B.I.O.S. FINAL REPORT No. 701
ITEM No. 22

THE GERMAN ASBESTOS TEXTILE, JOINTING AND FRICTION LINING INDUSTRIES

BRITISH INTELLIGENCE OBJECTIVES SUB-COMMITTEE

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THE GERMAN ASBESTOS TEXTILE, JOINTING AND FRICTION LINING INDUSTRIES.

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Purpose of Visit

The Mission was instructed to investigate the German Asbestos Industry, with particular reference to aircraft brake linings. This could not be divorced from the more general uses of the industry's products and we therefore sought out all the Friction lining, Jointing, Packing and Asbestos Textile Manufacturers. Particular attention was paid to the development of asbestos substitutes or entirely new materials.

Introduction

This report contains information on the products and equipment of the targets visited. Unfortunately three of the four most important friction lining manufacturers, Kirchbach, Arthur Hecker and Emero Bremsbelag G.m.b.H. (making Jurid, Bremsit and Emero linings) were situated in the Dresden district and were not available for inspection. Kirchbach and Hecker are also two of the most important asbestos textile manufacturers in the German industry.

Richard Klinger G.m.b.H, one of the principal jointing manufacturers, situated at Gumpoldskirchen, near Vienna, was also in the Russian Zone and could not be visited.

Plants Visited

I. FRANKFURTER ASBESTWERKE PAUL KIND A.G., (Kesselberg-strasse 2, Niederad, Frankfurt-am-Main.

A. Persons Seen.

1. Paul Kind (owner since 1938)
2. Ernst Hof (Kind's son-in-law)

Both speak English, Ernst Hof very well.

The factory had been about 60% destroyed. The whole of the textile section (mainly weaving and braiding) had been destroyed, and the asbestos millboard plant damaged. The power plant, jointing and proofed goods section had been little damaged and were operating.

B. Asbestos Textiles.

This firm had had a complete asbestos textile plant, but the whole of the preparation, carding, spinning, and weaving plant at Bornheim had been destroyed. They had put up a small dispersal plant for weaving at Walldorf near Frankfurt, but this was almost exclusively engaged with glass silk.

The only textile items seen at the Frankfurt factory were a few braiding machines, in poor condition, probably saved from wrecked buildings. They were not running.

C. Glass Textiles.

This firm had 12 sheeting looms, all of 1-metre width, and of very light construction.

The picking speed of those looms seen working was 100 to 120 picks per minute. The looms were fitted with spiked roller side tension devices to prevent narrowing of the fabric.

The final roller on which the woven fabric was taken up was of normal type, covered with perforated sheet metal, with the rough edges of the holes outward. The yarns used in different types of cloth were stated to be as follows :-

/Single 3s.

Single 3s.
2/24s.
2/16s.
Single 16s.

One combined asbestos and glass yarn was seen, consisting of 2/16s glass twisted with single 9s asbestos.

The materials woven were all single ply plain woven sheetings, 1 metre wide, and the following are details as given by the foreman, of some of those seen in the looms:-

1. Warp and weft both 2/24s glass. Warp and weft both spaced 8 threads per inch. Weight of fabric: 650 grms/sq.metre. Thickness of fabric given as 1 m.m.

2. Warp single 16s, 2 ends up, weft 2/16s. Warp and weft spacing: 10 threads per inch. Weight: 1050 grms/sq.metre. Thickness given as 1 m.m.

3. Glass warp and Asbestos weft. No details available.

4. Glass filter fabric with very thick warp with low or zero twist, and weft 2/16s.

Samples Taken.

A number of samples were obtained and have been analysed with the following results :-

	Sample (a)	Sample (b)
Type of Material	Low Twist Glass Yarn	Glass Yarn
Weight of 10 yards	75 grains	190 grains
Yards per lb.	935	368
Counts. (Asbestos System)	18.7	14.75
Ply.	Single	2
Strength	4.75 lbs.	13.6 lbs.
Singles Twist. (Turns per in.)	0.7	4.4
Doubling Twist. (Turns per in.)	-	2.3

/Sample (d)

	Sample (d)	Sample (e)
Type of Material.	Glass Fabric.	Glass Fabric.
Weight per sq.yard.	20 ozs.	35 ozs.
Ends per Inch.	9	10 double ends.
Shots per Inch.	8	9
Counts. Warp.	6s. single.	15s single.
Weft.	16s. "	2/12s "
Twist. Warp.	0.5	4.0
(t.p.i.) Weft.	0.75	4.0 single. 3.0 double.

	Sample (f)	Sample (g)
Type of Material.	Glass Fabric.	Glass/Asb.Fabric.
Weight per sq.yard.	20 ozs.	28 ozs.
Ends per Inch.	8 double ends.	8
Shots per Inch.	9	7
Counts. Warp.	15s single	2 ends of 24s glass. 1 end of 12s asbestos. all twisted together.
Counts. Weft.	15s single	Same as warp.
Twist. Warp. (t.p.i.)	2.0	4.0 single asbestos. 7.2 single glass 2.4 double.
Twist. Weft. (t.p.i.)	2.0	Same as warp.
Type of Asbestos	-	Very poor grade of asb. similar to waste, card droppings; 35% staple fibre.

D. Jointing Manufacture.

The plant consisted of the following main items :-

1 Rubber Mill.
4 Spike Mixers.
3 Jointing Calenders.
1 Hand-Guillotine.
1 Two-bowl Plying Calender.
1 Power Operated Guillotine.

/The

The rubber mill was probably associated mainly with the Proofing Department, but may have been used to soften some of the synthetic rubbers before solution.

The mixers were of quite an ordinary type. Of the three calenders, two were of a large type with bowls 63 ins. in width and stated to be 5 metres (197 ins.) in circumference. The third was smaller, with a back bowl about 40 ins. wide and 150 ins. in circumference.

The thickness control was by worm-geared movement of the back bowl, operated by a hand wheel about 18 inches in diameter.

Steam pressure was 2 kgs. per sq.cm. (about 28 lbs/sq.in.).

The time for building a 2 m.m. sheet was stated to be 6 to 8 minutes and the output of one machine was given as 250 kgs. (about 5 cwts.) of jointing in 8 hours.

Plying was by a normal weight and lever-loaded 2-bowl calender with bowls about 12 ins. in diameter. Both surfaces to be stuck together were solutioned before plying.

Cutting to size was by hand guillotine for the single ply material, and by power guillotine for the plied sheets.

It was stated that they had not been successful in making wire-mesh insertion jointing. The high pressure between the jointing calender bowls invariably distorted the wire-mesh.

Spirit Recovery.

This was not really of much interest, since it was admitted to be an out-of-date process, and we were informed that spirit recovery plant of normal type was on order from the Silica-gel-Gesellschaft, Berlin.

The scheme in use was a simple condensation process. Each calender was enclosed and connected to an underground duct. The lower half of the enclosure contained a cold water radiator in close proximity to the circumference of the large bowl. A large proportion of the spirit condensed on this, and the cooling water and condensed spirit flowed down the duct to a separating tank and pump system outside the building. There was no air exhaust. It was stated that they got 50 to

/60%

60% recovery which seemed a remarkably high figure for such a crude and simple system.

Formulae.

No detailed formulae were obtained. We were told that they had had to make quite wide variations owing to supply difficulties associated mainly with transport dislocation. The general lines of the formulae were stated to be as follows:-

> Total bond 8 to 10% including 1 to 2% crude rubber and the rest made up of Buna, Oppanol and Reclaim. The fillers included about 30% of asbestos and the rest the usual range of fillers including Lithopone, Barytes, and in some cases Graphite, for coating. The finished jointing was rough in surface texture and extremely low in tear resistance.

E. Proofed Goods Manufacture.

This department was not running when seen. It had no special features and was concerned with the usual process of making up by hand.

The spreading tables, mixers, shaping rollers and joint cutters were all of normal types.

Materials made from some bast fibre (probably Hemp), also from woven paper-base yarns, and glass silk, were noted.

II. FICHTEL AND SACHS G.m.b.H., Schweinfurt.

A. Persons seen.

Dr. Schneider. (General Manager).
Dr. Wittig. (Technical Director).
Mr. Binder. (Development Engineer).
Dr. Schneider and Mr. Wittig spoke English.

B. Company's Activities.

This company manufactures clutch units but not friction linings. They have licenses under both Borg and Beck and Long patents, and they are the largest suppliers of plate clutches to the German motor industry.

They have various other activities including transmission parts, and small stationary petrol engines.

/The

The factory had been about 70% destroyed by bombing.

Our discussions covered only the performance of clutch linings, and the cementing of linings to plates.

1. Clutch Linings Used.

They had used normal woven and moulded asbestos base types before the war.

They now used Emero-Stahl linings where possible. These linings were stated to be made of steel wool bonded with Buna type rubber. They claimed a high friction, fair wear, no fade, unaffected by oil, and superiority in respect of shudder to conventional types. They admitted some scoring, but said it was not bad.

They had also used two types of Jurid linings, one on a woven brass wire base with a phenol-formaldehyde type resin bond, and the other a moulded resin bonded steel wool reinforced disc. These both showed fade and erratic friction.

Moulded Textar discs showed good friction, but relatively poor wear.

Test graphs with a maximum temperature of 200°C. were shown. Under these conditions the Emero discs showed frictions varying from 0.30 to 0.35, with an initial peak at 0.45 in one case.

2. Cementing Process.

This was developed because the Emero Stahl lining had poor strength and doubtful resistance to severe clutch stress or high centrifugal stresses.

The cement used was Bakelite Resinit 240 and was sprayed on to the clutch disc only. The plate (either steel or Duralumin) was sandblasted.

The disc was allowed to air dry for one day.

The plates and discs were then assembled in packs 40 to 50 units high. Three of these packs were placed in a special trolley carrying a pneumatic press, and pressed at a pressure of 5000 - 6000 Kg. per disc. This is equal to between 200 and 400 lb/sq.in. for an average size disc.

/The

The press unit is put in an oven and cured at 140°C. for three hours.

The process was stated to work only with the Buna bonded discs. It did not work with phenol-formaldehyde bonded materials. It was carried out at a dispersed unit at Chemnitz and the Russians were reported to have removed the plant.

III. DICHTUNGSRING G.m.b.H., Stockach str.16, Stuttgart.

A. Persons Seen.

O. Hermann (Manager - speaks a little English).
O. Gehring (Assistant).

B. Company's Activities.

This firm proved to be purely a marketing organisation with a large general trade in all types of gaskets and proofed goods.

The premises had been gutted by fire but some reconstructions were being undertaken to sell stocks which had been dispersed.

IV. MERKEL & KIENLIN A.G., Esslingen.

A. Persons Seen.

Hans Merkel, Commercial Director, showed us the process. His brother, Fritz Merkel, who is responsible for the Works side, was away. The Glass Silk Foreman was also present. The plant was not running when inspected.

B. Company's Activities.

The factory was a large well-equipped textile mill. It had originally been a woollen mill, but had been largely changed over to substitute fibres, mainly staple fibre.

The factory appeared to be almost completely idle. This was stated to be due to lack of fuel.

The glass yarn section was a comparatively small and recent development. It was the only section of the factory inspected. It was not running when seen.

/C.

C. Glass Textile Processes.

This was a carding, not a combing process. It included the following steps :-

Conditioning.
Cutting.
Opening.
Re-conditioning.
Carding.
Drawing.
Spinning.

In addition to these, there were doubling and winding processes which were not inspected.

1. Raw Material.

This was glass fibre obtained in hanks about 10 ft. long. The hanks were very ropy in appearance, suggesting that in the drawing process a good deal of water must have been put on the drum. The fibre diameter was 0.0005 - 0.0006". The material was obtained from Faser-Industrie, Mulhausen, Alsace-Lorraine.

2. Conditioning.

The hanks were stored for an unstated time in a wool conditioning room, with a temperature of 100 to 120°F.

3. Cutting.

Hanks of glass were passed through a simple guillotine machine on a belt conveyor and cut into pieces 3" long.

4. Opening.

The cut fibre was passed through a machine stated to be a standard Hartmann Opener. It had a lattice feed. The material was carried on a lattice, and the main cylinder had very coarse teeth. The output was blown from the exit end into a settling chamber.

5. Re-conditioning.

After the Opening process, the fibre was stored in the

/conditioning

conditioning room again.

6. Carding.

The machine used was stated to be an absolutely normal woollen card. It had three feed cylinders with short blunt teeth followed by an enclosed main cylinder (not seen) and an output cylinder covered with fine tooth clothing, the teeth being straight, approximately 5 m.m. long and with about 26 teeth per sq.cm. The output from this card was stated to be 4 kgs. (about 9 lbs.) per hour. There were 13 cards of the same type used on this process. There was no dust exhaust. They stated that a good deal of skin trouble had arisen, especially with blondes.

7. Drawing.

The rovings were drafted on a machine made by Richard Hartmann of Chemnitz, which was stated to work on the French system. Four of these machines were in use. The draft was stated to be $2\frac{1}{2}$ to 3 times. They had also experimented with gill box drawing.

8. Spinning.

This was carried out on wool spinning frames on the flyer system, but with very small bobbins. Six of these were in use.

9. Grades of Yarn Made, and Twist.

They made two grades of yarn, No.3 and No.5, on the metric system. These appeared to correspond approximately to 30s and 50s on the British Asbestos count system. The twist put in was stated to be 190 and 220 turns per metre (about 5 T.P.I.) on the No.3, and 240 to 250 turns per metre (6 T.P.I.) on the No.5. The strength of the yarn was not known.

D. Cost.

During the war, prices had been fixed by the Government and the cost of the raw glass was 2.6 marks per kilo, and the price of the finished yarn was 6.3 marks per kilo.

/E.

E. Miscellaneous Information.

Mr. Merkel stated that many visitors were surprised that the product was made by carding rather than combing. He understood that all the material was bought to be woven up for insulation purposes. The following is a list of his customers:-

Deutsche Asbestwerke, Goergi, Reinhold & Co., Berlin-Zehlendorf, Postfach.
Deutsche Kap-Asbest-Werke K.-G., Hamburg-Bergedorf, Postfach.
Norddeutsche Asbest-und Gummiwerke, Kurt Weber, Hamburg-Wandsbek, Wendemutstrasse 8 - 14.
Pet. Wilh. Krommes G.m.b.H., Wulfrath bei Wuppertal, Postfach.
Frankfurter Asbestwerke, Paul Kind Kom.-Ges., Frankfurt-Main-Niederrad, Kesselbergstrasse 2.

Mr. Merkel expressed the view that the future of glass fibre lay mainly in mixed yarns, especially glass and asbestos. This opinion did not seem to be in general agreement with that of other users who were successful with glass silk yarns but had not had much success in incorporating them with asbestos and other fibres.

F. Samples Available.

Sample (c)

Type of Material	Glass Yarn.
Weight of 10 yds.	29.5 grains.
Yards per lb.	2500
Counts. (Asbestos System)	50s.
Ply.	Single.
Strength.	4.15 lbs.
Twist (turns per inch)	6.4

Note: This sample is very slubby.

V. PAHLSCHE GUMMI-UND ASBESTWERKE A.G., Am Gather Hof Str.43, Dusseldorf-Rath.

A. Persons Seen.

Dr. Hans Pahl	(Director)
Dr. Heinrich Pahl	(Works Director)
Dr. Alfuss	(Chemist)
Dr. Schutz	(Temporary Assistant- speaks English).

/B.

B. Company's Activities.

This had been a large factory making rubber hose, and conveyor belting, rubber mechanicals, jointing, and asbestos millboard. The buildings had been about 80% destroyed by bombing, but some of the heavier items of plant, including jointing calenders, had been salvaged and were being re-conditioned.

Only the jointing plant, which was being re-instated as far as possible, was inspected.

C. Jointing Manufacture.

1. De-Polymerisation of Buna.

The material usually Buna 85, was cut into small pieces and heated in a steam autoclave at 135°C. This reduced the viscosity and increased adhesion.

2. Solution Mixing.

The rubber and Buna were then dissolved in spirit in a rotary mixer. This solution and the fillers were then charged into vertical mixers 3 ft. 6 ins. to 4 ft. in diameter and about 4 ft. 6 ins. deep. These mixers had a central vertical shaft with blades which rotated between standard horizontal blades attached to the sides of the mixer. There was a discharging vent about 1 ft. in diameter at the bottom of the mixer. It was stated that in the pre-war plant the mixers, which were situated in the second storey of the building, had discharged direct into containers which had been carried on a conveyor system to the calenders. All this system, however, had been destroyed.

3. Calenders.

These were of Pahlsche's own design, made by the firm of Krupp Grusonwerk, Magdeburg. They were of unusual design being vertical two-bowl calenders with both bowls the same size. This was given as 2 m. 40 cm. in width and 2 m. 40 cm. in circumference (94½ inches each way). The bottom roll was cooled, and the top one steam heated, the pressure being given as 60 to 100 lbs. per square inch.

The figure given for calender speed was 8 revs. per minute, and the time taken to make a 1 mm. sheet stated to be 20 minutes. The calender was worked by one operative with an assistant (apparently one assistant shared between a number of calenders) to help in the removal of sheets. Thickness

/control

control was by a hand operated wheel. They did not know the actual load between the rolls, but stated that the weight of one roll was 16 tons. The rolls had to be taken out of the calender for re-grinding; they were then mounted on a special grinding unit. We were told that the approximate variation in thickness of a 1 m.m. sheet was about 10% overall. They were not aware of any tendency for variation in thickness between middle and ends. The output was stated as 20 metric tons per month of average thickness material for one calender working three shifts.

4. Plying.

The material was normally cross laminated and the plying was done with a two bowl calender; sometimes 3-ply was made. Normally 0.5 to 1.5 m.m. were made on the calender, but it was possible to make up to 3 m.m. without plying.

5. Wire Insertion Jointing.

It was stated this was made on the calender by placing the wire on the lower bowl without any tensioning device, and coating with jointing mix. The wire was then turned over and the other face coated. This process was repeated two or three times on each face.

6. Costs.

The present cost of manufacture was given at 1.7 mks. per kilo. Pre-war it was probably about 20% cheaper.

7. Spirit Recovery.

They had an activated carbon plant made by the firm of Bamag Meguin. They claim an operating efficiency of 80%. A point of interest mentioned was that the layer of carbon in the absorber rested on a layer of pebbles, there being about 40 cm. depth of carbon and 30 cm. depth of pebbles. The pebbles were stated to retain heat after the steaming operation and to help to dry the carbon. The pebbles were variable in size, between $\frac{1}{2}$ inch and 2 inches, diameter, and rounded, but not spherical.

8. Formulae.

(a) Standard Jointing.

Particulars of the formulae used during the war were obtained. A certain amount of natural rubber was available, and the whole of this was used on the first layer in order to get

/adhesion

adhesion to the calender bowl.

The formulae of the first layer, second layer (body) and third layer (top cover) are given below :-

First Layer	Kilos
Buna 85	9
Smoked Sheet Rubber	10
Oppanol B.200	5
Barytes	150
Silica Flour (Steinmehl)	50
Red Oxide (Englisch Rot)	8
Carbon Black (Russ.II)	0.4
Aldol Alpha Naphthylamine	0.4
Asbestos Grade III.	75
Asbestos Grade II.	25
Disintegrated Jointing.	99
Jointing broken down in Spirit	132

In the above formula the jointing swollen with spirit is a mixture of equal parts of jointing and spirit. An equal weight of spirit is added to the above dry mix for the jointing mix.

Second Layer (body)	Kilos
Buna S	30
Sulphur	0.8
Vulkacit DM.	0.7
Vulkacit D.	0.1
Litharge	2.0
Aldol Alpha Naphthylamine	0.3
Zinc Oxide	2.0
Barytes	120
Disintegrated Jointing	165
Asbestos H.5. (Russian)	130
Asbestos Powder	60

An equal weight of spirit was added to the above to make a jointing mix.

/Third

Third Layer (top cover)	Kilos.
Buna S	40
Red Oxide (Englisch Rot)	25
Red Oxide (Japanese Rot)	7
Silica Flour (Steinmehl)	63
Sulphur	1.2
Vulkacit DM.	0.8
Zinc Oxide	2
Disintegrated Asbestos Millboard.	270

This formula was also used with an equal weight of spirit.

(b) Wire Insertion Jointing.

A different formula was used for this material with a higher percentage of bond and a shorter fibre as follows :-

	Kilos.
Buna S	45
Sulphur	2
Vulkacit DM	0.5
Zinc Oxide	3
Litharge	3
Silica Flour (Steinmehl)	150
Asbestos Powder	110
Disintegrated Asbestos Millboard.	110

This formula was used with an equal weight of spirit.

(c) Pre-war Formula.

They informed us that they did not have available their pre-war formulae owing to their destruction of records, but that details of these were given in the book "Handbuch der Gesamten Kautschuktechnologie" by E.A. Hauser, 1935.

This book has since been examined and the following formulae are given. They are merely basic formulae of no particular interest.

Formula 1.

Rubber.	15%
Asbestos.	85%

/Formula 2.

Formula 2.

Rubber	11%
Sulphur	0.2%
Magnesium Oxide	1%
Barytes	7.8%
Asbestos	80%

An equal weight of spirit is added to the above mixing.

VI. DANCO-WETZEL A.G. Kanalstrasse 80, Dortmund.

A. Persons Seen.

R.W. Doedtler (Director)
H.J. Diederichs (Private Secretary to Director)
R. Rafflenbeur (Works Foreman)

H.J. Diederichs speaks fair English.

The factory was about 20% damage. The millboard plant had been entirely destroyed. Most of the rest of the plant had suffered little damage.

B. Textile Processes.

They carried out all normal asbestos textile processes, including crushing, opening, carding, spinning, weaving, and braiding.

1. Raw Materials.

Before the war they had used normal Canadian and Rhodesian asbestos, except for some special electrical applications for which they said they had obtained Arizona (U.S.) iron-free asbestos. During the war they had used Russian and Jugo-Slav asbestos. The latter was stated to be equal to Rhodesian Grade 3 asbestos and on the U.S. standard sieve test was between 0-8-6-2 and 0-0-8-8.

They had not had any success in carding glass wool, but had been able to card mineral rock wool into coarse yarns for brake lining. The process was just as for asbestos except that a rather coarser card clothing was used.

/2.

2. Opening.

Normal methods were employed with a roll crusher, and a Creighton type opener.

3. Carding.

They had 8 cards, 3 single and 5 double. One was of Hartmann manufacture, and the others all of Gessner make.

The only point of interest was that at the input end of the finishing card, an additional feed arrangement was available. This consisted of a pair of rollers with shallow grooves which formed the outlet at the base of a hopper. Rotation of the rollers allowed short fibre, or powder which filled the grooves to be fed on to the web. The purpose of the device was the addition of shot fibre to the mixture.

4. Dust Exhaust.

As normal British practice. No special point of interest.

5. Spinning Process.

They had 9 Flier Spinning Frames, and 6 Ring Spinning Frames, making a total of 1500 spindles.

They preferred Ring Frames for fine yarns. Ring Frames had a bigger output than the Flier type, but made the yarn rather less smooth and even.

A figure of 700 - 800 r.p.m. was given for the Flier Frames, and the Ring Frames were stated to be run at a rather higher speed.

6. Card and Spinning Frame Output.

It was stated that for counts of 1 kilo per 1000 metres (equivalent to about 10s counts on the British system) the output of the frames was as follows:-

7.5 Kilos (about 16.5 lbs.) per hour for a 54 spindle Flier Frame.
12 Kilos (about 26 lbs.) per hour for a 56 spindle Ring Frame.

/The

The card output on the same counts was 30 to 36 Kilos per hour (63 to 80 lbs.)

7. Weaving.

There was nothing of note. They had 24 sheeting looms, 4 brake lining looms, and some 14 web tape looms. These had been making glass silk tape for electrical applications, using a soft twist glass yarn.

8. Braiding.

They had 13 machines for packing manufacture, and 6 machines for lagging. The packing machines were inverted so that the braided section could go straight through the pool of impregnating grease.

There were two points of some interest in connection with the lagging. In one case a machine was fitted with a very simple conveyor feed for the filling.

This was carried up a 6" wide belt conveyor, fitted with two side ramps converging at an angle of about 30° to the end of the conveyor where the ramps were about $1\frac{1}{2}$" apart. The filling was thus made to converge and dropped into the machine in a compacted form.

The other point was the manufacture of the patented Danco-Wetzel Coke Oven Door Seal. In this case normal 60 m.m. lagging was put through a braiding machine and given a braided cover of thin steel strip about 1/8" wide.

C. Jointing Compositions.

This plant had three calenders, and normal type of additional equipment. There was nothing out of the ordinary about the process. The rubber was swelled in spirit, mixed in a solution mixer, and the jointing mixed in a spiked mixer. There were three calenders, two large ones 1.5 metres (about 60") in width, and 5.3 metres (about 208") in circumference. The smaller calender was the same width but smaller circumference.

/The

The surface speed of the calenders was stated to be 8 to 10 metres per minute; the output of 1 m.m. thick jointing was stated to be 20 minutes per sheet for the best quality and 10 minutes for the second quality, the average production being 800 kilos (about 16 cwt.) in an 8 to 9 hour shift.

All the calenders had hand wheel thickness control. One of the calenders, the newest, had certain points of interest. It was very robustly made and had the gearing entirely separated from the machine with flexible couplings to each bowl. The maker of this calender was Siemag, Kleindahlbruck, Kreis Siegau.

D. Friction Linings.

1. Processes.

These were commonplace, and possessed no outstanding features.

(a) Roll and Flexible Brake Lining.

This was made by a normal batch process with relatively crude tackle.

The woven asbestos was dipped in rolls in the impregnating solution, removed, drained, partly dried, squared, and finally dried.

(b) Rigid Brake Segments.

The material was treated similarly up to the drying stage. After suitable drying it was cut to length, and given a normal hot press cure.

(c) Clutch Discs.

These were made from a dry moulding mixture by a normal press-moulding operation.

2. Material Used.

(a) Woven base.

This was normally woven asbestos. We /were

were told that occasionally woven rock-wool had been used.

An interesting point was the use of a Zinc Alloy wire reinforcement, stated to be used instead of brass.

Analysis by the R.A.E. gave the following composition.

Zinc.	97.9%
Copper.	1.1%
Aluminium.	0.8%
Iron	0.1%
Lead, Chromium	traces.

This wire was obtained from the firms of Schmoele, Menden and Sundwiger Messingwerk, Sundwig.

It is apparently slightly higher in tensile strength than pure zinc, though less ductile.

(b) Moulded Materials.

Mineral filled Phenol-formaldehyde types of moulding mixtures were used.

One which was mentioned was Type 31 Press Mass from Venditor, Troisdorf, but moulding mixtures were also obtained from Kurt Albert, Weisbach, and from Bakelite Gesellschaft.

(c) Impregnating Resins.

Bakelite 160 was used in methylated spirit solution, also resins from Venditor and Wagner.

3. Plant.

The impregnating and drying arrangements were very crude, consisting only of tanks, lifting tackle, squaring machines and batch stoves.

The press room was a normal one with six presses ranging from 25 to 60 ton capacity.

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4. Production.

This was stated to be 6000 to 8000 clutch discs per month normally, and about 12,000 metres of woven brake lining. At present about 4000 clutch discs monthly were being made, and very small amounts of brake lining.

5. Test Equipment.

They had a very old fashioned testing machine which looked as if it were never used.

VII. TEXTARWERKE - BAUERNFEIND & CO. Leverkusen-Schlebusch, Near Cologne.

A. Persons Seen.

P. Bauernfeind (Managing Director)
Fraulein Els Bauernfeind (Daughter of above)
Frau Decker. (Prokurist)
Herr Bauernfeind speaks good English, and his daughter fair English.

This firm is a subsidiary of British Belting and Asbestos Ltd., Cleckheaton, England. The factory was undamaged.

B. Company's Activities.

Clutch discs and friction linings were made from asbestos and similar yarns dressed with cresol-formaldehyde resin and wound into cylindrical billets which were cured in an autoclave and cut into segments or discs.

C. Friction Linings.

1. Materials.

The wound type discs and shoes were made either from asbestos yarn of a poorish grade, or from a material under the name of "heimatstoff", a substitute yarn which, so far as we could ascertain, was made from a slag wool base, with some short asbestos.

The moulding mixtures were made from various mineral fillers such as iron oxide, and slate powder, also asbestos powder, slag wool, and sometimes steel or aluminium wool.

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The resins used were ordinary liquid cresol-formaldehyde resins for the wet processes, and solid phenol or cresol-formaldehyde resins for the dry mouldings.

2. Plant.

There was a disintegrator and spike mixer for dry mixing, presses for wet preforming, and some quite modern electric ovens for drying the wet preforms, and also for during the wound billets.

The presses were an odd lot with no special features.

3. Production.

This had reached a maximum of 2 - 3 tons per month in 1940 - 1942, when they had about seventy employees. They were now reduced to twenty-five employees. There was a demand, but this could not be fully met even when licenses were obtained because of the shortage of synthetic resin supplied.

4. Test Equipment.

They had a reasonable Inertia Machine made up to an old British design, and possessing no notable features. It seemed to be in regular use.

VIII. DEUTSCHE KAP-ASBESTWERKE A.G., Kampschauseestrasse 9, Hamberg-Bergedorf.

A. Persons Seen.

Herr Ahrens (Managing Director).
Herr Brandt

Herr Ahrens speaks fair English.

The factory was undamaged.

B. Personnel Employed.

350 - 400 pre-war.
430 during the war.
120 now.

C. Materials Used.

1. Asbestos.

They still had about three months' stock. They had worked

worked mainly on pre-war Canadian and South African asbestos, and had also used Russian. They had had Finnish and Italian, both very poor, and some Jugoslavian, even poorer.

2. Slag and Glass Wool.

They had made trials incorporating up to 50% with cellwolle and asbestos. The yarns were brittle and crushed easily. The cost was 200% more than asbestos.

D. Textile Processes.

All the formal textile processes of opening, carding, spinning, doubling, weaving (sheeting and tape only) and braiding were carried out.

1. Opening.

The fibre was usually, but not always crushed in an end runner mill. The opening was done in a Hartmann opener, similar in principle to a Creighton opener. The unit seen was provided with a pneumatic condenser, and fed into a large chamber closed by doors. This chamber had dust exhaust.

In some cases especially with short fibre, the material was simply disintegrated with or without a preliminary crushing in an end-runner mill. This process was seen in operation on a mixture of Blue asbestos, and a dark coloured fibre stated to be recovered asbestos.

2. Admixture of Staple Fibre.

This was not done as a lap, but first of all roughly by hand, and then the blend put through an opening machine similar to a willeying machine. The materials seen were being mixed with cellwolle. This was a carded staple fibre which was lofty and looked to make quite a good blend. The users regarded it as inferior to cotton.

3. Carding.

This was a well arranged plant, with 5 double, and 3 single cards, all Gessner make. Double carding was used for counts finer than 1.2 metric (about 12s on our system), and single carding for coarser counts. In considering this point it should be remembered that some preliminary opening would be provided by the process of mixing with staple fibre.

The dust exhaust was normal except for the arrangement

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of the shed. The cards were arranged side by side in the normal way down one side of the shed. Down the length of the shed immediately above the ends of the cards, and rather to one side of the middle of the shed a partition extended from the roof down to within about 7'6" of the floor. This partition was provided with exhaust ducts at intervals. These were in addition to the normal exhaust ducts on the cards.

Some asbestos was being carded, and this was stated to have 20% added cellulose. This was probably a low estimate.

Blue asbestos was not seen being processed. We were told it was moistened by hand in a heap on the floor before carding.

Card Grinding, except on one new card was rather rudimentary. The cylinders were taken out, and ground up on a separate machine with a central grinding cylinder which dealt with two card cylinders at once, one on each side.

4. Spinning.

They had 11 Ring Frames (750 spindles) and 4 Flier Frames (400 spindles). These were generally old, and had no special features of interest. They used Ring Spinning for counts finer than 1.5 metric (about 15s counts) and Flier for coarser yarns.

Output was given as 100 kilos (about 220 lbs.) of 0.5 metric yarns, or about 5s counts on our system, per eight hours. The spindle speed on the Flier Frames was given as 700 r.p.m. but looked a good deal less. Ring speeds stated to be somewhat higher.

It was evident that there was a large number of end breakages, but the yarn was uneven, and had many weak places.

5. Doubling.

12 Frames, no special features seen.

6. Weaving.

There were 27 looms, all tape or sheeting looms.

The sheeting looms were of normal light construction. Dust exhaust was rudimentary. They were weaving either glass silk or mixed glass silk and asbestos fabric. The weaving

/speed