. at 144° F.	30 mins. to 65°F.

The chief divergence of opinion was on the rate of cooling. Schultheiss Patzenhofer regarded slow cooling as important while the Bavaria St. Pauli brewery favoured quick cooling.

The sweet malt beers were usually sent out in stainless steel casks and pasteurised in these. At one brewery however the beer was bulk pasteurised and filled into sulphur dioxide gassed stainless steel casks.

Even before the war it had been customary to sweeten these dark top fermentation beers with saccharin or similar sweetening agents and the proportions had been increased during the war. Sugar beet residues had also been used in these beers. Otherwise only malted wheat had been used as a malt substitute.

A number of breweries used bottle crates only half the height of the bottles. At least one brewery had calculated that the extra breakage was more than compensated by savings affected in increased pay load etc.

At this brewery breakages were kept low and losses were given as follows:-

	Percentage losses.	Total Percentage.
Filling etc.	1½ - 2%	
Pasteurising.	1%	3½ - 4%
Distribution.	1%	

At the other extreme one brewery reported 30% breakage of bottles produced recently in Germany.

Bottles are of green or amber glass and are produced in standard sizes of one third litre (0.6 pint) for home beers and two thirds litre (1.2 pints) for export. The shapes in the Berlin district are standardised and they are unmarked so that they are interchangeable between breweries.

Transport and distribution

The government tax on beer is levied monthly on the returns of the brewery gateman of beer going out. The drayman collects the money for bottled beers while the brewery for cask beer it is paid direct to the brewery.

Owing to the great fuel and transport difficulties great care had to be expended in organising transport. At one brewery horse transport was used for local deliveries, electric trucks for deliveries up to about 40 miles and producer gas lorries for greater distances.

During the war exchange and zoning systems had been worked between breweries similar to those in this country.

Casks

The cask position in Germany was carefully investigated because of the difficulties at home. For a number of years before the war the Germans had been confined to the use of home grown oak as a result of the self-sufficiency drive.

It was generally known that the quicker growing German oak was inferior to that from Polish, Rumanian or Jugoslav sources. However in the opinion of some brewers the German oak was satisfactory if it had been seasoned for at least four to five years.

All the breweries had been compelled to use the laminated casks manufactured by Mueller of Leipzig. These appeared to consist of three thick plys of beech. No brewer was satisfied with them and complaints were made of plys lifting and forming pockets for infection and of pitch not taking on the beech. They were stated to give trouble after one year and to have a life of five to six years compared with twenty years for an oak cask.

As stated earlier the sweet malt beers were generally pasteurised in stainless steel casks. These were Krupps V 2A steel about 1/8th inch in thickness and made to hold 50 litres (11 gallons). About 4-6% space was left for expansion in pasteurisation. The objections to these casks were, as might be expected, on the score of high cost and liability to damage.

Aluminium casks, lined with special pitch (Scholdkroeten), had also been tried and were of course even more liable to denting.

No satisfactory solution to the cask problem had therefore been developed in Germany.

By-products

Grains: Were used as cattle food under Military Government control.

Spent Hops: These were washed and dried. All over Germany it appeared that the dried hops were shredded and used as a substitute for tobacco. Alternative uses were as a stuffing for furniture, or as a source of cellulose for paper making.

Yeast: At the present low gravities there is little by-product yeast. The utilisation as food is considered later.

War-time measures

It will have been obvious throughout this report and in many aspects that, as Hitler was a teetotaller, the development of the brewing industry had not been favoured during the Nazi regime. This had been reflected in a movement to develop non-alcoholic drinks and in a general reduction of beer strength. This reduction had been continued to a very extreme degree in the post war food shortage.

At the time of the visit brewing for the German population was permitted at original gravities varying from 1003° to 1008° in different regions.

Much of the time of the research institutes had been spent on solving the technical problems of producing beer of such low gravity.

From the microbiological standpoint the interesting observation was made that, as the original gravity is lowered, successively different kinds of organisms become prominent as infections. The position as outlined by Stockhausen at the V.L.B. is

Beer O.G.	Chief Infecting Organism
Around 1050°	Streptococcus (Sercina)
Around 1030°	Wild yeast
Around 1025°	Torula yeasts
Around 1010°	Putrefactive bacteria

In the main Prof. Schnegg at Weihenstephan agreed with this. He stated that at 1010° and below the chief bacteria are B. subtillis and tharmo-bacteria while B. coli had been reported. Two other points were interesting and surprising. The weak beers are more liable to infection than the corresponding worts. This Schnegg thinks is due to a combination of several circumstances - the presence of growth substances excreted by yeast, the high pH of the diluted beers and the alcohol, being below l%, probably acts as a stimulant.

The other interesting point is that if the water used for diluting is boiled it is much more sensitive to infection (e.g. by B. subtilis) than raw water. Consequently he favours the use of raw water for dilution or in bad cases chlorination of the water first. This chlorination does not introduce undesirable flavours. Both the bacteriologists and the brewing chemists agreed that the best way to brew these weak beers is to ferment a wort of about 1030° O.G. and dilute at the height of fermentation. This gives the greatest bacteriological soundness, good attenuation and yeast yield and proper saturation with carbon dioxide.

At such low gravities the percentage of carbon dioxide becomes important both for flavour and preservative action and so for the weak beers, instead of the usual 0.38%, 0.4 - 0.46% carbon dioxide content was recommended.

The hop rate also needs adjustment to a quantity intermediate between that required for a normal beer and that proportionally reduced to allow for the low gravity of the beer. All the hops of course are added to the initial brew at 1030° O.G.

The diluting water also needs to be decarbonated. Acids are not permitted so that lime treatment must be used. A case was quoted of a beer diluted with untreated water where the pH had been raised to 6.5 and as a result a precipitate of calcium phosphate had formed.

With proper precautions it was claimed that a satisfactory drink could be produced, but at the best little could be expected of a beer at 1008° O.G.

N.A.F.F.I. Beer

At the same time many of the breweries were brewing beer of about 1030° original gravity for the British troops. Here in order to simulate British beer, the hop rate had been increased from a normal lager quantity of about 14 to 16 oz. per barrel to 21 oz. per barrel. This appeared to upset the balance of the beer flavouring constituents and an additional rough taste with some of the beers could probably be attributed to some of the brewers reusing spent hops as an economy measure.

"Champagne" Beer

At Weihenstephan experiments had been made on the production of "champagne" beer. In this wort from malted wheat was fermented for two days at 70-76°F. and then stored for two to three months in a glass lined steel tank in the cold room at three atmospheres pressure. The product was filtered and bottled at this high carbon dioxide content. (F.I.A.T. 492).

Non-alcoholic drinks

Under the Nazi regime an attempt had been made to produce annually some 15 to 18 million barrels of non-alcoholic drinks and the research stations had devoted much attention to this.

Whey beer

One attempt was to utilize the whey left from cheese making. In the V.L.B. process the whey is heated to 160 - 175°F. to coagulate the protein, then cooled to 85 - 95°F. and fermented by a lactose fermenting yeast. The samples tried were not to the taste of the party.

An alternative process was seen in commercial operation at the Herford brewery. Here the proteins of the whey were coagulated by heat and removed. Then the liquid was boiled with spent hops, cooled and carbonated. The result had a surprising resemblance to beer in colour and flavour.

Ludwig beer

In this patent process a high maltose constant wort is produced and after the addition of 1% cane sugar is fermented by Saccharomyces Ludwigii which cannot ferment maltose. The result is a sweet drink of low alcohol content.

Other proposals

Other proposals had been to brew and ferment normally then to distil off the alcohol - this is not very practical. In the V.L.B. it was proposed to mash so as to produce a very low maltose content wort and ferment this normally.

Wort-beer blends

An interesting proposal had been put forward by Schnegg and co-workers at Weihenstephan.

In his view the production of the special drinks indicated above would be insufficient in amount, too expensive and could not easily be carried out in breweries which were the only available places. If worts were incompletely fermented the process could not be stopped satisfactorily.

Therefore the process Schnegg proposed was to take an ordinary fully attenuated beer at about 1030° O.G. and blend with it sweet wort at 1025° which had been pretreated with activated charcoal to remove the raw wort taste. This blend was stated to be stable even although only pulp filtered, and to give a satisfactory flavour.

Food yeast

As is well known the production of food yeast was particularly encouraged in Germany and has been the subject of a number of reports. (B.I.O.S. 5, 6, 7 and 135 Item 22, C.I.O.S. File XXIX nos. 4, 5, 6 and 7 Item 22, F.I.A.T. Final Report No. 499). The findings have been summarised by H.J. Bunker (*Proc. Soc. Am. Bact.* 1946). The object was to increase the protein supply of Germany and supplement the vitamin supply. Generally Torula utilis was grown for the purpose on trade wastes. Surplus brewery yeast was also utilised.

Torula utilis has the advantage of fermenting pentose sugars as well as the ordinary hexose sugars and consequently the organism can be employed to ferment sugary liquids obtained by the hydrolysis of wood, straw, corn cobs, etc. Prof. Reindl of Weihenstephan had isolated a superior strain of Torula utilis which gives a yield of yeast dry substance of 50% instead of the usual 38%, based on the quantity of sugar supplied.

Sulphite liquor from wood pulp plants was the main source of sugars. It was oxidized by aeration at 175°F., neutralised by lime and fermented at about 85-90°F., after addition of nutrients (ammonia or ammonium sulphate and superphosphate, sometimes with potassium chloride and magnesium sulphate.)

When using waste material such as sulphite liquors or residual liquors from fish washing as material for growing food yeast it was found that trace metals from the plant tended to accumulate in the yeast to a harmful. extent - particularly lead. The quantities had been reduced by care in constructing the plants. Similarly arsenic could accumulate unless pure superphosphate was employed as a nutrient.

The vitamin B1 content was good and could be supplemented by causing the yeast to synthesise more from pyrimidine and thiasole (as discovered in America). Generally the vitamin tests appeared to be behind our own, and B1 had been chiefly studied, possibly because it is easier to estimate.

The proteins of yeast are such as to supplement the less completely nutritive proteins of cereals but it was found that one essential amino-acid is still missing - the amino-acid cystine; and efforts had been made to supply this deficiency from such cystine-rich proteins as the keratins and those in slaughterhouse offal. It did not appear that an entirely satisfactory solution had been reached in respect of flavour or nutritive value. The maximum recommended in human food was 20 grams daily - more could not be taken, probably because of the high purine content.

Part II of this report will appear in a later issue of the journal.