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FINAL REPORT

MASTER-PLAN FOR THE DEVELOPMENT OF ALUMINIUM DOWNSTREAM INDUSTRIES AND PREPARATION OF DETAILED PROPOSALS FOR MODERNIZATION OF STATE-OWNED EXTRUSION MILLS, PHASE II IN INDONESIA

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Project No: DP/INS/83/020

October 1988

Distribution
LIMITED
UNIDO/

UNITED NATIONS
INDUSTRIAL DEVELOPMENT
ORGANIZATION

ENGLISH

FINAL REPORT

Masterplan for the Development of Aluminium Downstream Industries and Preparation of Detailed Proposals for Modernization of State-Owned Extrusion Mills, Phase II in Indonesia

by

the team of ALUTERV-FKI

and

PT.UNECONA AGUNG (Jakarta)
as a local consultant firm

UNIDO Contract No. 87/141
Project No. DP/INS/83/020
Activity Code: J13420

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ABSTRACT

The aim of present work was to analyse the possibilities for improving the quality and incresing the quantity of aluminium extrusions and wire-rods from points of view of both domestic use and export.

In connection with this question the expert team had to visit the extrusion plants and on a special request the wire-rod factories selected by the Ministry of Industry for Indonesia and to prepare development proposals for each of them including findings and recommendations.

For the wish of the management of the industry a special attention had to be devoted to the problem of export and the relating quality.

During factory visits we met several daily problems which should be solved in order to improve the quality. Many of them were answered on the spot and some which needed more thoroughful investigation are reflected in the Annexes of this report.

In accordance with the management of the industry the study gives a real picture on the the development possibilities promoting the efforts of decision makers to help the activity of this line.

Summarizing the proposals it can be stated that as a consequence of the developments performed in the last two years (which were in close relation with our original suggestions given in the Master Plan) the visited factories are already able to produce exportable quality but its quantity is still limited. The variety of alloys manufactured has broadened considerably and this kind of market demand has been satisfied from all point of view.

Although there are examples of good billet quality in the majority of cases it is still weak and causes several difficulties for producing exportable quality extrusions. In every factory the treatment of molten metal requires more attention from the charge

composition to the filtering of melt. In the extrusion plants the optimal parameters of the whole manufacturing process must be determined for the given local conditions.

Technical solutions of the proposals and elaboration of optimal technologies can be subject of a feasibility study for the plant concerned.

A very special problem exists in connection with domestic market situation of wire-rods since on this product there is low import duty and the foreign (first of all Taiwan made) wire-rods are strongly competitive in Indonesia while the domestic products have a relatively high price because of the extra costs of surplus treatments (eliminating the high titanium content of the raw material) or of expensive imported ingots of EC grade. Although sometimes the surface quality is unfavourable the majority of wire-rods satisfies the export requirements.

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I. INTRODUCTION

On the basis of the contract between United Nations Industrial Development Organization (UNIDO - Vienna) and Hungalu Engineering and Development Centre (ALUTERV-FKI, Hungary, Budapest) a Hungarian team elaborated the "Master Plan for the Development of Aluminium Downstream Industry in the Republic of Indonesia" in 1986. The aims of this work were to study the existing capacities of Indonesia for manufacturing aluminium semi-products, to collect experiences referring to the basic technologies and technical levels, to evaluate the market situations for giving a forecast of aluminium consumption in Indonesia as well as in other ASEAN countries and last but not least to show the possible ways of development for increasing the quality and quantity of aluminium semis. The all efforts were performed to make the Indonesian aluminium downstream industry competitive on export markets and to ensure a more profitable production.

Within the downstream industry the extrusion represents a considerable part which is supported by the fact that more than 20 % of total semis is extruded. In this field the capacities are much higher, than the production and without any essential investment the quantity of extruded bars and profiles can be increased substantially. Considering this fact the second phase of the work has been started to implement a more thoroughful investigation of extrusion plants in order to prepare detailed proposals for modernization.

In connection with extrusion technology of Indonesian plants statements given in Master Plan I reflecting the situations in 1986 can be summarized as follow:

- The majority of machines and equipments is in good conditions and represents an acceptable technical level. Many of them have an extruding load under 10 MN which is insufficient for profiles having greater cross-section or high strength alloy. The mechanization of presses is rather weak, many operations are made manually.

- Extruded profiles are utilized mainly in the building industry as materials of decoration, climatic prevention, covers, doors and windows namely in those structures where high strength is not required. It also means that the variety of alloy types is poor, besides aluminium of commercial purity low alloyed AlMgSi materials are extruded only. Hollow sections, thin walled profiles are very frequent but their cross-sections are small. Profiles of higher strength with complicated and/or greater section need machines with higher load capacity.
- The extrusion dies are generally manufactured in the plants on an acceptable technical level.
- The majority of billets is cast in the plants themselves. The casting technology is generally simple, the amount of scrap remelted is rather high therefore the quality of billets is poor and this comes down to extruded profiles, too.
- Heat treatments of profiles are on medium level.
- Among all only two or three factories are able to produce exportable quality. The extension of this possibility needs a better quality control and billet quality.
- Surface treatments are applied for the purposes of both decoration and corrosion prevention. The technology is generally sulphuric acid one, the colouring is on tin-base method. Every plant has its own anodization shop where 80-95 % of extruded products come to treatment. The technical level of anodizing equipments is low, the mechanization is weak. The variety of colours is rather poor. The anodic oxide layers have an appropriate quality.

In connection with the development of aluminium downstream industry formerly we analysed the demands of extruded aluminium profiles both on domestic and export markets in the past and the near future as shown in the Master Plan I, Chapter IV and V. Considering the fact that two years have already passed from the original data collection we have repeated this activity but focusing on the total aluminium consumption and within it only on extruded profiles and wire-rod up to 2005. The new data are summarized in the Table 1. It can be seen that a moderate but continuously increasing demand is expectable. Analysing the data of the Table I and comparing them to the previous ones given in Master Plan I, Table 30a-e it can be seen that in cases of extrusions and wire rods there are differences in the two kinds of demands predicted earlier and now. These differences are considerable ones after 1990 only and are growing up to 2000. The simple cause of it is the export activity in both cases. According to the earlier analysis of Indonesian aluminium consumption, production and capacities (Master Plan I, Chapter III/b.c.) it is evident that besides some special semis which have to be imported the aluminium industry is able to satisfy the domestic demand and excess capacities exist even hereupon. The only way of their utilization is the export but in relation with this there are problems since the products especially the extruded profiles and wire rods are not competitive on the international market in every aspect namely in the quality and the price. It is expected that this situation will change as a consequence of the further developments in the production of both products and a steady growing export quantity will characterize the extrusions and wire-rod as shown in the Figure 1. On the basis of statements mentioned above and of conceivable demands of extruded aluminium products both on domestic and export markets it can be stated that on the way of modernization of existing plants the quality of extruded products should be increased to fulfill the export requirements and at the same time it is accompanied by a moderate growth of capacities and production. However it has to be mentioned that the existing capacities of extrusion plants up to now have been still much higher than the production thus for the only sake of quantity there should not be necessary to perform a modernization. The quality deserves this program which inevitably brings a capacity enlargement, too. It is also interesting to note that the costs of modernization are substantially less than those of new facilities.

Considering all of these circumstances and facts the scope of this work is to prepare development proposals for the plants being selected by the Ministry of Industry of Indonesia for a reasonable time period. These proposals can help the factories' management in its decision for the modernization and the Government in the creation of a climate promoting the development programs.
Activities of the Master Plan - Phase II were organized in accordance with these aims and experiences of site works, modernization proposals as well as solution of some special problems are given in the next chapters of the report.

Table 1

FORECAST FOR DEMANDS OF ALUMINIUM EXTRUDED PRODUCTS AND WIRE-RODS FROM 1986 UP TO 2005 IN INDONESIA

(in 1000 t)

Year	Total consumption	Extrusion	Rod
1986 (+)	66.6	11.1	18.0
1987 (+)	66.0	11.7	16.1
1988	71.7	13.8	15.3
1989	75.7	14.6	16.1
1990	79.2	15.3	16.9
1991	82.6	16.0	17.6
1992	86.1	16.6	18.3
1993	89.7	17.3	19.1
1994	93.1	18.0	19.9
1995	97.2	18.8	20.7
.	.	.	.
.	.	.	.
1998	108.6	21.2	21.2
.	.	.	.
.	.	.	.
2000	116.0	22.8	23.0
.	.	.	.
.	.	.	.
2005	136.0	27.0	26.0

REMARKS

1. (+) means the facts, the other data are estimated
2. Earlier data up to 1985 can be found in Master Plan I.

Source: P.T. UNECONA AGUNG, June of 1988.

II. DESCRIPTION OF EXPERIENCES OF FACT-FINDING SITE WORKS

1. Preliminary considerations and arrangements

The expert team arrived in Jakarta in the 31st of March, 1988 for the site fact-finding mission. They organized an official meeting with the representatives of the Ministry of Industry for Indonesia and the UNIDO SIDFA in Jakarta. On this occasion the managers and leaders of factories and plants interested in the question of modernization had also been invited by the Ministry.
At this meeting the team leader briefly summarized their tasks and asked the co-operation of persons present.
On behalf of the Ministry of Industry Mr. Toyib expressed their wish that besides extrusion plants to be selected for the moderization the experts should also supervise the wire-rod production because the management of the industry would have liked to put more emphasis on the development of this technology. It was told that all efforts should have to be directed for promoting the export possibilities and enlarging the sortiment of alloys manufactured. Finally it was given a suggestion for selecting the plants to be visited. These were in sequence of date of site works as follow:

P.T. Supreme Alurodin	(wire-rod production)
P.T. Alcarindo Prima	(wire-rod production)
P.T. Alexindo	(extrusion)
P.T. Edico Utama	(extrusion)
P.T. Superex Raya	(extrusion)
P.T. Indal Al. Extrusion	(extrusion)

This proposal was accepted by both the UNIDO SIDFA and the Hungarian team. It was interesting to note that except the last one (P.T. Indal Al. Extrusion) all of them had been already inspected in connection with the first phase of the Master Plan's elaboration.

Having finished the site works the team briefly described its experiences in connection with the present situtation and problems then gave some preliminary suggestions for the further development in case of each plant. These all were summarized in a short report which formed a part (as an Annex) of the "Minutes of Meeting" signed in the Ministry of Industry in the presence of the representative of the UNIDO SIDFA at the end of the site work.

The management of the Ministry accepted the report and agreed with its statements. They requested to elaborate the "Final Report" on the basis of this one.

2. Experiences of factory visits

Except two of the plants mentioned above they were described in the Master Plan. In spite of this fact the idea was to give again a description of all of them because in one side in the last two years changes and modifications happened in the technology as well as in the machinery of theirs and the other side the correct picture of the plants should help the decision making process of the industry's management in connection with further development and investment. The basic features of factories and plants are described in chronological order of visits:

P.T.Supreme Alurodin

Location: Cengkareng - Jakarta Barat. Km.16
Jln. Raya Semanan - Daan Mogot

In the factory the production started in the March of 1986. They apply the Properzi technology for manufacturing aluminium wire-rod with continuous casting and rolling. The material processed consists of nearly 50-50 % of EC grade and E-AlMgSi alloy ones. Wire-rod diameters are 7.6 and 9.5 mm. The capacity of the machine is about 1000 tons monthly. In case of EC grade material the production may reach the 3 tons/hour figure, at the same time for the alloy this figure varies between 2.5-2.7 tons/hour only. The working period is generally 250 days annually, the remaining part serves the maintenance. Production goes on 3 shifts.

The main equipments and machines are as follow:

- melting furnace with 20 tons capacity,
- two holding furnaces with 12 tons capacity each,
- Properzi 6E/13 Mini casting-rolling machine with 13 rolling stands as a maximum,
- recoiler.

In connection with quality control the choice of measuring devices show a heterogeneous picture because the technology itself has not been followed thoroughly by controlling ones, otherwise the end-products get an efficient investigation. Computerized spectrometer, Kelvin bridge, tensile testing machine and binocular microscope serves the quality control in the laboratory.

The raw material comes from the INALUM and foreign firms just like COMALCO, ALCAN and PECHINEY. There is a problem in connection with the INALUM ingots namely these ones don not fulfill the requirements of EC grade because the Ti content is beyond the standard limit. The heavy metal impurities (like titanium, vanadium, chromium, manganese) in the aluminium matrix sharply decrease the conductivity, therefore they have to be removed. Considering the possible quantity of these metals it can be stated that titanium is the most unfavourable one. In its case a very effective method of the removal is the boron treatment of the melt. At the same time this method draws awkward consequences in the furnace, because high amount of slags containing boron and titanium compounds deposit on the walls and the bottom of furnace which destroy the linings very quickly. At the P.T Supreme Alurodin furnace cleaning and maintenance is more frequent (three times annually) than usual in case of EC grade raw material and by this way it makes the cost of production to increase considerably. For the boron treatment Al-B master alloy is used. Considering the fact that the elimination of heavy metals from the matrix is harmful for the grain refinery a secondary treatment is also applied for this purpose. It needs an Al-Ti-B master alloy. The two processes can be solved in one step as well with the help of a special Al-Ti-B alloy which has a double advantage namely it eliminates the high Ti content and at the same time it gives a suitable grain refinement, too. It is imported from the Kawecki firm. The other master alloys for E-AlMgSi wire-rod are also bought from abroad.

A vertical coiler is attached to the cast-rolling machine where wire-rods get a gravity settlement on. This process results loose coils therefore they must be recoiled to produce tight ones.

In the factory there are 80 employees. The stock of raw material is enough for 3 months. The technical conditions of maintenance are poor because of the lack of spare parts.

P.T. Alcarindo Prima

Location: Jakarta Timur, Km.3
Jln. Tipar Cakung

The production started in the May of 1985. They manufacture aluminium wire-rod with Properzi technology and AlSi12 ingots on scrap base. The ingot casting began only a year ago for producing basic material of the die-casting shops. For the wire-rods EC grade aluminium and E-AlMgSi alloy are used in the ratio of 60/40 %. The dimensions of rods are 9.5 and 7.6 mm respectively. In case of EC grade Al the capacity of cast-rolling machine is about 3 tons/hour as long as for the alloy this figure is only 2.5-2.7 tons/hour. For the time being every 20 day continuous production is followed a 10 day period of maintenance.

In 1987 the total production was 7.800 tons and from technical point of view there are no difficulties to increase the output it depends on the order only. Five cable factories make use of their wire-rods and the biggest one among them is the "Voksel Electric" locating in the neighbourhood of the P.T. Alcarindo Prima.

The main equipments and machines are as follow:

- melting furnace of 20 tons capacity,
- holding furnace with the same capacity,
- Properzi 6E/13 Mini cast-rolling machine with 13 rolling stands as a maximum,
- recoiler,
- melting furnace of 5 tons for the ingot production,
- holding furnace of 7 tons capacity,
- chain-type ingot caster.

The quality control shows a heterogeneous picture. A modern laboratory with up-to-date facilities serves the control of end-products and at the same time the manufacturing process is not instrumented well. In case of wire-rods the chemical composition, the tensile properties and conductivity are tested with high precision.

As refers to the raw materials they use Al99.7 ingots of P.T. Inalum and imported ones. In connection with the domestic ingot the problem is the high titanium content which has to be eliminated with an additional boron treatment. It is performed with Al-Ti-B master alloys in wire form imported from Kawecki firm. The other materials needed for the alloying process of E-AlMgSi are also imported.

A vertical coiler has been fitted to the cast rolling machine where the wire-rods get a gravity settlement on. It produces a loose winding of 3 m diameter. Because of dimension and state this needs a recoiling.

The scr... for the manufacture of AlSi12 ingots are bought from different ...estic factories.

In the factory there are 45 employees, among them 10 have higher technical qualification.

P.T. Alexindo

Location: Pondok Ungu, Bekasi Km.28
Jln. Raya Bekasi

The factory was established in 1973 and the production started in 1974. The owner is the P.T. Sinar Alam Pekmai. They manufacture extruded profiles mainly for architectural purposes but for the time being a smaller part of the total quantity goes to the aircraft industry. In the last two years the alloy sortiment widened and now five types are used namely 6061, 6063, 5052, 5056 and 7075 ones. The majority (over 50 %) is the 6061 alloy, the others have the share of 20 % of 6063 and 20 % of 5052-5056. The remaining part fells to the 7075 alloy applied for loaded structures in the aircraft industry. In a less extent they produce alloyed ingots with high silicon content for die-casting shops.
The production is practically 100-150 tons monthly, but the 200 tons/month quantity can be easily realized.
The factory consists of four shops, a casting, an extruding, an anodizing and a tool manufacturing one.
In the casting shop the manufacturing processes are quite simple ones, the DC casting equipment of billets is outdated. Process control does not exist. The ingot casting part of the shop is fairly well instrumented. In connection with the casting of 7075 type alloy many difficulties exist for the lack of a modern casting facility. A new melting furnace is under construction. In case of 6061 alloy billets the charge contains high amount of scrap. Billets with higher requirements are cast with the charge of much less scrap and high amount of primary ingot.
In the extrusion shop two presses work. They are supplemented with rolling tables, shears and straighteners. Two drawing benches and a heat treating furnace exist in this place. The extruded profiles

are collected in racks of 7-8 m length. At the time of the visit profiles of 7075 alloy were extruded and these had a considerable distorsion due to unproper technological parameters.
In the anodizing shop is a craned hall where 15 bathes work. 90 % of the profiles is anodized, a quarter of them gets coloured surface. Black, gold and brown colours are produced in the row of a sulphuric acid technology and tin-base electrolytic colouring. The quality of surface is quite good, in connection with the shade and homogenity some problems arise for the high amount Fe content.
In the tool manufacturing shop besides the normal machine-tools two spark erosion devices work. The quality of tools is proper.
The quality control includes the measurements of chemical composition, the Brinell hardness and the anodic oxide layer thickness. For the composition control a Japan-made computerized spectrometer is applied.

The main equipments and machines are as follow:
- two melting and a holding furnaces with 5, 3 and 3 tons capacity respectively with DC billet casting facility,
- an equipment (Inductotherm) for producing alloyed ingots on scrap base supplemented with a chain-type ingot caster,
- billet homogenizing furnace,
- billet die-casting machine,
- two extrusion presses (Vickers and Cheng-Hua) with 18 and 6 MN loads respectively,
- two drawing benches,
- ageing furnace (Birlec type one),
- anodizing line with 15 bathes,
- machine tools for die-manufacture.

Consumption of raw material is about 200 tons monthly with the majority of scrap. P.T.Inalum supplies the ingots of 1070 material (Al99.7). The auxiliary materials and master alloys are imported for the production.

In the factory 100 people work among them 20 have technical qualification.

P.T. Edico Utama

Location: Jakarta
Jln. Pulogadung No.7 (Kawasan Industri)

The extrusion started in 1982 for producing profiles of small wall thickness and complicated cross sections mainly for the building industry. Up to now the production is about 100 tons monthly but the theoretical capacity reaches the 250 tons. The variety of materials is very poor, practically they manufacture only AlMgSi alloys (6063 type). 40 % of the profiles goes to anodization without colouring. The remaining part is sold in mill-finished state.

The melting and billet casting are outdated. The casting shop is under reconstruction for the erection of a new DC casting facility with a furnace of 4 tons. Scrap gives the majority of charges, the primary metal ingots represents only 20 % of the total quantity being cast. The ingots are bought from the P.T. INALUM. In spite of the simple technology the surface of the billets is quite a good one. There is no process control, the chemical composition of billet varies by chance. There is no homogenization.

In the extruding part of the factory three presses are working, the smaller ones in 3 shifts, the bigger one only in 1 shift. The presses are supplied with stretch-straighteners and shears. Containers of three diameters are used e.g. 3.5, 4 and 6 inches. For the artificial aging of profiles there is a furnace in the shop.

In the anodizing shop a line of 11 bathes are settled. The oxide layer thickness produced is generally 5 microns only. Technical improvements are needed for the introduction of colouring process.

In the tool manufacturing shop besides the normal machine-tools three spark erosion machines ensure the possibility of die production. Among them only one can be considered as an appropriate machine, the other two ones are old and outdated.

The main equipments and machines are:

- melting furnace with billet casting facility,
- three extrusion presses of 3, 6 and 16.5 MN loads respectively,
- heat treating furnace,
- anodizing line with 11 bathes,
- machine tools for die manufacture.

The quality control is very poor. Chemical composition is analysed time to time at other firm (P.T.ALCAN) outside. The only test which follows the manufacturing process is the hardness measurement with Webster catch that is otherwise not so precise.
In the plant 120 people work, the number of qualified ones is low (only 9 engineers and technicians).

P.T. Superex Raya

Location: Tangerang Km.23
Jln. Pembangunan Batu Ceper

The extrusion started in 1979. Besides extruded profiles they manufacture building elements (doors and windows), too, on the basis of their own products. In 1987 the total output was 2300 tons. The capacity is much higher it can reach the 4000 tons annually. The decisive majority of profiles gets anodisation, but only colourless technology has been applied. The material of profiles is the 6063 type alloy.
In the casting shop two furnaces are operating with DC billet casting facilities. The technical level is out-of-date, both the machinery and the technology have to be modernised. A considerable amount of scrap is remelted and mixed with primary aluminium ingot derived from P.T.INALUM.
For the time being in the extruding part of the factory three presses are operating and a new one is in the finishing period of installation. The auxiliary equipments of the presses are outdated, the control of technology is not satisfactory. To reach the T5 state the profiles are artifically aged in two furnaces. The shop works in 3 shifts.
In the anodizing shop 15 bathes work in the craned hall. There is a reconstruction period now and finishing the installation they shall be able to produce coloured anodic layers with sulphuric acid technology and tin base electrolytic colouring.
The whole die manufacturing process is done here with normal machine tools and two spark erosion machines.
The main equipments and machines are:

- two melting furnaces with billet casting facility,
- three extrusion presses of 6, 6 and 8 MN loads respectively (the

new one is not listed yet),
- anodizing line with 15 bathes,
- two heat treating furnaces,
- machine tools for die-manufacture.

The quality control is rather poor. The chemical composition is analysed with an outdated spectrometer. The whole technological process is followed by hardness testing. In connection with anodisation the layer thickness is controlled only.
The number of workers is 250, 10 % of them has technical qualification.

P.T. Indal Al. Extrusion

Location: Surabaya
Desa Sawotratap (Waru)
Jln. Pecindilan No.66-68

The factory belongs to the Maspion Group. The production started in 1971. For the time being 375 tons/month of profiles are extruded, the estimated capacity exceeds a bit, it is about 400 tons monthly. Two types of alloys are manufactured namely 6061 and 6063 ones of AlMgSi group. 220 tons of the total quantity per month is anodized, the majority of them gets coloured surface (160 tons monthly). Besides anodization painting is also applied as a surface treatment. About 50 tons/month quantity goes to the spraying boothes for painting. The remaining part of the profiles is sold in mill finished state.
The billets for extrusion are given by the P.T. ALUMINDO which takes place in the neighbourhood of the extrusion factory as it is also a member of the Maspion Group.
In the extruding part of the factory four presses are working with the all auxiliary equipments needed. The machinery represents an up-to-date technical level. On the run-out and cooling tables the graphite inserts are installed in improper way which should cause surface defects during the transfer of profiles. After the extrusion the profiles go to the heat treating furnace for artificial ageing. The unavoidable shape defects are corrected on a rolling bench.
In surface treating shop the anodizing line works under good technical conditions with sulphuric acid oxidation and tin-base electrolytic colouring (Nordicolor technology). On the anodised profiles the surface contains white and black sticks which are in connection with the quality of billets especially with homogenity and impurity content of theirs. The paint spraying boothes are

automatized and tightly controlled.
In the tool manufacturing shop there are machine tools of up-to-date techical level e.g. CNC milling machine and five spark erosion machines with numerical control.
The main equipments and machines are as follow:

- four extrusion presses with two times 3.5 and 16 as well 18 MN loads respectively,
- ageing furnace,
- anodizing line,
- three paint spraying boothes,
- punching and rolling machine,
- machine tools for die manufacturing.

The quality control satisfies the requirements. The chemical composition of billets is not checked here, they accept the results of supplying firm where the analysis is made on a computerized spectrometer. Hardness and layer properties are investigated according to the order of technology.
In the extrusion plant 200 people are working and there is a lack of qualified employees.

3. General survey and opinion of factory leaders

During factory visits the team discussed the questions of present situation, the export possibilities and the development ideas with the leaders and experts of plants. The important thougths and experiences are summarized in the following for each factory.

P.T. Supreme Alurodin

Negotiating parties: Gunawan,H. - Director
Raharjo,D.M. - Deputy Plant Manager
Dr.Pasaribu,W. - Corporate Secretary

- The quality of wire-rods is suitable for the export but their prices are not competitive even in the domestic market, because of the high cost of INALUM ingots and the import duty exemption of foreign wire-rods. The PLN - the Electricity Government of State - generally offers tenders for satisfying its demand and on these ones the domestic firms have unfavourable position for the low import duty.
- Although the manufacturing process is based on the original Italian know-how, several problems arise in connection with the homogenity, hot and cold cracking as well as with further drawability of wire-rods especially of alloyed ones. On the linings of channel between the holding furnace and casting cracks can be observed frequently. In the last two years the German made casting wheel had to be replaced five times by new one for its cracking behaviour.
- In 1987 a small quantity of wire (about 50 tons) was exported to Japan though not for conductors. For the time being they have orders from Japan and Malaysia in sum of 100 tons for conductors and another 100 tons for wrapping purposes.

- On the basis of technical developments the quality can be increased with decreasing cost of manufacture and they promote the exporting activity. In connection with this question the high rate of interest of credit and the long time of turnover cause difficulties.
- For financial problems there is a lack of the imported spare parts of machinery by which the downtime is long in case of getting out of order or of maintenance.

P.T. Alcarindo Prima

Negotiating parties: Tjandrawinata,F. - Director
Waworontu,A.L. - Director
Yogiawan - Chief Quality Control
Atmadja,B. - Director (representing the P.T. Voksel Electric, too)

- The Electricity Government of State (PLN) created a strong competition on the domestic market for offering tenders of wire-rod delivery. The PLN comsumption has increased up to 20.000 tons annually and the two wire-rod factories (P.T. Alcarindo Prima and P.T. Alurodin) are able to satisfy this demand. The lowered import duty resulted that foreign firms reached good position in price at the tenders and for the time being about 7.500 tons/yr of wire-rod they transport to the Indonesian market. At the same time the government does not stimulate the export activity with extra premium. Beside the supressed domestic market the high ingot price is the other cause which makes an unfavourable position for the wire-rod production.
- In 1987 the export quantity of wire-rod was low (only 75 tons to Malaysia). In case of this product the competitivness and

exportability are given by the further processing to insulated wires. overhead conductors, cables etc. These are realized at the P.T. Voksel Electric which takes place in the neighbourhood of theirs and utilizes the majority of wire-rods produced.

- Surface defects, cracks and fractures are very frequent on wire-rods. The small cracks and faults make the further cold drawing process difficult for the great number of in-process breakings. They gave samples of cracked wire-rods to find the origin of theirs (see ANNEX 3).

P.T. Alexindo

Negotiating party: Putra,P.K. - Manager

- The greatest problem in the factory is the billet casting. The whole casting shop needs an immediate reconstruction. The life-time of ceramic foam filters is short, the process control of casting is poor.
- For improving the quality of profiles, realizing a considerable export and shifting the hard/soft alloy ratio towards the hard one the quantity of scraps remelted has to be lowered and at the same time the ingot's quantity must be increased. The high price of ingot impedes this tendency.

P.T. Edico Utama

Negotiating parties: Riyanto,S. - Director
Iswata - General Manager

- The market position of extruded profiles is weak which is direct consequence of the high price of ingots. There is no difference between the prices of domestic (P.T.INALUM) and imported ones. The cost of 1 ton ingot is 2700 USD and the surplus direct cost of extrusion is about 500 USD/ton profile.

- The export activity started with a 40 ton delivery to Singapore.
- The lack of skilled workers impedes the development and quality improvement which are unavoidable for enhancing the export. They need governmental steps to organize training programs in centralized form.
- They have not got information in connection with extrusion plants of the developed countries, up-to-date technologies, possible alloys to be extruded and application fields of special profiles therefore it is difficult to find the right way for their own development. They ask some help in this question.
- The efficiency of production (ratio of the output and input material quantities) is about 75-80 %.- They want to introduce the colour anodization but beside technical improvements know-hows and experts are awaited to it.

P.T. Superex Raya

Negotiating parties: Prakoso,S. - Director
Hidayat,P. - Factory Manager

- The export activity started in 1987 with a 40 tons quantity and now it reaches the 80 tons. The business is organized by a wholesaler in Singapore. In the future the export quantity can reach the 25 % of total production.
- There are orders for colour anodized profiles but this technology can not be done now yet. The forecasts gave impetus for investing a new equipment of electrolytic colouring.
- In the aluminium downstream industry the marketing means a great problem in Indonesia. It would be advisable to organize it in

centralized form.

- In the next year beside the 6063 type alloy the 6061 type will enter into production.
- There is a lack of skilled workers. Training is done in the factory but centrally organized ones would be highly appreciated.
- Melting and casting capacity should be increased. In the near future an automatic temperature control with additional heat exchanger will be introduced at melting furnaces utilizing a Belgian made equipment.
- It was mentioned that in the neighbourhood of the factory a new plant will be erected with Japan financial aid for producing billets and extruded profiles from which windows and other finished products will be made immediately. The name of the firm is P.T. Intalan. This firm can be considered as a billet supplier.

P.T. Indal Al. Extrusion

Negotiating parties: So Sun Kwan - Assistant to Director
Alinafia,M. - Q.C.Chief/Die Designer

- Billets are supplied by the P.T.Alumindo and they have no information in connection with their homogenity and properties influencing the workability and anodisation. Sample was given to the team for a comprehensive investigation (see ANNEX 2).
- There are fluctuation in mechanical properties and surface quality at the same alloy. The greatest difficulties come to light in connection with 6063 alloy. They ask for the exact parameters of the extrusion and heat treatment from the Hungarian team (see ANNEX 1).

4. Conclusions of factory visits referring to development possibilities of machinery and technology

On the basis of site experiences and information of local experts and leaders the following conclusions can be drawn for each factory in sequence of the time of visits.

P.T. Supreme Alurodin

- The quality of wire-rods satisfies the export requirements but some modifications are needed in the technology for producing defect-free homogeneous rods with more favourable mechanical and electric properties. This means fundamentally the modification of molten metal treatment (fluxing, degassing, place and method of alloying) but the suitable parameters of hot rolling and quenching have to be also determined as well as the replacement of loose winding with a direct tight one is necessary for eliminating the rewinding process.
- The quality control is satisfactory in connection with finished rods but it would be advisable to follow the cracking behaviour of bars and rods behind the casting wheel and the rolling stand for controlling the technology. Non-contact in-line measuring devices (e.g. Defectomat which applies eddy-current for the detection) must be installed on the Properzi machine.

- Comparing the actual production to th possible capacity it can be stated that a surplus of about 3C ons of wire-rod annually is to be reached. Increasing the utilization and the efficiency of the machine the spacific cost would decrease which strengthens the competitivness.
- There is a strong claim to EC grade ingots. It is advisable to discuss the possibility of boron treatment during the production of primary aluminium with the officials of P.T.INALUM.

P.T. Alcarindo Prima

- Although the quality of wire-rod satisfies the export requirements the whole manufacturing process should be supervised for revealing the reserves in the technology and machinery in order to increase both the quantity and quality. Between the melting and holding periods there is a time-lag. For this reason it is useful to install another holding furnace and by this way to shorten the time and increase the yield. The surface defects, cracks and fractures of wire-rods and cold-drawn wires refer to poor treatments of molten metal and inappropriate parameters of cast-rolling technology. These have to be modified according to the requirement of homogeneous microstructure. The surface quality can also be improved by replacing the loose winding with an immediate tight one.
- The instrumentation of quality control laboratory is appropriate for testing of finished rods at the same time the plant's technicians have not got information on manufacturing process because of the lack of instruments installed directly on the machine. Crack-sensing and temperature measuring in-line devices should be applied for the cast-rolling equipment.
- It is advisable to reconcile with competent officials of

P.T.INALUM for supplying EC grade ingots. This reconciliation should be a trilateral one for drawing the P.T. Supreme Alurodin into it as well. All of these mentioned above should result that the cost of production decreases and by this means the competitivness improves on both domestic and export markets.

P.T. Alexindo

- The machinery and the technology in the casting shop are not satisfactory for manufacturing products of high quality especially in case of high strength alloys (6061 and 7075 types). The furnaces and the casting machine have to be modernized and a new one must be built. The problem of DC casting of high strength alloys has to be solved.
- There is a need for improving of the molten metal treatment and casting technologies. A possible way is to buy know-how or to ask for technical assistance. The quality of billets has to be checked (including chemical composition, gas and inclusion content, grain structure, etc.). Filtering the molten metal with ceramic foam filters is an important step in this process but it is not yet enough. Proper metal treatment can increase the life-time of the expensive filters.
- Billet homogenization has to be introduced especially in case of high strength alloys. For this operation a new homogenizing furnace is necessary.
- The disposable extruding loads of the existing presses seem to be less than those needed for the extrusion of profiles from high strength alloys. In case of these products having greater cross-section area the deformed structure is unfavourable because of the low extrusion ratio (which can be under 10).
- The auxiliary equipments of presses have to be modernized in order to avoid surface defects on the profiles. It refers to

run-out table, cooling table with forwarding facilities, puller, profile cutting with acethylene gas, etc.

- The extrusion technology including ageing and profile cooling has to be improved. By means of control of water quenching the distorted form of pieces can be avoided. The technological parameters should be checked by appropriate instruments.

P.T. Edico Utama

- The melting and casting equipments as well as operations are out-of date. The new casting shop being under construction will create possibilities to widen the scale of alloys manufactured. Buying know-how or applying technical assistance seems to be necessary in connection with molten metal treatment and billet casting especially for high strength alloys. Homogenization of billets has to introduced.
- The quantity of alloying elements varies in a wide scale. For the interest of homogeneous quality the fluctuations of the chemical composition must be moderated which inevitabely needs the systematical and continuous chemical analysis of charges. For this purpose a spectrometer has to be invested.
- High precision machine tools should be applied for the manufacture of dies. A wire-cut machine is needed. Know-how for the die design should be also necessary.
- The productivity of extrusion is rather low. The auxiliary equipments are not satisfactory and for this reason the required surface quality and mechanical properties can not be kept safely. They have to be modernized allthough the basic parts (e.g. stretch-straightener) would remain. The productivity and efficiency of manufacturing process of 6063 alloy profiles should be raised by applying container of 8 inches as well as billets with the same diameter at the 16,5 MN press.

- The introduction of colour anodization is inevitable.

- It is necessary to ensure the appropriate skilling level of labour force as well as to supply the management of the factory with information and guides referring to the machinery and extrusion technology.

P.T.Superex Raya

- The equipments and technologies are outdated in the casting shop therefore they have to be modernised including furnaces, molten metal treatment, casting machine, cooling water quality, etc. in order to produce billets with better properties. Grain refining, metal filtering and billet homogenization have to be introduced.
- The auxiliary equipments of presses must be modernized and the extrusion technologies have to be supervised for increasing the efficiency and improving the recovery.
- The technical level of the die manufacture needs some improvements in order to produce more sophisticated profiles which are more profitable than those of simple ones.
- The introduction of colour anodization can promote the marketability of extruded products.

P.T. Indal Al. Extrusion

- Apart from technological uncertanity this plant has the highest technical level comparing to the others visited. Most of their difficulties are relating to the billet quality for which the specifications have to be determined and transferred to the supplier (P.T.Alumindo). This may include the determination of chemical composition, gas content, non-metallic impurities and inclusions as well as grain structure.

- The parameters of extrusion and heat treatment technologies have to be supervised and refined for improving the efficiency, the surface quality and stabilizing the mechanical properties.

III. PROPOSALS FOR MODERNIZATION AND DEVELOPMENT

1. General remarks and suggestions

Two points of view dominate the elaboration of our work which correspond with the demand of the management of industry in Indonesia namely the promotion of export activity and the enlargement of variety of alloys manufactured. Among them the export activity has the greater importance thus it deserves to give a general survey of the present situation and possibilities for the future.

In connection with extrusion plants it can be find out that as a consequence of developments performed in the past two years the visited factories are already able to manufacture products for export but their quantity is still limited. It is interesting to note that their developments followed the directions which had been elaborated in the course of the first phase of this work (Master Plan I) and were discussed and evaluated together with the competent experts of both the Ministry of Industry and the plants in details. They have also acquainted with requirements of export market and in this way they can determine their possibilities and limits.

For the extruded products among the all criteria of export oriented manufacture the greatest emphasis is put on the quality of billets because it has the decisive influence on the properties of extruded products. Generally the quality of billets is weak but P.T. Indal Al. Extrusion shows a good example on what level should be reached. The properties of this billet are summarized in the ANNEX 2. Second in the row of quality affecting factors are the parameters of manufacturing technology which have to be optimized from points of view of properties, geometrical tolerances, appearance of surface, efficiency and yield. All efforts of the

optimization can be done together with the modernization of equipments. These consist of several steps, each of them is able to improve the quality but a synergic effect can be reached by all together. The detailed suggestions are summarized step by step in second part of this chapter.
In case of wire-rod plants the question is not the quality fundamentally but the competitivness in price. Of course it does not mean there is need not to do anything in connection with quality improvement because many problems exist from the treatment of molten metal to the finishing operation of coil winding but these are not so serious for jeopardizing the success of technology. The original Properzi know-how needs only some modifications to ensure the accord among technology and local circumstances. The lack of the proper accord causes first of all an increment in the cost of production which is unfavourable from point of view of competitivness. Referring to this question they would be the greatest steps toward the competitivness if P.T.INALUM produced and supplied EC grade ingots to the wire-rod plants as well as if the relative dispreference of domestic wire-rods cancelled against imported ones.

2. Detailed proposals
On the basis of local experiences and consultations which were summarized previously we consider the following changes, developments and technological modifications to be important for improving the quality and increasing the export quantity. The proposals and explanations are as follow in sequence of the plants (the suggested machines and equipments are specified in the Annex 4):

P.T. Supreme Alurodin

- The critical section of the whole manufacturing technology is the molten metal treatment from the composition of charge to inflow of metal to the casting wheel. This needs a supervision for determining the optimal parameters of fluxing, degassing, alloying and filtering to minimize the slag deposition in the melting furnace, to avoid the cracks of channel linings and to ensure inclusion-free molten metal for the solidification. In connection with the export quality of wire rods the last thought has the greatest importance because our experiences have also shown a rather high content of oxide inclusions. The present filtering method is not so effective therefore we suggest to install an in-line filtering equipment (SNIF R-10 system) before the casting wheel. In connection with the frequent wheel cracks the solution of the problem can be looked for in the overheat of wheel which is highly dependent on the cooling water composition. If the water were hard enough (the salt content is high) the heat convection on the surface of the wheel should decrease quickly because of the deposition of hard components. The worse the heat convection the higher the overheat and the danger of thermal cracks. From this point of view it is worth to analyse the composition of cooling water and in case of necessity to install a water pretreating equipment to make the water soft.
- The improper solidification properties (first of all the long time of solidification caused by weak heat removal on the casting wheel in connection with scaled surface) and the high impurity content should initiate cracks in bars and rods. It is advisable to follow these ones during the manufacture and to interfere in the technology in more serious cases. Considering this fact non-contact crack sensing and temperature measuring devices have to be settled on the Properzi machine between the casting wheel and the rolling stand.

- The number of surface faults of wire-rods can be decreased eliminating the recoiling process of loose coils for tight ones. For this reason it is necessary to replace the vertical loose-winding coiler with a twin bobbin tight winding system of tandem arrangement of the two drums at the end of Properzi machine.
- In connection with alloyed rods the problems of hot and cold cracking can be avoided with proper parameters of heat treatment and hot rolling. From this point of view it is necessary to supervise these processes and to determine the optimal parameters.

P.T. Alcarindo Prima

- Considering that both the machinery and the technology of this firm are the same as those of P.T. Supreme Alurodin the proposals are also similar mentioned above with an additional one to erect a new holding furnace for eliminating the time lag between the melting and holding processes. This furnace is under construction now.

P.T. Alexindo

- The first step of the improvement of billet quality is to reconstruct the old melting furnaces and to erect a new one. Either reconstruction or erection the emphasis is put on the instrumentation (e.g. precise determination of the metal temperature). The molten metal treatment has to be supervised for determining the optimal parameters of operations especially in case of high strength alloys. By this way the life time of ceramic foam filter should be longer and the profile quality should be higher than earlier.
- Beside the molten metal treatment the billet casting technology

is the other factor in the question of exportable products. For the time being the process has not been instrumented therefore the control is based on visual observations and performed manually. Thus it is necessary to install up-to-date DC billet casting machineries with proper control.

- The homogenity of billet is in direct connection with the quality of extruded products therefore it is advisable to introduce the billet homogenization especially in case of high strength alloys. In the casting shop there is a homogenizing furnace but it is out-of-operation. This should be reconstructed and supplied with suitable control or replaced with a new, up-to-date one.
- The exportable quality supposes the defect-free surface of profiles. The majority of the defects is induced on the supplementary equipment of extrusion presses thus it is necessary to modernize the existing auxiliary equipments of presses (quenching system, run-out table, cooling table with forwarding facilities, puller, profile cutter with acethylene gas).

P.T. Edico Utama

- The replacement of the old casting shop with the machinery is inevitably necessary with a new one. Now it is under construction and attention must be devoted for instrumentation and control possibilities especially in connection with molten metal treatment.
- From points of view of productivity and manufacturing cost it is advisable to introduce billets with 8 inches diameter. These should be extruded on the press with 16.5 MN load. It needs billets of the same diameter. The container of the press and the DC billet casting machine have to be modified according to this diameter.

- The homogenity of extruded profiles need billets with homogeneous structure. It can be done in a billet homogenizing furnace which must be installed.
- The export quality needs the introduction of quality control system. It means a permanent investigation of properties (chemical composition, mechanical features etc.) which demands a spectrometer for chemical analysis and a tensile testing machine.
- The auxiliary equipments of the extrusion presses are outdated therefore the surface quality and mechanical properties vary in a very wide scale. Modernization of them is necessary but not so urgent.
- The export market needs a variety in surface colour. The replacement of the old anodizing line with a new one is inevitable and it will be able to produce electrolitically coloured aluminium surface. Beside the equipment know-hows are also required for the anodization.

P.T. Superex Raya

- The whole casting shop is outdated and is not able to produce billets for exportable profiles.The modernization must be extended to the melting furnace (replacing it with a renewed one) and the DC billet casting equipment. The molten metal treatment needs some modifications in the grain refining and filtering. The billet homogenization must be introduced with installing a new homogenizing furnace.
- For the sake of productivity and defect-free profiles the the auxiliary equipments of presses should be modernized.
- The new colour anodizing line is under construction. It is advisable to supervise the technology and to find new possibilities for enlarging the choice of colours.

P.T. Indal Al. Extrusion

- The factory shows a high technical level from point of view of machinery. There is no need for further modernization here but some modification is inevitable e.g. the graphite cooling inserts on the run-out and cooling tables are in wrong position, they have to be adjusted correctly.
- Although the technology is correct it would be advisable to supervise the parameters of extrusion and heat treatment for improving the efficiency and the surface appearance and for stabilizing the mechanical properties.

IV. COST STRUCTURE OF EXTRUDED PRODUCTS, ESTIMATED CAPITAL FOR THE NEW INVESTMENTS

Generally speaking in any kind of product the cost structure can be determined on the basis of the fixed and variable expenses of the plant involved. These items appear in the cost structure of the producing plant as well thus it is evident that there is a close relation between the two kinds of cost structures. In connection with the elaboration of the Master Plan I we tried to collect data and information for the elements of cost structure in every plant examined but there were problems as the plants had treated these figures and data confidental and gave only estimations instead of exact figures or disclosed nothing. On the basis of these data, our experiences and the generally accepted relations the cost structures of the different semis producing factories had been elaborated and presented in the "Final Report", Chapter III.B.4. For an extrusion plant it was summarized in the Table 11 (Master Plan I).

In connection with the new data collection in this year the experiences showed the same as referred to the cost figures of the operation. The situation has not changed in the respect of that the plants considered these data and information internal matter and treated them confidental further on. For this reason it was impossible to elaborate cost structures of extruded products for each factory but for the sake of comparison we give such a cost structure for an extrusion which charaterizes the product of a Middle-European (Hungarian) plant with nearly the same size and 5-10 years operation as the visited Indonesian extrusion plants have. This cost structure is given by the Table 2.

Table 2

Cost structure of extruded products
in a Hungarian extrusion plant

	Percentage of total cost
Raw material	80,8
Cost of casting production	1,3
Cost of extrusion production	4,3
Variable part of factory costs (auxiliary materials, energy, etc.)	3,2
Fixed part of factory costs	4,4
Cost of plant management	6,0
Total	100,0

According to the Chapter III the proposed modernizations and investments with their estimated capital were summarized for each factory involved in the Table 3. It was mentioned formerly but it should be emphasized again that these modernizations serve first of all the increase of quality and have only very moderate effect on the quantity. At the same time the reality is that the installed capacity has been much higher than the demand and the question of the Indonesian aluminium downstream industry especially the extrusion and wire rod production is not the quality but above all the quality. It is evident that the quality improvements will be accompanied with an increase in the quantity, too. For this reason in the Table 4 there are shown the production and the expectable capacity data for each plant.

For the analysis of figures and data in the last two tables from point of view of realization it has to be mentioned that the proposed modernizations and investments can be done independently in the plants and each step has its own effect on the quality but a synergic one may be expected on the basis of all steps together. The selection and the time-table of realization of the appropriate modernization program must be made by the management of the plants but this type of work can be helped and supported by such an organization (Technical Advisory and Markeing Centre) that had been proposed in the Master Plan I, Chapter VIII.

Table 3

Estimated capital for the modernizations

1000 USD

Plant	No.	Identification	Piece	Price	Installation	Civil engineering	Total cost
P.T.Supreme Alurodin							
	1.	In line filtering equipment for molten metal (MINT I- Selee)	1	100	10	10	120
	2.	Water pretreating equipment	1	130	15	5	150
	3.	Non contact crack sensing equipment	1	40			40
	4.	Temperature measuring device	2	0,5			1
	5.	Twin bobbin winding equipment	1	500	10	10	520
P.T.Alcarindo Prima							
		From item No.1 to No.5 see above at the P.T.Supreme Alurodin					
	6.	Holding furnace, 20 tons, gas fired	1	660	130	40	830

Table 3 (cont.)

Estimated capital for the modernizations

1000 USD

Plant	No.	Identification	Piece	Price	Installation	Civil engineering	Total cost
P.T.Alexindo							
	1.	Reconstruction of old melting furnace	1	50	20	5	75
	2.	New melting furnace, 5 tons, oil fired	1	190	50	20	360
	3.	In line filtering equipment for molten metal (.SNIF-R10)	1	235	15	5	255
	4.	Reconstruction of DC casting machine	1	50	20	15	85
	5.	New DC casting machine, 5 tons, mechanical type	1	250	35	75	360
	6.	Reconstruction of homogenizing furnace for billets	1	50	25	10	85
		(New one, 5 tons, oil fired)		(200)	(40)	(15)	(255)
	7.	Auxiliary equipments for press of 1800 tons (puller, run-out table, etc.)		300	45	20	365
	8.	Auxiliary equipments for press of 660 tons (puller, cooling system, hot cut-to-length shear)		80	12	8	100

Table 3 (cont.)

Estimated capital for the modernizations

1000 USD

Plant	No.	Identification	Piece	Price	Installation	Civil engineering	Total cost
P.T.Edico Utama							
	1.	Melting furnace, 8 tons, oil fired	1	430	70	25	525
	2.	Holding furnace, 5 tons, oil fired	1	290	50	20	360
	3.	In line filtering equipment for molten metal (MINT I-Selee)	1	100	10	10	120
	4.	DC casting machine, 5 tons, mechanical type	1	250	35	75	360
	5.	Homogenizing furnace	1	200	40	15	255
	6.	Spectrometer for chemical analysis	1	100	10	10	120
	7.	Universal mechanical testing machine	1	80		5	85
	8.	Auxiliary equipment for the press of 1650 tons (puller, water-air cooling system, run-out table)	1	300	45	20	365

Cont.

Table 3 (cont.)

Estimated capital for the modernizations

1000 USD

Plant	No.	Identification	Piece	Price	Installation	Civil engineering	Total cost
P.T.Edico Utama							
	9.	Auxiliary equipment for one of other presses of 300 tons	1	60	10	5	75
	10.	Reconstruction of anodizing line	1	50	20	10	80
	11.	Know-how for the anodization		20			20
P.T.Superex Raya							
	1.	Reconstruction of melting furnace, 10 tons, oil fired	1	50	20	10	80
	2.	Reconstruction of holding furnace, 6 tons, oil fired	1	40	20	5	65
	3.	In line filtering equipment for molten metal	1	100	10	10	120
	4.	DC casting machine, 10 tons, mechanical type	1	350	40	100	490
	5.	Auxiliary equipment for one of the presses of 600 tons	1	80	12	8	100

Table 3 (cont.)

Estimated capital for the modernizations

1000 USD

Plant	No.	Identification	Piece	Price	Installation	Civil engineering	Total cost
P.T.Indal Aluminium Extrusion							
	1.	Know-how for the extrusion of AlMgSi profiles		120			120

Table 4

The present production data and expected capacities after modernizations

in 1000 tons/year

Plant	Product	Actual production	Production envisaged by the plant	Estimated capacity
P.T.Supreme Alurodin	Wire-rod (EC quality 50 % and EAlMgSi quality 50 %)	12	12	15-18
P.T.Alcarindo Prima	Wire-rod (EC quality 60 % and EAlMgSi quality 40 %)	7,8	10	15-18
P.T.Alexindo	Profile (6061, 6063 alloy) Rod, profile (7075 alloy)	max.1,8	2,4	3,6
P.T.Edico Utama	Profile (6061, 6063, 7075 alloy)	1,2	3,0	4,0
P.T.Superex Raya	Profile (6061, 6063, 7075 alloy)	2,3	4,0	6,0
P.T.Indal Al.Extr.	Profile (6061, 6063, 7075 alloy)	4,5	4,8	7,2

V. ANALYSIS OF EXPORT POSSIBILITIES AND PROPOSAL FOR APPROPRIATE NATIONAL DEVELOPMENT PLAN

Considering all points of view it can be stated that for the Indonesian semis export the most convenient markets are in the ASEAN countries. These countries are the closest neighbours of Indonesia thus the the cost of transportation in their case is lower than that for farther ones. Another fact which is important in this question is the economic cooperation among the ASEAN countries. Although the ASEAN is first of all a political alliance its parties have closer economic contacts which promote the commerce among them and should give different preferences for the products moving inside them.

Besides Indonesia the ASEAN countries have neither smelters nor domestic resources for primary aluminium thus their demand is satisfied by the way of import only. At the same time some of them have considerable capacities for producing aluminium semis to supply not only the domestic demand but for exporting them as well to take the advantage of value added of semis. This also means that although Indonesia has the strongest aluminium industry (and within it the biggest semis production) she must compete on the ASEAN market and the competitivness of her aluminium semifinished products has to be raised by increasing the quality and widening the scale of assortment as well as manufacturing special alloys and unique forms.

The demand and consumption of aluminium products in the ASEAN market were analysed in the Master Plan I and the consequences can be summarized as follow:

- in the import of ASEAN counterparts the unwrought aluminium represents about 60 % while sheets are 13 %, foil is 7 %, extrusions are 12 %, wires and cables are 5 % as well as finished goods are 3 % of the total quantity,

- in case of basic materials North America and Australia are the main suppliers while for semis and processed materials Europe and Japan export more into this region,
- among the allied countries Malaysia and Singapore are the strongest export position which is in close connection with their economic ppotential and development. It is interesting that although Thailand has considerable capacities for aluminium semis their export is on rather low level.

At the same time the balance of trade of Indonesia with the ASEAN partners is usually positive (except the case of Thailand) and it could cause problems for increasing the Indonesian export to Malaysia, Singapore and the Philippines. Avoiding the problems the possible way is to replace such kind of aluminium semis which are imported from outside of this region. In case of extrusions up to now about 5.000 t while of wire rod 3.000 t are to be substituted annually. It is evident that considerable market efforts and developments of the own semis production are needed for being in the replacing position but it can be stated that about the year of 2000 these export quantities of extrusions and wire rod should be reached if the modernization of extrusion plants and wire-rod factories fulfilled.

The Indonesian government should have a guide-line for the export tp promote the activities in this field. The following has to be considered as a general proposal for which the details shall have to be elaborated on the basis of the future intention of the Ministry of Industry for Indonesia and of the financial possibilities. The main points of the plan are:

1. Evaluation of the imported extrusions in the ASEAN countries from point of view of their quality requirements. Comparison of the foreign and the Indonesian specifications and standars.
2. Analysis of the product-mix of extrusions made by

Indonesian firms in connection with their complexity, homogenity (defects), cost, etc. Qualification of extrusion plants to determine their ability for the export, devoting special attention to their product quality and price.

3. Determination of the concrete projects of the modernization modernization and the technical improvements of the plants selected on the basis of this Report.
4. Promotion of the marketing activity of the plants. Elaboration of export incentives granted by the Government.
5. Determination of the ways and methods by which the financial basis for the modernization can be guaranteed.
6. Accomplishment of the modernization in the plants.

In connection with the elaboration and promotion such a plan it would be advisable to organize a technical advisory and marketing team (as proposed in the Master Plan I, Chapter VIII/4.) which should give closer relations between the Government and the aluminium industry as well as among the the plants and the surroundings.

Remark

As it was stated the main direction of the semis export of the Indonesian aluminium industry leads to the ASEAN market but some other possible ways should deserve the further consideration. In connection with the elaboration of an UNIDO project (No.UC/UD/RLA/88/123) named "Identification of specific projects for the production of semi-finished non-ferrous metals in Latin America" the experiences have shown the interest of Chile and Peru to strengthen their commercial relation with the South-East Asean countries. In their case there is not aluminium production, all of their aluminium demands are satisfied by import. As they have very limited semifinishing capacities semis represent about half of their aluminium import (which is between 5.000 and 6.000 t altogether in each country). At the same time they have abundant reserve of copper ores and manufacturing capacities for producing copper concentrate, blister and refined metal. All of these are exported to all over the world. They buy aluminium from those Latin American countries where this industry is strong (Venezuela, Brazil, Argentina) and to where they sell copper. The export-import relations among the Pacific and Atlantic side countries of South America are strongly affected and hindered by the geographic situation namely the Andes mountains. Because of the lack of railway transport the only way is the shipping. Transporting by ship between the two sides of South America it has also difficulties either taking the Panama channel or coming round the Horn cap. It was said that much more convenient for Chile and Peru to use only the Pacific for the turnover of products sold and bought. From this point of view it would be advisable to analyse a possible copper-aluminium barter business or an aluminium semis export among the ASEAN countries and Chile or Peru looking for the interest of the Indonesian industry and of the manufacturers of semis.

VI. CONCLUSION

Considering all the experiences, proposals and suggestions it can be stated that in both cases of products (extrusion and wire-rod) the development activity must be directed to ensure the good quality of starting material which is in case of extrusion the billet and in case of wire-rod the melt.

Of course the billet quality is highly depends on the treatment of molten metal just like the melt to be tapped but in this case the casting operation is also important especially its machinery background. For the time being in this field there are out-of-date DC casting machines and incidental technologies.

Naturally there are some problems in connection with manufacturing technology as well but these can be eliminated easily on the basis of certain modifications both in equipments and technological parameters.

It has the greatest importance that as a consequence of the finished developments (in accordance with the recommended ones in the Master Plan) all the visited plants and factories are able to manufacture exportable products though their quantity is still limited. It is direct consequence of the fluctuations in the technology and starting material quality.

Our proposals tries to direct their development activity for stabilizing the production first of all on the basis of minimum investment cost.

At last the correct knowledge of present situation and of possible modernizations should help the decision making process of the industry's management for promoting the development and investment in this line.

ANNEX 1

Description of the technology for extruded profiles from 6063 type alloy

The 6063 alloy (or 6163) provides a good combination of extrudability and mechanical properties as well as a decorative appearance. The extruded profiles can be sophisticated and thin-walled, easy to polish, chemical brighten and anodise. The visible surface has to be uniform in colour and smoothness. The required mechanical properties at European markets are as follow:

Temper	UTS (MPa)	0,2% proof stress (MPa)	Comment
T4	150-160	80-120	rarely used
T5	200-240	150-200	very common
T6	220-240	160-200	rarely used

The higher values can be reached by using 6163 type alloy.

The adequat technology has to satisfy the following requirements:

1. Chemical composition

The chemical composition limits have to be narrower than those of the national standards:

Elements in wt.%

Alloy		Cu	Mg	Mn	Si	Fe	Zn	Ti
6063	min.	0,05	0,47		0,39	0,16		
	max.	0,10	0,57	0,10	0,47	0,25	0,10	0,05
6163	min.	0,10	0,47		0,39			
	max.	0,20	0,57	0,05	0,47	0,15	0,10	0,05

The proposed compositions suit to the standard SII.0405-81.

2. Billet quality

The cast surface must be smooth, the grain structure uniform and fine (minimum 400 grains/cm2), the dendrite cell structure has to be fine, too (the average cell size is maximum 30 microns). The circumferential zone containing high amount of alloying elements and impurities has to be thin (the maximum thickness is 0,3 mm). Non-metallic and gaseous inclusions must be avoided in the billet. The permitted hydrogen content is maximum 0,15 cm3/100 g Al. The raw material has to be dry.

In order to meet this demand the melt needs proper grain refinement (with Al-Ti-B master alloy) and treatment with flux (hexaclorethan). The too high Ti content can decrease the extrudability and the life-time of dies.

3. Homogenization

The homogenizing heat treatment increases the formability and improves the mechanical properties. The hardening phase (Mg_2Si) has to go into solution during the extrusion process therefore the homogenization must ensure a good dispersion of alloying elements for promoting the diffusion process prior to deformation. Only the magnesium and silicon being in solid solution can be quenched by air cooling from the extrusion temperature.

The proper parameters of homogenization:

- holding temperature: 560-580 °C
- holding time: 4-8 hours depending on the temperature.

The air temprerature in any part of the furnace must be kept within +/- 10 °C.

4. Extrusion process

The billet preheating temperature and the extrusion speed are correlating parameters. The main thing is to take into solid solution the whole quantity of alloying elements. It needs usually only some seconds in the deformation zone at a temperature of 540-550 °C supposing that we have well homogenized billet. We have to try to combine the parameters in that way we can measure 520-540 °C on the extruded profile at the nearest point to the die even where we are able to do it.

The considerations that influence the parameters choosen:

- the capacity of the extrusion press (upper limit for the extrusion speed)
- the resistance of the die (upper speed limit because of the incresed load and heat generation in the deformation zone)
- the quality of the die (only a good construction ensures correct shape and dimensions at elevated speed or in a wide range of speed)
- the oxide content and too high titanium quantity cause roughening of the surface (pick-ups) at higher speeds
- using too high speed the time is not enough for the solution of hardening phase
- applying too low preheating temperature the thermal conditions of the deformation zone will not be enough for the solution process.

The practical range of the billet temperature is between 450 and 500 °C, the extrusion speed can vary between 10 and 60 m/min (depending on the dimensions and shape of extruded product and the die construction as well as on its resistance).

Very important operation is the the air cooling from the extrusion temperature. The critical cooling rate of the alloy is about 1.5 °C/sec (depending on the chemical composition) in the temperature range of 520-250 °C. We must arrange the suitable cooling intensity to exceed the critical value.

Application of puller is very useful in order to avoid the torsion of extruded profiles and to keep more extrusions coming from the same die in the uniform length.

4. Tempering

The T4 (solution heat treated and natural aged) is a rather rarely used temper as it does not exploit the possibility of the alloy. The great advantage of the alloys 6063 and 6163 is that the extensive step of the solution heat treatment in separate furnaces can be avoided thus the T6 temper (solution heat treated and artifically aged) is rarely used, too. The T5 temper is the usual one (aircooled from the extrusion temperature and artifically aged).

The aging parameters:

- temperature: 160-180 °C
- holding time: 8-16 hours.

Using higher temperature we can decrease the length of time but in this case the danger of overaging increases.

ANNEX 2

Metallographical examination of billet sample given by P.T.Indal Al. Extrusion

Antecendents:

The expert team visited the plant on the 12th of April, 1988. They were shown an AlMgSiO,5 cast billet sample and asked to qualify it. The sample was prepared by turning and anodization. On the anodised cross section of the billet a porous ring of 15-20 mm width and a rather rough grain structure could be seen. The experts were given an other sample of the billet with a smaller size in order to investigate it at home.

Results of the test:

The sample was turned and etched (acidic etching) to make the macroscopic grain structure visible. As shown on the Figure 2 the grain structure is satisfactory fine, the grain diameter is about 300-400 microns, the density is 700 grains/cm2 in average.

After that the sample was polished and etched in sodium hydrate to develop the porosity. Macroscopic porosity could not be observed and photographed.

The dendrite structure was investigated by means of optical microscopy. Figure 3-5 show the structure at the edge of the sample (on the billet surface). An acceptable thin layer (0,1-0,2 mm thick) rich in alloying elements can be found there. Near the surface under this layer an acceptable fine microstructure can be measured, the average size of the secondary dendrite cells is 40-60 microns (see Figure 6-8).

In the axis of the billet a very fine microstructure can be found - the average cell size is 20-30 microns (as shown on the Figure

9-11).

The magnifications of microphotographs (Figure 2-11) is 100 times. Some pores can be observed under the surface (with diameter of 50-200 microns) and some smaller ones in the middle of the billet (20-40 microns).

The Figure 12 and 13 show separately some pores (magn.500x) and the cell boundaries can be seen in Figure 14 and 14 (magn.500x).

The chemical composition of the sample (responding to the main alloying elements):

Mg=0,55 % Si=0,43 % Fe=0,32 % Mn=0,009 % Cu=0,005% Ti=0,009%

Summary:

Although the iron content is rather high and some porosity also exists the billet is suitable for producing extruded profiles of exportable quality. There is a contradiction between the visual experience on the spot and the result of investigations. It may be supposed that the samples do not derive from the same billet. That what we have investigated can be considered as a standard for the good quality.

ANNEX 3

Metallographic investigation of surface defects on wire-rods

Antecedents:

During the visit of P.T.Alcarindo Prima the expert team studied the quality of wire-rods and in several cases observed surface defects on the products. The management of the firm mentioned that cracks, overlaps and fractures occured on the surface of wire-rods many times and the cable factory (P.T.Voksel Electric) several times had noticed them for the increasement of fracture cases during the cold wire drawing process supposing a close connection between the weak surface quality of wire-rods and the bad drawability. They asked the team to analyze problem and to suggest solution for it.

Results of investigation:

We have got a wire-rod piece of 9.5 mm diameter made from EC grade aluminium consisting several surface defects and a short part of a cold drawn wire of 4.8 mm with surface cracks. The visually observable defects and faults of wire-rod are shown on the Figure 16-19 and those of cold drawn wire on the Figure 20-21 (with magnification of 3 times). On the figures it can be seen that the faults have an overlapping and longitudinal cracking character basically on the wire-rods and transversal cracks on the cold drawn wire.

From the neighbourhood of cracks and overlappings we have taken samples off for metallographic investigation in transversal and longitudinal directions. Having finished the preparation process the non-metallic inclusions were observed in polished state while

the microstructure after etching. A large oxide inclusion is to be seen on the Figure 22 in the cross section (magn. 175x). There is a considerable difference between grain structures of the near-surface and the central positions of wire-rod as seen on Figure 23-24. At the grain boundaries high amount of secondary phases can be observed beside the oxide type impurities which occur within the grain, too.
Comparing the test results with our domestic experiences in connection with Properzi technology it can be stated that the basic cause of the defects is the high oxide content. In case of improper filtering of the molten metal (it happens when the glass-textile filter gradually loses its filtering ability during long-run work) the aluminium oxide inclusions get in the solidifying metal with increasing quantity. The very different physical properties of inclusions and metal matrix develop an incoherency between them which appears in the form of small cracks in the bar and overlappings and fractures in the rods induced by hot-rolling process.
The surface defects of wire-rods come down to the cold drawn wire, too, in a somehow different appearance because the cold deformation process generally causes weld-like adhesion on longitudinal overlappings and fractures on the deep transversal cracks.

Summary:
The surface defects are direct consequences of the improper filtering of molten metal. Applying glass-textile filter it is advisable to check the filtering capacity several times a working period and to replace the unfit one. The correct solution is to introduce an in-line filtering equipment as specified in the next Annex. It is also useful to control the soundness of bars and rods on the Properzi machine with non-contact crack sensing devices such as Defectomat.

ANNEX 4

Specifications of proposed equipments and devices

1. SNIF R-10 system

The SNIF stands for Spinning Nozzle Inert Flotation which is a patented inert gas aluminium refining process developed by Union Carbide Corp. The SNIF R-10 single nozzle system provides a normal continuous in-line filtering rate of 4545 kg per hour. The system consists of a process control panel, a refining furnace, a furnace control panel and a furnace transformer.

The specially designed refining furnace has a refractory-lined steel shell. The refining chamber is designed to permit total process gas bubble saturation throughout the melt and uses internal baffles to control the flow of metal ensuring complete refining of the aluminium as it flows through the SNIF system. One wall of the refining chamber contains a graphite heater block with three removable electric heating elements. This internal heating capability provides prcise temperature control of the metal as it leaves the SNIF furnace. The installation and maintenance are easy. The inlet and outlet connections are located on the same end of the furnace. The furnace is equipped with front mounted access doors and side mounted clean hatch for dross removal. The furnace can also be tilted and drained for alloy changes or extensive cleaning using an overhead crane.

General specifications:

Furnace capacity 4545 kg/hour

Power comsumption 15 kW

Estimated weigths

Furnace	1906 kg
Transformer	205 kg
Control panel	290 kg
Process control panel	454 kg

Furnace dimensions 1041x1448x1930 mm

Transformer 483x711x864 mm

Control panel 508x610x1829 mm

Process control panel 864x1219x1980 mm

Electrical supply 15 kW - single phase -50/60 Hz

Process gas 10.5 m3/hour - 344.5 kPa

Cover gas 3.2 m3/hour - 344.5 kPa

Emergency gas o.32 m3/hour - 587.7 kPa

Air, nozzle cooling 16 m3/hour - 585.7 kPa

Chlorine, if required 0.53 m3/hour - 172.3 kPa

The estimated cost of the equipment is 235.000 USD.

2. Automatic twin-drum coiler

The proposed equipment is the CLECIM (France) coiler which can deliver either tight-wound or loose-wound wire-rod coils of round or sector rod of excellent quality.

The pitch control by traversing motion of the drum guarantees the following performances:

- absence of bending action on the wire-rod prior to entry into drum
- absence of twisting motion on the wire-rod during coiling
- absence of friction of the wire rod against guide rolls, a feature which obviates any deterioration to wire-rod surface quality.

The equipment ensures that operations from casting to coiling are executed on the same vertical plan. The drum pitch is digitally controlled from the controle console ensuring the perfect rod position on the drum and the regularity of coil. The coils can be easily removed onto coil pallet conveyer through use of a swivel mounting system.
The estimated cost of the equipment is 500.000 USD.

3. Automatic handling equipment to extrusion presses

The CLECIM (France) made equipment performs cooling, stretching and cut to length of aluminium extrusion in fully automatic way. This includes a puller combined with a fix or movable hot extrusion saw, a graphite intermediate table, a cooling table (rectangular pitched), a stretcher, a storage table with automatic batching and a cut to length line with lateral evacuation.
The puller, combined with a cut or shear device close with the press is fully automatic and does not need an operator at the press output. After the end of extrusion and the product cut, the puller evacuates and indexes the extrusion batches on the run-out table. This is extremely accurate (less than 100 mm). The stretcher fixed head is no longer moved at every batch bit only at extrusion changes. The indexed batch is laterally moved onto the cooling table through a rectangular motion. The extruded batch goes systematically into the stretcher jaws. A lengthwise ventilation shaft as well as a number of blowers under the table ensure proper cooling. A water quench with standing wave is optional.
Technical data:
Maximum extrusion length 43.2-50.4-64.8 m
Puller force 200-1200 N

Product holder pitch	800 mm
Stretcher	20 tons
Width of batches	700 mm

Estimated cost of the equipment is 1.000.000 USD.
In connection with extrusion technology it is interesting to note that for the time being the following prices must be considered in case of the investment of new machinery:

Extrusion press with 1600 tons load	cca. 1.000.000 USD
Simple handling equipment	500.000 USD
Automatic handling one (see above)	1.000.000 USD
Puller itself	100.000 USD

4. Defectomat C 2.820

The Institute Dr.Forster (Germany) made device performs eddy-current defect analysis on circular and sector profiles both in on-line and off-line mood. The Defectomat C 2.820 tests metal wire at temperatures up to 1200 C and the highest menufacturing speeds - up to 100 m/sec - fully automatically and on-line. It makes possible 100 % control, immediately detecting production faults at high speed. Rapid feedback of flaw data saves time and material, thus achieving more economic production. The detected flaws are the long laps or recurring flaws due to faulty initial material or inclusions. The equipment has a built-in flaw density and flaw-total monitoring module complies fully with all requirements for automatic testing and evaluation. The tester produces signals according to preset quality characteristics for the marking of defective areas and for information on the quality of the test material. In addition, external units such as counters and recorders can be connected to the tester. The equipment needs an appropriate transmitter system adjusted to the given product.

Frequency range 1-1000 kHz

Testing speed 0,002-100 m/sec

Phase adjuster 0-360 in 10 step

Estimated price is 40.000 USD.

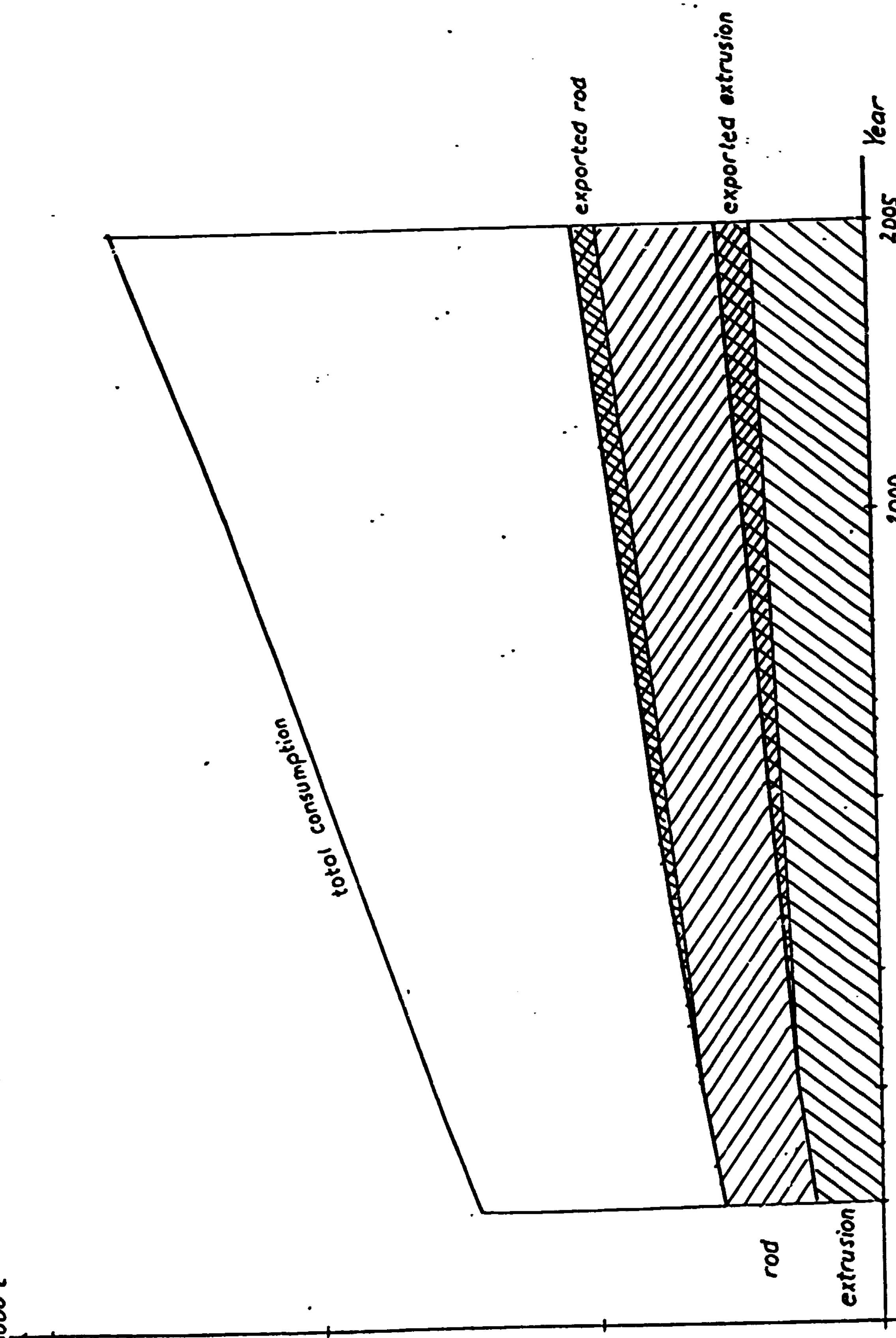
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Figure 1

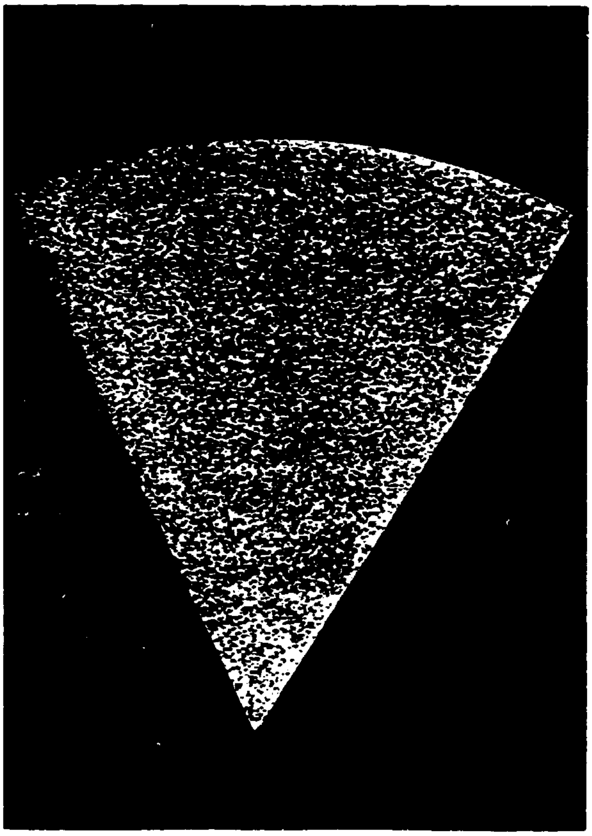


Figure 2

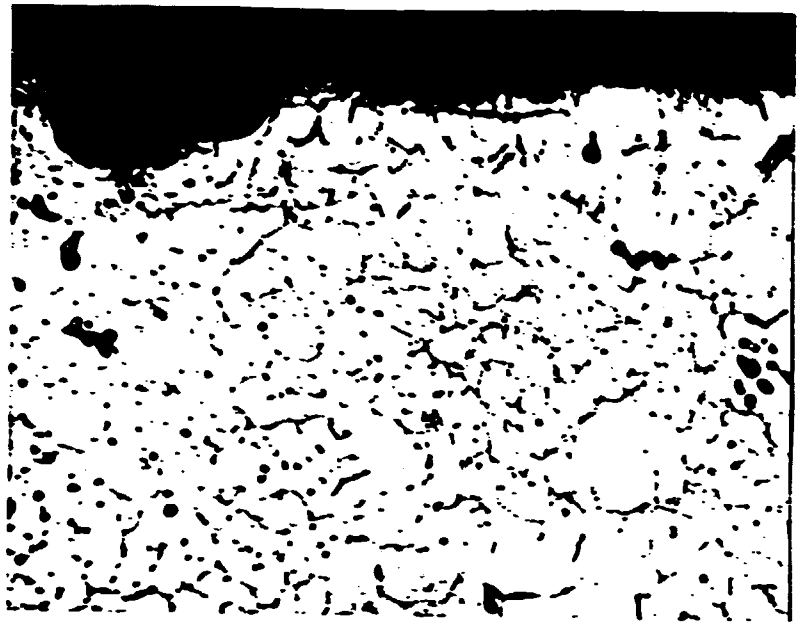
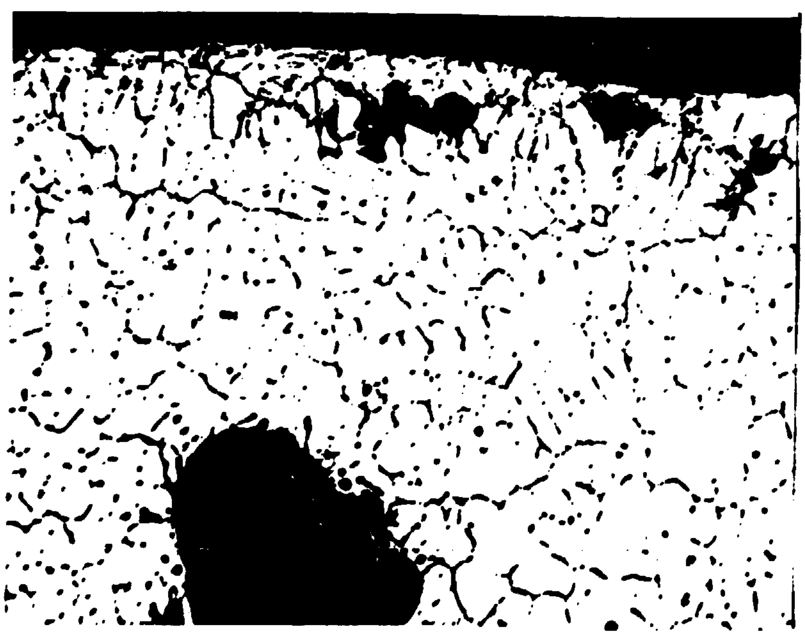


Figure 3

Figure 4



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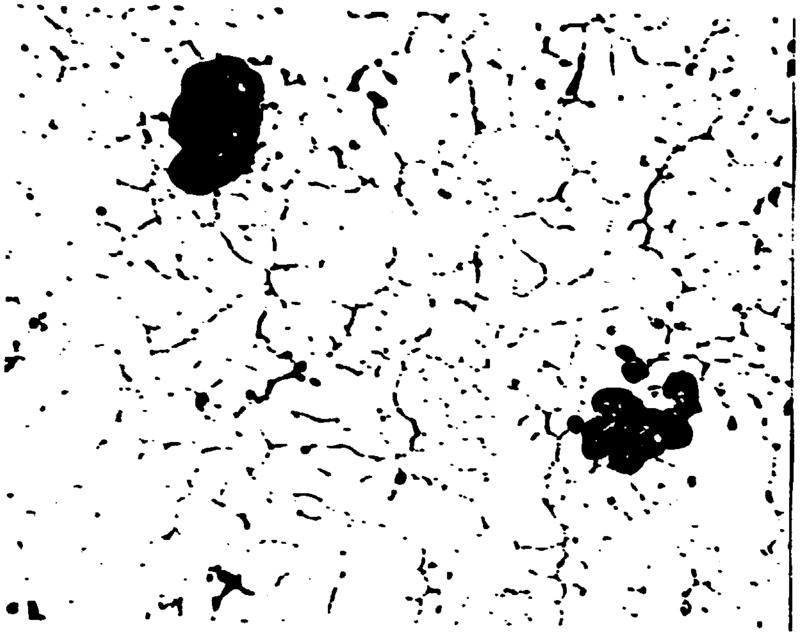

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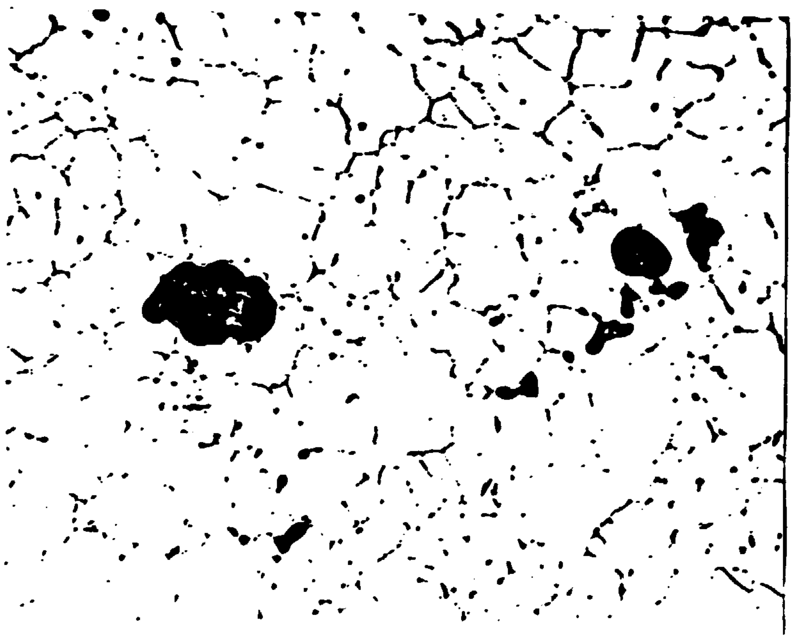

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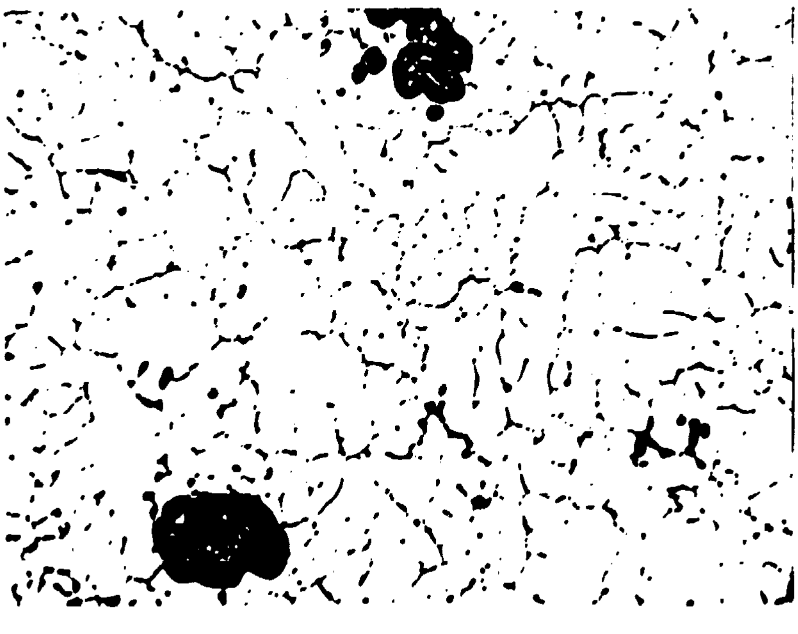

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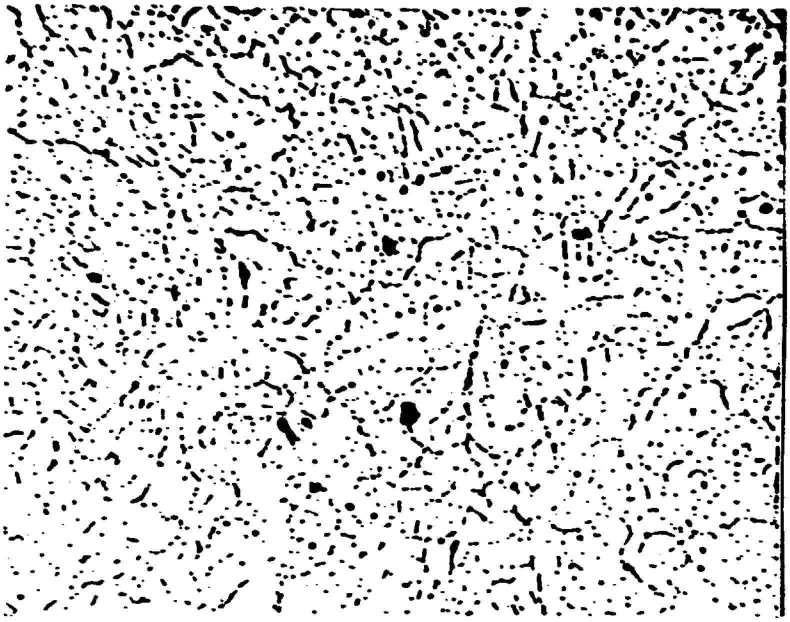

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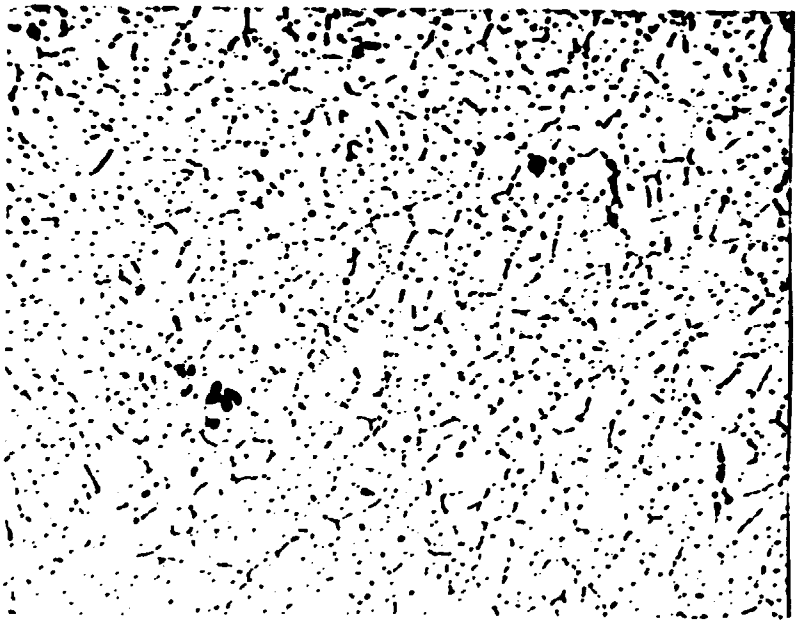


Figure 10

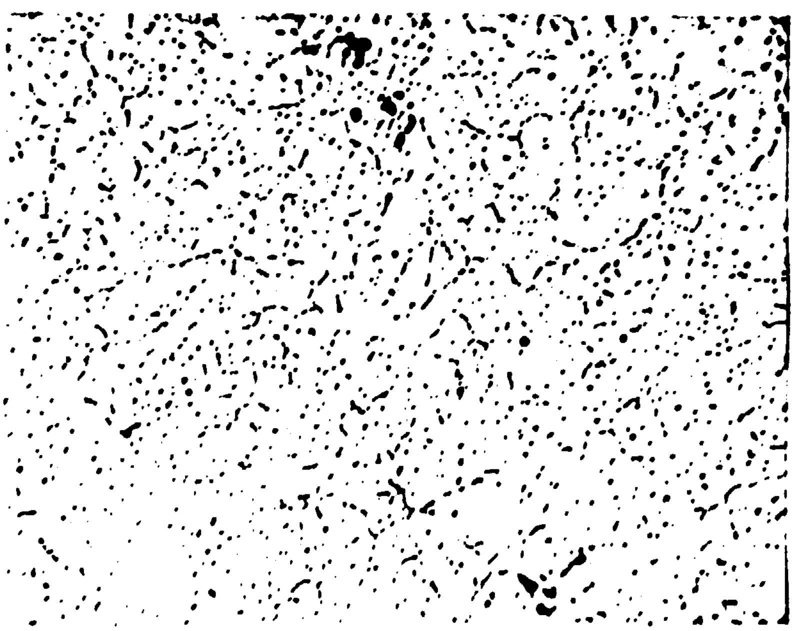
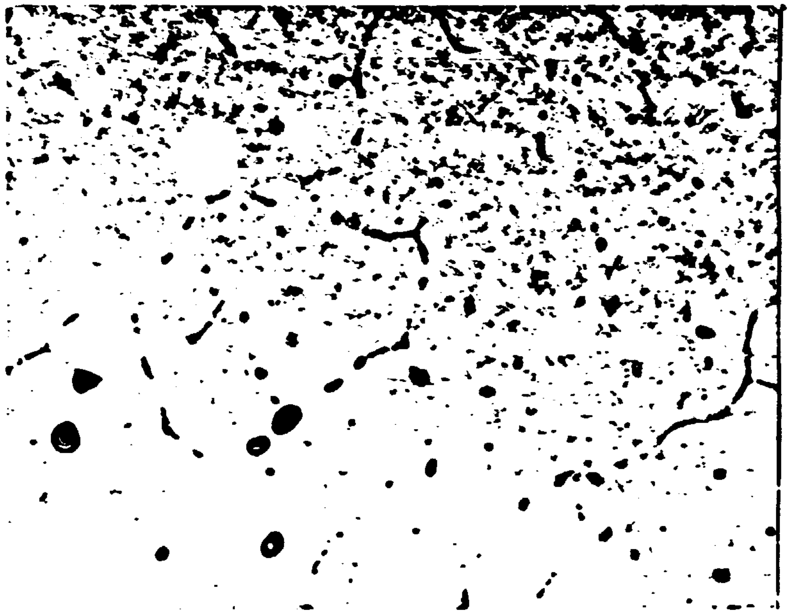


Figure 11

Figure 12

Figure 13



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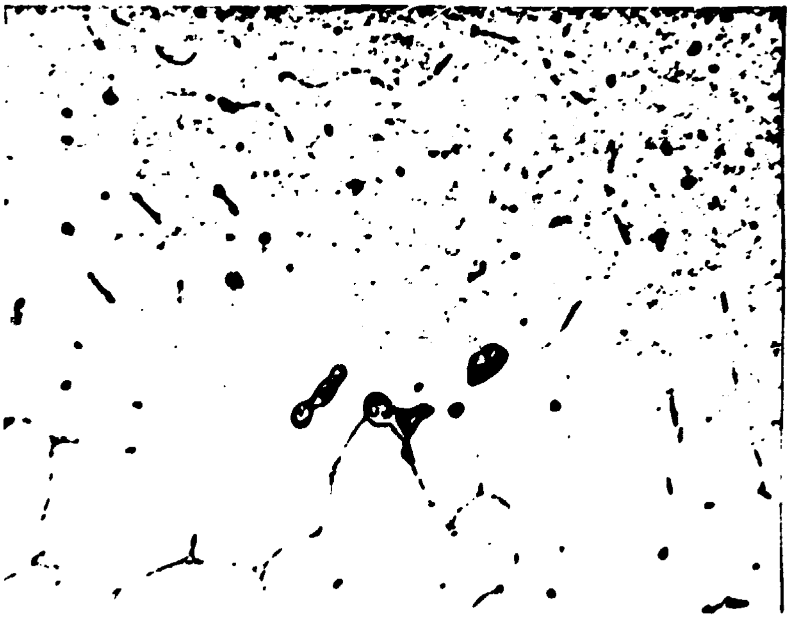

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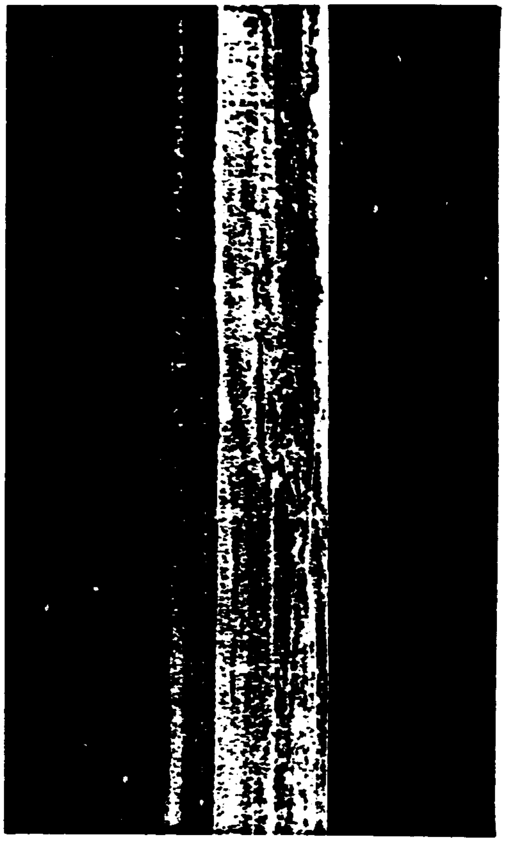

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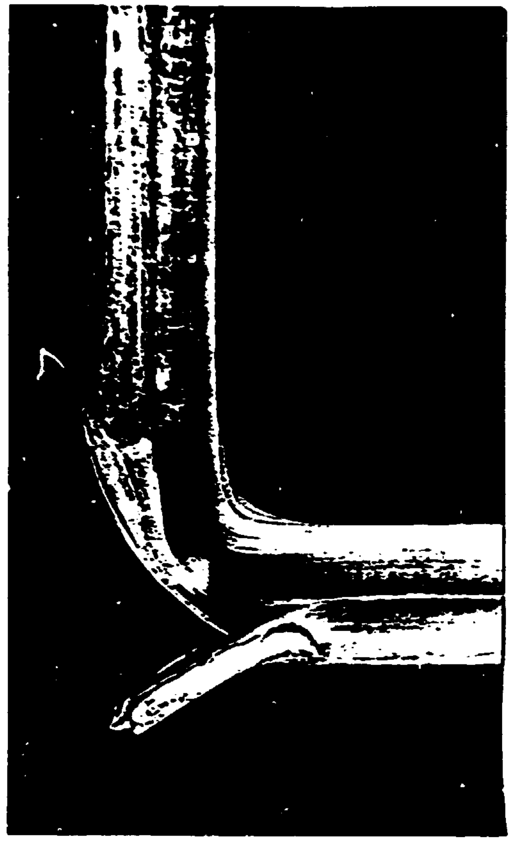

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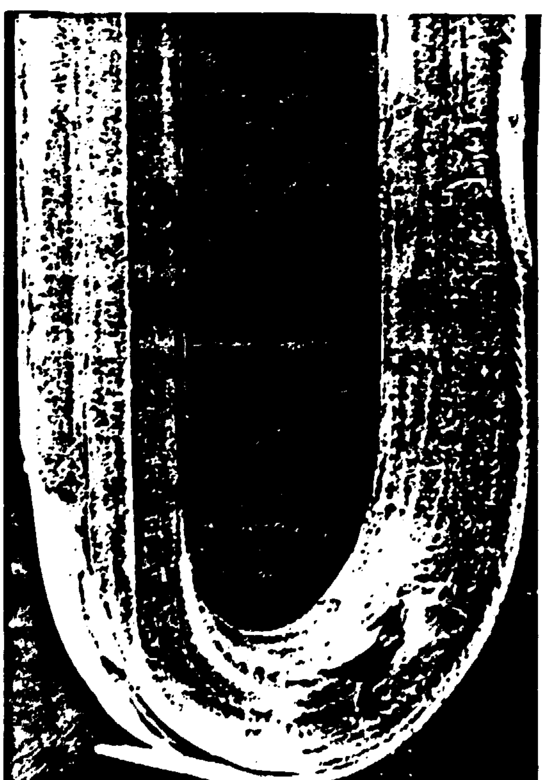

Figure 18

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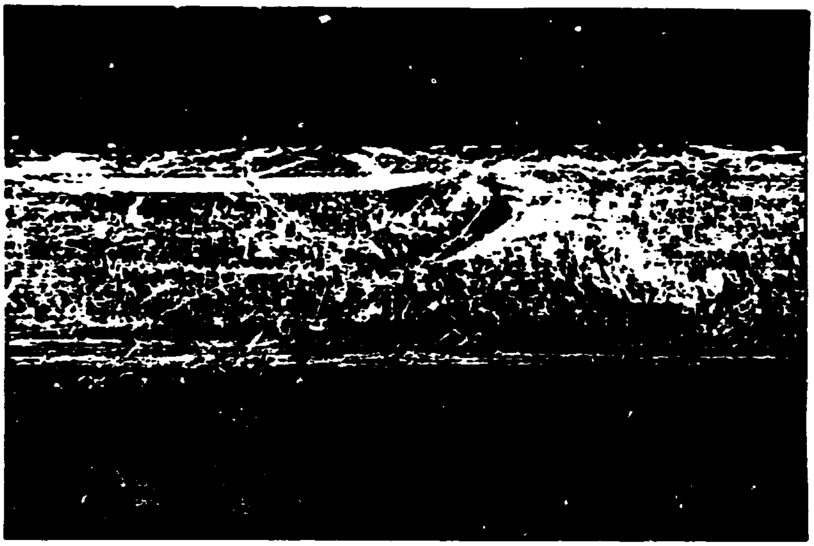

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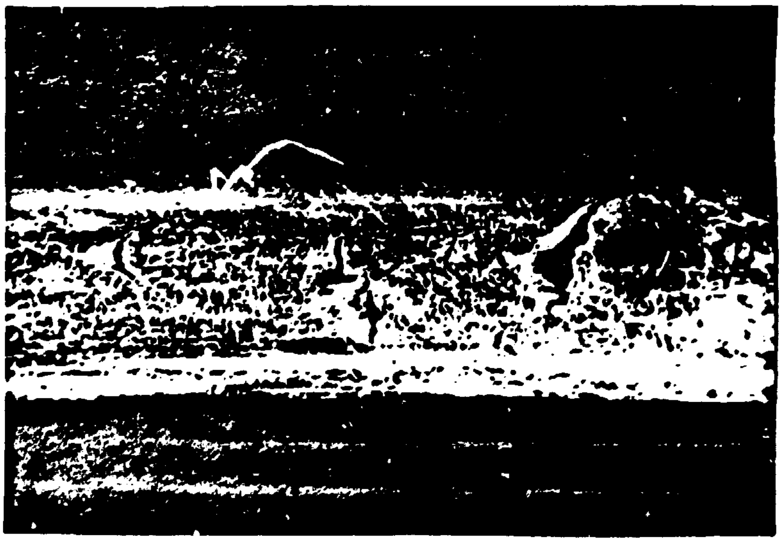
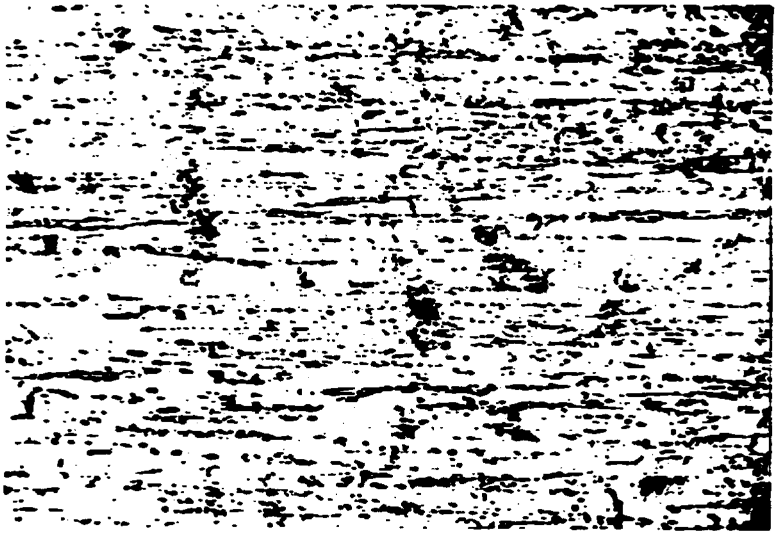


Figure 21

Figure 22



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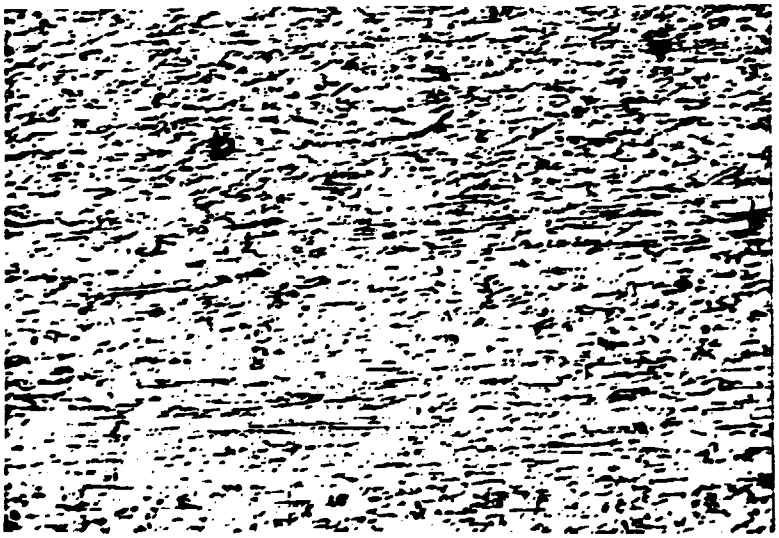

Figure 24