

Oxygen Production

The pressure-gasification plants erected at Hirschfelde, Boehlen and Bräx are equipped with air-separation plants of the standard Linde type erected by Ges.fuer Linde's Eismaschinen, A.G. of Munich. Lurgi have not carried out any research on problems connected with the separation of air into components and could supply no detailed information concerning recent developments in the use of expansion turbines.

The Messer Co. of Frankfurt-am-Main have erected a number of air-separation plants of the Linde type using normal heat exchangers, but were believed to have carried out some work on the design of expansion turbines. The contract for the air separation plant of

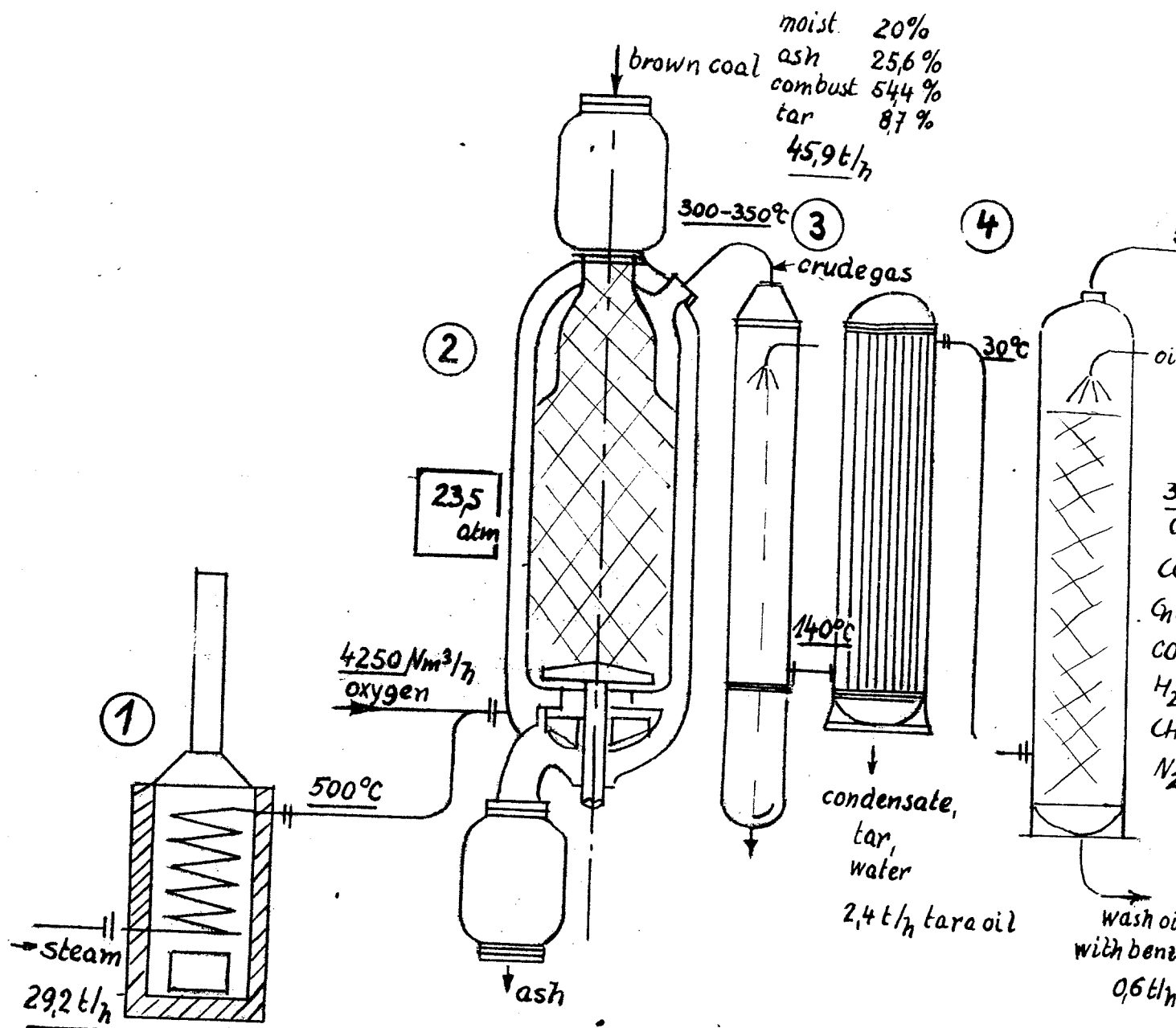
one Societa Italiana Carburanti Sintetici project, which was to use the Lurgi Gasification process, was placed with Messer, not because their estimate of power consumption was lower than that of Linde (0.536 as compared with 0.56 Kw. per Nm³ of O₂), but because Linde was unable to undertake the contract.

For the purpose of estimating the cost of oxygen production, Lurgi use a figure of 0.65-0.68 KwH per Nm³ for total power consumption on the air-separation plant excluding power for the subsequent compression of the oxygen to the pressure used for gasification, (A figure was obtained later at Boehlen of 1.2 KwH including the power for compression to 23 atm.). The total cost of producing oxygen in plants containing units of from 1000 to 2000 Nm³ per hour capacity was estimated as 2.2 to 2.5 pfg. per Nm³ of which cost, 40% is for capital depreciation, 40% for power and 20% for wages, maintenance and chemicals. The cost would be less for larger units; thus, in connection with a recent project requiring 17,000 Nm³ per hour, Linde had proposed a plant consisting of 6 units, one a stand-by, and had estimated that the total cost of production would be 1.5 pfg. per Nm³ of which 0.4 pfg. would be for capital depreciation.

The oxygen used for pressure gasification was usually of about 95% purity. This concentration could be reduced by addition of air when gas of low calorific value was required. The plant at Hirschfelde was operated on "rich air" containing 70-75% of oxygen.

A short description of the Linde-Frankel Process for air separation was given as follows:-

All the inflowing air to be separated is compressed in Turbo-compressors (made by Guttehofnungshütte, Oberhausen) to 4.5 or 5.atm. After removal of carbon dioxide by means of aqueous caustic, the compressed air is introduced into the separating equipment which comprises oxygen and nitrogen-regenerators filled with aluminum packing, and the rectifier. A smaller part of the low-pressure air coming from the first compression-stage is further compressed from 4.5 atm. to 200 atm. following which the highly-compressed air is cooled to minus 45°C. before entering the expansion machine. The high-pressure compressors have 5 stages. The cold required for the process is provided in expansion machines (Heylandt, Berlin-Tempelhof) in which a portion of the compressed air from the high-pressure compressors is expanded from 200 atm. to 4.5 atm. with energy recovery. For plants of very large capacity, Linde has employed other process method; for example, expansion of the outlet cold nitrogen from the separating equipment in turbines. The manufacturers for the machines and apparatus of the plant follow:-



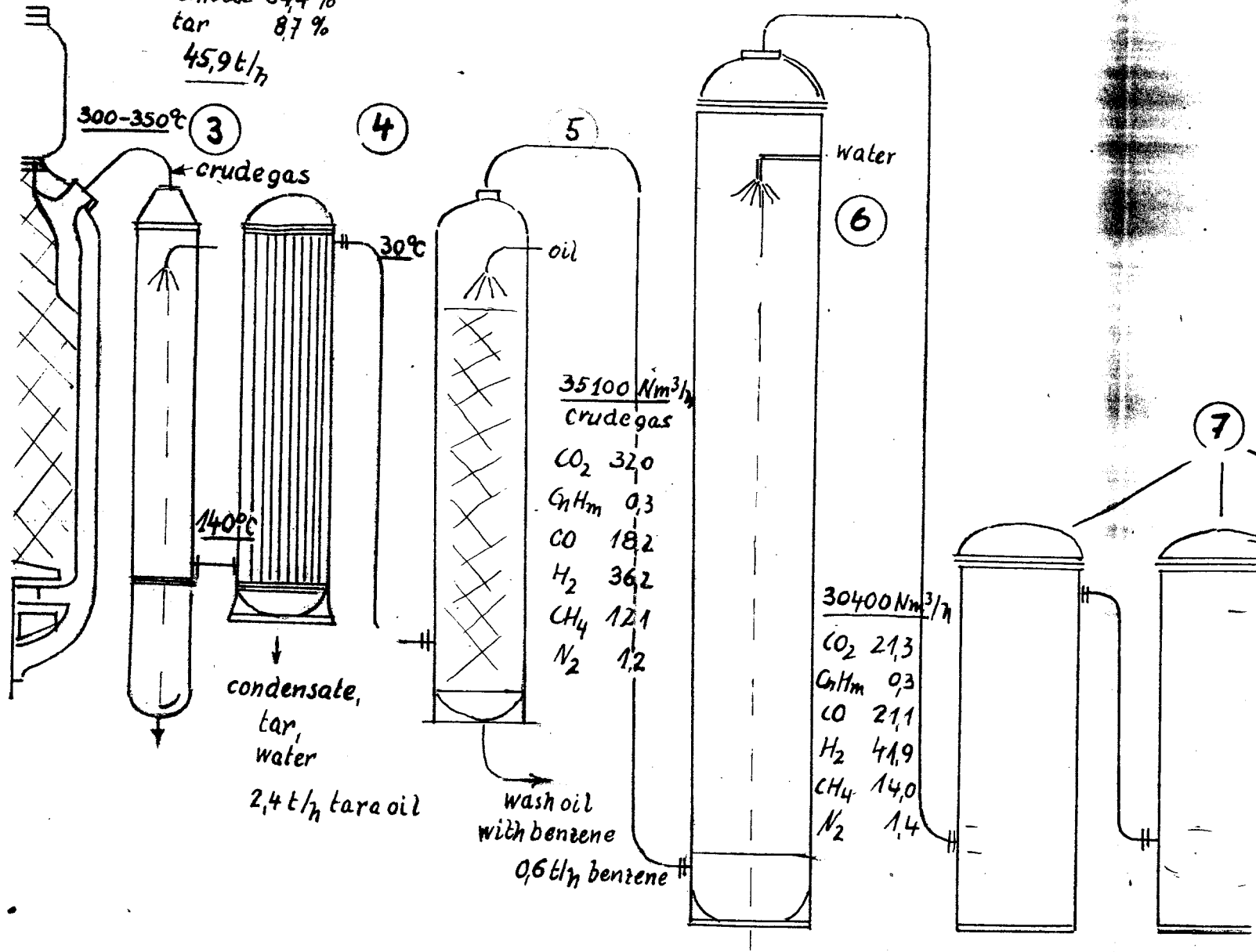
① steam superheater

② gas producer

⑧ saturator

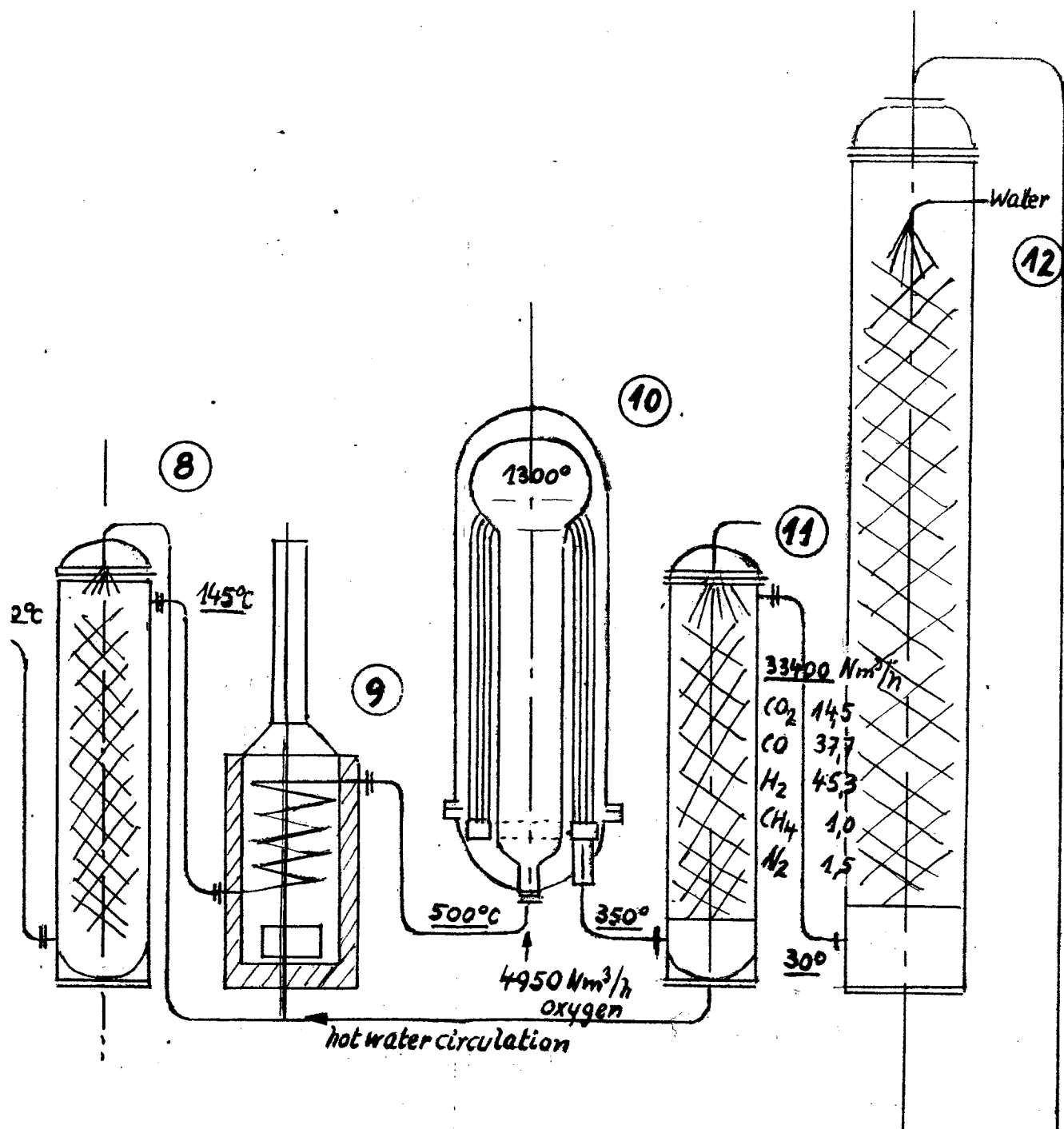
⑨ gas superheater

brown coal
 moist 20%
 ash 25,6%
 combust 54,4%
 tar 8,7%
 45,9 t/h



(8) saturator

(9) gas superheater



synthesis gas:

$29600 \text{ Nm}^3/\text{h}$

CO_2 2,0

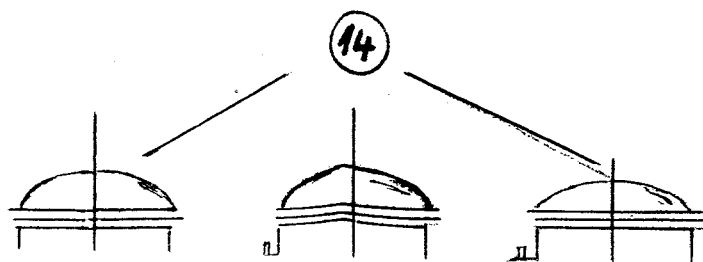
C_2H_6 0,2

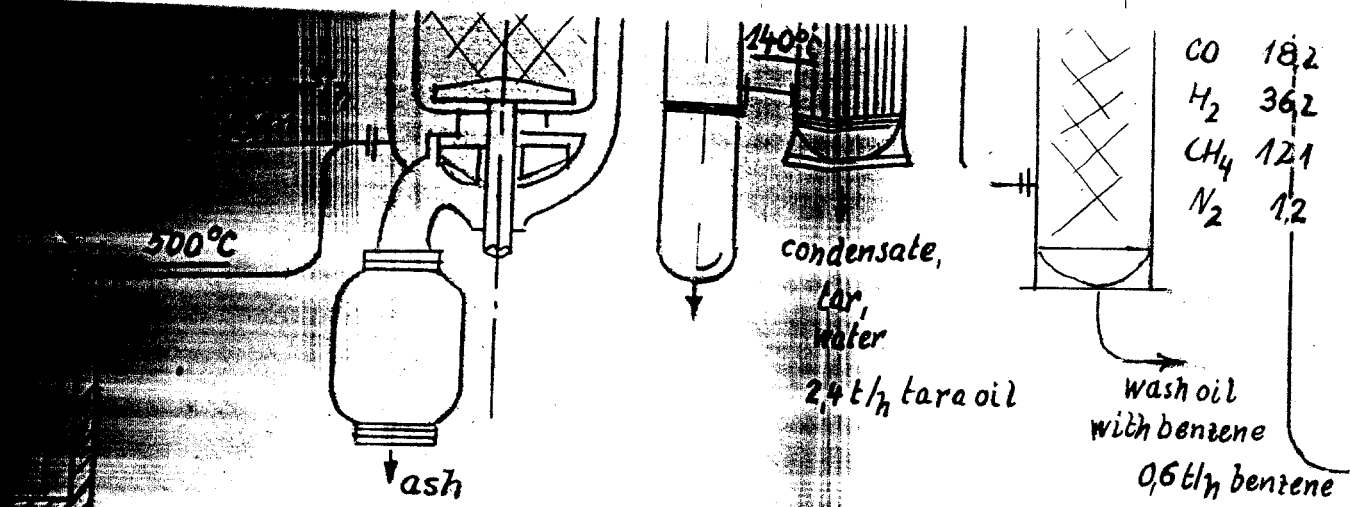
CO 42,2

H_2 50,7

CH_4 24

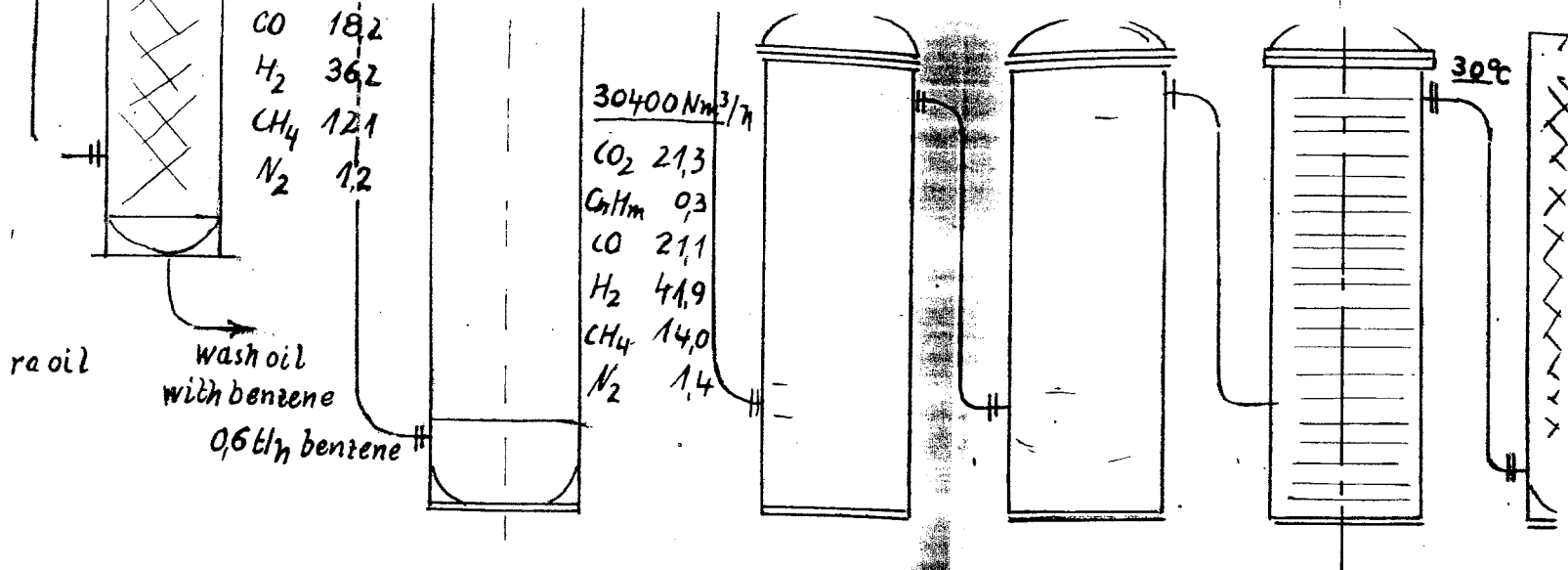
N_2 25





- ① steam superheater
- ② gas producer
- ③ spray cooler
- ④ tube cooler
- ⑤ benzine scrubber
- ⑥ water wash tower I
- ⑦ extraction of H₂S

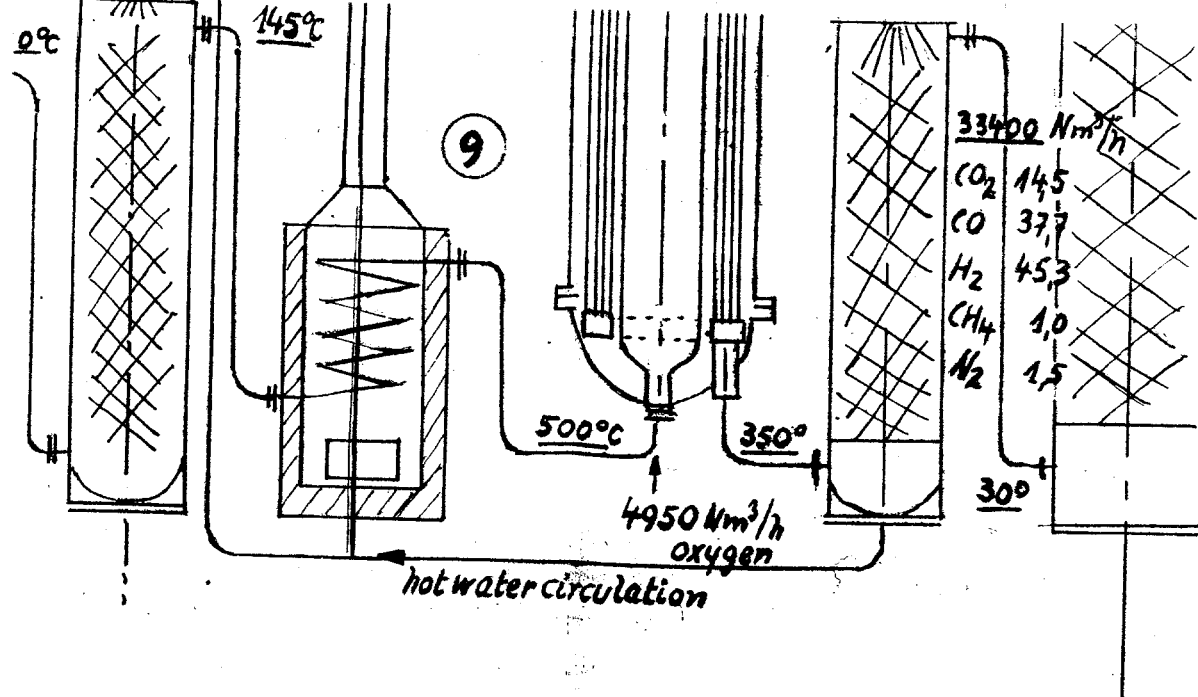
- ⑧ saturator
- ⑨ gas superheater
- ⑩ cracking chamber
- ⑪ spray cooler
- ⑫ water wash tower
- ⑬ superheater
- ⑭ extraction of organ



- 3) saturator
- 7) gas superheater
- 0) cracking chamber for methane
- 11) spray cooler
- 12) water wash tower N.
- 13) superheater
- 14) extraction of organic sulphur

to synthesis

Fig. No. 8.



synthesis gas

29600 Nm³/h

CO₂ 2.0

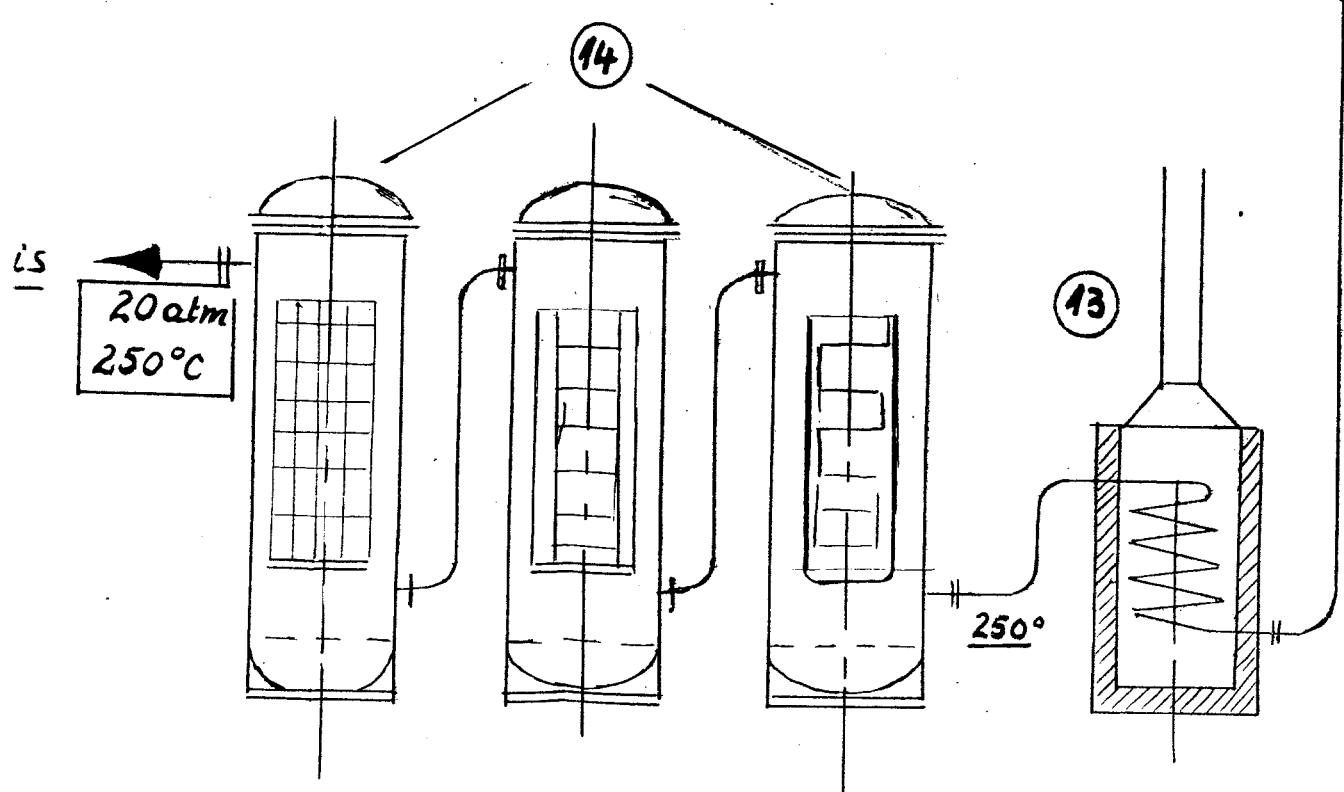
C_nH_m 0.2

CO 42.2

H₂ 50.7

CH₄ 2.4

N₂ 2.5



Lurgi Gasification Process.

Ffm. 4.12.45 Dec

(1) Compressors and Blowers:-

Gutthoffnungshütte, Oberhausen,
Maschinenfabrik Sürth, Sürth b.Köln,

(2) Separating Apparatus:-

Linde Werke, Hüllriegelskreuth b. München,

(3) Expansion Machines:-

Heylandt, Berlin-Tempelhof,

(4) Aluminum Packing for the Regenerators:-

Fränkel, Augsburg-Plattling.

VIII. SYNTHETIC LUBRICATING OILS

Lurgi built the equipment for the Rheinpreussen synthetic lubricating oil plant at Homberg. Dr. Herbert said that this was the only plant of its kind in Germany, but he had no personal knowledge of the quality or uses of the oil made there. However he had been told by Dr. Kolbel, in charge of this work at Homberg, that they considered the oil a superior lubricant for steam engine and marine use only. A flow diagram for this Rheinpreussen process as furnished by Lurgi in response to the request of Capt. Chaffee, is reproduced as Figure 9, page 43. The operation of this plant has been described in detail in CIOS report No. 2, Target 30/5.05.

Lurgi also built the atmospheric and vacuum stills for the synthetic lubricating oil made by the Ruhrchemie aluminum chloride polymerization process at Oberhausen. These stills were designed by Messrs. Morlock and Siebert of the Lurgi organization in 1940 or 1941. Dr. Herbert believed that the capacity of the Ruhrchemie plant was 20-25 tons of lubricating oil per day and that the operation was entirely successful. He did not know where the products were tested or used. Preliminary fractionation tests on the overall product were made at the Lurgi carbonization laboratory in Hedderneim, but Dr. Herbert doubted if any samples of the oil would still be left at this laboratory since it had been badly damaged by bombing. It seems probable that additional information about these oils could be obtained from Lurgi files or by interrogation of Morlock and Siebert. However these possibilities were not pursued since it was assumed that first-hand information would be obtained from Ruhrchemie by other CIOS teams.

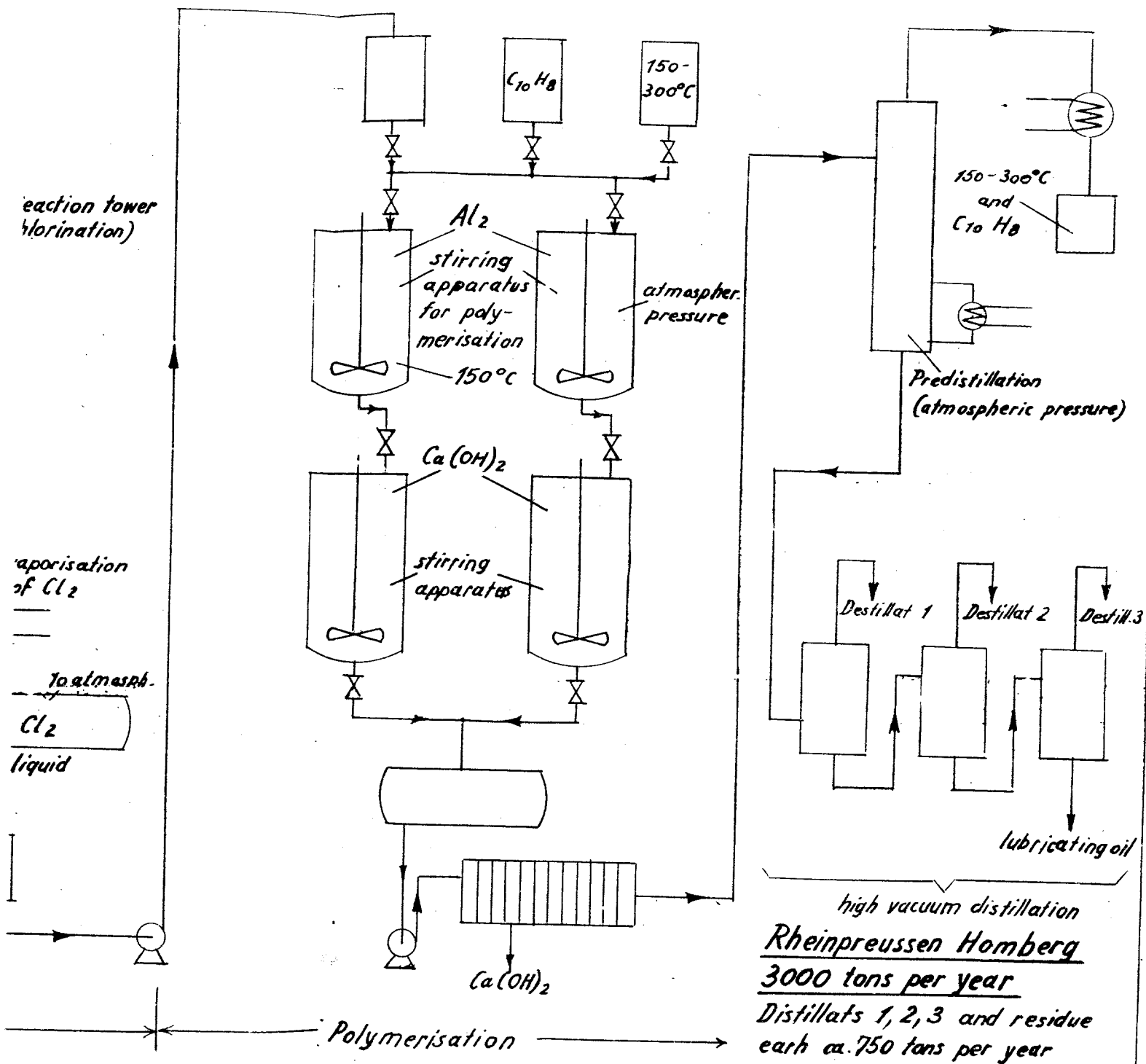
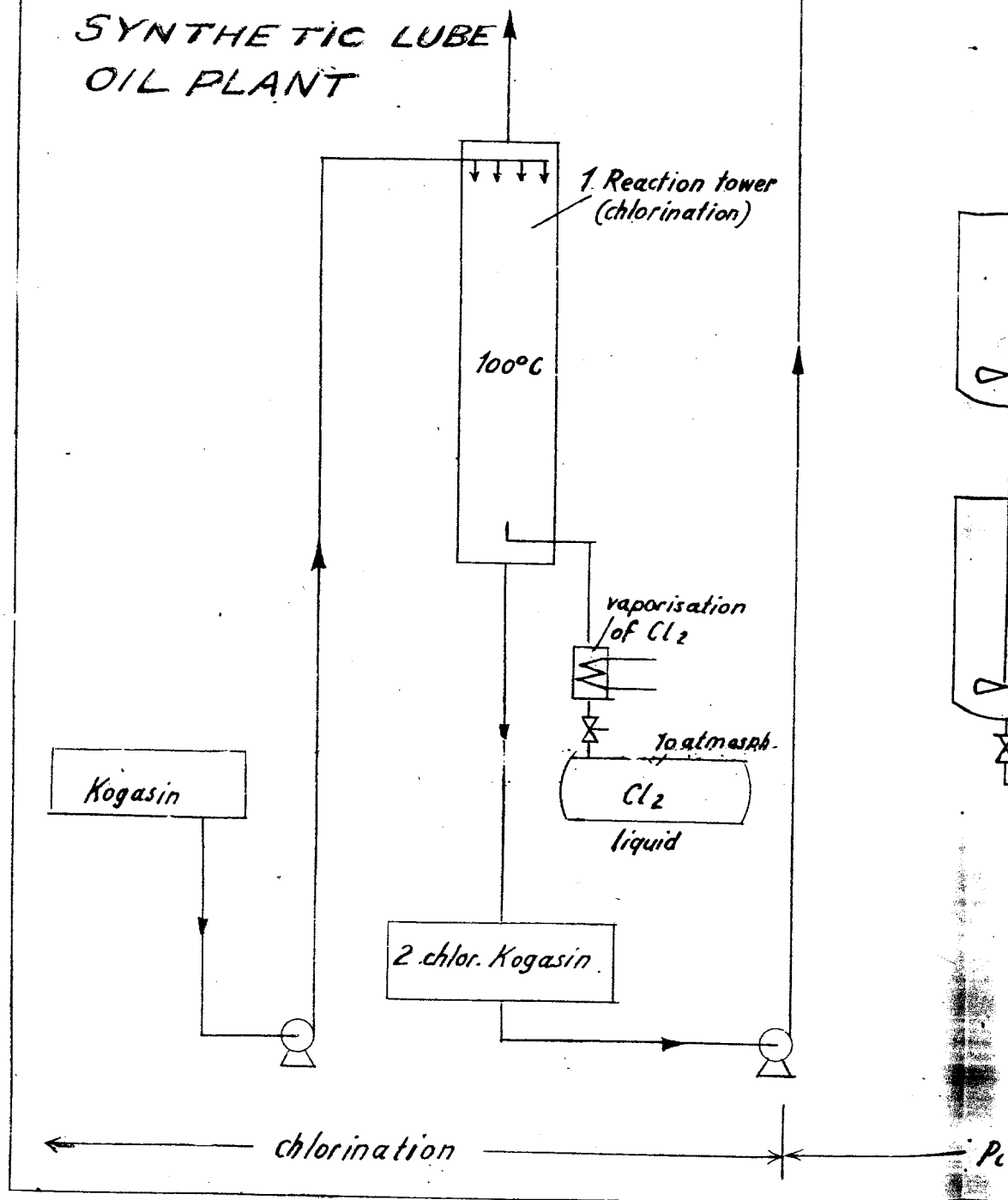


FIGURE 9
HOMBERG
SYNTHETIC LUBE
OIL PLANT



IX. PARAFFIN WAX OXIDATION.

Lurgi had started the construction of a plant for the oxidation of Fischer-Tropsch wax by the firm Hubba & Fahrenholz at Magdeburg. This plant was not entirely finished but had operated on a small scale until the supply of Fischer-Tropsch wax was cut off by bombing of the synthesis plants. Presumably more information on this subject could be obtained from Lurgi files, or by questioning of the officials concerned, but lack of time prevented this course being followed on the present trip. Lurgi did not have any contractual agreement with Ruhrchemie regarding the oxidation of Fischer-Tropsch wax.

X. MISCELLANEOUS RESEARCH.

According to Dr. Herbert the research on protective coatings for metals, mentioned in the attached outline of activities, related to treatment with phosphate solutions (similar to Parkerizing). Details could be obtained from Dr. Roesner at the Metallgesellschaft laboratory in Erbstadt but time did not permit getting in touch with him on this trip.

Dr. Herbert also stated that the indicated work on rubber softeners consisted mainly in routine evaluations of solvent extracts from Rhenania Ossag conducted at the Lurgi Frankfurt Laboratory for some outside firms who were using such extracts. No further enquiries were made on this subject.

XI. PATENT ACTIVITIES:

The Patent Department of Metallgesellschaft and Lurgi had been moved to Castle Koenigstein at Kronberg, and was functioning there until shortly before the arrival of American troops. Certain business departments of Metallgesellschaft had also moved to the Castle and additional activities were housed in the Kronberg-Hof. The patent files were inspected superficially with Mr. H.C. Heine, head of the Patent Department. They include about 800 pending patent applications and a fairly complete file of United States and German patents for research purposes. The German patents were believed to be complete up to the time when the German Patent Office ceased to function, and would be a useful collection of recent German patents in the fields of Metallgesellschaft and Lurgi activity. Unfortunately these files were badly disarranged in transfer to the Reichsbank at Frankfurt, but are presumably intact and available there if needed. From Lurgi indexes for recent years a list of their patent applications which appeared to be of particular interest to the oil industry had been prepared. This list is attached for the use of anyone who may desire to obtain these files from the Reichsbank.

The chemical research reports of Metallgesellschaft were stated to be located at the laboratory in Erbstadt, near Friedberg, 20 miles north of Frankfurt. Documents relating to metals and gasification, among other subjects, were stored temporarily in Niedernhausen, near Wiesbaden, but were bombed out and shipped to Boehlen. It was suspected that these documents were lost in transit, but no definite information was available.

XII. RECOMMENDATIONS.

1. All Lurgi experimental data and reports relating to their work on the Fischer-Tropsch process should be examined, and Dr. Herbert and others should be interrogated further as indicated by a study of these data.
2. The Lurgi pilot plant at Hoesch Benzin (Dortmund) should be inspected and all pertinent local data regarding its operation should be picked up.
3. Details of the wax oxidation plant designed for Hubba and Fahrenholz should be obtained from appropriate Lurgi officials.
4. The Metallgesellschaft laboratory at Erbstadt should be visited and Dr. Roesner and other officials there should be interrogated in detail about their research on protective coatings and other problems.
5. The Metallgesellschaft-Lurgi pending patent applications and recent patents should be examined.
6. Complete data should be obtained regarding the iron catalyst tests conducted by Ruhland, including the details of preparing all of the catalysts involved.