XXV. BRÜX

Introduction

Several bus-loads of staff and workmen from the Hermann Goering Works at Brüx arrived at Leuna on the night of 12/13th May. They had left Brüx on the night of 7th/8th May just before the Russian entry. The party included Dr. Damm, the managing director and Dr. Amon, the chief engineer. Dr. Ottens, the chief chemist of the plant had been separated from the main party en route and was expected later. Dr. Damm had no papers and was in no condition to give a detailed account of the plant and its operations. He disclosed that arrangements had been made in March to evacuate to Schwarzenfeld, near Amberg, Bavaria, in the event that a Russian occupation of Brüx appeared likely. When the Western advance developed, this plan was dropped but a considerable number of documents were evacuated to the Porceline Fabrik Buchtal A. G. at Schwarzenfeld. A further batch of documents had been sent to the Kohlen Chemische Institut at Claustal in the Hartz Mountains. Others had been hidden in the central shaft of the brown coal mine at Brüx.

It was the intention of the Brüx staff to proceed to the Hermann Goering Works at Walenstadt, near Brunswick, where they hoped to work out a plan for distribution of people to other works.

General Outline of the Brüx Factory.

The plant, erection of which was commenced in 1939, consisted of the following sections:

(a) Brown Coal Carbonisation

This consisted of four groups of 20 carbonisation units designed by Lurgi to operate with recycle gas. The coal carbonised was the local hard brown coal containing 30% water. Each unit had a throughput of 250-300 tons/day of wet coal. Parts of this plant commenced operation in 1942 and by May 1944 when the programme began to be interrupted by air raids, 60 units had been erected and 55 were working. Tar yield was 10-12% by weight on the coal carbonised and middle oil and heavy tar were produced separately by fractional condensation of the tar vapours. It was proposed to sell the middle oil as heating oil after topping it to increase the flash point to $>85°C$. The heavy tar was to be the feed to the hydrogenation plant.

(b) Hydrogen Production

Six large Winkler Generators, each with a capacity of 20,000 M^3/hour water gas, were installed, together with Linde units for oxygen manufacture. The hydrogen plant for completion of the reaction $CO + H_2O = CO_2 + H_2$ operated at 12 ats. pressure. Nine hydrogen plant units were installed at Brüx. They were all Bamag design.

The anticipated steam savings were not achieved and initially trouble was experienced by salting up and corrosion of parts of the plant. Trouble was also experienced with the life of catalyst which had to be removed every 4-6 weeks for cleaning by rumbling and sieving. At times, the operation of the hydrogen units definitely limited plant operation and Dr. Damm was firmly of the opinion that atmospheric pressure hydrogen sets are to be preferred.

(c) Hydrogenation Plant

The hydrogenation plant was in two sections, each consisting of two liquid phase stalls, two pre-saturation and two splitting hydrogenation stalls. Each stall had four converters operating at 325 ats. The anticipated output of final liquid products from this plant, i.e. fuel oil from carbonisation + petrol and diesel oil from the hydrogenation units, was 600,000 tons/year. The plant began operations in May 1943 and by May 1944 output had been brought up to 45,000 tons/month. Bombing commenced in May 1944 and continued at regular intervals. The output of the plant was greatly reduced as a result and in the last 6 months of 1944 was only 20,000 tons of liquid product. Output during 1944 was 100-120,000 tons. It was considered that, apart from air raid damage, the output of the complete plant could have been easily increased from 600,000 to 1,000,000 tons/year liquid product by the addition of two more liquid phase stalls and by increasing the capacity of the carbonisation plant.

Phenol Extractions

The brown coal tar was very rich in phenols. Aqueous liquors produced in the carbonisation and hydrogenation plants were extracted with phenosolvan as at Blechhammer. Phenols from the crude cold catchpot product of the hydrogenation plant were recovered by a method developed by Koppers. The product was subjected to steam distillation and the distillate passed through caustic soda solution and maintained at about 100°C, the resulting phenate being worked up in the ordinary way. A third source of phenol was the light oil from the carbonisation units, which was extracted with caustic soda.

The phenosolvan extract was very rich in catechol. The crude extract was purchased by the I. G. and was worked up at Leuna. The rest of the caustic soda extracted phenols were worked up at Brux and sold through the Phenols Sales Board in Berlin. Refining was not carried beyond the crude carbolic acid and crude cresols stages although it was intended later to install plant for the production of pure phenolic products.

...ion of the Hydrogenation Units

The heavy brown coal tar was hydrogenated in much the same way as ...d at Leuna. The heavy tar was mixed with the cold catchpot product ...ctionated into middle oil boiling up to 325°C and heavy oil, the latter being fed to the liquid phase hydrogenation stalls and hydrogenated using a suspended iron on Grude catalyst.

The Brüx tar was quite different from Middle German brown coal tar. In addition to its higher content of phenols, including catachol, it had a considerably higher asphalt content. It was also apt to contain arsenic compounds which gave rise to considerable trouble in the plant. Arsenic compounds were found in deposits in the pre-saturation hydrogenation stall interchangers and on the catalyst. The source of the arsenic was thin bands of high arsenic content Pyrites in the coal. As a temporary measure trouble was minimized by careful selection of the coal but it was intended to install a coal washery, operating the flotation process in order to remove Pyrites from the coal carbonised.

Dr. Amon stated that ordinary gas-fired preheaters were used for the liquid phase and the splitting hydrogenation stalls but the preheaters for the pre-saturation stalls were electrically heated.

Costs

At the full output of 600,000 tons/year liquid products, it had been calculated that motor gasoline would cost 260 marks/ton at Brüx. This assumes that crude wet coal costs 12 marks/ton delivered, and is made up as follows:

Raw materials	120 marks/ton
Operating costs	80 " "
Capital charges	60 " "

The corresponding cost of heating oil was estimated to be 220 marks/ton.

Present Condition of Brüx Plant

When the staff left Brüx, 16 carbonisation units were capable of operating and another six could have been put on line very quickly. Dr. Damm considered that within 12 weeks, 30 carbonisation units could be in operation. Three Winkler gas Generators were in operating condition and it was estimated that the Linde plant could be made to operate at half capacity in 1-2 months' time, given freedom from air raids. The same was considered to apply for the hydrogen sets CO_2 and CO removal and compression.

As far as the hydrogenation plant was concerned, one liquid phase unit was in running order and a second could be put on line in four weeks. Two saturation and two splitting hydrogenation stalls were in working order.

Storage tanks had suffered badly in air raids but Dr. Damm considered that sufficient tanks were available for operation of the plant at roughly half its flowsheet output. Most of the storage tanks were sunk about one-third of their height below ground and were surrounded with 18" concrete walls.

Underground Hydrogenation Plant

The Hermann Goering Works at Brüx had started work on an underground hydrogenation plant at Bad-Schandau in Polenstal. This plant was intended to make 5,000 tons/month of petrol from tar. It consisted of two liquid phase and two vapour phase stalls and was known as Schwalbe III.

TABLE IX.

	Motor Spirit	Aviation Base VT. 702	DHD Aviation Base.VT.342	Diesel Oil 1	Diesel Oil 2	Marine Fuel Oil
Density at 15°C	0.735-0.765	0.715-0.730	0.760-0.810	0.845-0.865	0.820-0.840	0.845-0.865
Boiling Range	35°-200°C	40°-145°C	40°-175°C	200°-330°C	115°-285°C	200°-330°C
Flash Point	-	-	-	>55°C	> 21°C	> 65°C
Aniline Point	-	max.52°C	max.10°C	-	-	-
Vapour Pressure, ats at 40°C	0.6 - 0.8	max.0.5	max.0.5	-	-	-
Residue on distillation	10 mgs.max.	5 mgs.max.	5 mgs.max.	-	-	-
Sulphur Content % by wt.	max. 0.1	max.0.05	max.0.05	max.0.5	max.0.5	max.0.5
Freezing Point	below -25°C	below -60°C	below - 60°C	-	-	-
Aromatic Content % by vol.	-	max. 15	40 - 55	-	-	-
Min. temperature for filtrability	-	-	-	at least -5°C	at least -30°C	at least 0°C
Pour Point °C.	-	-	-	at least -10	at least -40	at least -5
Viscosity at 20°C(Engler)	-	-	-	1.5 min.	1.2 min.	1.5 min.
Ash & Hard Asphalt Content	-	-	-	-	-	-
Octane No.	min.65	min.70	min.78	-	-	-
Octane No. with 0.09% by vol. of lead	-	min. 87	min. 87	-	-	-
Cetane No.	-	-	-	45	40	45

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TABLE X. - GERMAN OIL PRODUCTION DATA.

Hydrogenation Plants		Capacity in 1000 Tonnes/year				Actual normal monthly production in late 1943 and early 1944						
		Total Petrol	Aviation base	Alkylate & Octane	DHD petrol in Aviation Base	Aviation base inc DHD	Motor Spirit	Diesel Oil	Fuel Oil	Lube Oil	Misc.	Alkylate & Octane
Leuna	1)	600	350	60	(300) 100	20	10	20				
Böhlen	1)	240	180	(30)	(200)	15	12 x	11				
Magdeburg	1)	220	120				9	9				
Zeitz	1)	280					5	12		2.5	3.5	
Scholven	1)	216	216	60	(200) 100	16						
Gelsenberg	1)	350	350			29						
Pölitz	1)	600	540	64	(300) 100	45			5	1.0		
Wesseling	1)	200	144	(20		10		7				
Welheim	2)	160	50			4						
Brüx	1)	(400)	250	(24)	(300)	20		8	9			
Blechhammer	1)	(425)	(205)	(40)	(200)		1		4			
Lützkendorf	1)	50					2	1	1			
Oppau	5)	50	50	4	50	4						
Heydebreck	7)				(50) 12	1	0.3					
Aushwitz	7)			(24)								
Moosbierbaum	5)	106	106		(140) 106	7						
Hüls	6)	12	12		(20) 12	0.7						
Schkopau	6)	9	9		9	0.6						
Total		3,918				172.3	27.3	57	19	3.5	3.5	16.0
Fischer Tropsch Plants												
Ruhrchemie	3+4)	72					2.1	0.8		1.2	1.4	
Victor Rauxel	3)	40					1.5	1.0			0.8	
Rehinpreussen	3)	70					2.8	2.1		0.2	1.1	
Krupp Benzin	3+4)	60					2.2	1.1			1.7	
Essener Benzin	3)	80					4.1	1.8			0.8	
Hoesch Benzin	4)	47					0.5	1.2		0.2	2.0	
Schwarzheide	3)	170					8.4	2.5			3.1	
Schafgotsch	4)	40					0.7	0.8			1.8	
Lützkendorf	3)	(70) 12					0.2	0.1			0.7	
		591					22.5	11.4		1.6	13.4	
Brown coal for distillation		50					3.0	9.5	27		4.3	
Total Hydrogenation + Fischer + Carbonisation						172.3	52.8	77.9	46	5.1	21.2	
German Petroleum		1920					13	56	10	65	3.5	
Bit. Coal Tar Distn.									32			
Benzol etc.						4	27					
Bit.Coal Carbonisation		36							3			
Grand Total German Production		[illegible]				[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	

176.3 | 92.8 | 133.9 | 91 | 70.1 | 24.7

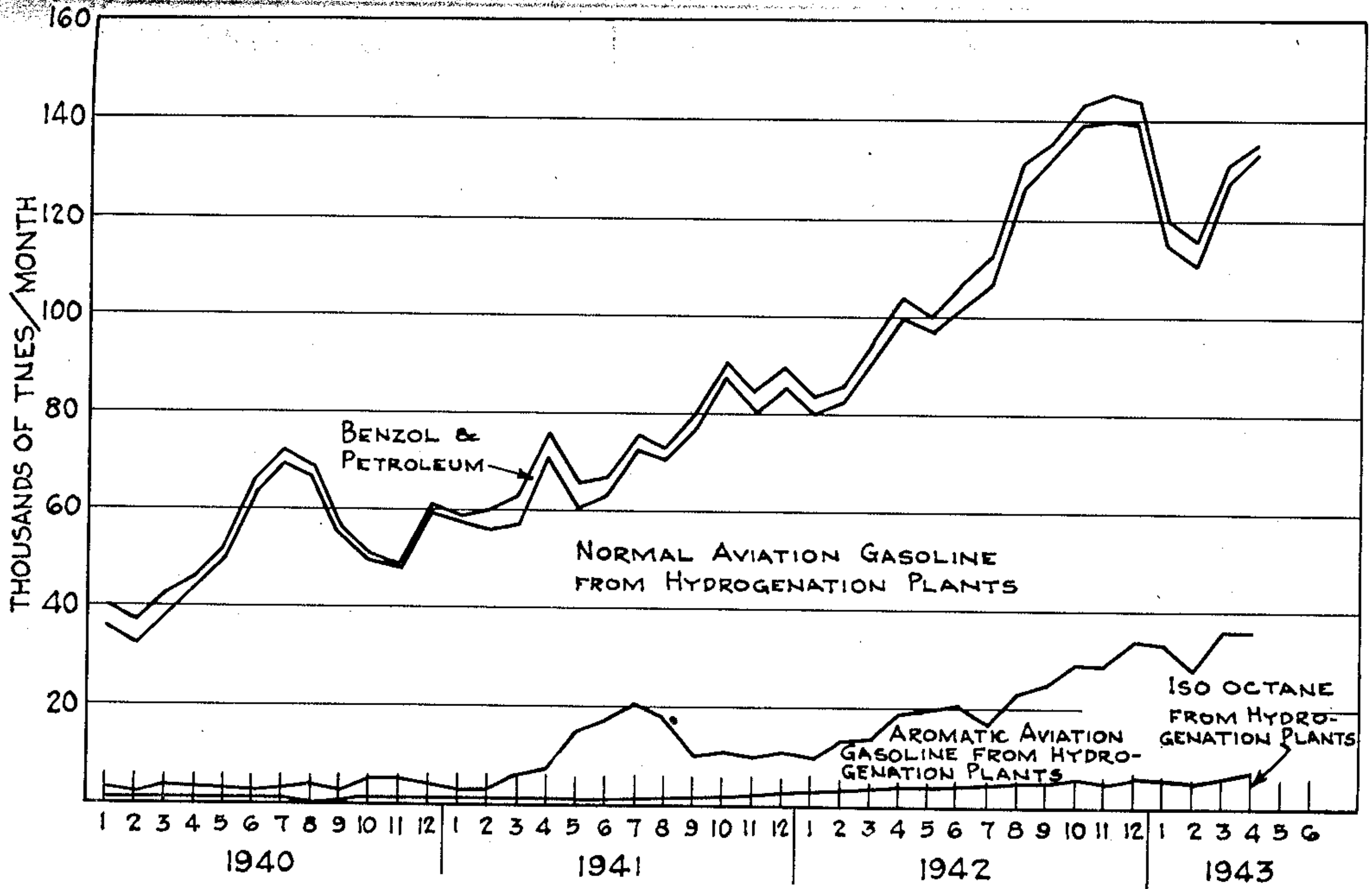

FIGURE XL.- AVIATION GASOLINE PRODUCTION.

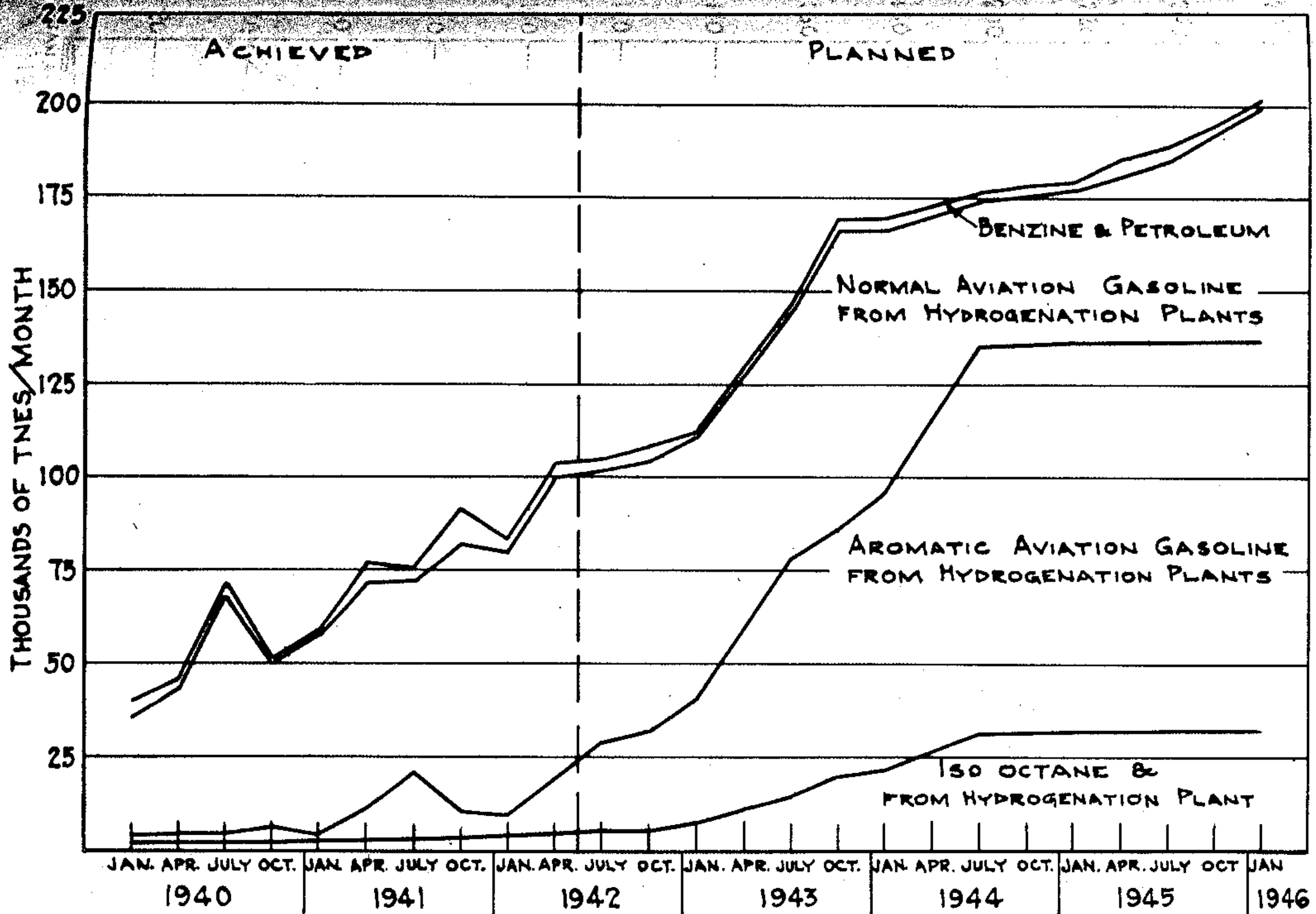

FIGURE XLI.- AVIATION GASOLINE PRODUCTION (NORMAL PROGRAMME)

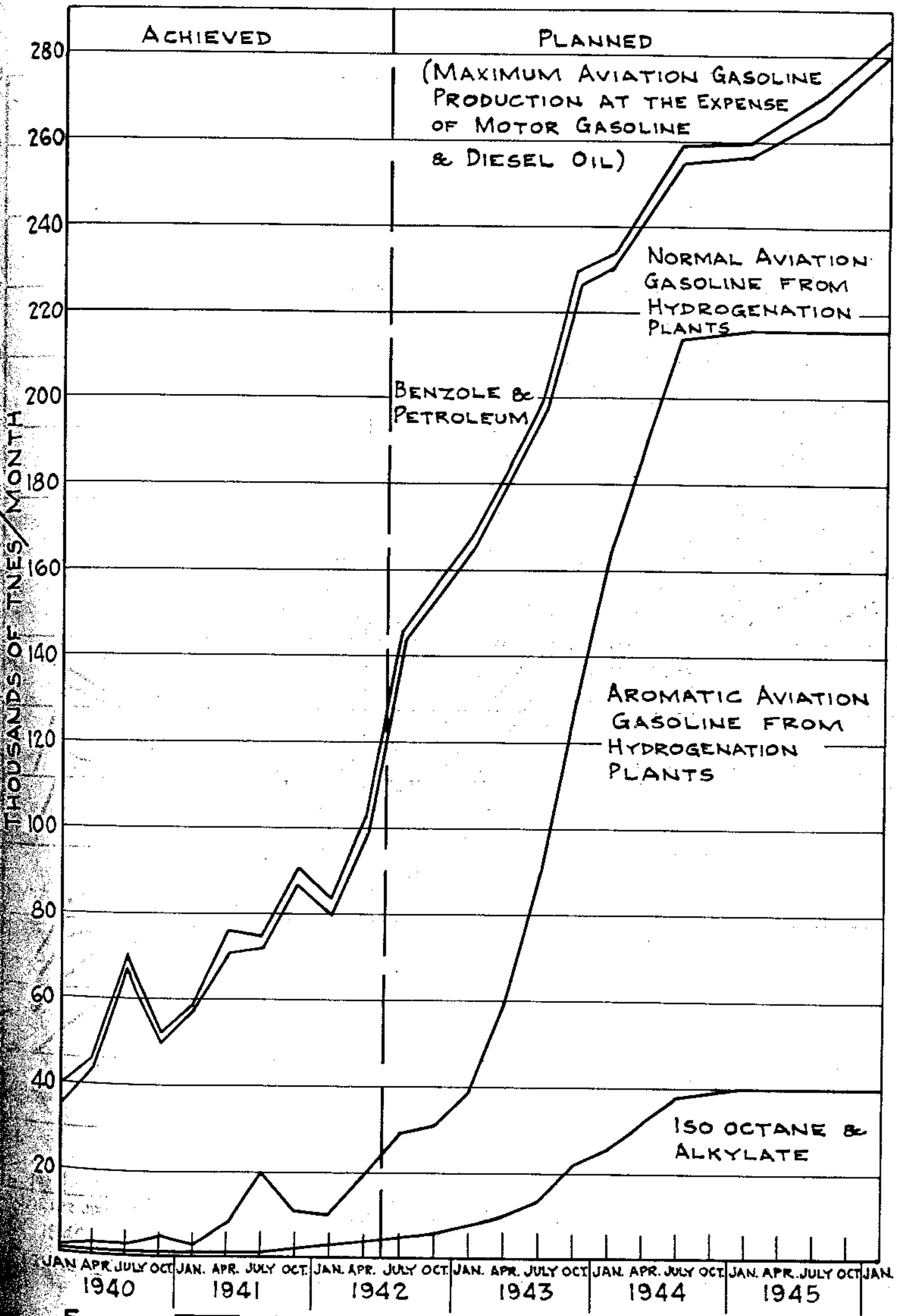

FIGURE XLII.- AVIATION GASOLINE PRODUCTION (MAXIMUM PROGRAMME).

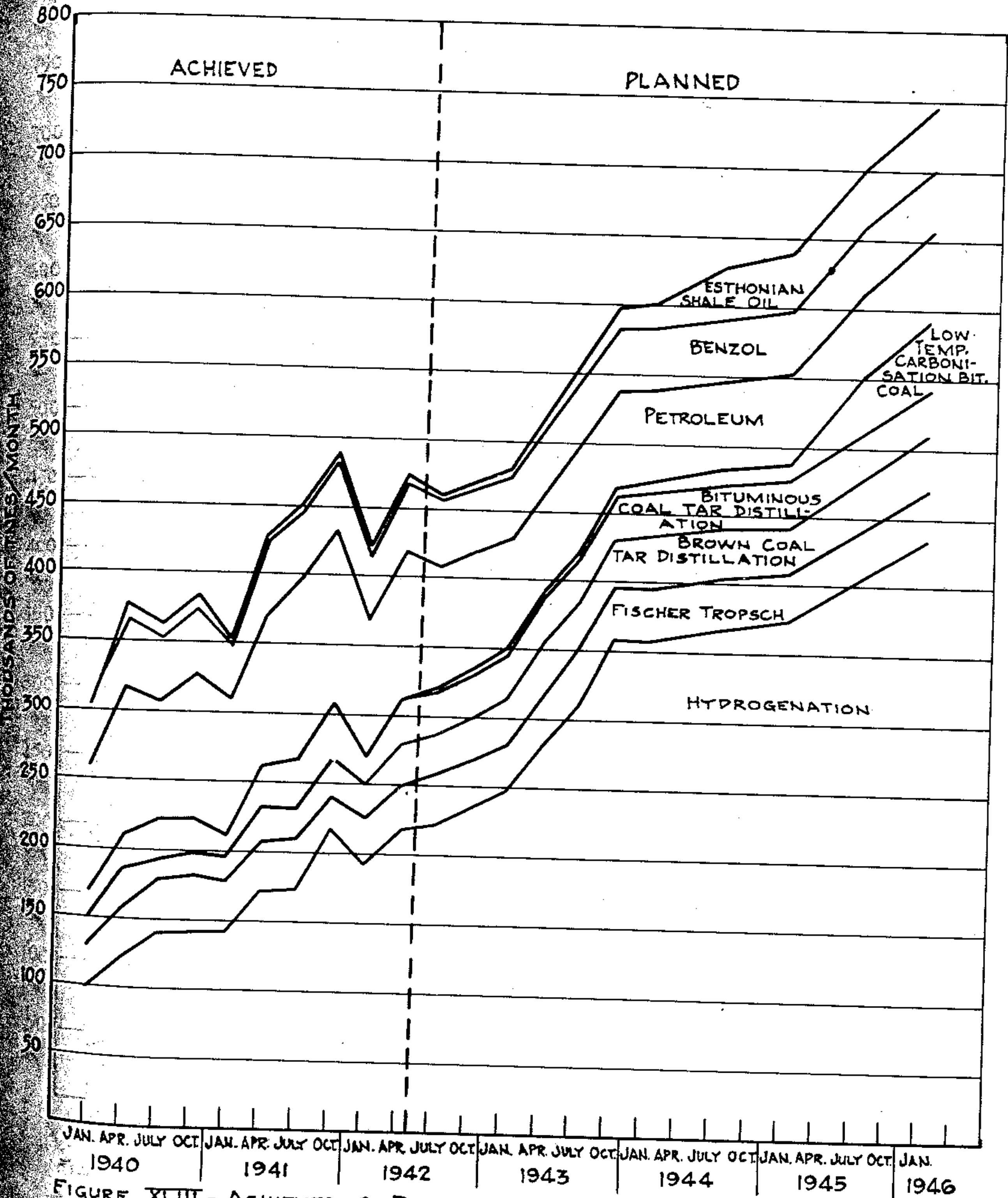

FIGURE XLIII - ACHIEVED & PLANNED OIL PRODUCTIONS (SUB-DIVIDED ACCORDING TO ORIGIN).

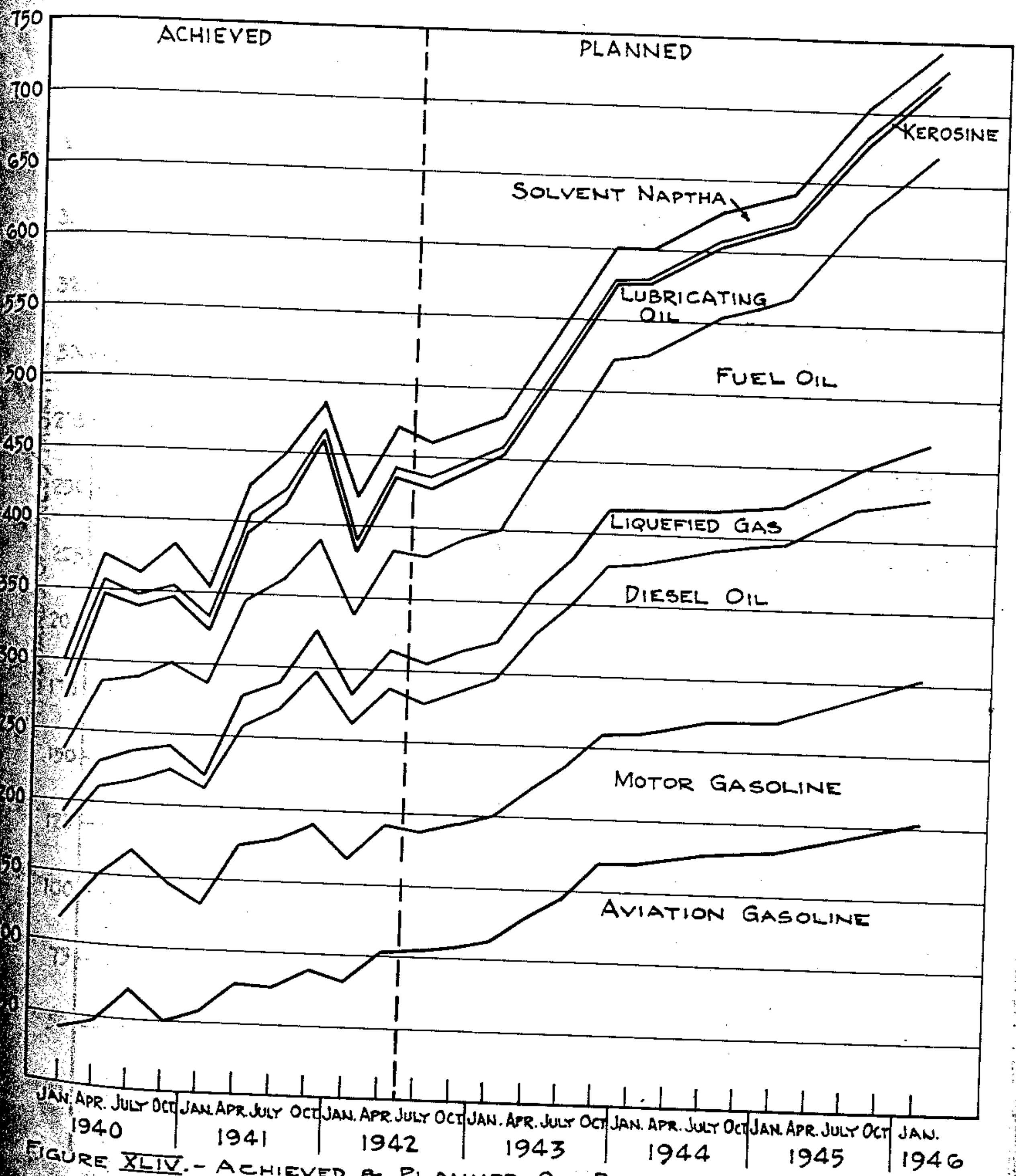

FIGURE XLIV. - ACHIEVED & PLANNED OIL PRODUCTIONS (SUB-DIVIDED ACCORDING TO PRODUCTS).

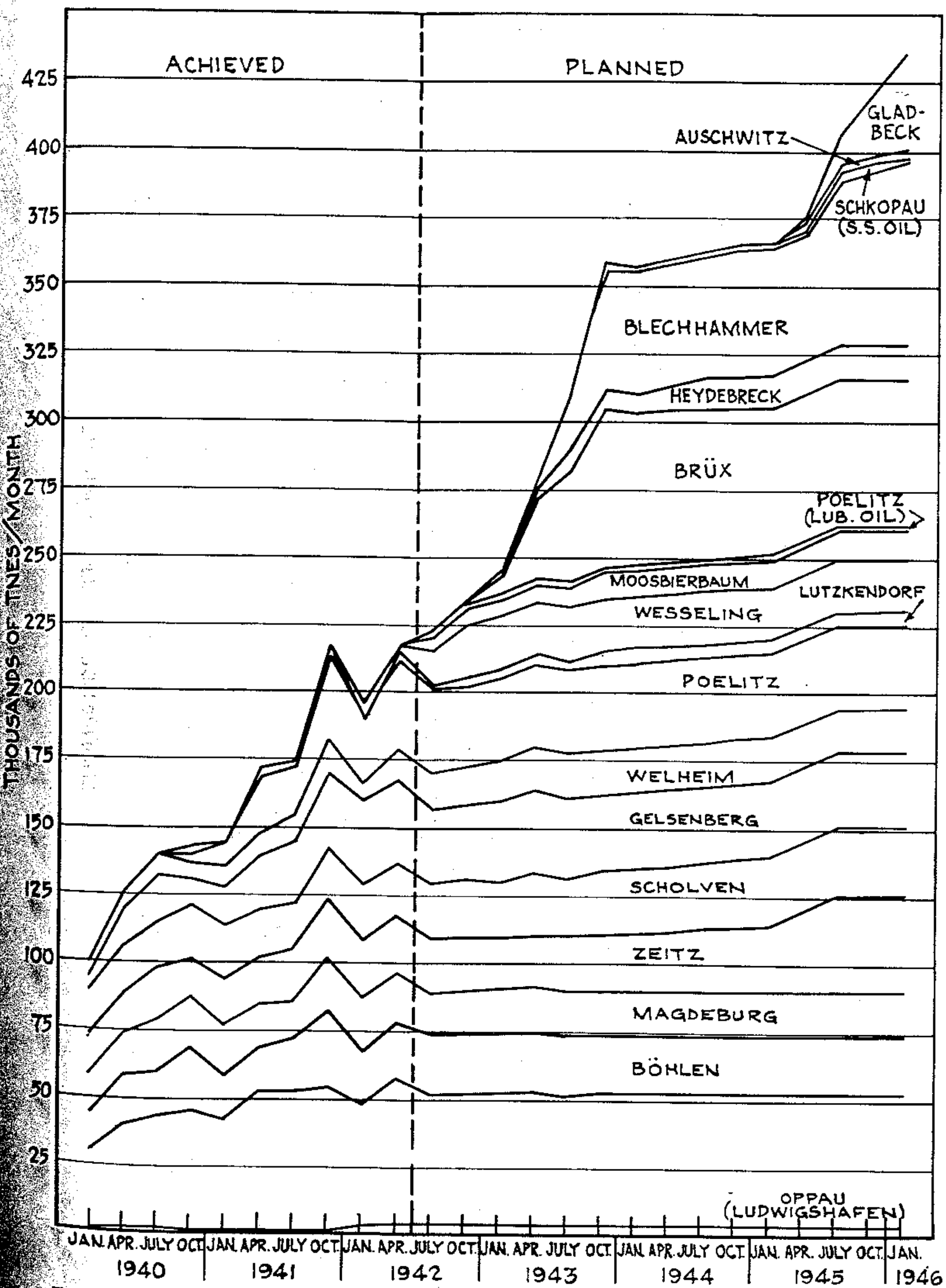

FIGURE XLV.- ACHIEVED & PLANNED PRODUCTIONS FROM HYDROGENATION PLANTS (INCLUDING HYDRO FORMING DHD, Di 1000 & S.S. OIL).

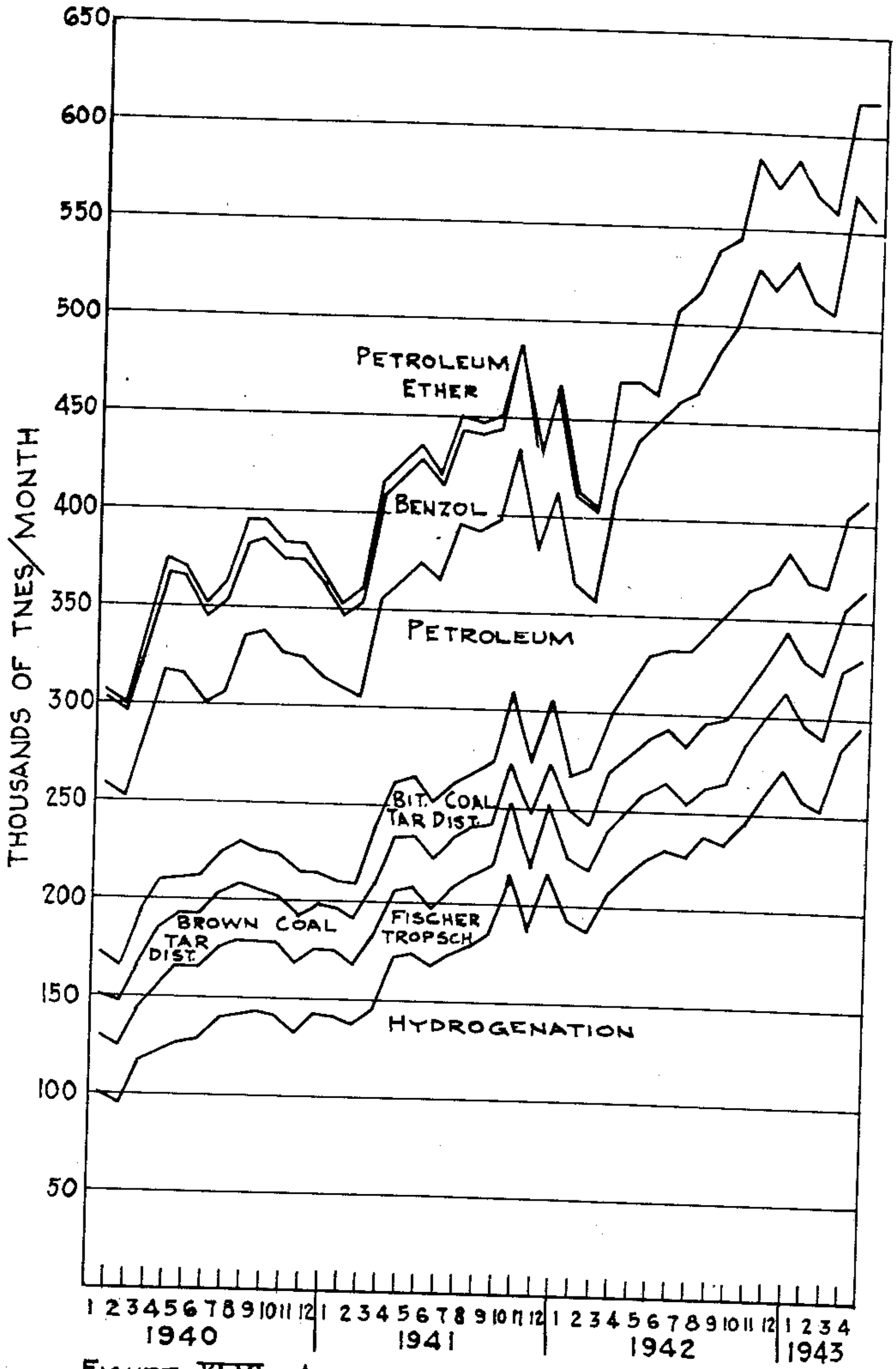

FIGURE XLVI.- ACHIEVED OIL PRODUCTION (SUBDIVIDED ACCORDING TO ORIGIN).

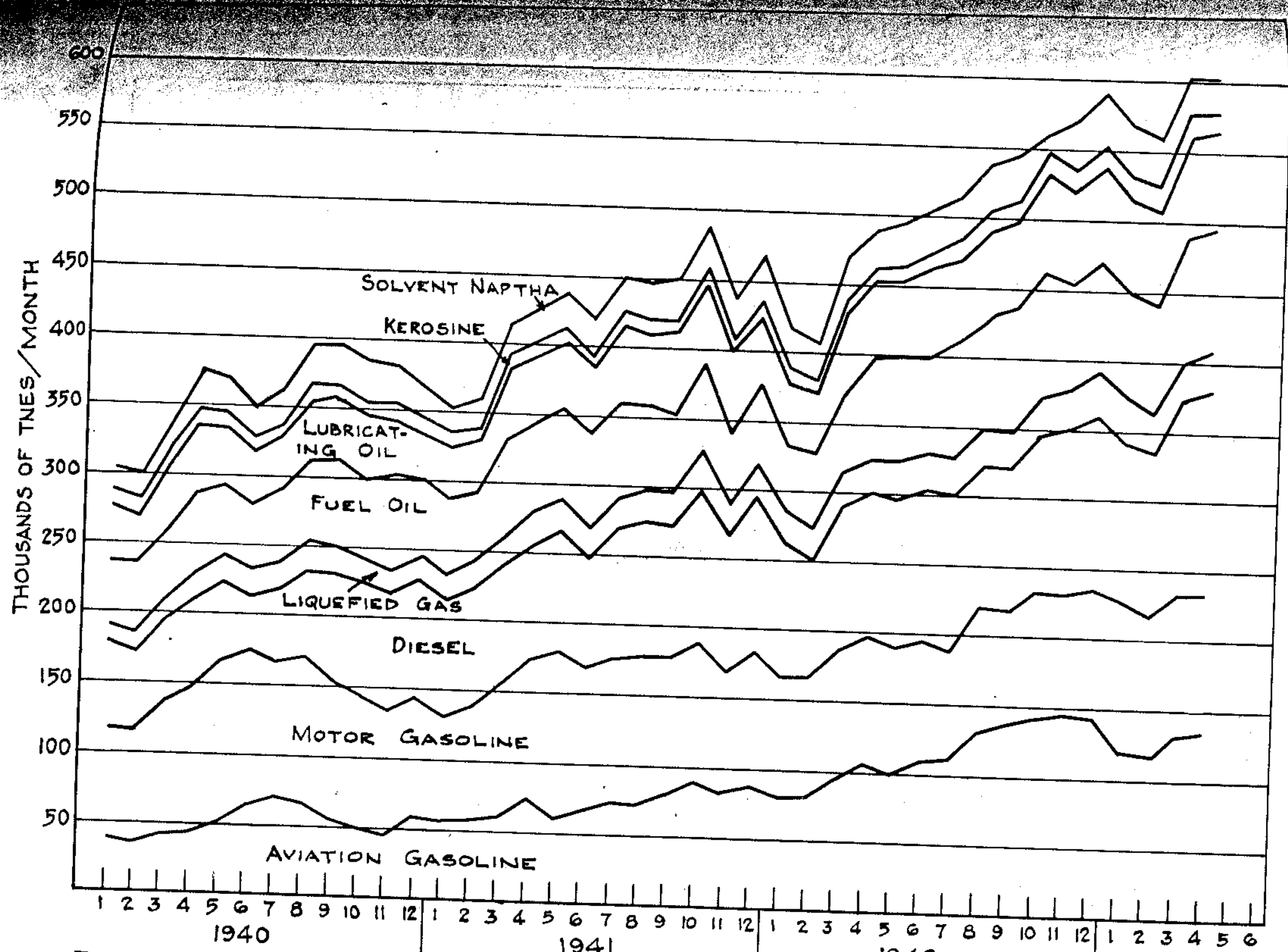

FIGURE XLVII.- ACHIEVED OIL PRODUCTION (SUB-DIVIDED ACCORDING TO PRODUCTS)

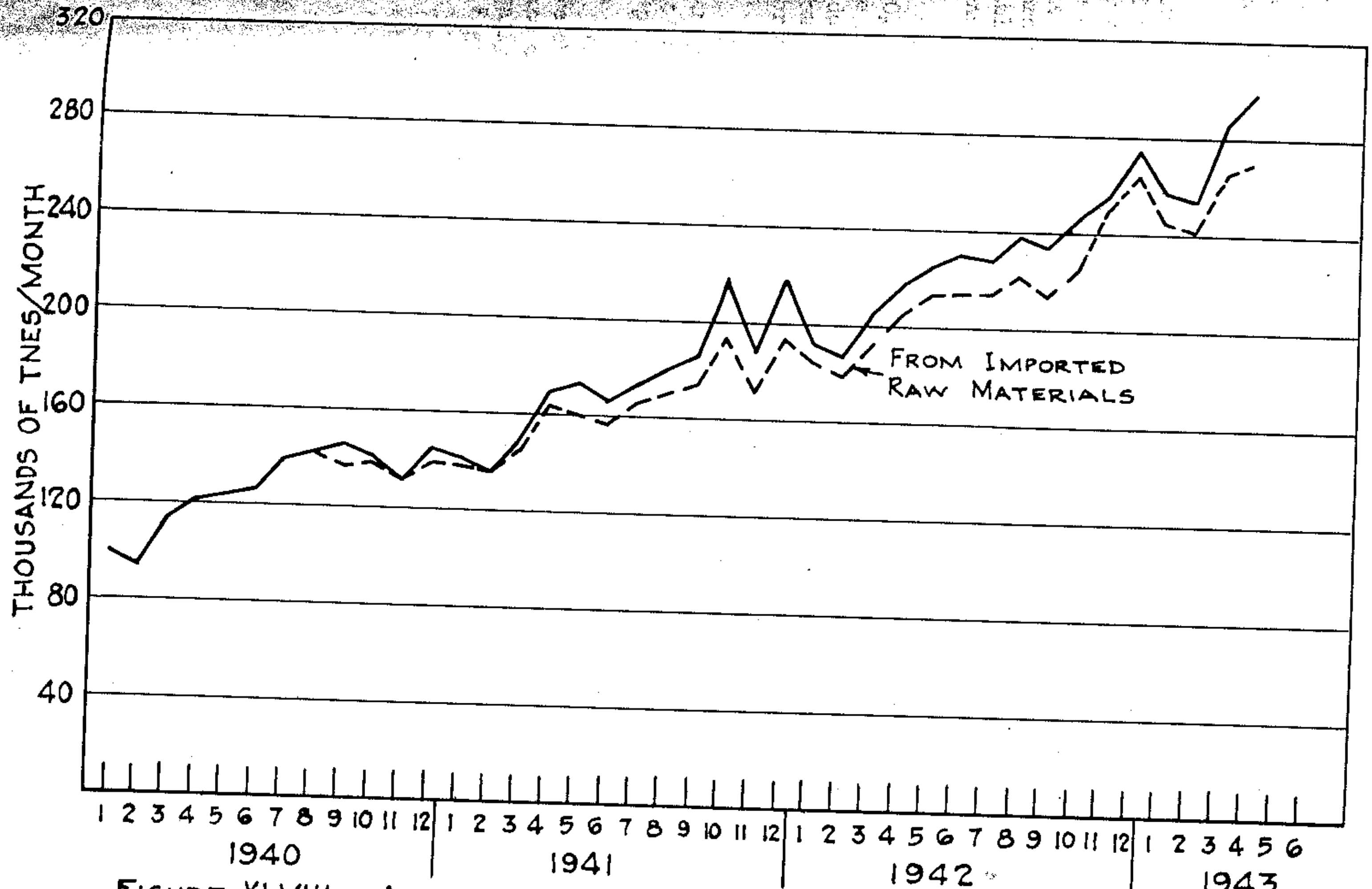

FIGURE XLVIII. - ACHIEVED OIL PRODUCTION FROM HYDROGENATION PLANTS.

XXVI. GERMAN OIL PRODUCTION

Dr. Bütefisch of Leuna was Chairman of the Wirtschaftgruppe for fuel production and of A.R.S.Y.N., the organisation which co-ordinated the production programmes of the various German refineries. He was questioned regarding the overall German oil position and supplied the figures given in Table IX.

The capacity figures in brackets refer to plant in course of construction. Lubricating oil figures refer to production by direct refining of oil products and do not include synthetic lube oils such as those made by polymerisation of ethylene. Production of liquefied butane and propane is not shown in the table but was normally 25-30,000 tons/month. Most of the Rumanian and Hungarian oil products were supplied direct to the armed forces in the Eastern areas and these supplies are not included in the table. The total Rumanian crude production was said to be roughly 6,000,000 tons/year.

Of the German crude oil production of 1,920,000 tons/year, some 8-900,000 tons/year came from the Austrian fields, 6-700,000 tons/year from the Hanover district, 200,000 tons/year from Heide and the remainder from Baden and the Polish frontier area. The German crudes, particularly those from Austria which contained only 5-7% petrol, were particularly good for lubricating oil production.

Examination of the table shows the overwhelming contribution of the hydrogenation plants to German aviation fuel production. It is also interesting to note the negligible extent to which Fischer-Tropsch activities were in process of extension.

Further data on German achieved and planned production of oil products were obtained in the form of graphs which were found in Dr. Bütefisch's Leuna office. These data are reasonably in line with those supplied personally by Dr. Bütefisch. Nine of the graphs are reproduced in this report in Figs. XL to XLVIII.

Dr. Bütefisch and Dr. Ottens supplied the data in Table X on the latest specification for German oil products.

XXVII. USE OF BOTTLED PROPANE AND BUTANE FOR ROAD VEHICLES

According to Dr. Butefisch, it was aimed to turn 60-65% of all German cars and commercial vehicles to bottled gas fuel. Shortage of steel and labour interfered with this plan and priority had to be given to conversion of trucks and vans. Actually only about 35% conversion was achieved. The monthly consumption of liquid gas was 25-30,000 tons. This compared with total consumption of petrol and diesel oil apart from that used by the armed services of 50,000 tons a month.

Pure butane was never used in Germany as bottled gas for road vehicles. Pure propane was used for household heating and lighting and it was also considered desirable to use propane in the winter months for road vehicles. In summer a mixture containing up to 85% butane was considered satisfactory. In actual practice, a blend of butane and propane in the proportions which corresponded to availability was employed during the war.

Dr. Scholtz of Leuna was the inventor of much of the equipment used in connection with liquid gas vehicles. He supplied the following information on I. G. development of liquid gas vaporisers.

In the first gasifier to be produced in commercial quantity, liquid gas was vaporised by means of a hot water preheater and the resultant gas vapour let down in two stages, firstly to a pressure of 0.4 ats. and finally to -20 m.m. water pressure. The sub-atmospheric second-stage pressure ensured efficient closing of the second-stage let down valve when the engine was shut off, but it led to difficulty because of a variable air/fuel ratio at different throttle openings. Air leakages backwards into the second stage let down chamber were prevented by fitting a non-return valve (actually a gas mask valve was used) between this vessel and the jet chamber.

The second type of gasifier was similar to the first except that the second-stage let down pressure was atmospheric. In order to ensure that no leakage occurred when shutting off the engine, a stop valve was incorporated in the liquid feed line. This was connected so that as long as there was a positive engine oil pressure it remained open. This model was extremely satisfactory and Dr. Scholtz considered it to be the best gasifier which has been produced. It is, however, fairly expensive; a pre-war production cost of 200 marks was mentioned.

A cheaper type has been developed during the war costing only 25-30 marks to make. Some 100-150,000 of this type of gasifier have been manufactured by the German Solex Carburetter firm. The preliminary vaporisation of the liquid gas is carried out in a coil heated by exhaust gases. The resulting vapour at a pressure of 1.2 ats. is let down first to 0.4 ats. and secondly to -5 m.m. water gauge. This assures satisfactory closing of the second stage let down valve and eliminates the rather expensive oil operated stop valve. At the same time it is sufficiently near atmospheric to avoid wide fuel air ratio variations with speed.

A third type was being developed in which vaporisation was brought about between the first and second let down stages.

Samples of these various types of gasifiers were procured at Leuna, together with detailed drawings. They were despatched to London through the usual channels but so far they have not materialised.

Dr. Scholtz said that a liquid gas had been used for running-in all aero engines during the war. A report giving a detailed description of the set up employed is amongst the documents removed from Leuna.

Some experimental work had been carried out at Leuna with a car running on neat methanol and also on a mixture of methyl ether and methanol.