OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

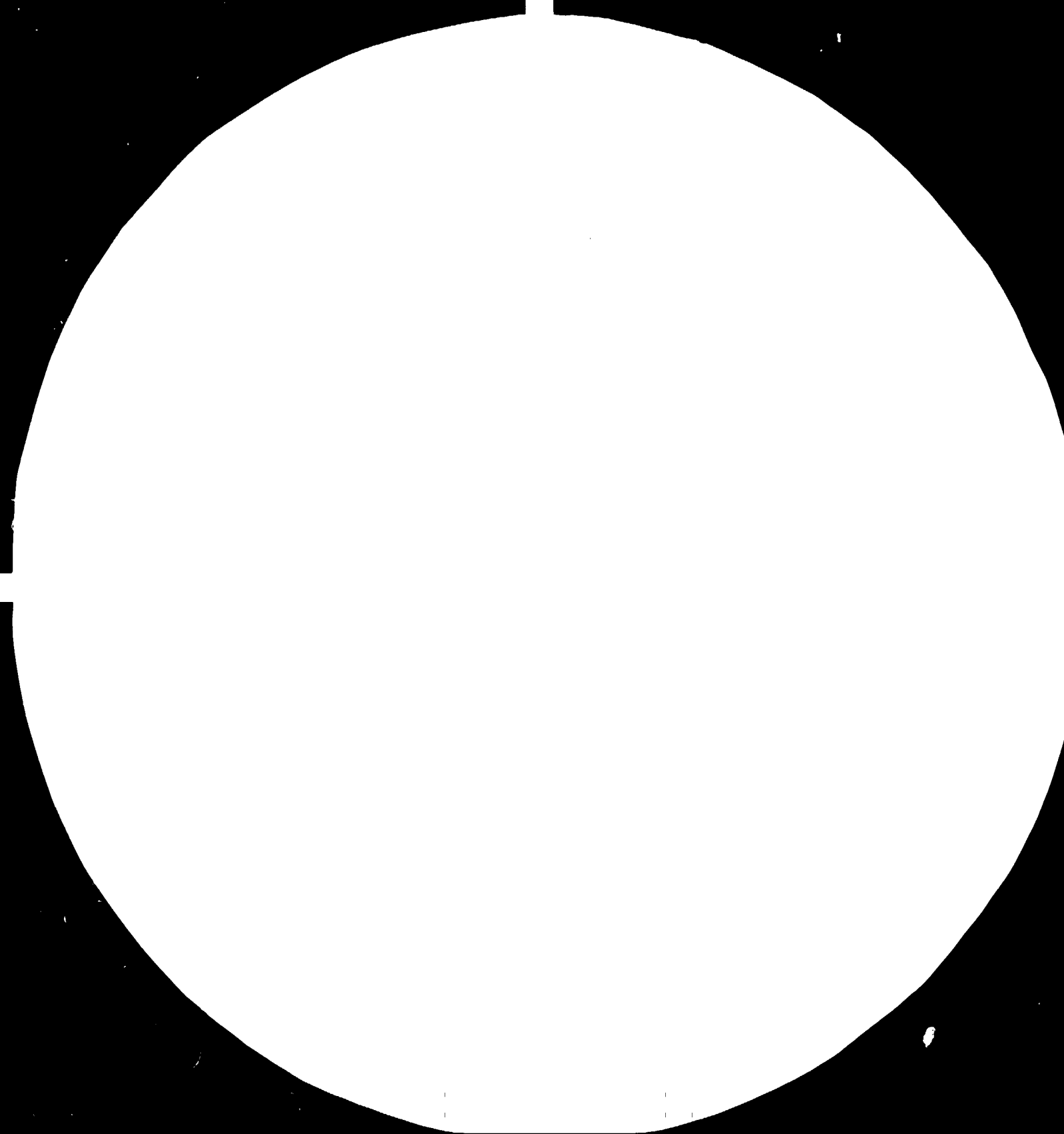
FAIR USE POLICY

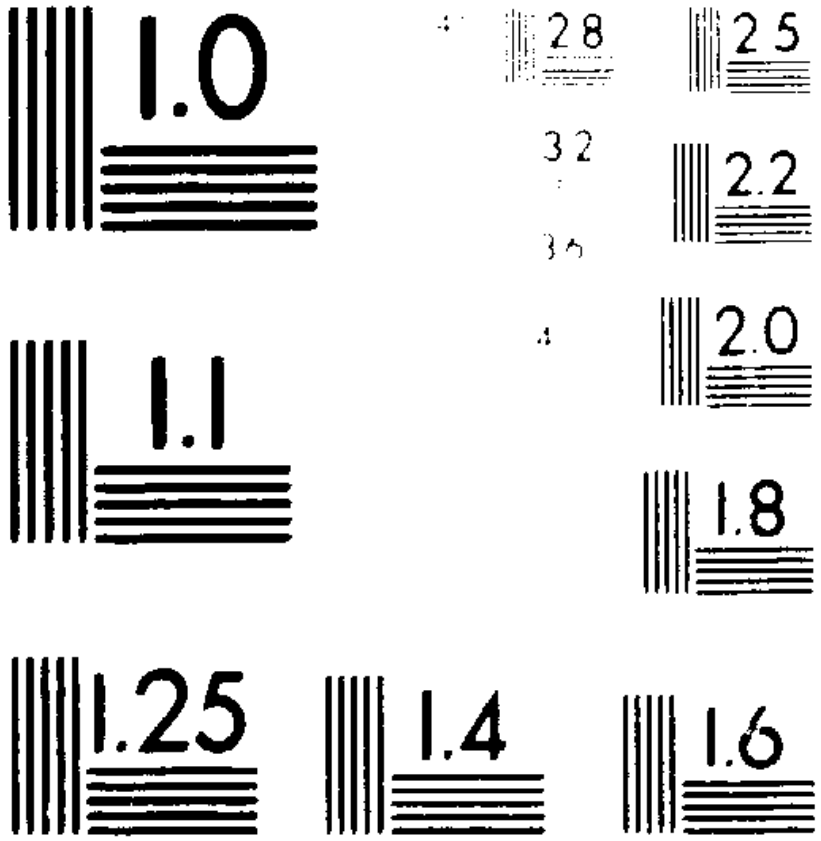
CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org





→ M. Dietrich

RESTRICTED

2 January 1985
ENGLISH

14265

Sri Lanka.

ESTABLISHMENT OF A CERAMIC RESEARCH AND DEVELOPMENT LABORATORY

US/SRL/78/207

SRI LANKA

Technical Report*

Prepared for the Government of Sri Lanka
by the United Nations Industrial Development Organization
acting as executing agency for the United Nations Development Programme

Based on the work of W. Biehler,
Consultant in Refractories

United Nations Industrial Development Organization
Vienna

* This document has been reproduced without formal editing.

PART I

STUDY FOR LANKA REFRACTORIES LIMITED

CONTENTS

ANNEXES

1) - Analysis Of refractory Raw Materials
   - Addresses Of Deliverers Of Refractory Raw Materials

2) - Production Divides Into Products
   - High Alumina
   - Medium Alumina
   - Low Alumina
   - Magnesite
   - Magnesite Chrome
   - Zircon

3) - Production Of Refractories 1983
   - List Of Customers
   - Production
   - Sales Value

4) - Proposal For Laboratory Tests
   - Raw Materials
   - Body Tests During Processing
   - Fired Items

5) - Proposal For New Machinery

1. PURCHASE OF RAW MATERIAL

1.1 General-Facts

In contrary to other ceramic productions the raw materials for refractories are much more expensive, normally the costs for refractory raw materials are about 50 % of the whole turnover. Therefore it is very important to contol and to test these materials because a great amount of money could be lost by a purchase of worng or too expensive raw materials.

Before doing payment the chemical analyses of the different bulks of raw material must be controlled and compared.

- In the annex 1 there are summed up some of the most important analyses for refractory raw materials as for instance

  - Magnesite
  - Mullite
  - SiC
  - Corundum
  - Specialities

  In annex 1 we also have named some well known companies which deliver those raw materials. Most of those companies are able to deliver an amount of 20 tons by containers.

  Probably it would be wise if Sri Lanka Refactories writes letters to some of those companies asking for test samples as well as for the data of qualities and of prices.

1.2 Procedure Of Buying Raw Materials

Normally the quality of the raw material has to be discussed by the partners.

A small amount of about 10 kg of test material should be delivered by the dealer to Lanka Refractories. Some tests have to be done with these raw materials in the laboratory in Meepe and in the Central Laboratory. The results of these tests are the base for the contract with the dealer.

After finishing these tests successfully a small container of about 20 tons of the material should be bought in order to manufacture refractory stones in a semi-technical test.

- A long term contract could be signed if these test series conform to requirements of Lanka Refractories. The procedure of testing the raw materials has to be fixed in the contract.

2. DEVELOPMENT OF THE MARKETING STRATEGY

2.1 Planning Of The Budget

For Lanka Refractories Ltd. which has a turnover of more than 12 mio. S.L.Rp per year it is absolutely necessary to have some planning figures which are the base for developping the budget.

- One of the most impcrtant figures to develop this budget is to know the data about the qualities and quantities of refractory materials used in the different industries and companies in Sri Lanka.

- At the same time it is nessecary to be informed about the developping plans of those industries.

By discussion I got the information that Sri Lanka has an import of about 47 mio. S.L.Rp for refractory materials without kiln furniture because these products do not range under refactories. These data are not sure because we could not prove them in the statistics of the Government. This proving has to be done by Lanka Refactories.

As we have mentioned already Lanka Refractories Ltd. has a turnover of about 12 mio. S.L.Rp per year and has about 300 working people. The turnover per man is about 40.000 Rupies.

- These data show that the personnel costs are very high in comparison to the turnover. To work profitable it is absolutely nessecary that the Lanka Refractories will increase the turnover.

Regarding the production possibilities of the factory there is nearly no problem to double the production with the personnel (300 men) and the staff of today.

In this case a turnover of 24 mio. S.L.Rp per year could be achieved. In comparison to the mentioned import we believe that it must be possible to reach this guessed turnover.

A turnover of 24 mio.S.L.Rp means that about 2,600 t/y have to be produced which is about 50 % of the figures which has been planned. Some figures speak of a possible production of 8,000 t/y what seems to be too high.

2.2 Analysis Of The Products

In table 1 we have compared the productions of the different qualities with their sales value and the prices per ton.

The detailed calculations are done in table 2, 'Production 1983', they base on the established list of Lanka Refractories of September 1984 concering the customers of 1983, (See annex 2, 3).

Normally to receive a complete survey those data have to be assembled at least for three to four years. During my stay in Sri Lanka it was only possible to collect the data of 1983. But I have asked the General Manager to install also those of 1982 and 1984.

- Regarding table 1 it shows that the biggest sales value of about 38 % was achieved by magnesite and magnesite chrome stones. On the other hand the quantity in tons for those stones is only 27 % of the whole production.

- The medium alumina bricks and fire clay follow with 33 % of sales value and 40 % in quantity of tons.

- At the third place range high alumina bricks and fire clay with 25 % of sales value and 27 % of production.

- Regarding the prices per ton it seems to be nessecary to control the price system again. For instance the prices of high alumina bricks are lower than those of medium alumina bricks. The insulating alumina bricks are cheeper per ton than the low alumina bricks.

  This price scale shows that in comparison to the international price level the prices per ton of Lanka refractories have to be recalculated.

Dr.-Ing.
BIEHLER

Table 1

PRODUCTION PROGRAM LANKA REFRACTORIES

Quality	Tons 1983		Sales Value 1983		Price p.ton
	MT	%	S.L.Rp	%	S.L.Rp
High Alumina Bricks + Fire Clay	353.5	27	2'973'482	25	6'109
Medium Alumina Bricks	405.7	32	3'524'342	29	8'463
Medium Alumina Fire Clay	107.0	8	467'843	4	4'374
Low Alumina	53.4	4	357'603	3	6'962
Low Alumina Insulating	21.9	2	130'404	1	5'960
Magnesite	1.5	0	37'030	0	24'687
Magnesite Misse	138.0	11	680'158	6	4'929
Magnesite Chrome Brick	200.4	16	3'855'382	32	23'781
Zircon	0.1	0	6'207	0	44'336
Total	1'281.5	100	12'032'451	100	-----

2.3 Analysis Of Clients

Regarding the list of Lanka Refractories in annex 3 we see that 22 companies are mentioned as clients of which three companies made 94.9 % of the turnover and 81.1 % of the production in 1983.

These companies are:

Name of the company	Tons per year %	Sales Value %
- Ceylon Cement Corporation	38.7	43.9
- Ceylon Steel Corporation	33.6	30.8
- Ceylon Ceramic Corporation	8.8	9.4
Total	81.1	94.9

This result seems to be dangerous because it shows that Lanka Refractories specially depends on two companies. If one of those companies decides to stop buying refractories Lanka Refractories will have a big loss.

2.4 Selling Efforts

The analysis of customers shows that it is nessecary to get more clients and to increase the turnover with each of them.

- For instance the glass industry has a big need of all sorts of refractories but until now it has not bought anything from Lanka Refractories.

- The Steel Corporation needs more refractories as they are going to buy now from Lanka Refractories.

- The Ceramic Corporation has bought a lot of kiln furniture by different other companies and even has produced some of it in one of its own ceramic factories.

It is absolutely nessecary that Lanka Refractories get better contact to the clients. Therefore a selling department with a Technical Officer as head of sales division has to be installed.

This expert must have a reasonable understanding of the processes and the requirements of the customers. He has to visit the big clients at least once a month in order to discuss their problems. To do this work sufficiently he needs good catalogues concernig quality, sizes and shapes inclusive some construction exsamples.

- The Technical Officer has to help to develop the marketing strategy of Lanka Refractories.

2.5 Forecast

We propose to make a real marketing analysis of all refractories which are used in Sri Lanka.

To do this prognosis the Technical Officer has to guess the development of the different industries, as for instance:

- steel industry
- glass industry
- ceramic industry
- lime industry
- bricks and tiles industry
- suggar industry
- railway industry
- and others

He has to find out what sort of products and what qualities might be used in the next years. These informations he only get by visiting the companies of the different branches.

At the same time, specially the statistics of import have to be proved exactly to see what refractory materials have been imported in the last years. But the statistics are not sufficient therefore it is nessecary to discuss this problem with the wholesalers who import the refractories.

Having the results of the statistics and the industries these both data have to be compared with the possibilities of the production of Lanka Refractories.

The result of this comparison is the base for the developping of a forecast for the factory.

Concerning the forecast it is nessecary to develop three different prognoses a:

- low level prognosis
- medium level prognosis
- high level prognosis

These prognoses should include data for all main qualities of refractories which could be produced. (It can be done in the same manner as we have listed up the production of 1983 in annex 2.)

- This analysis with a forecast for the next years is the base for the planning of the development of Lanka Refractories.

3. DEVELOPMENT OF THE PRODUCTION

Generally the market has to implement the variaty of production. Without having a detailed market analysis we make the following prognosis concerning the products of Lanka Refractories:

- The base of the production should be alumina bricks in all wanted shapes with an alumina content from 23 % to 90 % Al_2O_3. Those products are produced out of:
  - Kaolin
  - Clay
  - Bauxite
  - Corundum
  - Tabular alumina
  - Mullite

- Insulating bricks for temperatures of 1,200 and 1,400 °C out of alumina with a content of 30 % and 50 % alumina made of clay, kaolin, bauxite, saw-dust, rice ash, the bulk density should be between 0.7 to 1.1 kg/cm^3.

- All sorts of zircon bricks for the steel industry but also for the ceramic industry specially for seggars (kiln furniture).

- All different sorts of kiln furniture, specially out of:
  - Mulcorite and Mullite
  - Silicon Carbide for the high burning porcelain industry.

- Magnesite and magnesite chrome specially for the steel industry and the cement industry.

- All sorts of mortars which are needed for binding the above mentioned refractory stones have to be produced and sold. Mostly these products are very profibable.

- In the next years, the demand of refractory casting, gunning and ramming masses will increase further on therefore it might be worth while to develop a production of those refractory materials.

  These products could be sold only if the construction and the handling is done by the deliverer. This selling system strengthens the contact to the clients.

It is not possible to develop all those products at the same time therefore a scale of value concerning the profitibility of the products has to be worked out.

In this case profitibility means low investment in raw materials and new machinery but high selling prices in growing markets. We believe that these requirements are fulfilled by the following products:

- High alumina bricks
- Insulating bricks
- Zircon bricks
- Kiln furniture
  (specially because those products can be sold in the own company.)
- Mortars

4. QUALITY CONTROL

4.1 Internal Control

For a refractory company the laboratory is one of the most important controlling and developping system therefore the chief of the laboratory must be directly responsable to the General Manager of the factory.

The quality control in Lanka Refractories seems to be realy good. Lots of different sorts of data are available. But these data are not summed up so that it is very difficult to get a survey of the quality control. We propose to design graphics as it has been started already and to scrutinize a statistical quality control.

4.2 Development Of New Qualities

During my stay in Sri Lanka I have taken nearly all raw materials and some products of Lanka Refractories to the Central Laboratory in Piliyandala to control the ceramical and physical data.

At the same time I have brought different sorts of kiln furniture of the Ceramic Corporation to the Central Laboratory also to get results of their qualities. These materials have been produced by different European and Japanese companies.

The described laboratory testing is the base to get informations about the qualities of raw materials and

products which are produced by Lanka Refractories today as well as about the data of the qualities of kiln furniture which are used in Sri Lanka today.

I propose that Lanka Refractories after finishing such base laboratory work officially orders a developping of products to the Central Laboratory. These products have to fulfil the requirements of the different industries concerning qualities.

Probably it would be good if the controlling system for the raw materials and for the products will not only be done in Meepe but also in the Central Laboratory in Piliyandala. This way of controlling guarantees a bigger security of equal qualities.

In annex 4 there are some proposals how to control refractories concerning

- Raw materials
- Body tests during processing
- Fired items

4.3 Developping Officer

The improvement of quality and the developping of new products is one of the main tasks of every refractory company. But in chapter 4.2 we proposed to do the developping in the Central Laboratory because the equipment of Lanka Refractories is not sufficient to do this work.

In order to get no loss in information and to have a good connection between fabrication, market on one site and the Central Laboratory on the other site a developping officer has to be anounced. This person should be a ceramic specialist who knows about the need of the market and the developping of products.

4.4 Additional Equipment for Central Laboratory

The Central Laborarory is excellently equipped to solve the developping tasks for Lanka Refractories. Only few new equipments are nessecary.

- For controlling the above mentioned products it might be nessecary to install a new under load high temperature burning system which could be delivered by Bickley or Netzsch. (See annex 5, new equipment)

- For the REM microscope it might be necessary to have a vacuum deposition system to get clearer results during the working. In annex 5 there are some catalogues of Balzers for those systems.

5. RECOMMENDATIONS FOR FURTHER DEVELOPMENT

The factory has been installed 1980 to 1982 and started working in 1982. The plant could produce about 4,000 to 5,000 t/year with the 300 labourers. Today only 1,300 t/ year are produced. It is not a question of quantity but a question of quality whether the factory will earn money.

- In Europe some of the refractory companies produce less than 50 % of their capacity but have a good profit.

It is only possible to earn money by producing high quality products for special markets. To get these informations it is nessecary to develop a market research for all products and qualities.

After knowing the market the fabrication has to be tuned to this demand. That means:

- New products have to be developped
- The qualities have to be increased
- The production and storing capacities have to be fixed
- A short and a long term budget have to be installed

To sell these refractory products realy good contacts to the customers have to be established. That means the selling officer has to be able to give advice in

- Refractory questions
- Construction problems
- Slagging problems
- Quality problems
- Handling system
- Heat transfer questions
- Insulating problems

This service also will help that the clients get confidence in the products and the reliability of the refractory company.

- We believe that it is not worth while to produce very high sophisticated products as direct bonded magnesite stones because those products have no market chances in Sri Lanka.

- Sri Lanka industries need refractory stones of good qualities. By help of a functional quality control these products can be produced without great investment costs at Lanka Refractories in Meepe.

- We propose after having finished the market research to build up an investment plan including

  - Raw materials
  - Machinery
  - Laboratory
  - Processing
  - Building
  - Maintenance
  - Logistic
  - Personnel costs

- The most nessecary investment in Meepe factory is to install a dust extracting plant because contaminations of dust can negatively influence the batch during processing. Additionally a good dedusting system helps to have clean and comfortable working places as well as to save the health ness of the working people.

A N N E X 1

Analysis of Refractory Raw Materials

Addresses of Deliverers of Refractory Raw Materials

CONTROL ANALYSIS

DIDIER :

Magnesite Sinter out of Spain

Called : Dimag F

- SiO_2 < 1 %
- CaO < 3 %
- Al_2O_3 0.05 %
- Fe_2O_3 < 5 %
- MgO > 90 %

			kg/cm³
-	Quality F	Bulk Density	3.15-3.20
-	Quality F D	Bulk Density	3.3

LONZA

Technical Documentation

LONZA LTD
Inorganic Chemicals Division
CH-4002 Basle
Tel. 061 50 88 50
Telex 62323 lonz ch

CARSILON

Chemical Composition of
Silicon Carbide middle grit Mixtures
for Refractory Products

	CARSILON I	CARSILON II
	%	%
SiC	98.2 min.	96.0 min.
free C	0.6 max.	1.2 max.
free SiO_2	0.4 max.	1.2 max.
Al_2O_3	0.5 max.	1.2 max.
Fe_2O_3	0.3 max.	0.6 max.
Si	0.6 max.	0.8 max.

Basle, October 1978
CISC-SiC

LONZA

Technical data sheet

LONZA-Werke GmbH

D-7890 Waldshut-Tiengen 1
Tel. (07751) 820
Telex 792244

Fused Aluminium Oxide ABRASIT®

for Super Refractories

Description

ABRASIT is a tough, regular Aluminium Oxide with a fine crystalline structure. It is produced in an electric arc furnace by melting high quality bauxites under reducing conditions in a tapping furnace. This process, which was developed by LONZA many years ago, allows a controlled rate of cooling of the melt. The result is an extremly low ferruginous homogenous product with excellent properties. The full range of gradings can be supplied and, with our modern methods of continuous control, a high quality product is guaranteed.

Applications

For Super Refractories where high mechanical strengths, chemical inertness and high thermal conductivity is required, i.e.

- refractory bricks in various shapes and dimensions
- ramming mixes, castables and mouldables, with ceramic, chemical or hydraulic bond
- to improve the Al_2O_3 content and wear-resistance of other refractory materials, e.g. fire-clay

Chemical Properties

Typical Chemical Analysis		Chemical Stability
Al_2O_3	95.0% - 96.5%	ABRASIT is resistant against most chemicals, slags, molten metals and furnace-gases, also at high temperatures.
TiO_2	2.5% - 3.5%	
SiO_2	0.4% - 0.8%	
Fe_2O_3	~ 0.1%	
CaO	~ 0.05%	
MgO	~ 0.2%	
Fe soluble	~ 0.05%	
Others	~ 0.1%	

Physical Properties

Colour	Original = grey-brown Colour after firing = blue at temperatures of approx. 1300 - 1400°C, in oxidising atmosphere depending on grit size, gradual whitening at higher temperature
Crystal Structure	α-Al_2O_3, trigonal - fine crystalline, predominantly 300 - 1000 µm approx. crystal size
Specific Gravity	3.94 - 3.98 g/cm³
Hardness	~ 21000 N/mm² (HV_{100}) or 9.5 (extended Mohs scale)
Toughness (Typical Values) - Battelle-method - (ball mill test)	Ideal Grit / lg. z' 14 (1.4 - 1.7 mm approx.) 3.04 25 (0.7 - 0.8 mm approx.) 2.70 35 (0.5 - 0.6 mm approx.) 2.63
Porosity (Pycnometer method)	1 - 2% (measured at grit sizes of 3 - 6 mm)
Grain Shape	Polyhedric, sharp-edged, compact
Melting Point	> 1900°C ≙ SC 40/41
Linear Thermal Expansion	0.8% between 20° - 1400°C approx., resp. ~ 8 x 10^{-6}/°C
Thermal Conductivity	~ 20 W/m K at room temperature ~ 14 W/m K at 100°C ~ 3 W/m K at 1100°C

Example in Application

To demonstrate the properties of this material, a trial mixture using a blend of different grain sizes of ABRASIT was manufactured with a 10% addition of clay as a bonding agent. The mixture was then dry pressed into the shape of bricks.

Formula for the trial bricks

25% ABRASIT 2 - 4 mm
15% ABRASIT 1 - 2 mm
25% ABRASIT 0 - 0.5 mm
25% ABRASIT 0 - 0.06 mm

10% bonding clay E - O (with 38,3% Al_2O_3 and < 0.2% alkali).

Concentrated sulphite solution was used as a temporary binder.

The mix was pressed on a normal hydraulic press. After drying, the bricks were fired in a chamber furnace at 1680°C.

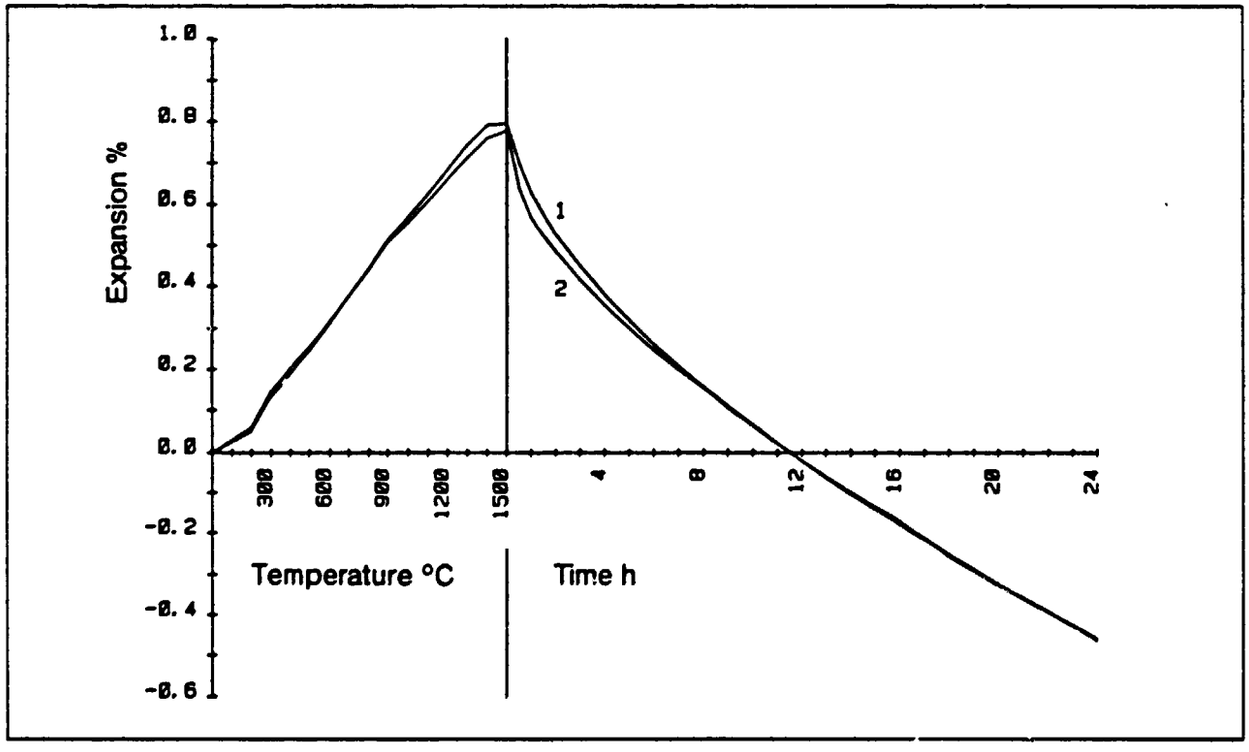
Chemical Analysis of the fired product

Al_2O_3	90.54%
SiO_2	5.92%
TiO_2	3.02%
Fe_2O_3	0.25%
CaO	0.05%
MgO	0.20%
Alkali	0.02%

The bricks had the following physical values:

Green-density	3.13 g/cm^3
True-densi.y	3.82 g/cm^3
Water Absorption	5.2%
Apparent Porosity	16.5%
Total Porosity	18.4%
Cold Crushing Strength (DIN 51067)	229.3 N/mm^2
Cold Bending Strength (DIN 51048, Part 2)	14.5 N/mm^2
Refractoriness under Load (DIN 51064)	t_a 1720°C
Hot Bending Strength (DIN 51048, Part 1)	5.3 N/mm^2
Thermal Shock Resistance (DIN 51068, Part 1) (water quenching process)	22 cycles

Creep in Compression according DIN 51053, Part 2



Trial 1: $E_{max.}$ 0.78% T_{10} - 0.71% T_{20} - 1.10% ($E_{max.}$ = maximum expansion at 1500°C)
Trial 2: $E_{max.}$ 0.80% T_{10} - 0.73% T_{20} - 1.12% (T_{10}, T_{20} = diminution of expansion after 10 h resp. 20 h)

Standard-Sizes (others by special agreement)

mm	Grain size distribution*)						Bulk-density tolerances**) kg/1000 cm³
3 – 6	%-R.	5 – 15	70 – 85	0 – 15			1.95 – 2.05
	Sieve-No.	5 mm	7 (2,830 mm)	through			
1 – 3	%-R.	0 – 5	30 – 45	50 – 65	0 – 10		1.95 – 2.05
	Sieve-No.	7 (2,830 mm)	10 (2,000 mm)	18 (1,000 mm)	through		
0,5 – 1	%-R.	0 – 5	85 – 95	0 – 10			1.85 – 1.95
	Sieve-No.	18 (1,000 mm)	35 (0,500 mm)	through			
0 – 0,5	%-R.	0 – 5	50 – 60	20 – 30	15 – 25		1.85 – 1.95
	Sieve-No.	35 (0,500 mm)	70 (0,210 mm)	140 (0,105 mm)	through		
2 – 4	%-R.	10 – 20	65 min.	0 – 15			1.95 – 2.05
	Sieve-No.	6 (3,360 mm)	10 (2,000 mm)	through			
1 – 2	%-R.	0 – 5	85 – 95	0 – 10			1.90 – 2.00
	Sieve-No.	10 (2,000 mm)	18 (1,000 mm)	through			
0 – 1	%-R.	0 – 5	30 – 40	30 – 40	15 – 25	5 – 15	1.95 – 2.05
	Sieve-No.	18 (1,000 mm)	35 (0,500 mm)	70 (0,210 mm)	140 (0,105 mm)	through	
0 – 0,1	%-R.	0 – 5	40 – 50	45 – 55			1.50 – 1.60
	Sieve-No.	140 (0,105 mm)	230 (0,062 mm)	through			
0 – 0,06	%-R.	0 – 5	20 – 35	60 min.			1.50 – 1.60
	Sieve-No.	200 (0,074 mm)	270 (0,053 mm)	through			

*) Tested with ASTM-Test Sieves using the ROTAP-Sieving Machine
**) Tested according to FEPA

LONZA

Technical data sheet

LONZA-Werke GmbH

D-7890 Waldshut-Tiengen 1
Tel (07751) 820
Telex 792244

Fused Aluminium Oxide ABRAMAX®

for Super Refractories

Description

ABRAMAX is a particularly pure Aluminium Oxide. It is produced in an electric arc furnace by melting special calcined aluminia of low impurities, using the Higgins „block" method. The selection and preparation of the molten „blocks" are in accordance with the quality requirements of the final products. ABRAMAX is specially comminuted to avoid foreign impurities and is magnetically treated to remove metallic iron. A full range of usual gradings can be offered. With our modern methods of continuous control, a very high quality product is guaranteed.

Applications

Super Refractories with high mechanical strengths at the highest temperatures and chemically inertness where the highest purity is required.

- shaped bricks, ramming mixes, castables and mouldables with ceramic, chemical or hydraulic bond.
- kiln furniture for the ceramic industrie
- wear resistant and abrasion resistant glazes
- batch component for technical ceramic
- oxide-ceramic

Chemical Properties

Typical Chemical Analysis		Chemical Stability
Al_2O_3	min. 99.50%	ABRAMAX is resistant to most chemicals, slags, molten metals and furnace-gases, also at high temperatures.
TiO_2	max. 0.02%	
SiO_2	max. 0.05%	
Fe_2O_3	max. 0.05%	
CaO	max. 0.05%	
MgO	max. 0.01%	
Na_2O	max. 0.30%	
Fe soluble	max. 0.02%	

Physical Properties

Colour	Original = white-transparent Colour after firing = white
Crystal Structure	α-Al_2O_3, trigonal, macro crystalline, predominantly 1000 - 3000 µm approx. crystal size
Specific Gravity	3.94 - 3.98 g/cm^3
Hardness	~ 22000 N/mm^2 (HV_{100}) or 9½ (extended Mohs scale)
Toughness (Typical Values) - Battelle-method - (ball mill test)	Ideal Grit — Lg. z' 14 (1.4 - 1.7 mm approx.) — 2.72 25 (0.7 - 0.8 mm approx.) — 2.62 35 (0.5 - 0.6 mm approx.) — 2.50
Porosity (Pycnometer method)	3 - 5% (measured at grit sizes of 3 - 6 mm)
Grain Shape	Polyhedric, sharp-edged, compact
Melting Point	~ 2000°C approx. ≙ SC 42
Linear Thermal Expansion	0,8% between 20° - 1400°C approx., resp. ~ 8 x 10^{-6}/°C
Thermal Conductivity	~ 20 W/m K at room temperature ~ 14 W/m K at 100°C ~ 3 W/m K at 1100°C
Specific Electric Resistance	at 400°C ~ 2 · 10^{13} Ohm · cm at 800°C ~ 3 · 10^8 Ohm · cm at 1200°C ~ 2 · 10^5 Ohm · cm at 1500°C ~ 1 · 10^4 Ohm · cm

Example in Application

To demonstrate the properties of this material, a trial formulation using a blend of different grain sizes of ABRAMAX was manufactured with a 10% addition of clay as a bonding agent. The mixture was then dry pressed into the shape of bricks.

Concentrated sulphite solution was used as a temporary binder.

The mix was pressed on a normal hydraulic press. After drying, the bricks were fired in a chamber furnace at 1680°C.

Formula for the trial bricks

25% ABRAMAX 2 - 4 mm
15% ABRAMAX 1 - 2 mm
25% ABRAMAX 0 - 0.5 mm
25% ABRAMAX 0 - 0.06 mm

10% bonding clay E-O (with 38.3% Al_2O_3 and < 0.2% alkali).

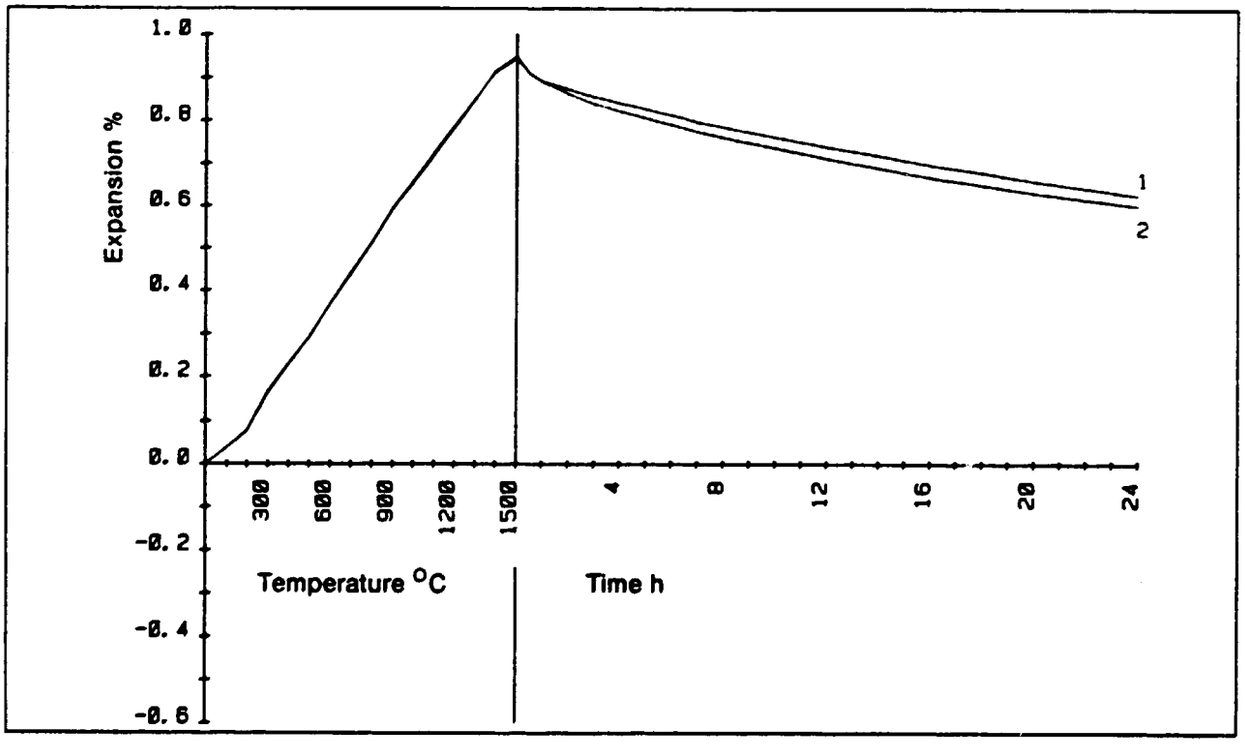
Chemical Analysis of the fired product

Al_2O_3	94.18%
SiO_2	5.17%
TiO_2	0.16%
Fe_2O_3	0.14%
CaO	0.05%
MgO	0.05%
Alkali	0.25%

The bricks had the following physical values:

Green-density	3.12 g/cm^3
True-density	3.93 g/cm^3
Water Absorption	5.6%
Apparent Porosity	17.6%
Total Porosity	20.6%
Cold Crushing Strength (DIN 51067)	250.5 N/mm^2
Cold Bending Strength (DIN 51048, Part 2)	24.0 N/mm^2
Refractoriness under Load (DIN 51064)	t_a 1720°C
Hot Bending Strength (DIN 51048, Part 1)	6.6 N/mm^2
Thermal Shock Resistance (DIN 51068, Part 1) (water quenching process)	23 cycles

Creep in Compression according to DIN 51053, Part 2



Trial 1: $E_{max.}$ 0.94% T_{10} - 0.21% T_{20} - 0.31% ($E_{max.}$ = maximum expansion at 1500°C)
Trial 2: $E_{max.}$ 0.95% T_{10} - 0.19% T_{20} - 0.29% (T_{10}, T_{20} = diminution of expansion after 10 h resp. 20 h)

Standard-Sizes (others by special agreement)

mm	Grain size distribution *)						Bulk-density tolerances**) kg/1000 cm³
3 – 6	%-R.	5 – 15	70 – 85	0 – 15			1.70 – 1.80
	Sieve-No.	5 mm	7 (2,830 mm)	through			
1 – 3	%-R.	0 – 5	30 – 45	50 – 65	0 – 10		1.70 – 1.80
	Sieve-No.	7 (2,830 mm)	10 (2,000 mm)	18 (1,000 mm)	through		
0,5 – 1	%-R.	0 – 5	85 – 95	0 – 10			1.70 – 1.80
	Sieve-No.	18 (1,000 mm)	35 (0,500 mm)	through			
0 – 0,5	%-R.	0 – 5	50 – 60	20 – 30	15 – 25		1.75 – 1.85
	Sieve-No.	35 (0,500 mm)	70 (0,210 mm)	140 (0,105 mm)	through		
2 – 4	%-R.	10 – 20	65 min.	0 – 15			1.70 – 1.80
	Sieve-No.	6 (3,360 mm)	10 (2,000 mm)	through			
1 – 2	%-R.	0 – 5	85 – 95	0 – 10			1.70 – 1.80
	Sieve-No.	10 (2,000 mm)	18 (1,000 mm)	through			
0 – 1	%-R.	0 – 5	30 – 40	30 – 40	15 – 25	5 – 15	1.85 – 1.95
	Sieve-No.	18 (1,000 mm)	35 (0,500 mm)	70 (0,210 mm)	140 (0,105 mm)	through	
0 – 0,1	%-R.	0 – 5	40 – 50	45 – 55			1.45 – 1.55
	Sieve-No.	140 (0,105 mm)	230 (0,062 mm)	through			
0 – 0,06	%-R.	0 – 5	20 – 35	60 min.			1.45 – 1.55
	Sieve-No.	200 (0,074 mm)	270 (0,053 mm)	through			

*) Tested with ASTM-Test Sieves using the ROTAP-Sieving Machine
**) Tested according to FEPA

europe commerce

société à responsabilité limitée

europe commerce · luxembourg · 10a, rue des roses

téléphone 47 24 31
télex 1338 eurcom
télégr. eurcom

Herrn Dr. BIEHLER
Spitzackerstr. 90
CH 4103 Gottmingen

luxembourg
10a, rue des roses

votre réf. | notre réf. CGS/msa | date 18.10.1984

Betr.: Mulcoa und Andalusit für Sri Lanka

Sehr geehrter Herr Dr. Biehler,

wir selbst können keines der beiden o.g. Produkten nach Sri Lanka exportieren.

Die Franzosen werden wohl kaum Interesse haben, Ihren Andalusit dorthin zu verkaufen, da sie mit Aufträgen aus Europa völlig ausgebucht sind.

Wir senden Ihnen deshalb anliegend Datenblätter für Mulcoa. Falls das Material für Ihren Kunden von Interesse sein sollte, so bitten wir Ihn, sich direkt mit dem Produzenten, der Fa

CE Minerals
King of Prussia

in Verbindung zu setzen.

Mit freundlichen Grüssen
EUROPE COMMERCE S.à.r.l.

Claudy Groos
Fondé de Pouvoir

MULCOA-47
REFRACTORY CALCINES
FROM C-E MINERALS

Mulcoa-47 has the lowest alkali content of any super duty clay. With less alkali you get greater hot strength and performance. Our process provides consistent quality and chemistry. Mulcoa-47 is used in a variety of products such as: castables, plastics, brick, ramming mixes, gunning mixes, mortars and ceramic fibers.

TYPICAL CHEMICAL ANALYSIS

AL_2O_3	47.80%	CaO	00.03%
SiO_2	49.30%	MgO	00.04%
TiO_2	01.78%	Na_2O	00.04%
Fe_2O_3	00.98%	K_2O	00.03%

TYPICAL PHYSICAL PROPERTIES

Bulk Density (ASTM C-357) 2.64 G/CC ——— PCE 35 ——— Typical Mullite Content 62%

MULCOA-47 (R-Grade) TYPICAL GRAIN SIZE DISTRIBUTION U.S.S. Sieves – % Retained

Grade	3 (6.7mm)	4 (4.75mm)	6 (3.35mm)	8 (2.36mm)	12 (1.70mm)	20 (850mic)	30 (600 mic)	40 (425mic)	60 (250mic)	100 (150mic)	Pan*
3	0-2	15-25	17-28	10-20	10-20	4-14					10-25
4	Tr	0-2	9-21	13-26	10-24	19-31					17-28
8			0	0-3		40-55		10-24	6-16	8-18	6-15
20						Tr-5	5-20	10-30	20-40	10-30	5-25
3 x 4	0-3	60-80	10-30	0-6	0-6						0-6
3 x 8	0-2	15-25	20-40	15-31	12-22	2-10					0-5
3 x 20	0-2	15-30	17-37	15-30	12-22	2-12					0-5
4 x 8	0-2	2-12	20-40	20-40	17-27	3-13					0-4
4 x 20	0-2	1-9	15-30	15-30	15-30	12-28	2-9				0-4
8 x 20			0	0-6	10-30	35-69	5-20				5-20

*"Pan" designates the percentage of material passing last reported screen for each sizing.

MULCOA-47 (R-Grade) U.S.S. Sieves – % Retained

Grade	20 (850mic)	30 (600mic)	40 (425mic)	50 (300mic)	60 (250mic)	100 (150mic)	200 (75mic)	325 (45mic)	Pan*
35	Tr		Tr-10	10-20		40-60	10-30		5-15
48		Tr					55-65		35-45
100			Tr				35-45		55-65
200					Tr		15-25		75-85
325					Tr			15-35	65-85

*"Pan" designates the percentage of material passing last reported screen for each sizing.

C-E MINERALS
COMBUSTION ENGINEERING, INC.

C-E MINERALS
A Subsidiary of Combustion Engineering, Inc.
901 East 8th Avenue, King of Prussia, Pa. 19406, U.S.A.
(215) 265-6880 • TWX: 510-660-2058 • Cable:SAMRAK

CEM 62 Rev. 5/82

MULCOA®-60 REFRACTORY CALCINES FROM C-E MINERALS

Mulcoa-60 provides the refractory producer with a high purity raw material carefully controlled, mined and processed from our Andersonville, Ga. plant. This material is used in refractory castables, plastics, brick, ramming mixes, gunning mixes, mortars and other high temperature applications.

TYPICAL CHEMICAL ANALYSIS			
AL_2O_3	58.00% min.	CaO	00.04%
SiO_2	38.30%	MgO	00.05%
TiO_2	02.25%	Na_2O	00.02%
Fe_2O_3	01.31%	K_2O	00.03%

TYPICAL PHYSICAL PROPERTIES

Bulk Density (ASTM C-357) 2.80 G/CC ——— PCE 37 ——— Typical Mullite Content 80%

MULCOA-60 (R-Grade) TYPICAL GRAIN SIZE DISTRIBUTION U.S.S. Sieves – % Retained

Grade	3 (6.7mm)	4 (4.75mm)	6 (3.35mm)	8 (2.36mm)	12 (1.70mm)	20 (850mic)	30 (600 mic)	40 (425mic)	60 (250mic)	100 (150mic)	Pan*
3	0-2	15-25	17-28	10-20	10-20	4-14					10-25
4	Tr	0-2	9-21	13-26	10-24	19-31					17-28
8			0	0-3		40-55		10-24	6-16	8-18	6-15
20						Tr-5	5-20	10-30	20-40	10-30	5-25
3 x 4	0-3	60-80	10-30	0-6	0-6						0-6
3 x 8	0-2	15-25	20-40	15-31	12-22	2-10					0-5
3 x 20	0-2	15-30	17-37	15-30	12-22	2-12					0-5
4 x 8	0-2	2-12	20-40	20-40	17-27	3-13					0-4
4 x 20	0-2	1-9	15-30	15-30	15-30	12-28	2-9				0-4
8 x 20			0	0-6	10-30	35-69	5-20				5-20

*"Pan" designates the percentage of material passing last reported screen for each sizing.

MULGRAIN-60 (R-Grade) U.S.S. Sieves – % Retained

Grade	20 (850mic)	30 (600mic)	40 (425mic)	50 (300mic)	60 (250mic)	100 (150mic)	200 (75mic)	325 (45mic)	Pan*
35	Tr		Tr-10	10-20		40-60	10-30		5-15
48		Tr					55-65		35-45
100			Tr				35-45		55-65
200					Tr		15-25		75-85
325					Tr			15-35	65-85

*"Pan" designates the percentage of material passing last reported screen for each sizing.

C-E MINERALS
COMBUSTION ENGINEERING, INC.

C-E MINERALS
A Subsidiary of Combustion Engineering, Inc.
901 East 8th Avenue, King of Prussia, Pa. 19406, U.S.A.
(215) 265-6880 • TWX: 510-660-2058 • Cable:SAMRAK

CEM 60 Rev. 5/82

MULCOA-70 REFRACTORY CALCINES FROM C-E MINERALS

Mulcoa-70 is produced from high purity alumina silica raw materials and provides consistent quality and chemistry.

TYPICAL CHEMICAL ANALYSIS			
AL_2O_3	68.00% min.	CaO	00.06%
SiO_2	27.90%	MgO	00.04%
TiO_2	02.61%	Na_2O	00.03%
Fe_2O_3	01.33%	K_2O	00.03%

TYPICAL PHYSICAL PROPERTIES

Bulk Density (ASTM C-357) 2.85 G/CC ——— PCE 39 ——— Typical Mullite Content 87%

MULCOA-70 (R-Grade) TYPICAL GRAIN SIZE DISTRIBUTION U.S.S. Sieves – % Retained

Grade	3 (6.7mm)	4 (4.75mm)	6 (3.35mm)	8 (2.36mm)	12 (1.70mm)	20 (850mic)	30 (600 mic)	40 (425mic)	60 (250mic)	100 (150mic)	Pan*
3	0-2	15-25	17-28	10-20	10-20	4-14					10-25
4	Tr	0-2	9-21	13-26	10-24	19-31					17-28
8			0	0-3		40-55		10-24	6-16	8-18	6-15
20						Tr-5	5-20	10-30	20-40	10-30	5-25
3 x 4	0-3	60-80	10-30	0-6	0-6						0-6
3 x 8	0-2	15-25	20-40	15-31	12-22	2-10					0-5
3 x 20	0-2	15-30	17-37	15-30	12-22	2-12					0-5
4 x 8	0-2	2-12	20-40	20-40	17-27	3-13					0-4
4 x 20	0-2	1-9	15-30	15-30	15-30	12-28	2-9				0-4
8 x 20			0	0-6	10-30	35-69	5-20				5-20

*"Pan" designates the percentage of material passing last reported screen for each sizing.

MULGRAIN-70 (R-Grade) U.S.S. Sieves – % Retained

Grade	20 (850mic)	30 (600mic)	40 (425mic)	50 (300mic)	60 (250mic)	100 (150mic)	200 (75mic)	325 (45mic)	Pan*
35	Tr		Tr-10	10-20		40-60	10-30		5-15
48		Tr					55-65		35-45
100			Tr				35-45		55-65
200					Tr		15-25		75-85
325					Tr			15-35	65-85

*"Pan" designates the percentage of material passing last reported screen for each sizing.

C-E MINERALS
COMBUSTION ENGINEERING, INC.

C-E MINERALS
A Subsidiary of Combustion Engineering, Inc.
901 East 8th Avenue, King of Prussia, Pa. 19406, U.S.A.
(215) 265-6880 • TWX: 510-660-2058 • Cable:SAMRAK

CEM 61 Rev. 5/82

Continentale Erz-Gesellschaft m. b. H.
Düsseldorf

Continentale Erz-Gesellschaft m. b. H., Postfach 9120, 4000 Düsseldorf 1

Herrn
Dr. Biehler
Spitzackerstraße 9o

CH-41o3 Bottmingen

Ihr Zeichen	Ihre Nachricht vom	Unser Zeichen	Datum
		W/ha	den 22-1o-1984

Betr.: FF-Rohstoffe für Srilanka

Sehr geehrter Herr Dr. Biehler,

wir beziehen uns auf das zwischen Ihnen und Herrn Wirtz geführte Telephonat. Bitte, finden Sie beiliegend

1.) einen Katalog der Firma KERAMETAL AG, in dem die wesentlichen Rohstoffe bzw. Fertigprodukte aus der CSSR aufgeführt sind

2.) eine Richtanalyse über gebrannten chinesischen Bauxit

Bitte, studieren Sie diese Unterlagen und geben Sie uns kurz auf, welche Materialien Sie hieraus speziell bevorzugen würden, damit wir dann in weiteren Detailgesprächen die entsprechenden Mengen, Preise, Lieferzeiten, Verpackungsarten, usw. erörtern können.

Wir hören gern wieder von Ihnen und verbleiben

mit freundlichen Grüßen

CONTINENTALE ERZ-GESELLSCHAFT mbH.

Anlagen

Hausanschrift: Jan-Wellem-Platz 3, 4000 Düsseldorf 1
☎ 0211/1 30 94-0
Drahtanschrift: Contierz Düsseldorf
Tx 8 582 501
Tx 8 582 460
Tx 8 582 175
Banken: BHF-Bank, Düsseldorf Kto. Nr. 40 030 199
Westfalenbank AG. Düsseldorf Kto. Nr. 412-0353
Landeszentralbank Düsseldorf Kto. Nr. 30 008 171
Postscheckkonto: Frankfurt/Main 399-600
Erfüllungsort und Gerichtsstand Düsseldorf

Geschäftsführung Dr. Otokar Bursák · Sitz der Gesellschaft: Düsseldorf · Eingetragen im Handelsregister unter HRB 1378, Registergericht Düsseldorf

Eigenschaftsblatt

China - Bauxit, 1. Qualität

chemische Analyse, typisch:

Al_2O_3	87,40 %
SiO_2	7,03 %
TiO_2	3,62 %
Fe_2O_3	1,3 %
CaO	0,18 %
MgO	0,2 %
Na_2O	0
K_2O	0,14 %
ZrO_2	0,15 %
P_2O_5	0,25 %
GV	0,19 %

Mineralaufbau:

Korund	62,0 %
Mullit	22,0 %
Tialit	vorhanden

Keramische Eigenschaften (Korn 2 - 5 mm):

a. Dichte g/cm^3	3,67
b. Rohdichte nach Din 51 065 12 g/cm^3 (Hg-Verfahren)	3,15
c. Rohdichte g/cm^3 (über Wasseraufnahme)	3,12
Wasseraufnahme %	4,1
offene Porosität %	12,6
Gesamtporosität % (errechnet aus a + b)	14,2
Gesamtporosität % (errechnet aus a + c)	15,0

Chemische und physikalische Parameter
von basischen Massen und Sinter

Qualität Bezeichnung	MgO /%/	Fe_2O_3 /%/	Al_2O_3 /%/	CaO /%/	SiO_2 /%/	Körnung	Raumgew. nach Aus trockner
			Sintermagnesit				
GMI-C /O/	80 - 82	7 - 8	<0,5	10 - 12	1 - 3	0-4, 0-8	3,10 - 3,25
GMI-S /O/	81 - 84	5,5 - 6,5	>0,5	3 - 5	4 - 6	0-4, 0-15, 0-1, 0-6, 1-4	3,10 - 3,25
GMII /O/	72 - 76	7 - 8	<0,5	14 - 18	1 - 3	0-2, 0-6, 0-4, 0-15, 2-4	3,10 - 3,25
R-78 /O/	78 - 81	7 - 8	<0,5	10 - 12	1 - 3	0-4, 0-6	3,10 - 3,25
R-78 "S" /O/	79 - 81	7 - 8	<0,5	10 - 12	1 - 3	0-4, 0-6	3,20 - 3,30
R - 86 /O/	84 - 86	7,5-8,5	<0,5	4 - 7	1 - 3	0-4, 0-6	3 ,20 - 3,30
B-Mischung	72 - 76	7 - 8	<0,5	14 - 16	2 - 3	0 - 6	3,05 - 3,15
B-Mischung "S"	80 - 84	5,5 - 6,5	>0,5	3 - 5	4 - 6	0 - 6	3,10 - 3,25
Magnesit Mehl	81 - 84	5,5 - 6,5	>0,3	3 - 5	4 - 6	0 - 0,2	-
			Steinsintermagnesit				
Ja /1/	86,5 - 88,0	7,5 - 8,5	<0,5	2,7 - 3,5	0,6 - 1,2	0-8, 0-6, 0-8	3,15 - 3,25
Je /2/	86,5 - 88,0	7,5 - 8,5	<0,5	2,7 - 3,2	0,6 - 1,2	0-4, 0-6, 0-10	3,15 - 3,25
Je "S"	87 - 89	7,5 - 8,5	<0,5	2,4 - 3	0,6 - 1,2	0-4, 0,5-4, 0-8	3,25 - 3,35
Lu	86,5 - 87,5	7,5 - 8,5	<0,5	2,5 - 3,2	1,5 - 2,2	0-2, 0-4, 0-6	3,15 - 3,25
Ko	87 - 89	5,5 - 6,5	>0,5	1,8 - 2,6	3 - 4	0-4, 0-6, 0-15	3,15 - 3,25
Ko - AKU	85 - 87	5,5 - 6,5	>0,5	2,5 - 3,0	4 - 5,5	0-4, 0-1 0-6, 1-4	3,20 - 3,30
Magnesit Mehl	86,5-88,0	7,5 - 8,5	<0,5	2,7 - 3,5	0,6 - 1,2	0 -0,2; >0,09mm max. 1%	-

Bemerkung: /o/ Grundqualität geölt
Die oben genannten Werte betrachten Sie als Orientierungswerte, gelten nicht als garantiert.

1/ Körnung
2/ Bindung
3/ Kaltdruckfestigkeit
   a/ nach Austrocknung bei 110°C
   b/ nach Ausbrennung bei 1750°C
4/ max. Anwendungstemperatur
5/ Raumgewicht nach Austrocknung

J = Jelšava
LU = Lubeník
Ko = Košice

UNIVERSAL ABRASIVES LIMITED

COMPANY PRODUCT PROFILE

TECHNICAL ADVISORY SERVICE

A team of experienced Technical Sales Representatives is readily available to inform, advise and assist customers in deriving the maximum benefit from the use of electro-fused abrasive grain.

Universal Abrasives welcomes the opportunity to collaborate with customers in projects of mutual concern and a team of qualified technologists can be called upon to provide an unrivalled service.

For further information contact:

UNIVERSAL ABRASIVES LIMITED

Stafford ST16 1EA
England
Telephone: Stafford (0785) 3281
Telex: 36198 UNIBRA G

A Unicorn Industries Company

Printed in England

Ref. No: UAL/1M/9.80.

COMPANY PROFILE

Universal Abrasives Limited is a member of the Electro-Minerals & Media Group of Unicorn Industries – one of the leading organisations in the world for Abrasives Technology.

The principal activities of the Company are concerned with the manufacture of electro-fused materials which are used for many and varied applications throughout industry, including grinding wheels, coated abrasives, refractories, blasting and polishing media.

Historically, the Abrasives Industry depended largely on the use of natural abrasives such as Emery, Garnet and Corundum, but such materials imposed limitations. Through the application of advanced Fusion Technology, electro-fused materials were introduced with consistent chemical and physical properties resulting in the introduction of products with improved performance characteristics.

Universal Abrasives is now established as a leading supplier of synthetic abrasive materials having effectively contributed to major advances in Abrasives Technology. A progressive Research and Development policy ensures the Company maintains this reputation and meets future demands for high performance materials. New products are continually introduced to satisfy increasing customer requirements and new developments are actively sought to broaden the range of applications.

PRODUCTION CAPABILITIES

The principal products manufactured by Universal Abrasives are white and brown fused aluminas. Additionally, the Company manufactures fused magnesia for electrical applications, and fused zirconia which is primarily used in the production of speciality refractories.

All products share a common feature in their manufacturing cycle, namely the production of high purity, synthetic raw materials using Electro-fusion Technology. The technical expertise acquired from years of practical operating experience is embodied in the design of efficient manufacturing units which employ modern processing techniques.

WHITE FUSED ALUMINA

White fused alumina is manufactured from calcined alumina, a material of high chemical purity produced by the Bayer process. Calcined alumina is purchased to a stringent specification, regular quality control checks of incoming raw material being an important feature.

White fused alumina is produced in a Higgins furnace, which consists of a water-cooled cylindrical steel shell covering a carbon hearth, together with three carbon electrodes. Calcined alumina is charged into the furnace, tamped and fused by an electric arc. Periodically, more calcined alumina is added to the furnace to compensate for the volume loss on fusion. An overall cycle time of 19 hours is necessary to produce a 10-tonne ingot, with temperatures reaching 2100-2200°C.

The finished ingot is allowed to cool within the furnace until it is solidified sufficiently for easy removal from the shell. Subsequently, the ingot is removed and air cooled under controlled conditions. Rough crushing is first carried out, followed by a critical visual inspection to remove unwanted beta-alumina and any partially fused material. The desired alpha-alumina, characterised by "blocky" crystals which render excellent abrasive properties, is then reduced by processing through a series of jaw crushers followed by crushing in hammer mills. (Certain products, demanded in specific applications, are alternatively processed in roll crushers and magnetically treated to remove impurities).

Following crushing and grinding, the fused alumina is leached by boiling with sulphuric acid to remove impurities such as alkalis and iron. The material is then dried and graded into standard sizes corresponding to FEPA or other specifications, or special customer requirements. Micro sizings are obtained by a wet sedimentation process (elutriation) followed by drying, whereas macro sizes are obtained by dry sieving.

BROWN FUSED ALUMINA

Brown fused alumina is produced by the electro-fusion of abrasive grade bauxite using similar technology for the manufacture of white fused alumina.

The crude brown fused alumina is produced by an associate company – Electro-Furnace Products Limited, Hull, which is jointly owned by the Norton Company and Unicorn Industries Limited – and is delivered by rail to the Stafford site of Universal Abrasives Limited where it is further processed to the final grain product. Initially, the lumps are crushed in hammer mills and then further processed to produce graded products of the required specifications. A proportion of brown fused alumina is sold in calcined form, calcination being carried out in a fluidised bed furnace at 1050-1100°C. This process improves the toughness of the material for certain abrasive applications.

FUSED MAGNESIA

Electrical grade fused magnesia is manufactured under a technical licensing agreement from the Norton Company, U.S.A., and sold throughout the world.

The raw material consists chiefly of pure, low sulphur, caustic-calcined magnesia from Greece and Turkey. Strict control of the charge material is exercised to ensure that the ultimate chemical composition of the fused product consistently complies with the desired specification.

Electro-fusion is carried out in a modified Higgins furnace using a single phase system. Following cooling, the ingot is roughly crushed and visually inspected to reject partially fused material. Subsequently, the fused magnesia is further crushed and ground using standard techniques. Prior to grading, additives are introduced and the product calcined at 1050°C. Fused magnesia is sold to manufacturers of heating elements, being used for electrical insulation purposes.

FUSED ZIRCONIA

Fused zirconia is currently manufactured primarily to meet the requirements of the Refractories Industry, and expansion plans are being implemented to increase production capacity to meet growing demand.

Zirconia is processed in a similar method to fused alumina and magnesia, although special techniques have been developed to ensure final product quality.

Dependent on the specific application, crystal structure is controlled by the addition of stabilising additives, such as lime or magnesia. The plant also has the capability to produce calcium zirconate which is fused from an equimolar mixture of zirconia and lime.

Subsequent processing is achieved by crushing and grinding the ingot and grading to the desired sizes.

QUALITY CONTROL

Universal Abrasives operates a stringent system of testing and inspection to ensure that finished products consistently meet defined specifications. Quality control is rigorous and all-embracing from the acceptance testing of incoming raw materials, through process control during the manufacturing cycle, to the final inspection of finished goods prior to despatch.

As an active member of the Federation of European Producers of Abrasives (FEPA), all abrasive grain used for the manufacture of Grinding Wheels and Coated Abrasive products conform to the appropriate FEPA specifications. Abrasive grain for grinding wheel production is also produced to conform to U.S.A. specifications defined by U.S. Standard B.74.12-1976.

Abrasive grain for Refractories Applications is manufactured to British Standards (BS 412 1962), other National Standards e.g., DIN 4188, or to customers' own precise specifications. In the field of Special Applications (principally for Air and Vapour Blasting) where no National or International Standards are in existence, abrasive grain is manufactured to conform with standards generally found to be suitable to the industry.

Standard Product	Product Name	Analysis	Typical Physical Properties	Types Available	Principal Applications
White Fused Alumina	White Bauxilite	99.5% Al_2O_3	Specific Gravity : 3.94 Colour : White Hardness : 9 (Moh's Scale) 1700-2000 kg/mm² (Knoop)	PW: acid washed, blocky grain PEN: unwashed, blocky grain PREN: roll crushed, sharp grain Available in a range of macrogrits and micropowders to FEPA Standards and other specifications.	Bonded Abrasive Products Coated Abrasive Products Refractories Blasting Media Polishing Compounds Lapping Compounds
Brown Fused Alumina	Brown Bauxilite	95.2% Al_2O_3 3.1% TiO_2 1.1% SiO_2	Specific Gravity : 3.95 Colour : Brown Hardness : 9 (Moh's Scale) 1700-2000 kg/mm² (Knoop)	AS: uncalcined, blocky grain ASi: calcined at 1060°C, blocky grain Available in a range of macrogrits to FEPA Standards and other specifications.	Bonded Abrasive Products Coated Abrasive Products Refractories Blasting Media
	UNI-SS Abrasive	95.2% Al_2O_3 3.1% TiO_2 1.1% SiO_2	Specific Gravity :3.95 Colour : Brown Hardness : 9 (Moh's Scale) 1700-2000 kg/mm² (Knoop)	Brown fused alumina abrasive having a low metallic iron content. Available in 8 standard sizes, controlled to precise grading specifications.	Air and Vapour Blasting Media
Reclaimed Materials	Uniblast	90% Al_2O_3	Properties available upon request	Available in standard sizes, controlled to precise grading specifications.	Air and Vapour Blasting Media
	Speedblast	85% Al_2O_3 approx.			
Fused Magnesia	Magnorite 70	93.4% MgO 3.7% SiO_2 1.3% CaO 1.3% ZrO_2	Tap Density : 2.395 g/cm³ Flow Time : 192 seconds (ASTM Apparatus) Magnetic Iron : 0.004% Resistivity : 89 Megaohm. cm. (at 980 C)	First quality electrical grade.	Electrical insulation of heating elements
Fused Zirconia	Pure Fused Zirconia	99.5% ZrO_2+HfO_2	Melting Point : 2700 C Mean Specific Gravity: 5.78 Phase Analysis : 100% Monoclinic	Available in a standard range of aggregate sizes. Other gradings can be supplied to meet individual requirements of customers. In addition special formulations can be produced for development purposes.	Refractories Electronics
	Lime Stabilised Zirconia	94.6% ZrO_2+HfO_2 4.2% CaO	Melting Point : > 2500 C Mean Specific Gravity: 5.55 Phase Analysis : 75% Cubic 25% Monoclinic		
	Magnesia Stabilised Zirconia	96.1% ZrO_2+HfO_2 3.0% MgO	Melting Point : 2700 C Mean Specific Gravity: 5.65 Phase Analysis : 60% Cubic 40% Monoclinic		
	Calcium Zirconate	69.8% ZrO_2+HfO_2 29.3% CaO	Melting Point : 2300°C Mean Specific Gravity: 4.65	2 standard grades : – 100 mesh Micronised	
Refractory Bonds	Uni Albond P.12	62.0% Al_2O_3	Loss on Ignition : 38% Packing Density : 1.0g/cm³ approx.	High purity alumina refractory bond available in dry powder form.	Refractories
	Uni Mulbond P.13	50.8% Al_2O_3 14.5% SiO_2	Loss on Ignition : 34.5% Packing Density : 1.0g/cm³ approx.	High purity mullite refractory bond available in dry powder form.	
Silicon Carbide	Unirundum GC	99.5% SiC (Green & Light Green)	Imported stocks of green and black silicon carbide are held in standard FEPA sizes, both macrogrits and micropowders.		Bonded Abrasive Products Coated Abrasive Products Lapping Compounds
	Unirundum BC	98.7% SiC (Black)			
Bubble Alumina	Bubble Alumina	> 99.0% Al_2O_3	Used for high temperature refractory insulation purposes. Available in a range of standard sizes.		Refractories

Detailed technical information for all individual products is available on request.
N.B. The technical data are quoted from averages of Quality Control results and are fully representative.
However, due to the fact that natural raw materials are used, no guarantee can be given and no warranty is implied.

UNIVERSAL ABRASIVES LTD.

Ernst Schlüßler
Postfach 1208
D 5473 Kruft (W. - Germany)
Tel. : Mendig (02652) 74 36

Juni 1983

R I C H T A N A L Y S E

E L E K T R O - S P I N E L L

Chemische Analyse:

SiO_2	ca	0,11 %
TiO_2	unter	0,01 %
Al_2O_3	ca	68,80 %
Fe_2O_3	ca.	0,06 %
CaO	ca	0,25 %
MgO	ca	30,10 %
K_2O	unter	0,01 %
Na_2O	ca	0,22 %
Dichte	ca	3,57
Korn-Raumgewicht	ca	3,48 *)

Die genannten Werte sind Durchschnittswerte, keine Garantiewerte.

*) ermittelt an $K_o$rn - 3/16 + 10 (= ca 4,76 - 1,67 mm) nach PRE 1977.

UNIVERSAL ABRASIVES LIMITED

STAFFORD, ENGLAND. ST16 1EA

UNI

Telephone: Stafford (0785) 3281
Telex: 36198 UNI BRA G
Telegrams: Uni, Stafford

Registered in England No. 299220
Registered Office: 285 Long Acre,
Nechells, Birmingham B7 5JR.

YOUR REF. OUR REF.

Ernst Schlibitz
Postfach 1208
D 5473 Kruft (W. - Germany)
Tel. : Mendig (02652) 74 36

REFRACTORY GRADE FUSED MAGNESIA

APPLICATION

Universal Abrasives Ltd high density refractory grade fused magnesia has been specifically designed for incorporation in magnesite-carbon products. The principal uses of such products are in severe and high wear applications in steelmaking furnaces, such as electric arc sidewalls or tuyere bricks in LD converters.

TYPICAL CHEMICAL ANALYSIS (%)

Silica	SiO_2	0.48
Titania	TiO_2	< 0.01
Alumina	Al_2O_3	0.10
Iron Oxide	Fe_2O_3	0.12
Lime	CaO	2.45
Magnesia	MgO	96.80
Potash	K_2O	< 0.01
Soda	Na_2O	< 0.10
Loss on Ignition		0.08
Lime: Silica Ratio		5.1

PHYSICAL DATA

Grain Bulk Density (30th PRE recommendation, 1977)	3.50
Specific Gravity	3.58
True Porosity (%)	2.2

The material is normally supplied as 5 mm ROM, but other gradings may be available.

All technical information is typical but does not imply any warranty.

UNIVERSAL ABRASIVES
Technical Data

LIME STABILISED ZIRCONIA

Application

4.2% Lime Stabilised Zirconia is ideally suited for applications where thermal shock resistance is a prime consideration, such as nozzles, crucibles, sliding gate refractories, liners and other hot metal contact wear, laboratory ware and kiln furniture.

Description

This is partially stabilised product with approximately 75% of cubic phase and 25% of monoclinic phase uniformly distributed throughout the fused product. This uniform distribution of the two phases imparts to the product low and controlled thermal expansion characteristics which enable dense refractories with good thermal shock resistance to be produced.

Typical Chemical Analysis for −30 grading

$ZrO_2 + HfO_2$	94.60%	Al_2O_3	0.41%
SiO_2	0.40%	Fe_2O_3	0.08%
CaO	4.20%	TiO_2	0.20%
MgO	0.05%		

Due to the migration of the CaO during the production process, the level will vary from about 3.5% for size −12+30 to 4.5% for size −300.

Physical Data

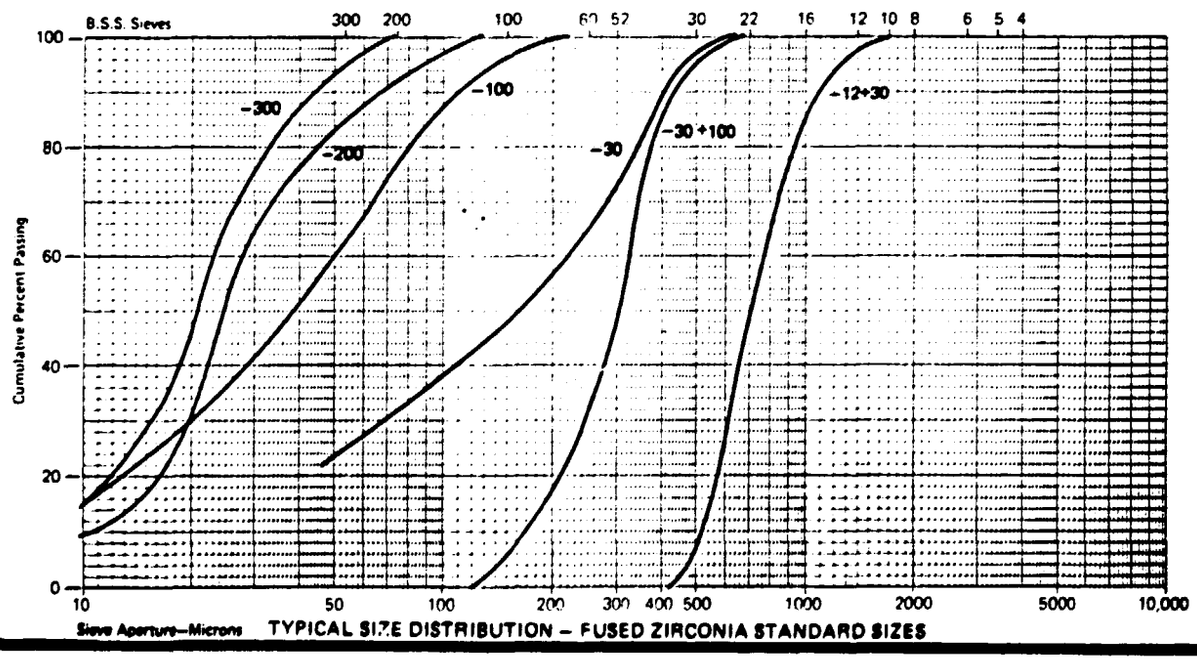
Melting Point	2,500°C
Mean Specific Gravity	5.55 g/cm³
Phase Analysis	75% cubic phase 25% monoclinic phase

Availability

These are available in a standard range of aggregate sizes:

BSS Sieves	−12+ 30	− 30	−200
	−30+100	−100	−300

Apart from the standard range of product types and sizes UNIVERSAL ABRASIVES LIMITED have the manufacturing and technical capability for the production of non-standard Zirconia products to meet individual customer requirements.



TYPICAL SIZE DISTRIBUTION – FUSED ZIRCONIA STANDARD SIZES

UNIVERSAL ABRASIVES
Technical Data

CALCIUM ZIRCONATE

Application

The principle uses for Calcium Zirconate are as a ceramic dielectric for micro circuit substrates, in glass contact wear, in high temperature furnace structures and as a bonding material for other refractory systems.

Description

Fused Calcium Zirconate is manufactured in an electric arc furnace by melting equimolar quantities of Lime and Zirconia.
It is a highly refractory material with a melting point of 2,300°C.

Typical Chemical Analysis	$ZrO_2 + HfO_2$	69.81%	Fe_2O_3	0.06%
	SiO_2	0.35%	TiO_2	0.12%
	CaO	29.30%	Al_2O_3	0.06%
	MgO	0.06%		

Physical Data

Melting Point	2,300°C
Mean Specific Gravity	4.65 g/cm³

Availability

1. −100
2. Micronised: Mean size 3 – 6 microns (100% 20 microns)

UNIVERSAL ABRASIVES
Technical Data

WHITE FUSED ALUMINA

Application Refractories — Monolithics and Fired Shapes.

Description White Fused Alumina is manufactured in an electric arc furnace by the fusion of a controlled quality pure grade of calcined alumina.

Typical Chemical Analysis

Al_2O_3	99.5%
SiO_2	0.03%
Fe_2O_3	0.05%
TiO_2	Trace
CaO	0.04%
Na_2O	0.32%
K_2O	0.01%

Physical Data

Colour	White			
Specific Gravity	3.94			
Bulk Specific Gravity	3.86 (Size 1-3mm)			
True Porosity	3.3%			
Melting Point	2050°C			
Typical Surface Area (Rigden's method)	(Grade)	−100	−200	−300
	(cm^2/g)	6236	10160	13070
Coefficient of Expansion	6×10^{-6} per °C (20-100°C)			
	8.5×10^{-6} per °C (20-1000°C)			
Hardness	1800-2300 K_{100}			
	9 Moh's Scale			
Electrical Resistivity	3×10^{13} ohms/cm^3 at 300°C.			

Availability

Standard Metric Sizes (DIN 4188)

Grade			Cumulative Percentages				
			1	2	3	4	5
			8 − 5mm	5 − 3mm	3 − 1mm	1mm − Dust	0.5mm − Dust
Sieves							
A.S.T.M.	B.S.S.	mm					
⅜	—	9.53	5 Max				
¼	—	6.35	20 Min				
4	3½	4.76	75 Min	10 Max			
5	4	4.00		20 Min			
7	6	2.80			10 Max		
10	8	2.00		90 Min	20 Min		
18	16	1.00			90 Min	10 Max	
35	30	0.50				20 Min	10 Max
60	60	0.25					20 Min
200	200	0.075				98 Max	
270	300	0.053					98 Max

Separate Data Sheet available for Standard British Sizes.

UNIVERSAL ABRASIVES
Technical Data

FUSED ZIRCONIA

Description – Zirconia ZrO_2

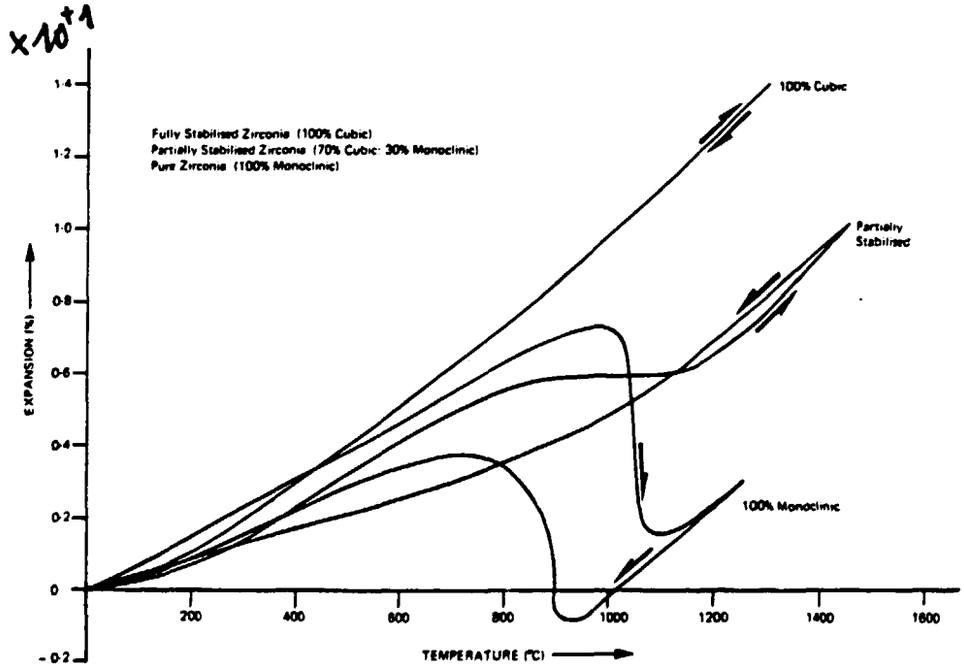
Pure Zirconia ZrO_2, has a melting point of 2,700°C and offers great potential as a refractory material. As well as being an extremely high temperature metal oxide, it is inert chemically, resisting most chemical reactions and is generally stable in both oxidising and reducing conditions.

The potential of Pure Zirconia as a refractory material is, however, hindered by its polymorphism i.e. two main crystal forms exist, a monoclinic form at low temperatures changing to a tetragonal form at around 1,000°C. This change in crystal structure is reversible and is accompanied by a rapid volume change of approximately 8%. This polymorphism limits the usefulness of Pure Zirconia in dense refractory bodies produced by orthodox fabrication processes.

The disruptive volume change can be avoided by the addition of controlled quantities of certain cubic oxides, Lime and Magnesia being the most commercially acceptable oxides for this purpose. When mixtures of Pure Zirconia and around 5% cubic oxide are fused in an electric arc furnace the lattice structure is altered to a cubic type.

Zirconia treated in this way is called *Fully Stabilised Zirconia,* has a uniform thermal expansion curve and offers good refractory properties.

For applications where thermal shock resistance is of paramount importance *Partially Stabilised Zirconia* manufactured by the fusion route offers exceptional properties. This material has a uniform distribution of cubic and monoclinic phases, lower thermal expansion characteristics and consequently very good thermal shock resistance.



Thermal Expansion of Zirconias

UNIVERSAL ABRASIVES
Technical Data

MAGNESIA STABILISED ZIRCONIA

Application

The principle use of Magnesia Stabilised Zirconia in dense refractory structures is applicable where lime cannot be tolerated, such as crucibles used for melting special alloys.

Description

Magnesia Stabilised Zirconia is manufactured in an electric arc furnace from controlled purity raw materials. The Magnesia content at 3% by weight imparts to this product a partially stabilised structure in which both Cubic and Monoclinic phases are present in a uniform distribution. Magnesia Stabilised Zirconia has the tendency to lose it stability when heated above 1,300°C, the cubic phase reverting back to the monoclinic phase.

Typical Chemical Analysis

$ZrO_2 + HfO_2$	96.10%	Al_2O_3	0.10%
SiO_2	0.40%	Fe_2O_3	0.10%
CaO	0.10%	TiO_2	0.20%
MgO	3.00%		

Due to the migration of MgO during the production process, the level in the finer product sizes may rise to about 3.7%.

Physical Data

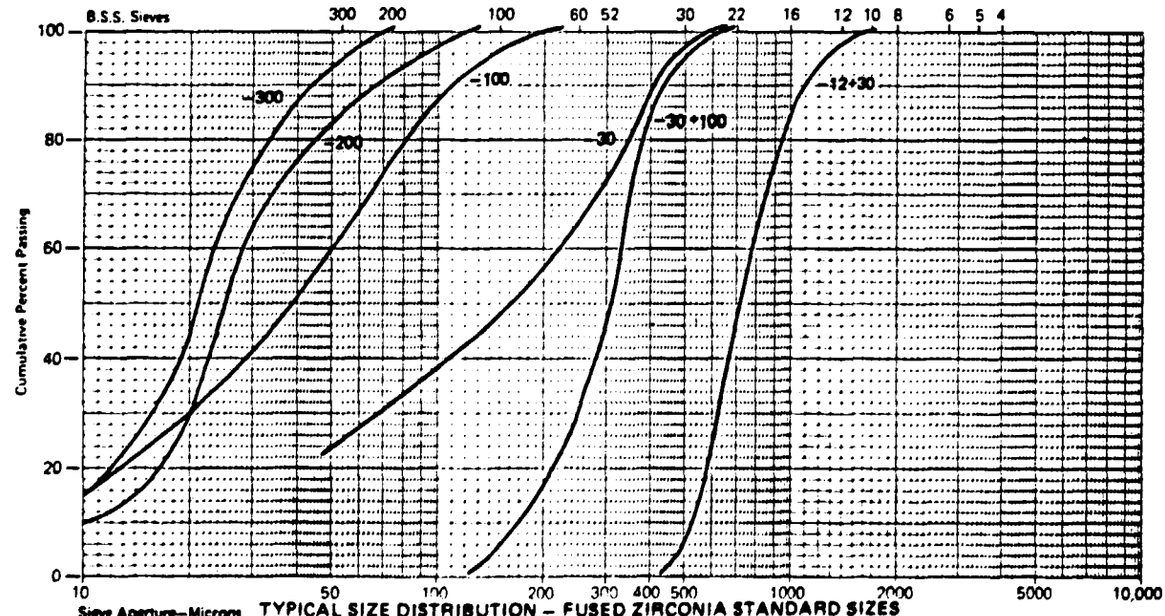
Melting Point	Approximately 2,700°C
Mean Specific Gravity	5.65 g/cm³
Phase Analysis	60% cubic 40% monoclinic

Availability

These are available in a standard range of aggregate sizes:

BSS Sieves	−12+ 30	− 30	−200
	−30+100	−100	−300

Apart from the standard range of product types and sizes UNIVERSAL ABRASIVES LIMITED have the manufacturing and technical capability for the production of non-standard Zirconia products to meet individual customer requirements.



TYPICAL SIZE DISTRIBUTION – FUSED ZIRCONIA STANDARD SIZES

UNIVERSAL ABRASIVES
Technical Data

PURE FUSED ZIRCONIA

Application

The principle uses for Pure Fused Zirconia are in refractories where thermal shock is not a consideration, as a bonding material for refractory shapes, as loose fill high temperature insulation, in foundry mould facings and washes, in piezo-electric ceramics, in titanate ceramics and as parting media.

Description

Pure Fused Zirconia is manufactured in an electric arc furnace from the highest purity raw materials. It has a monoclinic structure and undergoes a reversible transformation to the high temperature tetragonal form at about 1,000°C. This change in crystal structure is accompanied by a severe volume change of approximately 8%.

Typical Chemical Analysis

$ZrO_2 + HfO_2$	99.5 %	MgO	0.05%
SiO_2	0.18%	Fe_2O_3	0.10%
CaO	0.01%	TiO_2	0.15%

Physical Data

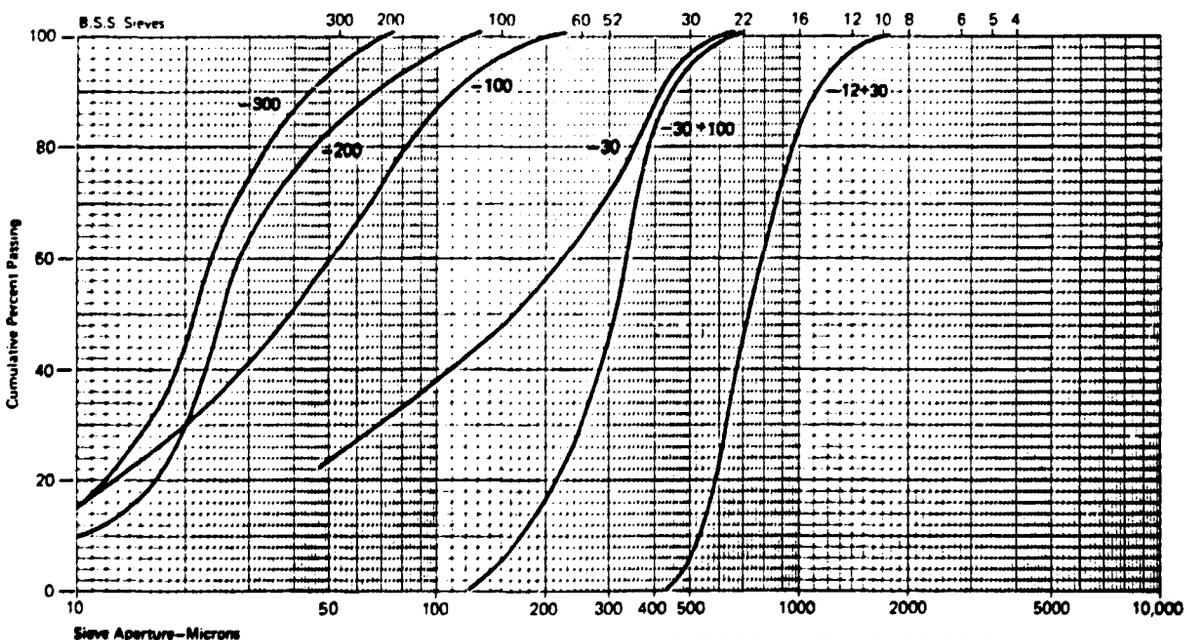
Melting Point	2,700°C
Mean Specific Gravity	5.78 g/cm³
Phase Analysis	100% monoclinic

Availability

These are available in a standard range of aggregate sizes:

BSS Sieves	−12+ 30	− 30	−200
	−30+100	−100	−300

Apart from the standard range of product types and sizes UNIVERSAL ABRASIVES LIMITED have the manufacturing and technical capability for the production of non-standard Zirconia products to meet individual customer requirements.



TYPICAL SIZE DISTRIBUTION — FUSED ZIRCONIA STANDARD SIZES

UNIVERSAL ABRASIVES

Refractory Grain

Increasing demands imposed by modern technology have created a need for reliable high grade refractories. The chemical and physical inconsistencies of many natural materials have led to the development of electrically fused materials which are manufactured under controlled conditions.

Universal Abrasives produce white fused alumina, brown fused alumina, fused zirconia (both stabilised and monoclinic), fused spinel and fused magnesia as standard products, and are able to investigate the production of other materials as the need develops.

The company has many years of experience in the production of electro fused materials, and through the years has gained considerable knowledge in controlling to close limits chemical purity, grain shape and size.

We have used this experience to design and construct manufacturing units which enable us to employ the most modern techniques. We are able to offer to the refractories industry a comprehensive range of size gradings to enable the manufacturer to meet the many and varied requirements of his customers.

For further information contact:

UNIVERSAL ABRASIVES LIMITED

Stafford ST16 1EA, England.
Telephone: Stafford 0785 3281.
Telex: 36198 UNIBRAG.

Dr.-Ing.
BIEHLER

DELIVERER OF REFRACTORY RAW MATERIALS

MAGNESITE

-	Austrian-American Magnesite AG	Austria P.O.Box A-9545 Radenthein Phone: 04246 21000
	(Austria Magnesite)	
-	Veitsche Magnesitewerke AG	Austia Schubertring 10-12 A-1011 Wien Phone: 0222 523611
	(Austria Magnesite)	
-	Didierwerke AG	Germany Lessingstr. 16-18 D-6200 Wiesbaden Phone: 06121 3591
	(Spain magnesite Seewater Magnesite)	
-	Continentale Erz-Gesellschaft	Germany Jan Wellemplatz 3 D-4000 Düsseldorf 1
	(CSSR Magnesite)	
-	C E Minerals	U S A 901 East 8th Avenue King of Prussia PA 19406

Dr.-Ing.
BIEHLER

DELIVERER OF REFRACTORY RAW MATERIALS

SiC /CORUDUM

-	Elektroschmelzwerk Kempten GmbH (SiC, Corundum)	Germany Herzog Wilhelmstr. 16 D-8000 München 33 Phone: 089 51201
-	Lonza Ltd Inorganic Chemical Division (SiC, Corundum)	Switzerland Münchensteiner Str. 38 CH-4002 Bale Phone: 061 508850
-	Mineralien Mahl-Schmirgelwerk (Corundum)	Germany P.O.Box 1169 D-7554 Kuppenheim Phone: 07222 4025
-	Universal Abrasiv ltd (Corundum)	Great Britain P.O.Box Staffort St 161/EA

Dr.-Ing.
BIEHLER

DELIVERER OF REFRACTORY RAW MATERIALS

TABULAR ALUMINA

-	Alcoa Chemie	Netherlands
		Rotterdam
	Selling office	Germany
		P.O.Box
		D-6700 Ludwigshafen
-	Vereinigte	Germany
	Aluminium Werke	P.O.Box 2448
		Gerichtsweg 1
		D-5300 Bonn
		Phone: 0228 552334
-	Kaiser Aluminium	International Group
	& Chemical	P.O,Box
		Oakland / Calif.

Dr.-Ing.
BIEHLER

DELIVERER OF REFRACTORY RAW MATERIALS

BAUXITE / MULCOA

- Continentale Erz-Gesellschaft (China Bauxite)
  Germany
  Jan Wellemplatz 3
  D-4000 Düsseldorf 1
  Phone: 0211 130940

- Phillip Brothers Salomon (Guinea Bauxite)
  U S A
  New York

- C E Minerals
  U S A
  901 East 8th Avenue
  King of Prussia
  PA 19406

SPECIAL PRODUCTS

- Universal Abrasiv Ltd (All sorts of products for Refractories)
  Great britain
  P.O.Box
  Staffort St 161 EA

A N N E X 2

Production of Refractories 1983

- Production devided into products
- High Alumina
- Medium Alumina
- Low Alumina
- Magnesite
- Magnesite Chrome
- Zirkon

Annex 2

Production of Lanka Refractories 1983

Hight Alumina Bricks and Fire Clay			Medium Alumina Bricks		
M.T	Price p.T	Sales Value	M.T	Price p.T	Sales Value
290.79	7,500	2,180,925	50.23	6,500	326,495
5.00	7,956	39,780	19.15	6,483	124,144
11.81	14,082	166,304	1.65	11,176	18,441
1.7	8,912	15,151	23.40	7,916	185,224
0.03	12,133	364	14.08	22,157	311,963
3.62	11,065	40,056	* 2.24	9,449	21,166
0.07	16,257	1,138	1.62	7,332	11,878
*40.44	13,100	529,764	146.40	9,078	1,228,948
			1.50	6,318	9,477
			0.08	21,663	1,733
			24.48	9,693	237,273
			23.02	6,798	156,499
			1.28	6,385	8,172
			4.20	5,786	24,300
			6.90	10,117	69,805
			4.50	10,202	45,910
			0.33	10,521	3,472
			9.37	6,518	61,075
			* 48.50	6,800	329,800
			* 22.70	10,781	245,115
			0.06	57,533	3,452
353.46	6,109	2,973,482	405.69	8,463	3,524,342
27 %	---	25 %	32 %	---	29 %

Medium Alumina Fire Clay			Low Alumina		
M.T	Price p.T	Sales Value	M.T	Price p.T	Sales Value
24.00	4,368	104,832	2.47	15,601	38,535
2.00	4,285	8,570	48.52	5,897	286,133
2.00	4,178	8,355	* 1.85	16,508	30,540
72.55	4,380	317,754	0.60	3,992	2,395
0.20	4,120	824			
0.25	9,932	2,483			
5.00	4,200	21,000			
0.40	4,120	1,648			
0.30	4,283	1,285			
* 0,26	4,200	1,092			
106.96	4,374	467,843	53.44	6.692	357,603
8 %	---	4 %	4 %	---	3 %

Annex 2

Production of Lanka Refractories 1983

Low Alumina Insulation			Magnesite		
M.T	Price p.T	Sales Value	M.T	Price p.T	
1.70	9,449	16,064	1.5	24,687	
16.00	5,070	81,113			
1.29	10,081	13,004			
2.55	6,294	16,050			
0.34	12,274	4,173			
21.88	5,960	130,404	1.5	24.687	
2 %	---	1 %	0 %	---	

	Magnesite misse			Magnesite Chrome Bricks		
Sales Value	M.T	Price p.T	Sales Value	M.T	Price p.T	Sales Value
37,030	138.00	4,929	680,158	*155.38 45.00	17,924 23,786	2,785,002 1,070,380
37,030	138.00	4,929	680,158	200.38	23,781	3.855,382
0 %	11 %	---	6 %	16 %	---	32 %

Annex 2

Production of Lanka Refractories 1983

Zirkon						
M.T	Price p.T	Sales Value	M.T	Price p.T	Sales Value	M.T
0.02	161,987	3,240				
* 0.12	24,725	2,967				
0.14	44,336	6,207	1'281.45	---	12'032'451	
0 %	---	0 %	100 %		100 %	

	Price p.T	Sales Value	M.T	Price p.T	Sales Value

Dr.-Ing.
BIEHLER

A N N E X 3

Production of Refractories 1983

- List of the costumers 1983
- Production
- Sales value

Annex 3

CUSTOMERS OF LANKA REFRACTORIES 1983

CUSTOMER	VARIATY OF PRODUCTION	WEIGHT M.T.	SALES VALUE S.L.Rs
Ceylon Cement Corporation	1) Medium Alumina bricks	50.23	
	2) High Alumina bricks	290.79	5,292,422.37
	3) Magnesite Chrome bricks	155.38	
Ceylon Plywoods Corporation	1) Medium alumina bricks	19.15	124,144.00
Ceylon Tyre Corporation	1) Medium alumina bricks	1.65	18,440.80
Ceylon Government Railway	1) Medium alumina bricks	23.40	185,224.00
	2) Medium alumina fire clay	24.00	104,832.00
	3) High alumina fire clay	5.00	39,780.00
Ceylon Sugar Corporation	1) Medium alumina fire clay	2.00	8,569.60
	2) Medium alumina bricks	14.08	311,962.72
State Hardware Corporation	1) Medium alumina fire clay	2.00	8,355.40
	2) Medium alumina bricks	2.24	
	3) Low alumina	1.7	37,229.92
HAYCARD LIMITED	1) Medium alumina bricks	1.62	11,877.80
	2) Medium alumina fire clay	0.25	2,483.00
	3) High alumina bricks	3.07	
	4) High alumina fire clay	0.55	40,055.81

CUSTOMER	VARIATY OF PRODUCTION	WEIGHT M.T.	SALES VALUE S.L.Rs
Ceylon Steel Corporation	1) Magnesite chrome	45.00	1,070,380.00
	2) Magnesite	1.50	37,030.00
	3) Magnesite misse	138.00	680,157.60
	4) Medium alumina bricks	146.40	1,328,947.95
	5) Insulation	16.00	81,112.60
	6) Medium alumina fire clay	72.55	317,753.50
	7) High alumina bricks and fire clay	11.81	166,304.18
			3,681,685.83
Ceylon Ceramics Corporation	1) High alumina	40.44	
	2) Medium alumina	48.50	
	3) Medium alumina materials	22.70	1,135,218.85
	4) Low alumina	1.85	
Ceylon Silks Limited	1) High alumina fire clay	1.70	15,150.80
Associated Marine Services	1) Medium alumina bricks	1.50	9,477.00
Ceylon Match Company	1) Medium alumina bricks	0.08	1,732.60
Engineering Component Ltd	1) Medium alumina fire clay	0.20	824.00
	2) Insulation	1.29	13,003.50
Swastik Textile	1) Medium alumina bricks	0.06	3,451.50
	2) Low alumina fire clay	0.60	2,395.00
	3) High alumina fire clay	0.03	363.60

CUSTOMER	VARIATY OF PRODUCTION	WEIGHT M.T.	SALES VALUE S.L.Rs
Lanka Walltiles Limited	1) Medium alumina bricks	24.48	237,273.18
	2) Medium alumina fire clay	5.00	21,000.00
Lanka Porcelain Limited	1) Medium alumina bricks	23.02	156,499.20
Xsvy Glass & Motor Company	1) Medium alumina fire clay	0.4	1,648.00
	2) Low alumina bricks	2.47	38,535.00
	3) Medium alumina bricks	1.28	8,172.40
	4) High alumina bricks	0.07	1,138.00
	5) Medium alumina	4.20	24,300.00
	6) Insulation	2.55	16,050.00
Colombo Commercial Company	1) Medium alumina fire clay	0.30	1,285.44
	2) Medium alumina bricks	6.90	69.804.80
Lanka Cement Limited	1) Medium alumina bricks	4.50	45,910.30
Link Natural Products	1) Medium alumina bricks and fire clay	0.33	3,471.80
Allied Industries	1) Zircon	0.12	
	2) Medium alumina bricks and fire clay	0.26	4,059.00

Dr.-Ing.
BIEHLER

CUSTOMER	VARIATY OF PRODUCTION	WEIGHT M.T.	SALES VALUE S.L.Rs
Other Companies	1) Zircon	0.02	3,239.75
	2) Low alumina bricks and fire clay	48.52	286,132.77
	3) Medium alumina bricks and fire clay	9.37	61,075.44
	4) Insulation	0.34	4,172.76
	total	1,281.45	12,032,448.00

A N N E X 4

Proposals for Laboratory Tests

- Raw Materials
- Body Tests during Processing
- Fired Items

Dr.-Ing.
BIEHLER

CONTROL PROGRAM LANKA REFRACTORIES

RAW MATERIAL TESTS

Chemical Analysis

- SiO_2 : .....
- AL_2O_3 : .....
- ZrO_2 : .....
- Fe_2O_3 : .....
- TiO_2 : .....
- CaO : .....
- MgO : .....
- Na_2O : .....
- K_2O : .....
- LOI (Loss of ignition) : .....
- Crystal water : .....
- Moisture content : .....
  (others if necessary)

Mineralogical Components

Very different depending on raw material

Physical Tests

- Seger cone : .....
- Shrinkage : .....
- After drying % : .....
- After firing % : .....
- Sieve analysis : .....
- Specific weight : .....
- D.T.A.(Differential Thermo Analysis) : .....
- T.G.A.(Thermo Graphimetric Analysis) : .....
- L.D. (Different Expansion) : .....

Name : Date :

Dr.-Ing.
BIEHLER

CONTROL PROGRAM LANKA REFRACTORIES

BODY TESTS DURING PROCESSING

Material : .....

Chemical Analysis (normally not done) : .....

Mineral Components (normally not done) : .....

Physical Tests

- Sieve analysis : .....
- Moisture content before entering the kiln : .....
- Weight after pressing : .....
- Measurement of the shapes (shrinkage or expansion) : .....
- Control of the texture : .....
- Control of the layers : .....
- Control of the surface : .....
- Control of the press : .....

Production Tests

- Pressure of the press : .....
- Speed of the press : .....
- Drying time : .....
- Burning temperature : .....
- Seger cone : .....

Name : Date :

Dr.-Ing.
BIEHLER

CONTROL PROGRAM LANKA REFRACTORIES

3. FIRED ITEMS

Chemical Analysis		Special Analysis	
- SiO_2	:	- ZrO_2	: .....
- Al_2O_3	:	- SrO_2	: .....
- Fe_2O_3	:	- Cr_2O_3	: .....
- TiO_2	:	- SiC	: .....
- CaO	:	-	: .....
- MgO	:	-	: .....
- Na_2O	:	-	: .....
- K_2O	:	-	: .....
- LOI (loss of ignition)	:		

Mineralogical Components

- Mullite : .....
- Pericles : .....
- Dolomite : .....
- Chrystobalite : .....
- Tridymite : .....
- others : .....
- ..... : .....
- ..... : .....

Physical Tests

- Buk density : .....
- Apparent porosity : .....
- Water absorption : .....
- Linear contraction : .....
- Cold crushing strength : .....
- Refractoriness under load : .....
- Expansion or shrinkage on reheating : .....
- Size control according to the order : .....
- Quality control : .....

Name : Date :

ANNEX 5

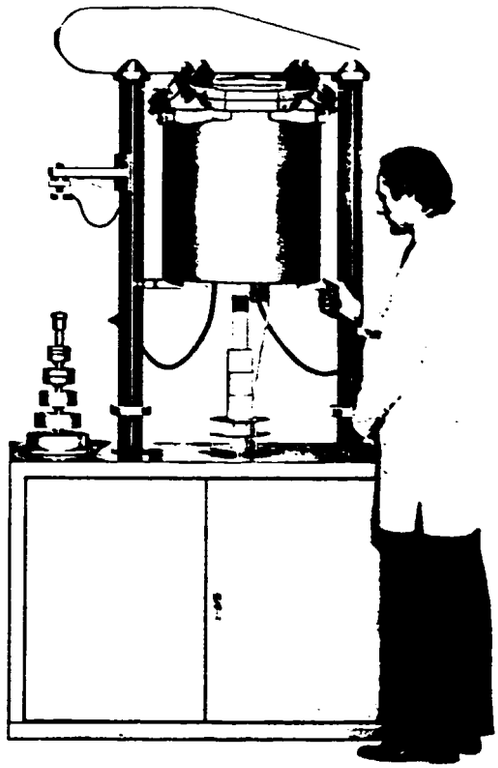
Proposal For New Machinery

HOT LOAD TESTING FURNACE 421 (RUL-CIC)

Temperature Range 25 . . . 1500°C (1700°C)
Determination of refractoriness under load (RUL) and creep in compression (CIC) of ceramic materials dependent on temperature according to DIN 51053 options e.g. for tests according to ASTM C 832-76, BS 1902 Part 1A 1966 Sect. 7, UdSSR standard GOST 4070, CSSR standard are possible if requested
Table frame with low friction load system
Difference measuring system for inside and outside measurements with LVDT, stroke ± 10 mm
Sample size 50 mm Ø, 50 mm high
Max. load 1000 N in steps of 100 cN
Recording of inner and outside sample temperature and change in length
Temperature control unit 406

Special designs

Device for alternating load to 700 N
High pressure to 100000 N (25 . . . 1500°C)



421 E/6 25 . . . 1700°C

HIGH-TEMPERATURE MOR-TESTER 422 (Modulus of Rupture)

(DBP 1648712)

Model 422 D/3

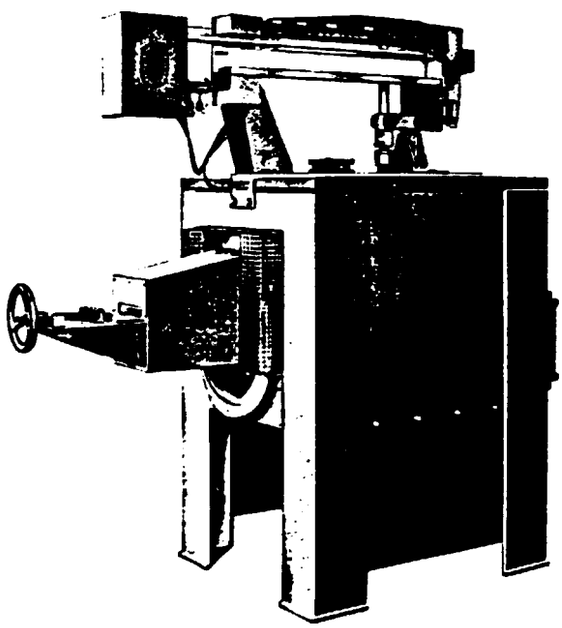
Temperature Range 25 . . . 1500°C
for the determination of the modulus of rupture at elevated temperatures according to DIN 51048
Chamber furnace with preheating zone, max. 30 samples
Dimension of samples 25 x 25 x 150 mm³
Three point bending device
Load by weighing lever in 4 measuring ranges up to 5000 N max.
Indication with linear scale
Load rates of 1.25 N/s to 125 N/s
Control device of sample position
Fully-electronic temperature controller 411
On request XY recording device
Supplement for: load and bending measurement power and bending measurement at preselected constant deformation rate

Model 422 D/4 for smaller samples

Temperature Range 25 . . . 1450°C
Hot Load Testing Furnace with transport palets for four-point bending device of silicon nitride
Sample dimensions 3.5 x 4.5 x 45 mm³
Load device like model 422 D/3

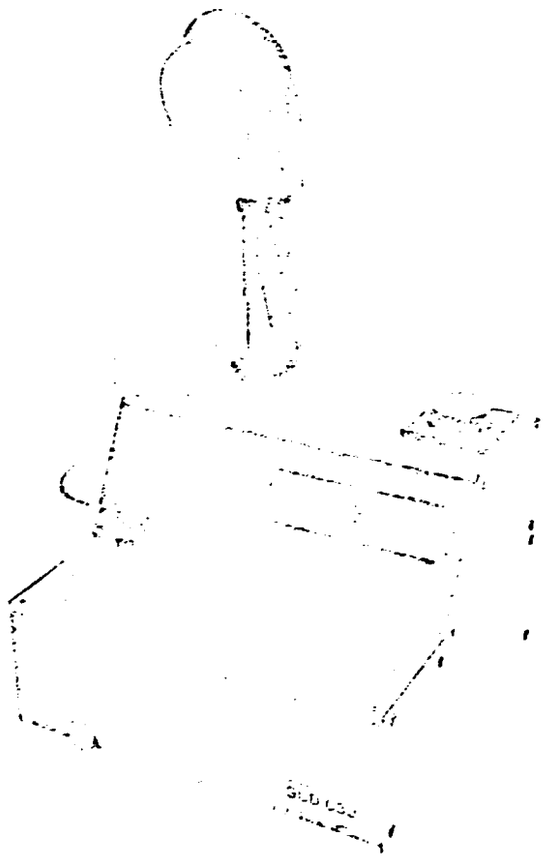
Model 422 E/4

for specially exact bending tests on one sample 3.5 x 4.5 x 45 mm³
Temperature range 25 . . . 1500°C
Split furnace
Measuring device for bending test with difference measuring system



422 D3 25 . . . 1500°C

BALZERS UNION



BALZERS UNION

Das von der BALZERS-UNION entwickelte Sputter-Gerät zeichnet sich durch folgende Merkmale besonders aus:

- Hohe Sputterrate bei geringer Probenerwärmung durch Wasserkühlung des Targets und des Objekttisches sowie durch Elektronenablenkung im neuartigen drehsymmetrischen Magnetsystem.
- Atzeinrichtung durch einfaches Umstekken an der Anlage z.B. zum Reinigen von Probenoberflächen zur Eliminierung von störenden Sauerstoffhaftungen.
- Eingebaute Blende, sodass Proben ohne Unterbrechung des Vakuums geätzt und anschliessend besputtert werden können. Zudem erlaubt diese Blende ein Vorsputtern von schwer sputterbaren Materialien (Oxydschichten) wie Nickel, Chrom, etc.
- Objekttisch stufenlos verstellbar auch während des Sputterprozesses.
- Vorwahl der Sputterzeit auf elektrischem Zeitgeber
- Vorbereiteter Anschluss für Quarz-Schichtdickenmesseinrichtung QSG 301
- Eingebautes Elektromagnetventil zur automatischen Unterbindung der Argonzufuhr nach Abschalten der Anlage.
- Automatisches Flutventil
- Schreiberausgänge der Vakuum- und Glimmstromanzeige
- Schnellwechsel-Folientargets
- Einfache und sichere Bedienung

BESTELLDATEN

BUO 07 120-T Sputter-Anlage komplett mit einem Goldtraget, ohne Vakuumpumpe

BUO 07 150 -T Zweistufige Drehschieber-Vakuumpumpe DUO 004 A, Saugvermögen 4 m³/h, Anschluss 220 V, 50 Hz

BUO 07 151 -T do. jedoch Anschluss 220 V, 60 Hz

BUO 07 155-T do. jedoch Anschluss 240 V, 50 Hz

VARIANTE:

BUO 07 156-T Zweistufige Drehschieber-Vakuumpumpe DUO 012 A, Saugvermögen 12 m³/h, Anschluss 220 V, 50 Hz

BUO 07 157-T do. jedoch Anschluss 220 V, 60 Hz

BUO 07 158-T do. jedoch Anschluss 240 V, 50 Hz

BUO 07 152-T 1,5 m Vakuum-Verbindungsschlauch

BUO 07 153-T Ölnebelfilter ONF 025

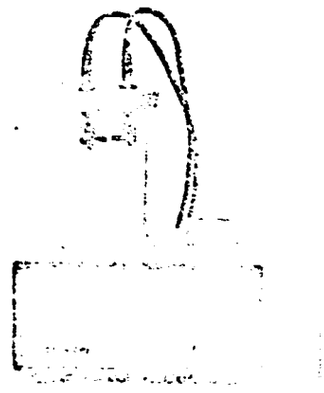
Folientargets

B8010 07 221	Goldtarget
BUO 07 222	Nickeltarget
BUO 07 223	Chromtarget
BUO 07 224	Kupfertarget
B8010 07 226	Silbertarget
B8010 07 228	Platintarget
B8010 07 229	Gold/Palladiumtarget

SPEZIFIKATION

Leistungsaufnahme	ohne Vorvakuumpumpe mit Vorvakuumpumpe DUO 004 A	170 VA 600 VA
Leistung	650 V / 150 mA	
Probenkammer	Pyrex-Zylinder ⌀ 108 x Höhe 106 mm	
Probentisch	⌀ 65 mm, wassergekühlt, höhenverstellbar ± 35 mm bei Mittelstellung	
Targets	Schnellwechsel-Folientargets ⌀ 54 mm wassergekühlt	
Aufstaubrate	max. 125 nm Gold in 1 Minute bei einem Abstand Anode / Kathode von 3 cm in Argonatmosphäre	
Probentemperatur	nicht wesentlich über 25° C an der Oberfläche bei einer Kühlwassertemperatur von 12° C	
Auspumpzeit	2 Minuten bis zur Betriebsbereitschaft bei Verwendung einer zweistufigen Drehschieberpumpe mit einem Saugvermögen von 4 m³/h	
Kühlwasser	Druck min. – max. Temperatur Durchflussmenge	1 — 4 bar 12 — 15° C 0,45 l/min
Wasseranschluss	Schlauchtülle ⌀ 8 mm	
Betriebsgas (Argon)	Druck (Überdruck) Verbrauch	1 — 15 bar 3 x 10^{-1} mbar l/sek
Gasanschluss	Schlauchtülle ⌀ 6 mm	
Vakuumanschluss	Schlauchtülle ⌀ 28 mm	
Schreiberanschlüsse	druckproportionales Signal 100 mV,	
Glimmstromm	100 mV	
Ausgänge	Steckdose für Vakuumpumpe (6,3 A), Steckdose zum Anschluss der Schichtdickenmesseinrichtung (1 A)	
Abmessungen	420 x 400 x 340 mm	
Anschlussspannung	220 — 240 V, 50/60 Hz	
Gewicht	22 kg	

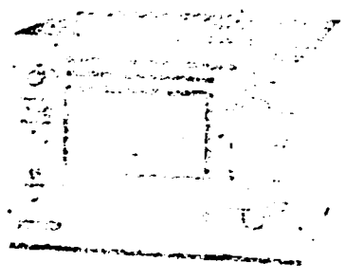
ZUSATZGERÄTE



BUO 07 160-T Kohleverdampfungs-Zusatz CEA 010

Zur Herstellung von leitenden Kohleschichten auf REM-Präparaten für die Mikrosonden-Analyse, sowie zur Herstellung von Kohleträgerfolien auf Trägernetzchen für die Transmissions-Elektronenmikroskopie; bestehend aus einem Spezialflansch mit Kohleverdampfer, Hochstromversorgung, Verbindungskabeln, Glasrezipient und einem Satz Kohlegarn.

BUO 07 161-T Ersatzkohlegarn (3,5 m)



BUO 07 055-T Quarz-Schichtdickenmesseinrichtung QSG 301,
komplett für Sputteranlage SCD 030

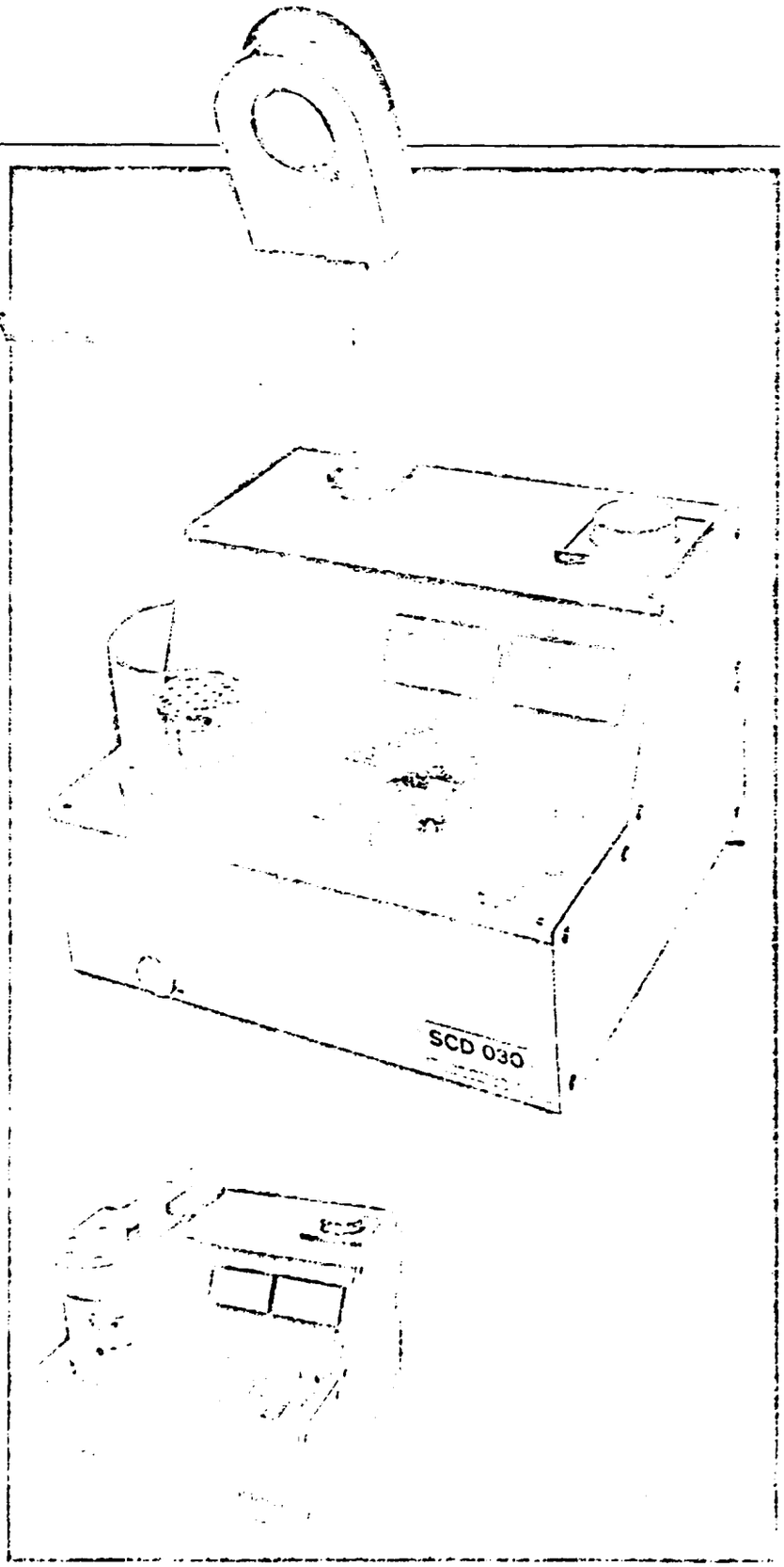
1 Messgerät QSG 301, BGS 04 250
1 Netzkabel B 4564 309 YN
1 Quarzhalter QSK 301, BGG 12 750
1 Oszillator BG 513 333-U
1 Verbindungskabel 1 m, BG 519 939-T
1 Verbindungskabel 0,5 m, BG 519 940-T
1 Verbindungskabel 0,3 m, BG 519 941-T
1 Satz à 10 Schwingquarze QS 010, BN 845 104-T

BUO 07 162-T Planetengetriebe zu Sputteranlage

Geeignet zur Aufnahme von 6 Probenteilern der REM Cambridge, Etec, Philips und Zeiss, inkl. 1 Batterie 9 V.

B8010 07 776 Ersatzbatterie 9 V

Sputtering De
SCD 030



Designed for the production of conductive films on SEM specimens, to avoid undesirable charging of the specimen surface.

The technique of manufacturing conductive films by sputtering is clearly superior to evaporation coating, particularly when the surface of the specimen is very rough. With this method a glow discharge is initiated between an anode and a cathode plate, in an air or argon atmosphere of 0.05 to 0.2 mbar. The gas ions are accelerated towards the cathode (for example, a gold target) where they knock off metal atoms. Through repeated collisions with the numerous gas molecules, present because of the high pressure, the free metal atoms are deflected in all directions. A cloud of metal atoms is formed which condenses on the cold surfaces of the immediate surroundings, and with the greatest possible homogeneity on the specimen covered anode surface. As the metal atoms reach the specimens from all directions a smooth thin metal film with sufficient conductance is formed, even on very rough surfaces. The increase of the film thickness is a function of the glow discharge current and the sputtering time, and is easily controlled.

Features:

High sputtering rate
Because the target is water cooled

The heating of the specimens by electrons is reduced
Because of a new type of electron deflection using an axially symmetric magnet system and in hight adjustable specimen table (which also can be watercooled)

The specimen surface can be cleaned to eliminate interfering oxide layers
Using the integrated etching device

Etching and sputtering both possible without breaking the vacuum
Because of the built-in shutter. It also allows oxidized and difficult-to-sputter materials such as copper, nickel and chrome to be presputtered (onto the shutter)

Reproducible film thickness
Because the sputtering time can be preset on a timer

Simple and easy to change foil targets
Because of hinged target arm with damping element, magnetic ring holder, and special foil targets

Fast venting of the chamber at the end of the process
Because of the automatic venting valve

Immediate cut-off of the argon supply at the end of the process
Because of the integrated solenoid valve

Personnel safety guaranteed
By the new safety concept which includes two vacuum relays and a forcibly activated terminal switch

Precise film thickness determination and semi-automatic operation
Using the QSG 301 quartz crystal film thickness monitor available as an accessory

The operating parameters can be recorded
Because separate outputs are provided for pressure and glow discharge display

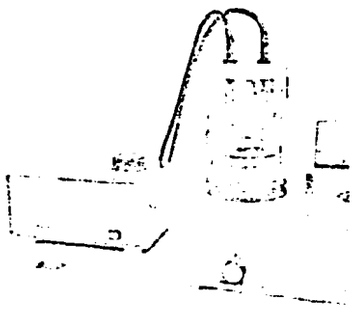
Wide variety of accessories
Allow the system to be retrofitted for special preparation techniques

Simple and easy operation
Because the controls and display instruments are clearly arranged.

Technical Data

Rating	
Without roughing pump	170 VA
With roughing pump DUO 004 A	600 VA
Voltage	650 V / 150 mA
Specimen chamber	
Pyrex cylinder ϕ 108 x height 106 mm	
Specimen table	
Water-cooled, height adjustable	± 35 mm
From the middle position	ϕ 65 mm
Targets water-cooled, quick change foil	ϕ 54 mm
Sputtering rate	max. 125 nm
For gold in 1 minute at an anode-cathode distance of 3 cm, in an argon atmosphere	
Specimen temperature	
Not significantly over 25 °C on the surface at a cooling water temperature of 12 °C	
Pumpdown time	2 minutes
Until ready for operation when rotary vane pump with using a two-stage pumping speed of 4 m^3/h	
Cooling water	
Pressure min – max.	1 - 4 bar
Temperature	12 - 15 °C
Throughput	0.45 l/min
Water connection hose nipple	ϕ 8 mm
Operating gas (argon)	
Pressure (above atmosphere)	1 - 15 bar
Consumption	3×10^{-1} mbar l/sec.
Gas connection, hose nipple	ϕ 6 mm
Vacuum connection hose nipple	ϕ 28 mm
Recorder output pressure proportional signal	100 mV
Glow discharge current	100 mV
Outputs	
Socket for vacuum pump	(6.3 A)
Socket for connection of the film thickness monitor	(1 A)
Connection voltage	220 - 240 V, 50/60 Hz
Dimensions	420 x 400 x 340 mm
Weight	22 kg

Accessories



BUO 07 160 -T Carbon evaporator accessory CEA 020

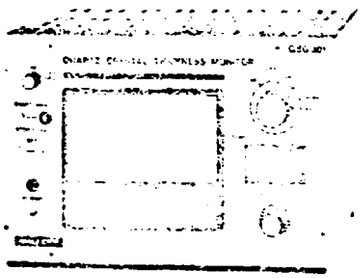
For producing conductive carbon films on SEM specimens and for micoprobe analysis, comprising a special flange with carbon evaporator, high current supply, connection cables, glass chamber and one set of carbon thread.

BUO 07 161 -T Spare carbon thread

BUO 07 162 -T Planetary drive for sputtering device

Suitable for holding 6 specimen mounts from Cambridge, Etec, Phillips, and Zeiss SEM's. Incl. 1 battery 9 V.

B 80 07 776 Spare battery 9 V



BUO 07 055 -T Quartz crystal film thickness monitor QSG 301

complete for the sputtering device SCD 030

1 measuring unit QSG 301, BGS 04 250
1 mains cable B 4564 309 YN
1 crystal holder QSK 301, BGG 12 750
1 oscillator BG 513 333 -U
1 connection cable 1 m, BG 519 939 -T
1 connection cable 0.5 m, BG 519 .. 40 -T
1 connection cable 0.3 m, BG 519 941 -T
1 set of ten crystals QS 010, BN 845 104 -T

Ordering Data

BUO 07 120 -T Sputtering system complete with one gold-target, without vacuum pump

BUO 07 150 -T Two-stage rotary vane vacuum pump DUO 004 A, pumping speed 4 m^3/h. Connection voltage 220 V, 50 Hz

BUO 07 151 -T Same as above, but 220 V, 60 Hz connection

BUO 07 155 -T Same as above, but 240 V, 50 Hz connection

Variant:

BUO 07 156 -T Two-stage rotary vane pump DUO 012 A, pumping speed 12 m^3/n, pumping speed 12 m^2/h connection 220 V, 50 Hz

BUO 07 157 -T Same as above, but 220 V, 60 Hz connection

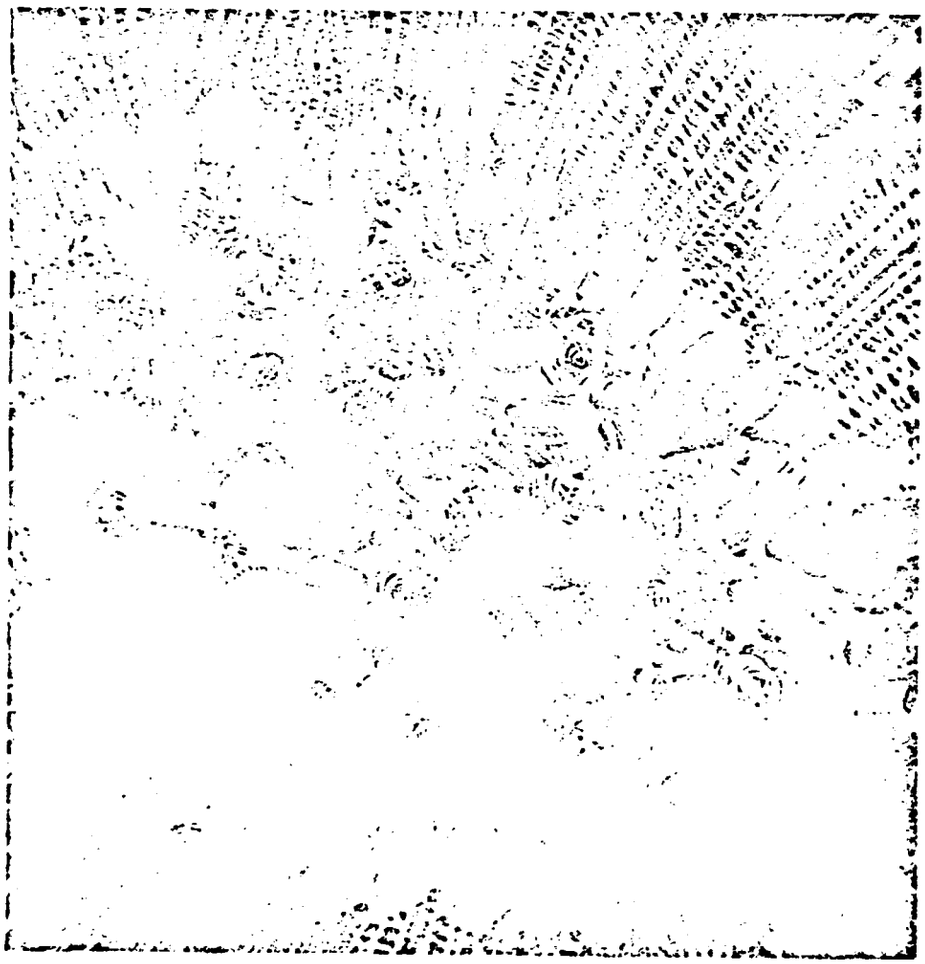
BUO 07 158 -T Same as above, but 240 V, 50 Hz connection

BUO 07 152 -T 1.5 m vacuum connection hose

BUO 07 153 -T Oil mist filter

Foil targets

B 8010 07 221	gold target
BUO 07 222	nickel target
BUO 07 223	chrome target
BUO 07 224	copper target
B 8010 07 226	silver target
B 8010 07 228	platinium target
B 8010 07 229	gold/palladium target

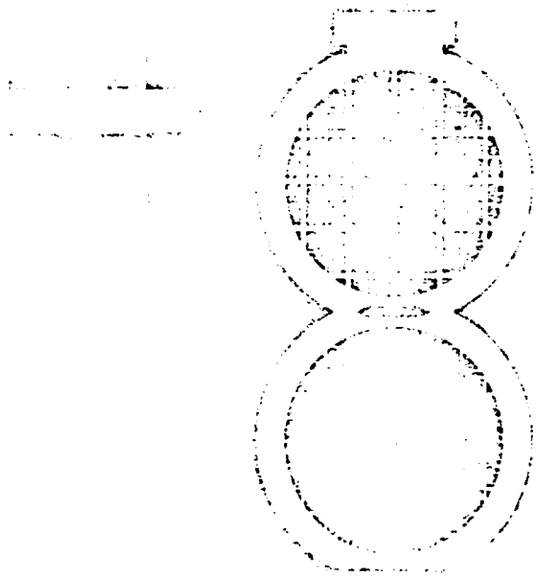


SEM micrograph of nemesia spec. (Scrophulariaceae) South Africa.
Section from the surface of a seed.
Manification: 185 x
Micrograph: Basel University
Laboratory for scanning electron microscopy
Bernoullistrasse 32
4056 Basel

BALZERS
UNION

Balzers Union Aktiengesellschaft
P.O. Box 75
FL-9496 Balzers
Principality of Liechtenstein
Tel. (075) 4 19 22 · Telex 77983

Printed in Liechtenstein



Preparation Technology for Electron Microscopy

Balzers Union have dedicated themselves to the development and improvement of apparatus used for electron microscopy so that the high technological standard of today's electron microscopes can be fully exploited. To accomplish this they combined their many years of experience in the fields of vacuum physics, vacuum deposition technology, and electron microscopy with close cooperation with universities and electron microscopists.

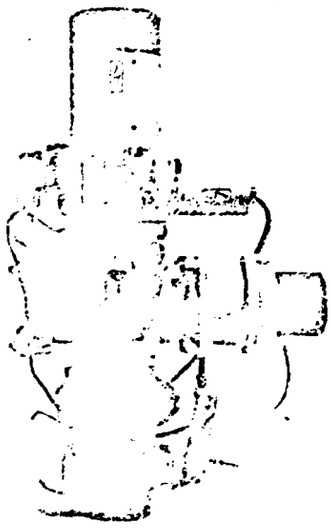
Today the Balzers Union range of preparation systems, instruments, and auxiliary materials offers practically everything needed to solve almost any preparation problem.

Freeze-Etching

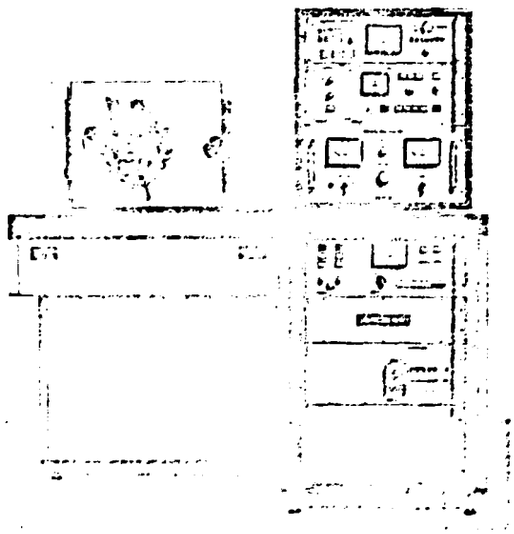
Balzers Union offer two different systems for freeze-etching: the BAF 400 high vacuum system for routine work, and the BAF 500 K ultra high vacuum system in which biological specimens can be freeze-fractured under UHV conditions (10^{-10} mbar pressure range) and at temperatures down to −260 °C.

Ion Etching

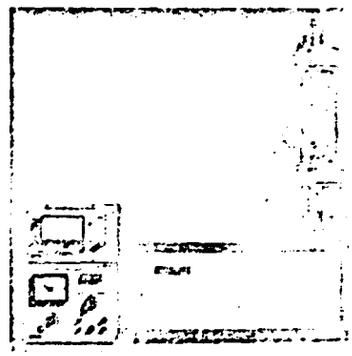
The IEU 100 universal ion etching system is suited for the preparation of solids, and for surface and thin milling of metals, semiconductor materials, ceramics, and rocks and minerals with one of a selection of etching profiles. With the appropriate accessories qualitative, mass spectrometric, and spectral analysis investigations can be made. This makes the IEU 100 also suited for IR and UV spectroscopy, and RHEED, HEED, SIMS, and IBSCA as well as for LM, TEM and SEM.



IEU 100
Ion etching system

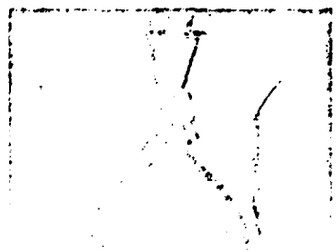


BAF 400
Freeze-etching system



BAE 080 T
Universal evaporation deposition system

Small tools used daily



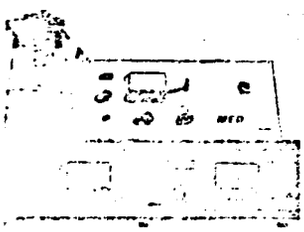
Evaporation Coating

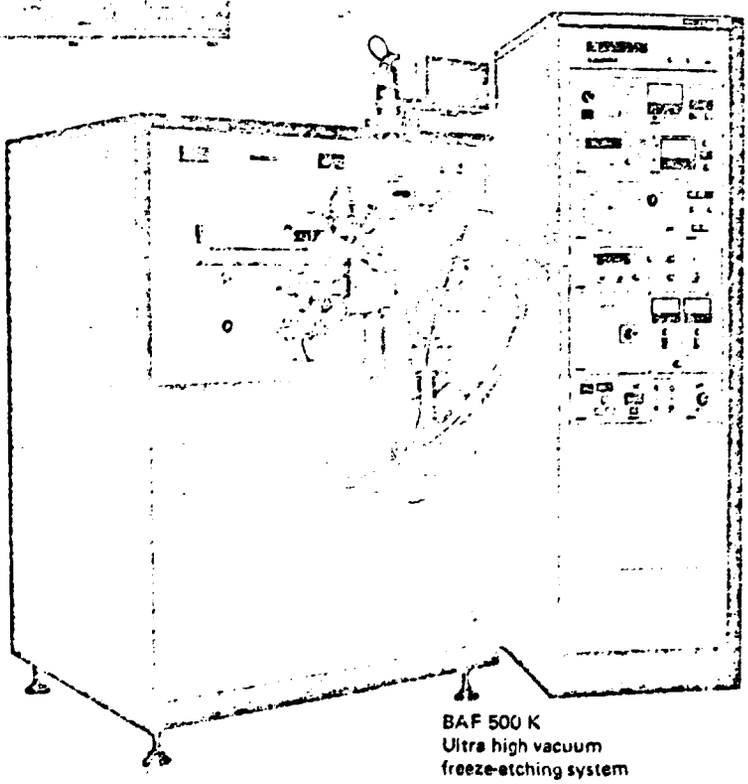
The wide field of preparation coating is covered by several types of systems, allowing the user to choose the one best suited for his purposes. Two of these systems are designed for use with the well proven quick release flanges which allow the widest possible choice of applications for any one system.

Ultramicrotomy

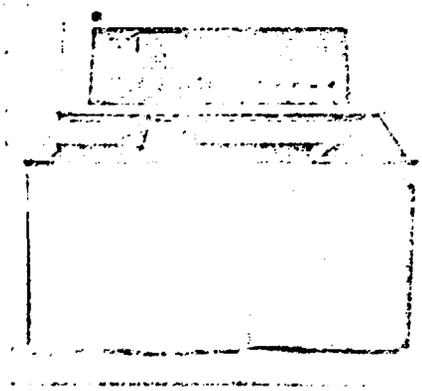
Balzers Union also have a variety of instruments and auxiliary materials for this technology. These include an apparatus for automatic dehydration and infiltration of synthetic resin embedding materials into small biological specimens. The LTE 010 low temperature embedding device effectively prevents the denaturing of proteins and lipoproteins in solvents.

MED 010
Small sized evaporation deposition system



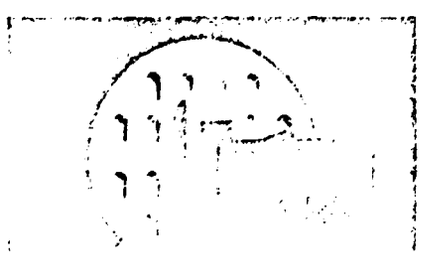


BAF 500 K
Ultra high vacuum freeze-etching system



LTE 010
Low temperature embedding apparatus

HPI layer of micrococcus radiodurans freeze-dried in the airlock and Pt/C shadowed at −264 °C under UHV conditions



Embedding materials

BALZERS UNION

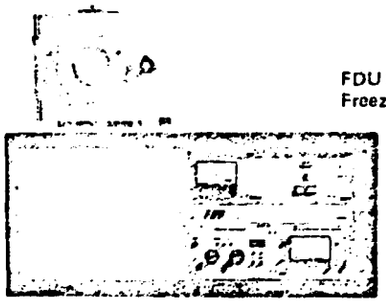
Freeze Drying

The FDU 010 system specially developed for EM purposes allows, for example, freeze drying and chemical fixation of EM specimens in osmium tetroxide plus subsequent embedding in synthentic resin without breaking the vacuum. A variety of accessories allow a number of preparation procedures to be carried out under optimum conditions.

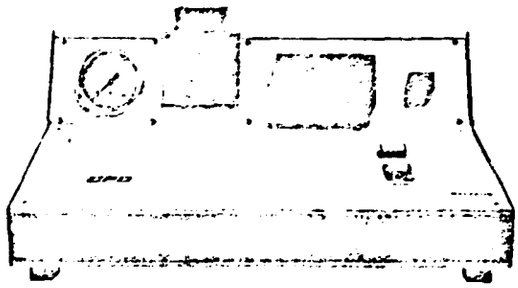
Scanning Electron Microscopy

A number of materials needed daily for work with the electron microscope, plus instruments for critical point drying and for sputter coating conducting films on SEM specimens, are also a part of the Balzers union range.

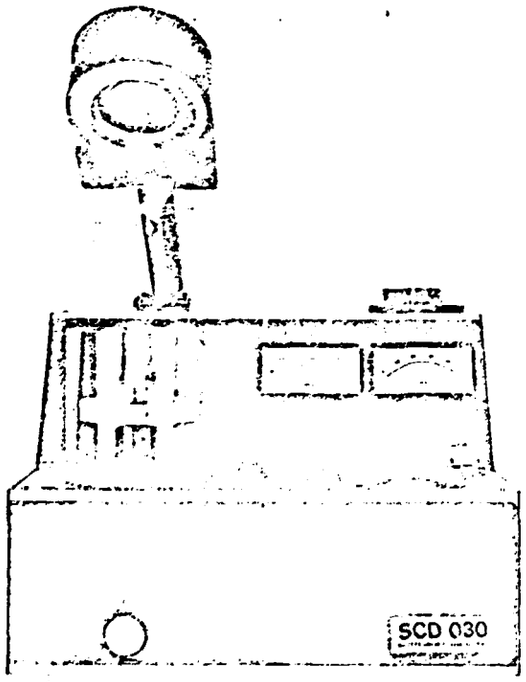
All the instruments and systems mentioned are described in detail in the 100 page Balzers Union catalog. This catalog lists over 2000 articles for electron microscopy.



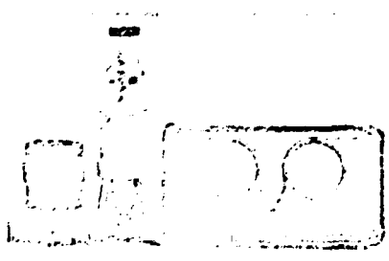
FDU 010
Freeze drying unit.



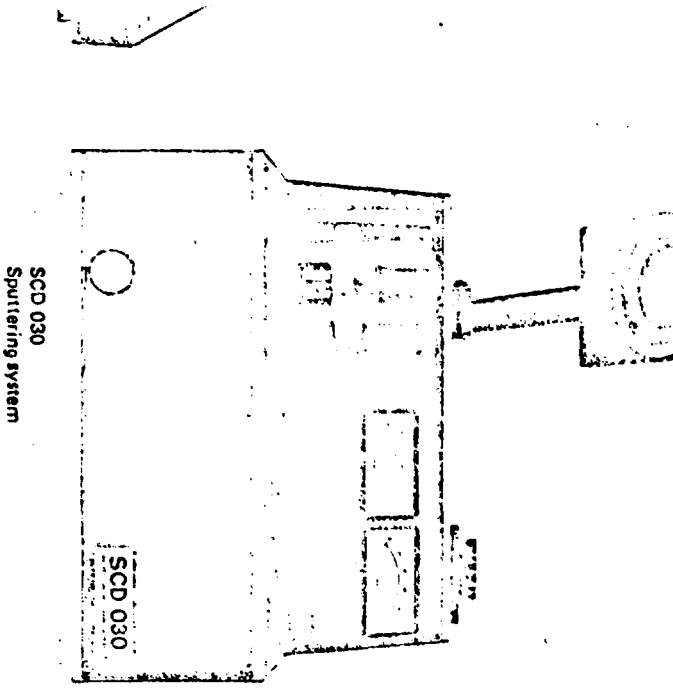
CPD 020
Critical point dryer



SCD 030
Sputtering system



General laboratory materials



BALZERS
UNION

I would like detailed information on:

Evaporation and sputter deposition systems

Critical point drying

Low temperature embedding

Freeze drying

Freeze etching

Ion etching

☐ Catalog with listings for more than 2000 articles for electron microscopy

☐ Customer Service Laboratory

☐ I would like to be contacted by a specialist at no obligation to me

Do you wish my further informations:

_____

_____

_____

_____

_____

_____

BALZERS UNION

BALZERS UNION

Scanning Electron Microscopy

A number of materials needed daily for work with the electron microscope, plus instruments for critical point drying and for sputter coating conducting films on SEM specimens, are also a part of the Balzers union range.

All the instruments and systems mentioned are described in detail in the 100 page Balzers Union catalog. This catalog lists over 2000 articles for electron microscopy.

stem specially develop-
es allows, for example,
chemical fixation of
osmium tetroxide plus
iding in synthentic
king the vacuum. A
ries allow a number of
dures to be carried out
onditions.

I would like detailed information on:

- ☐ Evaporation and sputter deposition systems
- ☐ Critical point drying
- ☐ Low temperature embedding
- ☐ Freeze drying
- ☐ Freeze etching
- ☐ Ion etching

- ☐ Catalog with listings for more than 2000 articles for electron microscopy
- ☐ Customer Service Laboratory
- ☐ I would like to be contacted by a specialist at no obligation to me

Do you wish my further informations:

_____

_____

_____

_____

_____

_____

Freeze Drying

The FDU 010 :
ed for EM purp
freeze drying a
EM specimens
subsequent em
resin without b
variety of acces
preparation pro
under optimun

from:

Name/Title

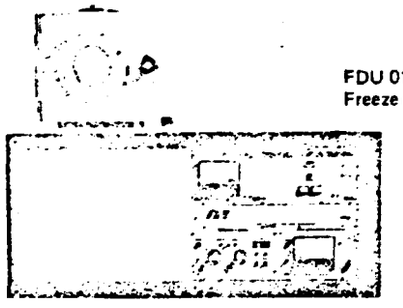
Company/Inst.

Address

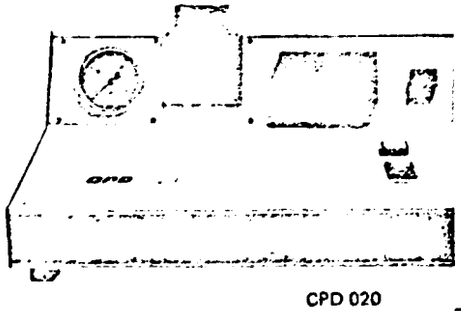
City/Postal Code

Country

Tel.



FDU 010
Freeze drying uni



CPD 020
Critical point dry

em-

Balzers Union Aktiengesellschaft
Postfach 75
FL-9496 Balzers
Fürstentum Liechtenstein

from:

Name/Title

Company/Inst.

Address

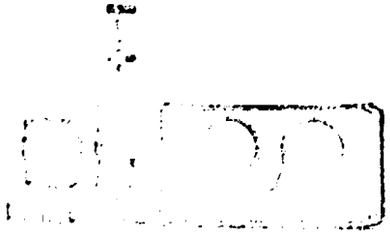
City/Postal Code

Country

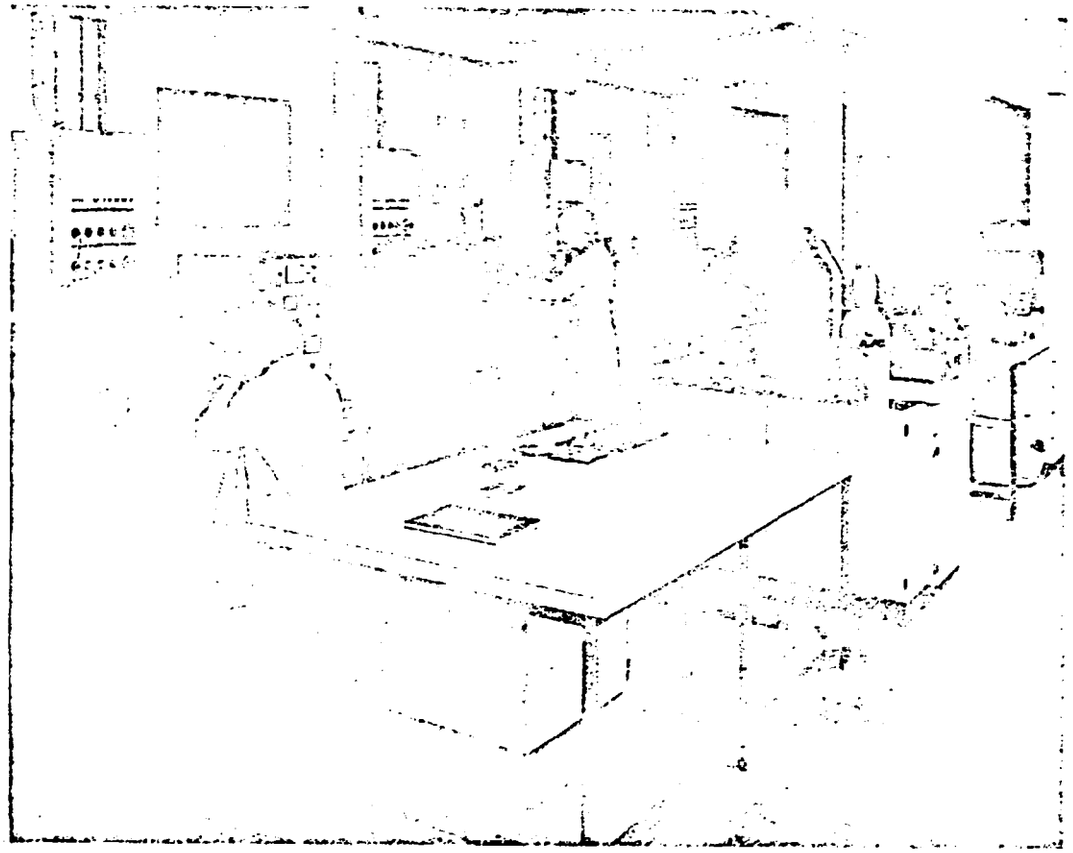
Tel.

als

General laborator
materials



Customer Service Laboratory



The Customer Service Laboratory in Liechtenstein is available to Balzers Union customers free of charge to try out their experiments on BU instruments and systems.

Owners of Balzers Union systems can be trained there by specialists to obtain optimum use from their new instruments. These courses, together with a number of technical publications, are available to them free-of-charge.

The Customer Service Laboratory is also used for training BU sales and service engineers who are available world-wide for consultation and service.

Sales and Service Companies

	Addresses	Telephone	Telex
Belgium/Luxembourg	N.V. Balzers S.A., Excelsiorlaan 7, B-1930 Zaventem	(02) 720 46 38	25 145
FRD	Balzers Hochvakuum GmbH, Siemensstrasse 11, D-6200 Wiesbaden-Nordenstadt	(06122) 6036-39	41 82 531
France	Balzers S.A., 47, rue d'Artelon, F-92190 Meudon	(1) 534 75 44	260864
Great Britain	Balzers High Vacuum Limited, Northbridge Road, Berkhamsted/Herts. HP4 1EN	(04427) 2181	82 209
Italia	Balzers S.p.A., Tecnica dell'Alto Vuoto, Via Favretto 13, I-20146 Milano	(02) 42 29 241	332242
Nederland	Balzers, Savannahweg 45, NL-3542 AW Utrecht	(030) 44 25 45	47389
Österreich	Balzers Hochvakuum Ges.m.b.H., Bischof-Faber-Platz 14, A-1180 Wien	(0222) 47 23 66	114676
Sverige/Danmark	Nordiska Balzers AB, Lilla Verkstadsgatan 2, Box 10272, S-434 01 Kungsbacka	(0300) 14045	21229
Schweiz/Suisse	Balzers Hochvakuum AG, Stampfenbachstrasse 48, Postfach 186, CH-8035 Zürich	(01) 363 32 66	52278
U.S.A. & Canada	balzers, 8 Sagamore Park Road, Hudson, NH 03051	(603) 889-6888	710 228 7431

Representatives

Argentina	ARO S.A., Casilla de Correo 4890, 1000 Buenos Aires	30-8278	17268
Australia	C. Berney & Co. Pty. Ltd., Balzers High Vacuum Equipment, 8th Floor, 159 Kent Street, Sydney, N.S.W. 2000	27 6153	071/72330
Brasil	Micronal S.A., Rua João Rodrigues Machado, 25, Santo Amaro, 04707 São Paulo-SP	241-3011	1123817
Chile	Bermat S.A., Lote 2250, Casilla (P.O.B.) 9761, Santiago de Chile	74 05 51	340341
Colombia	Arotec Colombiana S.A., Calle 52 A No. 18 - 76, Apartado Aéreo 050862, Bogota	2 49 64 56	04-1203
Espana	Germán Weber S.A., Hermosilla 102, E-Madrid 9	(01) 4 01 51 12	45 260
Hellas	Dr. C.J. Vamvacas, Chemical Products & Equipment, P.O. Box 115, Mantzarou Str. 1 - 3, Neo Psychiko, Athen	67 23 405	214290
India	Toshniwal Bros. Pvt. Ltd., 6-2-969/1/1 Raj Bhavan Road, Khairatabad, Hyderabad 500 004	37 114	15 5618
Japan	Hekuto Co. Ltd., Balzers Division, P.O. Box 25, Tokyo Central	3412 611	22912
Majulah Singapura	Balzers Representative Office, c/o Sinusa Pte. Ltd., 401 Colombo Court, P.O. Box 447, Singapore 9117	33 738 73	33 231
Mexico	Maquinaria y Accessorios S.A., Alfonso Reyes 15, 06170 Mexico	516 25 12	017-74217
Norge	ISY Instruments & Systems as, Enebakkvn. 287, Postboks 70, Abelso, N-Oslo 11	(02) 28 28 30	17660
Peru	Ing. Erich Brammertz S.C.R.L., Avenida José Pardo 182, Oficina 905, Apartado 180, Miraflores 18	45 81 78	25739
Portuguesa	Equipamentos de Laboratorio Lda., Apartado 1.100, 1002 Lisboa Codex	97 65 51	12702
Republic of Korea	Keehwa Enterprise Corp., RM 801 Hanjun Bldg. 154, Nae Soo-Dong, Changro-ku, Seoul, Republic of Korea	723-1130	28 183
Rep. of South Africa	Balzers Division, Labotec (Pty.) Ltd., 51 B Richard Road, Industria North, 43161 Industria 2042	(673) 4140	42 5866
Suomi	Havulinna, Instrumentarium Oy, P.O. Box 357, SF-00101 Helsinki 10	805 52 81	124426
Taiwan	Young Brothers International Inc., 7th Floor Enterprise Building, 54-11 Chung Shan N. Rd., Sec. 3, P.O. Box 1659, Taipei	59 26 245-7	21 097
Venezuela	Secotec S.A., Apartado 3452, Caracas 1010	573 0270	21652

Range of Products from the Balzers Division

Components for the production, measurement, and regulation of medium, high and ultra high vacuum
Rotary vane vacuum, roots vacuum, oil diffusion, turbomolecular, titanium sublimation, and cryo pumps; line construction elements, feedthroughs, and valves with standard KF, ISO, and CF flanges; total and partial pressure measurement and regulation instruments, vacuum monitors, leak detection devices

Mass spectrometer systems
for the analysis of gases, liquids and solids as well as for process monitoring

Vacuum systems for thin film technology
Evaporation and sputtering systems for optical coatings, for microelectronics and semiconductor technology, for metal coating plastic, for surface treatments; evaporation materials, evaporation sources, and sputtering targets

Thin film products
Laser coatings and components, infrared coatings, interference filters, antireflection coatings, color filters and color separation filters, components for light-heat separation, electrically conductive transparent coatings, replicated optics, etc.

Ophthalmic lens coatings

Coated substrates for the production of chrome masks and hybrid circuits; resistor chips

Wear-resistant and corrosion-proof decorative coatings

Vacuum systems for metallurgy
Melting and casting systems, sintering furnaces, heat treatment furnaces, soldering furnaces

Preparation systems and accessories for electron microscopy
Evaporation and sputtering systems, freeze-etching and ion etching systems, auxiliary equipment and laboratory utensils

Special systems – Special processes – Large scale experimental systems for physics
Space simulation chambers, automatic leak detection devices, components for accelerators and storage rings, separation nozzle test systems for isotope separation systems, etc.

Project engineering
Design, planning, and construction of complete turn-key production sites for manufacturing thin film products and vacuum components, with full production and quality guarantees

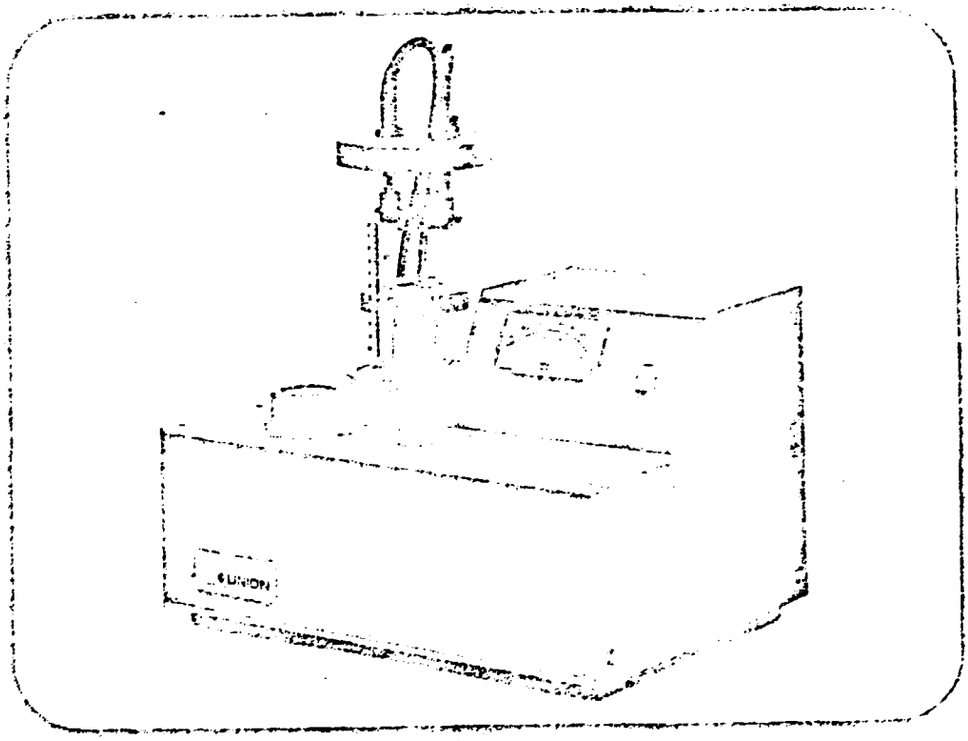
BALZERS UNION

Balzers Union Aktiengesellschaft
P.O. Box 75
FL-9496 Balzers
Principality of Liechtenstein
Tel. (075) 4 19 22 · Telex 77953

Printed in Liechtenstein

BALZERS
UNION

Carbon Evaporation Device
CED 010



Special features:

The main feature of the new BALZERS UNION Carbon Evaporation Device CED 010 is that it can be operated with just one fore vacuum pump. On the one hand, it is thus possible to achieve fast pumping times and hence rapid working cycles; on the other hand, the device has a most reasonable price.

Furthermore, there is the advantage that when evaporating at relatively high pressures, the average free path of the sublimed atoms is very small, enabling continuous coating even in the case of sample surfaces extremely full of fissures.

By using carbon thread instead of carbon rods as evaporation material, a complete degassing of the carbon can furthermore be achieved. Due to this pre-degassing, the usual "spitting" during evaporation can be avoided, which often leads to destruction of the required carbon film. The sharpening and adjusting of the carbon rods is also saved when using carbon thread.

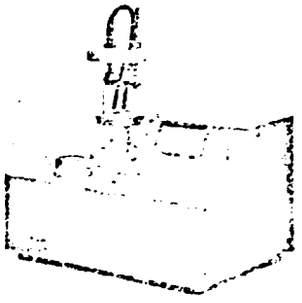
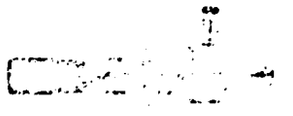
The film thickness can be determined simply by varying the distance between the evaporation source and the specimen and can be easily determined with the aid of a calibration curve. However, feedthroughs are provided for, enabling a later addition of a quartz film thickness measuring device.

Various types of sample plates for electron scan microscopy can be fitted to the built-in sample table. The support grids to be coated for transmission electron microscopy can be simply placed on the table on filter paper or glass specimen supports.

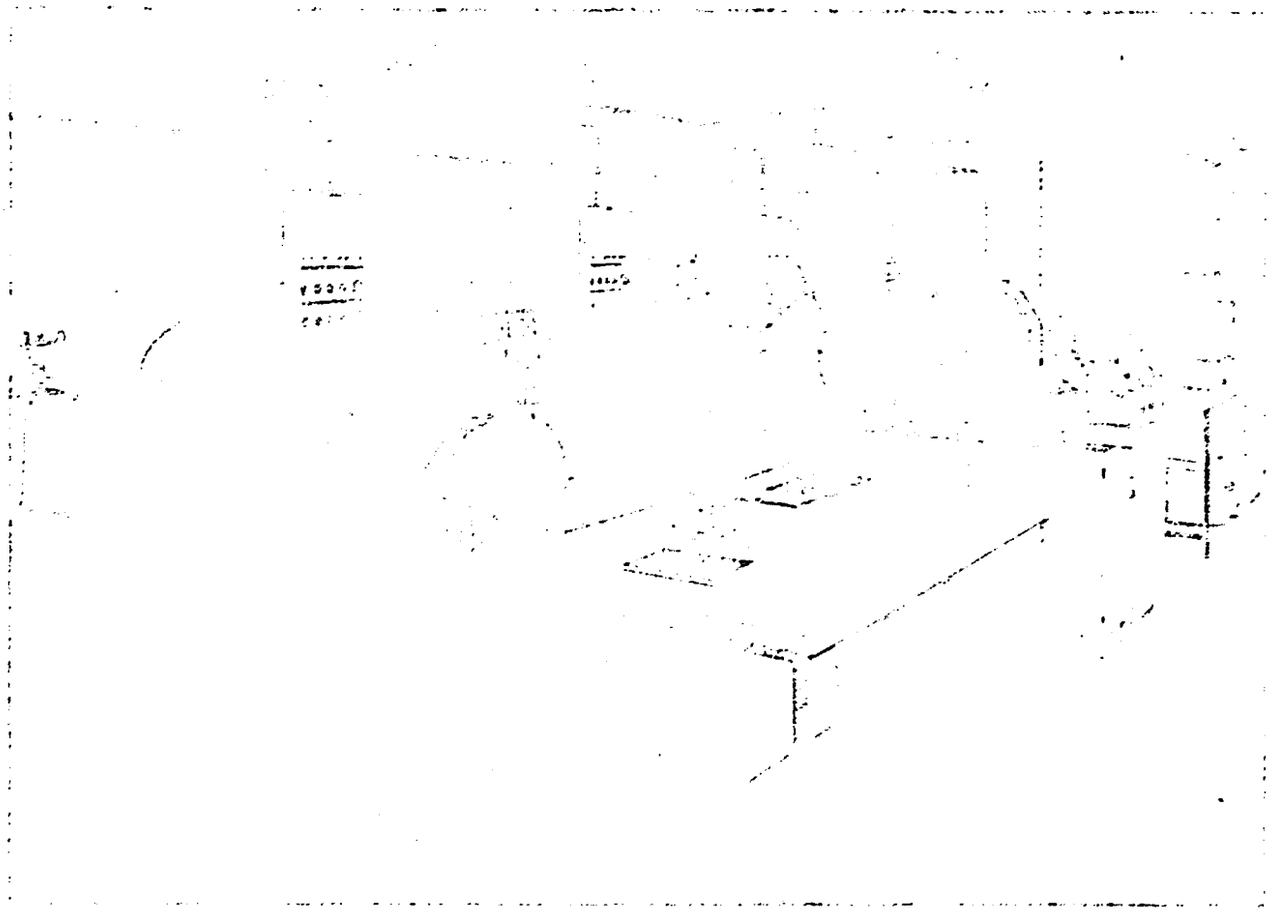
TECHNICAL DATA

Electrical equipment	Input max.		1.1 kW
	Connection voltage		220 V / 50 Hz
	Dimensions (Length x breadth x height)		420 x 300 x 260 mm
	Weight		21 kg
	High current transformer	power	500 VA
		primary voltage	260 V
		secondary voltage	4 / 8 / 16 V
	Regulating transformer for regulating the primary voltage for the high current transformer		
		power	500 VA
		primary voltage	220 V
		secondary voltage	0 – 160 V

ORDERING DATA

		Order No.
	Carbon Evaporation Device CED 010 compl. with 1 set of carbon thread, without vacuum pump	07 170
	Two-stage rotary vane pump type DUO 004 A, pumping speed 4 m³/h, connection 220 V, 50 Hz	07 150
	ditto, but connection 220 V/60 Hz	07 151
	ditto, but connection 240 V/50 Hz	07 155
	1.5 m vacuum connection hose	07 152
	Oil mist filter ONF 025	07 153
	Gas dosaging valve for dosaging the gas inlet during the pumping process	07 480
	1 packet 3.5 m spare carbon thread	07 161

The BAL Applications Laboratory – a special service for our customers



■ There's nothing missing here, because Balzers University has everything that belongs in an EM laboratory in stock.

■ The EM laboratory is available for those who are interested in trying out a particular experiment with our equipment.

■ In our laboratory, headed by specialists, our customers are individually trained in exactly what they want to use their newly purchased instruments for.

Is equipment available in the BU Customer Service Laboratory

BU-Systems and instruments...

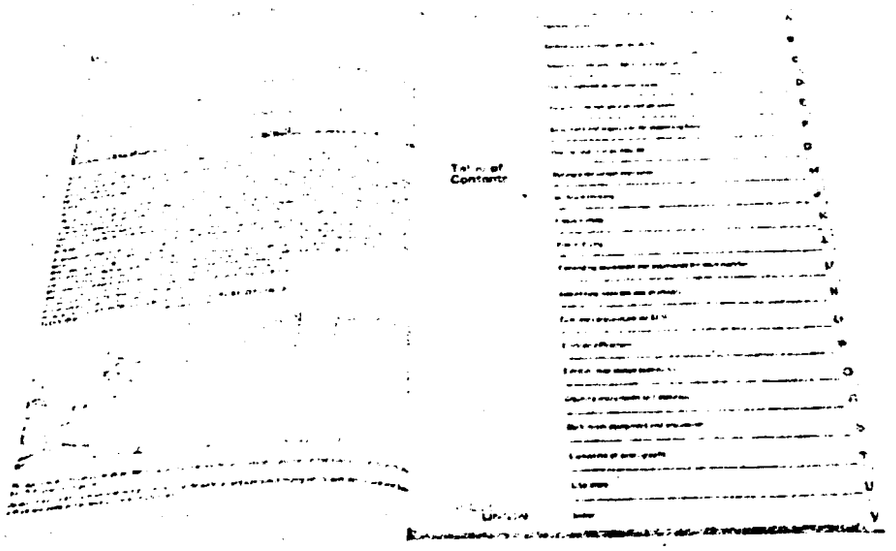
BAE 080	Small scale preparation system with various quick release flanges and a diffusion pumping system
BAE 060	Small scale preparation system with various quick release flanges and a diffusion pumping system
BAE 370	Universal high vacuum preparation system with large belljar chamber
BAF 400	Freeze etching system with rotary cold table, counter flow loading and double replica devices, eltron beam evaporator, etc.
IEU 100	Ion etching system for preparing nonbiological materials for the electron microscope
QFD 020	Cryo-Jet: quick freeze device for biological specimens
FDU 010	Freeze drying device
SCD 030	Sputtering device
CED 010	Carbon evaporation device
CPD 010	Critical point dryer
RWA 010	Replica Washing Apparatus
BENJAMIN II	Automatic dehydration and embedding apparatus

...and in addition

TEM	EM 109 Zeiss
SEM	600 M, Cambridge
LM	M 4, 50 x, Wild

Centrifuge up to 5000 RPM
Drying cabinet
Refrigerator
pH meter
as well as all other necessary laboratory materials

If you would like to know more, send for our leaflet "Information for Visitors to the Balzers Union EM Customer Service Laboratory"



Have you seen our catalog? It contains more than 1800 articles for electron microscopy.

Send for it today!

BALZERS UNION

Balzers Union AG
Postfach 75
FL-9496 Balzers, Liechtenstein
Tel.075/ 4 19 22, Telex 77 983

BALZERS
UNION

Price list

Electron Microscopy

Valid from 1.2.1984

Conditions

Prices subject to change.

The prices are understood as ex works, not including packing, insurance, shipping, or customs duty.

Payment upon receipt of invoice, net.

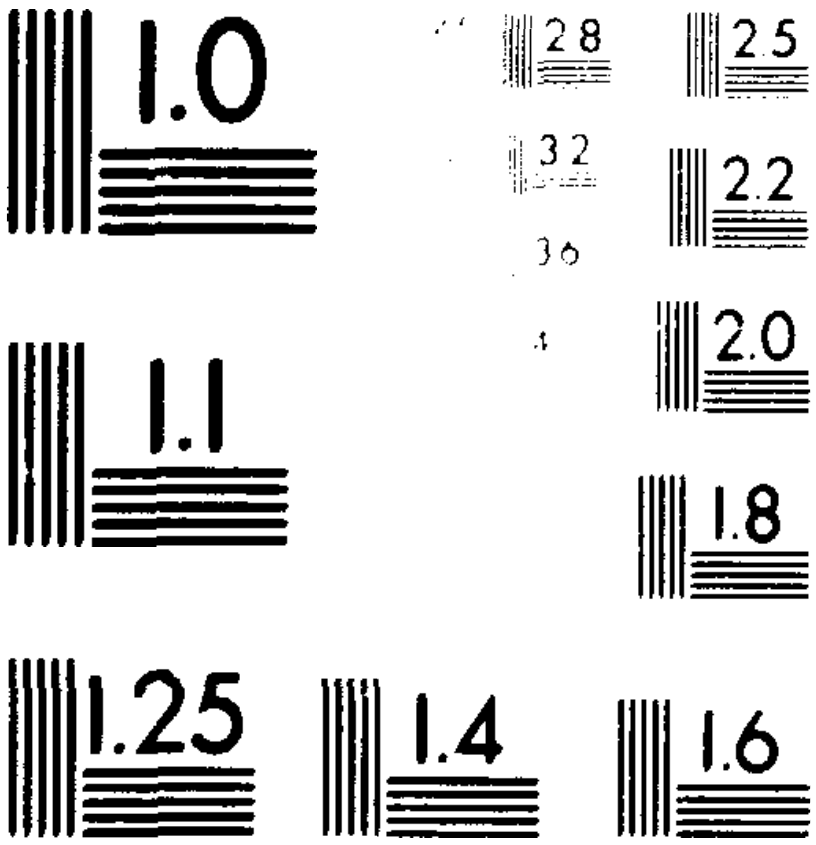
These prices invalidate all earlier prices.

PART-NUMBER	PAGE CAT.	PRICE SFR
B...		
B 0490 121	74	14,00
B 2221 330 -H	51	11,00
B 4564 369 YN	52	9,40
B 4564 399 YQ		22,00
B 4564 491 DB		130,00
B 5170 062 CZ		1.400,00
B 5170 063 CZ		3.400,00
B 5181 401 GZ	36	850,00
B 5294 211 AA	60	B 8010 090 01
B 6105 059 A2	76	2.700,00
B 6105 059 A5	76	3.400,00
B 6105 059 A8	76	5.600,00
B 7302 250 ZB	60	5.300,00
B 8010 010 00	4	19,00
B 8010 010 01	4	19,00
B 8010 010 02	4	20,00
B 8010 010 03	4	29,00
B 8010 010 04	4	19,00
B 8010 010 05	4	20,00
B 8010 010 06	4	29,00
B 8010 010 07	4	19,00
B 8010 010 08	4	20,00
B 8010 010 09	4	29,00
B 8010 010 10	4	19,00
B 8010 010 11	4	20,00
B 8010 010 12	4	29,00
B 8010 010 13	4	19,00
B 8010 010 14	4	20,00
B 8010 010 15	4	29,00
B 8010 010 16	4	19,00
B 8010 010 17	4	20,00
B 8010 010 18	4	29,00
B 8010 010 27	4	19,00
B 8010 010 28	4	20,00
B 8010 010 29	4	48,00
B 8010 010 30	4	50,00
B 8010 010 33	4	23,00
B 8010 010 34	4	24,00
B 8010 010 35	4	39,00
B 8010 010 36	4	19,00
B 8010 010 39	4	19,00
B 8010 010 42	4	19,00
B 8010 011 00	5	17,00
B 8010 011 01	5	17,00
B 8010 011 02	5	19,00
B 8010 011 03	5	26,00
B 8010 011 04	5	17,00
B 8010 011 05	5	19,00
B 8010 011 06	5	28,00
B 8010 011 07	5	17,00
B 8010 011 08	5	19,00
B 8010 011 09	5	28,00
B 8010 011 10	5	17,00
B 8010 011 11	5	19,00
B 8010 011 12	5	28,00
B 8010 011 13	5	17,00
B 8010 011 14	5	19,00
B 8010 011 15	5	28,00
B 8010 011 16	5	17,00
B 8010 011 17	5	19,00
B 8010 011 18	5	28,00
B 8010 011 19	6	48,00
B 8010 011 20	7	48,00
B 8010 011 21	6	46,00
B 8010 011 22	6	48,00
B 8010 011 23	6	48,00
B 8010 011 24	6	48,00
B 8010 011 25	6	48,00
B 8010 011 26	6	48,00
B 8010 011 27	5	17,00
B 8010 011 28	5	19,00
B 8010 011 29	6	48,00
B 8010 011 33	5	48,00
B 8010 011 34	5	50,00
B 8010 011 35	5	29,00
B 8010 011 36	5	17,00
B 8010 011 39	5	17,00
B 8010 011 42	5	17,00
B 8010 011 45	5	17,00
B 8010 011 48	5	17,00
B 8010 011 51	5	17,00
B 8010 011 54	5	17,00
B 8010 011 57	5	17,00
B 8010 011 60	5	17,00
B 8010 011 63	5	17,00
B 8010 011 66	5	17,00
B 8010 011 69	5	17,00
B 8010 011 72	6	17,00
B 8010 011 75	6	37,00
B 8010 011 76	6	37,00
B 8010 011 77	6	37,00
B 8010 011 78	6	37,00
B 8010 011 79	6	37,00
B 8010 011 80	6	37,00
B 8010 011 81	6	37,00
B 8010 011 82	6	37,00
B 8010 011 83	6	37,00
B 8010 011 84	6	37,00
B 8010 011 85	6	37,00
B 8010 011 86	6	37,00
B 8010 011 87	6	37,00
B 8010 011 88	6	37,00
B 8010 011 89	6	37,00
B 8010 011 90	6	37,00
B 8010 011 91	6	37,00
B 8010 011 92	6	37,00
B 8010 011 93	6	37,00
B 8010 011 94	6	37,00
B 8010 011 95	6	37,00
B 8010 011 96	6	37,00
B 8010 011 97	6	17,00
B 8010 011 98	7	48,00
B 8010 011 99	7	43,00
B 8010 012 00	7	17,00
B 8010 012 01	7	17,00
B 8010 012 02	7	19,00
B 8010 012 03	7	28,00
B 8010 012 04	7	17,00
B 8010 012 05	7	19,00
B 8010 012 06	7	28,00
B 8010 012 07	7	18,00
B 8010 012 08	7	20,00
B 8010 012 09	7	28,00
B 8010 012 10	7	17,00
B 8010 012 11	7	19,00
B 8010 012 12	7	28,00
B 8010 012 13	7	17,00
B 8010 012 14	7	19,00
B 8010 012 15	7	28,00
B 8010 012 16	7	17,00
B 8010 012 17	7	19,00
B 8010 012 18	7	28,00
B 8010 012 19	8	48,00
B 8010 012 20	9	48,00
B 8010 012 21	8	48,00
B 8010 012 22	8	48,00
B 8010 012 23	8	48,00
B 8010 012 24	9	48,00
B 8010 012 25	9	48,00
B 8010 012 26	9	48,00
B 8010 012 27	8	17,00
B 8010 012 36	8	17,00
B 8010 012 39	8	17,00
B 8010 012 42	8	17,00
B 8010 012 45	8	17,00
B 8010 012 48	8	17,00
B 8010 012 51	8	17,00
B 8010 012 54	8	17,00
B 8010 012 57	8	17,00
B 8010 012 60	8	17,00
B 8010 012 63	8	17,00
B 8010 012 66	8	17,00
B 8010 012 69	8	17,00
B 8010 012 72	8	17,00
B 8010 012 75	8	37,00
B 8010 012 76	8	37,00
B 8010 012 77	8	37,00
B 8010 012 78	8	37,00
B 8010 012 79	8	37,00
B 8010 012 80	8	37,00
B 8010 012 81	8	37,00
B 8010 012 82	8	37,00
B 8010 012 83	8	37,00
B 8010 012 85	8	37,00
B 8010 012 86	8	37,00
B 8010 012 87	8	37,00
B 8010 012 89	8	37,00
B 8010 012 90	8	37,00
B 8010 012 92	8	37,00
B 8010 012 94	8	37,00
B 8010 012 95	8	37,00
B 8010 012 96	8	37,00
B 8010 013 01	8	19,00
B 8010 013 02	8	28,00
B 8010 013 03	4	ON REQUEST
B 8010 013 04	4	ON REQUEST
B 8010 013 05	4	ON REQUEST
B 8010 013 06	4	ON REQUEST
B 8010 013 07	4	ON REQUEST
B 8010 013 08	4	ON REQUEST
B 8010 013 09	4	ON REQUEST
B 8010 013 10	4	98,00
B 8010 013 11	4	98,00
B 8010 013 12	4	98,00
B 8010 013 13	4	98,00
B 8010 013 14	4	98,00
B 8010 013 15	4	110,00
B 8010 013 16	4	130,00
B 8010 013 17	4	130,00
B 8010 013 18	4	130,00
B 8010 013 19	4	130,00
B 8010 013 20	4	130,00
B 8010 013 21	4	140,00
B 8010 013 22	5	28,00
B 8010 013 23	5	ON REQUEST
B 8010 013 24	5	ON REQUEST
B 8010 013 25	5	ON REQUEST
B 8010 013 26	5	ON REQUEST
B 8010 013 27	5	ON REQUEST
B 8010 013 28	5	ON REQUEST
B 8010 013 29	5	ON REQUEST
B 8010 013 30	5	59,00
B 8010 013 31	7	19,00
B 8010 013 32	7	28,00
B 8010 013 33	7	ON REQUEST
B 8010 013 34	7	ON REQUEST
B 8010 013 35	7	ON REQUEST
B 8010 013 36	7	ON REQUEST
B 8010 013 37	7	ON REQUEST
B 8010 013 38	7	ON REQUEST
B 8010 013 39	7	ON REQUEST
B 8010 013 40	7	55,00
B 8010 013 41	5	19,00
B 8010 020 01	10	52,00
B 8010 020 02	10	52,00
B 8010 020 03	10	52,00
B 8010 020 04	10	52,00
B 8010 020 05	10	59,00
B 8010 020 06	10	59,00
B 8010 020 07	11	170,00
B 8010 020 08	10	19,00
B 8010 020 09	10	19,00
B 8010 020 10	10	19,00
B 8010 020 11	10	27,00
B 8010 020 12	10	27,00
B 8010 020 13	10	30,00
B 8010 020 14	10	30,00
B 8010 020 15	10	30,00
B 8010 020 16	10	30,00
B 8010 020 17	10	35,00
B 8010 020 18	10	35,00
B 8010 020 21	10	17,00
B 8010 020 22	10	27,00
B 8010 020 23	10	27,00
B 8010 020 24	11	42,00

PART-NUMBER	PAGE	CAT.	PRICE SFR
B 8010 020 25	11		42,00
B 8010 020 26	11		35,00
B 8010 020 27	11		35,00
B 8010 020 28	11		40,00
B 8010 020 29	11		40,00
B 8010 020 30	11		35,00
B 8010 020 31	11		35,00
B 8010 020 32	11		40,00
B 8010 020 33	11		40,00
B 8010 020 34	11		38,00
B 8010 020 35	11		33,00
B 8010 020 36	11		31,00
B 8010 020 37	11		31,00
B 8010 020 38	11		35,00
B 8010 020 39	11		35,00
B 8010 020 40	12		58,00
B 8010 020 41	12		58,00
B 8010 020 42	11		39,00
B 8010 020 43	11		39,00
B 8010 020 44			ON REQUEST
B 8010 030 01	13		14,00
B 8010 030 02	13		14,00
B 8010 030 03	13		14,00
B 8010 030 04	13		22,00
B 8010 030 05	13		20,00
B 8010 030 06	13		28,00
B 8010 030 07	13		16,00
B 8010 030 08	13		14,00
B 8010 030 09	13		20,00
B 8010 030 10	13		22,00
B 8010 030 11	14		24,00
B 8010 030 12	13		20,00
B 8010 030 13	13		16,00
B 8010 030 14	13		19,00
B 8010 030 15	14		19,00
B 8010 030 16	13		21,00
B 8010 030 17	14		43,00
B 8010 030 18	14		28,00
B 8010 030 19	14		17,00
B 8010 030 20	15		39,00
B 8010 030 21	15		30,00
B 8010 030 22	15		56,00
B 8010 030 23	14		25,00
B 8010 030 29	14		28,00
B 8010 030 30	15		22,00
B 8010 030 31	15		209,00
B 8010 030 32	15		120,00
B 8010 030 33	15		93,00
B 8010 030 34	15		220,00
B 8010 030 35	16		200,00
B 8010 030 37	16		35,00
B 8010 030 38	16		46,00
B 8010 030 39	16		35,00
B 8010 030 40	16		220,00
B 8010 030 41	16		170,00
B 8010 030 42	15		50,00
B 8010 030 46	17		51,00
B 8010 030 47	17		39,00
B 8010 030 48	17		4,90
B 8010 030 49	17		11,00
B 8010 030 50	17		26,00
B 8010 030 51	17		6,80
B 8010 030 52	17		26,00
B 8010 030 53	17		11,00
B 8010 030 54	18		25,00
B 8010 030 55	14		33,00
B 8010 030 56	14		30,00
B 8010 030 57	18		11,00
B 8010 030 58	18		25,00
B 8010 030 59	18		13,00
B 8010 030 60	13		21,00
B 8010 030 61	20		8,80
B 8010 030 62	21		28,00
B 8010 030 65	17		9,70
B 8010 030 67	18		74,00
B 8010 030 68	13		27,00
B 8010 030 69	13		52,00
B 8010 030 70	20		8,80
B 8010 030 72	21		8,60
B 8010 030 73	21		5,80

PART-NUMBER	PAGE	CAT.	PRICE SFR
B 8010 030 74	21		4,00
B 8010 030 75	21		5,10
B 8010 030 76	21		39,00
B 8010 030 77	21		8,40
B 8010 030 78	21		14,00
B 8010 030 80	20		22,00
B 8010 030 81	21		20,00
B 8010 030 83	22		21,00
B 8010 030 84	22		1,10
B 8010 030 85	21		34,00
B 8010 030 86	21		34,00
B 8010 030 87	22		24,00
B 8010 030 90	21		04,00
B 8010 030 91	22		17,00
B 8010 030 92	22		31,00
B 8010 030 93	23		15,00
B 8010 030 95	22		5,00
B 8010 030 96	22		47,00
B 8010 030 97	14		24,00
B 8010 031 03	14		29,00
B 8010 031 05	13		21,00
B 8010 031 07	13		22,00
B 8010 031 08	13		25,00
B 8010 031 09	13		26,00
B 8010 031 10	13		26,00
B 8010 031 11	16		220,00
B 8010 031 12	16		220,00
B 8010 031 13	13		22,00
B 8010 031 15	18		56,00
B 8010 031 17	16		200,00
B 8010 031 18	14		41,00
B 8010 031 19	14		41,00
B 8010 031 20	19		14,00
B 8010 031 23	13		28,00
B 8010 031 25	24		18,00
B 8010 031 26	19		89,00
B 8010 031 27	18		140,00
B 8010 031 28	18		36,00
B 8010 031 29	23		26,00
B 8010 031 30	15		13,00
B 8010 031 31	15		13,00
B 8010 031 32	15		13,00
B 8010 031 33	24		180,00
B 8010 031 34	24		6,90
B 8010 031 35	24		6,90
B 8010 031 36	24		6,90
B 8010 031 37	24		6,90
B 8010 031 38	24		6,90
B 8010 031 39	24		6,90
B 8010 031 40	24		8,20
B 8010 031 41	24		8,20
B 8010 031 42	24		8,20
B 8010 031 43	24		8,20
B 8010 031 44	24		8,20
B 8010 031 45	24		8,20
B 8010 031 47	24		7,10
B 8010 031 48	24		12,00
B 8010 031 49	24		13,00
B 8010 031 50	24		32,00
B 8010 031 52	16		14,00
B 8010 031 53	16		63,00
B 8010 031 54	16		63,00
B 8010 031 55	16		63,00
B 8010 031 56	16		63,00
B 8010 031 57	16		63,00
B 8010 031 58	16		63,00
B 8010 031 59	16		63,00
B 8010 031 60	16		63,00
B 8010 033 32	15		120,00
B 8010 040 01	25		2.200,00
B 8010 040 02	25		ON REQUEST
B 8010 040 03	26		460,00
B 8010 040 04	26		600,00
B 8010 040 05	27		650,00
B 8010 040 06	27		150,00
B 8010 040 07	27		53,00
B 8010 040 08	27		13,00
B 8010 040 09	27		13,00
B 8010 040 10	17		13,00
B 8010 040 11	27		13,00

PART-NUMBER	PAGE	CAT.	PRICE SFR
B 8010 040 12	27		13,00
B 8010 040 13	27		13,00
B 8010 040 14	27		13,00
B 8010 040 15	27		13,00
B 8010 040 16	27		13,00
B 8010 040 17	27		13,00
B 8010 040 18	27		13,00
B 8010 040 19	27		13,00
B 8010 040 20	27		77,00
B 8010 040 22	25		2.700,00
B 8010 040 24	26		39,00
B 8010 040 25	27		180,00
B 8010 040 26	27		16,00
B 8010 040 27	27		16,00
B 8010 040 28	27		16,00
B 8010 040 29	27		16,00
B 8010 040 30	27		16,00
B 8010 040 31	27		16,00
B 8010 040 32	27		16,00
B 8010 040 33	27		16,00
B 8010 040 34	27		16,00
B 8010 040 35	27		16,00
B 8010 040 36	27		16,00
B 8010 040 37	27		16,00
B 8010 040 38	27		170,00
B 8010 040 39	26		200,00
B 8010 040 40	26		330,00
B 8010 040 41	26		370,00
B 8010 040 42	26		200,00
B 8010 040 43	26		260,00
B 8010 040 44	25		2.700,00
B 8010 040 45	26		15,00
B 8010 043 01	25		2.200,00
B 8010 043 05	27		850,00
B 8010 043 22	25		2.700,00
B 8010 043 44	25		2.700,00
B 8010 050 01	29		600,00
B 8010 050 02	29		16,00
B 8010 050 03	29		16,00
B 8010 050 04	29		16,00
B 8010 050 05	29		16,00
B 8010 050 06	29		16,00
B 8010 050 07	29		16,00
B 8010 050 08	29		11,00
B 8010 050 09	29		11,00
B 8010 050 10	29		2,50
B 8010 050 11	29		2,50
B 8010 050 12	29		4,20
B 8010 050 13	29		2,50
B 8010 050 14	29		4,70
B 8010 050 15	29		5,60
B 8010 050 24	29		4,10
B 8010 050 25	29		4,10
B 8010 050 26	29		4,10
B 8010 050 27	29		6,20
B 8010 050 28	29		8,70
B 8010 050 31	29		19,00
B 8010 050 32	30		19,00
B 8010 050 33	30		11,00
B 8010 050 34	30		11,00
B 8010 050 35	30		6,90
B 8010 050 36	30		6,90
B 8010 050 37	30		32,00
B 8010 050 39	30		3,90
B 8010 050 40	30		79,00
B 8010 050 41	30		8,30
B 8010 050 42	31		8,30
B 8010 050 43	30		8,30
B 8010 050 44	30		2,20
B 8010 050 45	30		20,00
B 8010 050 46	31		230,00
B 8010 050 48	31		0,70
B 8010 050 49	31		0,70
B 8010 050 50	31		0,70
B 8010 050 51	31		0,70
B 8010 050 52	31		0,70
B 8010 050 53	31		0,70
B 8010 050 54	31		0,70
B 8010 050 55	31		0,70
B 8010 050 56	31		2,00



PART-NUMBER	PAGE CAT.	PRICE SFR
B 8010 050 57	31	2,00
B 8010 050 58	31	2,00
B 8010 050 59	31	1,30
B 8010 050 60	31	1,30
B 8010 050 61	31	1,60
B 8010 050 62	31	1,60
B 8010 050 63	31	1,60
B 8010 050 64	31	1,60
B 8010 050 70	36	12,00
B 8010 060 01	32	14,00
B 8010 060 02	32	14,00
B 8010 060 03	32	17,00
B 8010 060 06	32	14,00
B 8010 060 07	32	14,00
B 8010 060 10	32	25,00
B 8010 060 12	32	27,00
B 8010 060 13	32	43,00
B 8010 060 14	32	15,00
B 8010 060 15	32	34,00
B 8010 070 32	54	6,20
B 8010 070 33	54	6,20
B 8010 070 34	54	6,20
B 8010 070 35	54	6,20
B 8010 070 36	54	6,20
B 8010 070 37	54	6,20
B 8010 070 38	54	6,20
B 8010 070 39	54	6,90
B 8010 070 40	54	6,90
B 8010 070 41	54	6,90
B 8010 070 42	54	6,90
B 8010 070 43	54	6,90
B 8010 070 44	54	6,90
B 8010 070 45	54	6,90
B 8010 070 46	54	6,90
B 8010 070 47	54	6,90
B 8010 070 49	54	33,00
B 8010 070 50	54	14,00
B 8010 070 51	54	49,00
B 8010 070 52	54	ON REQUEST
B 8010 070 59	53	5,30
B 8010 070 60	53	11,00
B 8010 070 65	53	7,00
B 8010 070 83	54	7,50
B 8010 070 84	54	14,00
B 8010 070 88	54	31,00
B 8010 070 91	56	22,00
B 8010 070 93	56	64,00
B 8010 070 97	56	95,00
B 8010 071 00	55	30,00
B 8010 071 0.	55	2,30
B 8010 071 05	55	2,30
B 8010 071 14	55	52,00
B 8010 072 21	96	750,00
B 8010 072 26	96	200,00
B 8010 072 28	96	910,00
B 8010 072 29	96	750,00
B 8010 077 76	96	7,10
B 8010 078 67	52	210,00
B 8010 080 06	57	250,00
B 8010 080 08	57	15,00
B 8010 080 09	57	17,00
B 8010 080 11	57	120,00
B 8010 080 14	58	760,00
B 8010 080 21	58	28,00
B 8010 080 22	58	16,00
B 8010 080 23	57	270,00
B 8010 080 25	57	210,00
B 8010 090 01		5.500,00
B 8010 090 10		6.530,00
B 8010 100 06	22	650,00
B 8010 100 07	23	310,00
B 8010 100 08	22	64,00
B 8010 100 12	17	8,30
B 8010 100 14	17	11,00
B 8010 100 15	17	8,80
B 8010 100 16	17	6,60
B 8010 100 17	24	570,00
B 8010 100 22	93	21,00
B 8010 103 17	24	570,00
B 8010 110 01	79	3.600,00
B 8010 110 02	90	6.300,00
B 8010 110 03	90	92,00
B 8010 110 04	90	5,50
B 8010 110 05	90	5,50
B 8010 110 07	88	540,00
B 8010 110 08	88	28,00
B 8010 110 09	90	94,00
B 8010 110 11	79	46,00
B 8010 110 12	85	110,00
B 8010 110 20	88	30,00
B 8010 110 21	81	38,00
B 8010 110 23	81	36,00
B 8010 110 33	84	85,00
B 8010 110 37	84	20,00
B 8010 110 38	84	20,00
B 8010 110 42	85	110,00
B 8010 110 51	79	6,10
B 8010 110 54	86	90,00
B 8010 110 55	86	79,00
B 8010 110 57	86	57,00
B 8010 110 58	86	31,00
B 8010 110 59	87	41,00
B 8010 110 62	86	33,00
B 8010 110 63	86	39,00
B 8010 110 65	88	220,00
B 8010 110 66	88	35,00
B 8010 110 67	88	74,00
B 8010 110 68	88	74,00
B 8010 110 69	87	96,00
B 8010 110 71	79	12.700,00
B 8010 110 73	86	38,00
B 8010 110 75	86	14,00
B 8010 110 76	86	53,00
B 8010 110 86	89	9,90
B 8010 110 88	89	7,10
B 8010 110 89	89	26,00
B 8010 110 90	89	46,00
B 8010 110 92	88	22,00
B 8010 110 95	89	280,00
B 8010 111 01	86	35,00
B 8010 111 10	89	20,00
B 8010 111 13	87	110,00
B 8010 111 30	81	15.400,00
B 8010 111 31	82	610,00
B 8010 111 32	82	170,00
B 8010 111 35	82	49,00
B 8010 111 36	82	49,00
B 8010 111 37	88	330,00
B 8010 111 38	88	47,00
B 8010 111 60	87	2.700,00
B 8010 111 61	87	3.300,00
B 8010 111 62	87	3.700,00
B 8010 111 63	87	4.100,00
B 8010 111 64	87	4.900,00
B 8010 111 65	87	7.600,00
B 8010 111 66	87	8.200,00
B 8010 113 01	79	3.600,00
B 8010 113 37	88	330,00
B 8010 113 71	79	12.700,00
B 8010 120 08	74	120,00
B 8010 120 09	74	120,00
B 8010 120 11	74	220,00
B 8010 120 12	74	15,00
B 8010 120 13	74	6,60
B 8010 120 16	74	29,00
B 8010 120 18	74	6,00
B 8010 120 19	75	3,30
B 8010 120 20	76	17,00
B 8010 120 21	74	13,00
B 8010 120 25	75	9,90
B 8010 120 26	76	1.200,00
B 8010 120 27	74	23,00
B 8010 120 36	76	670,00
B 8010 120 38	74	47,00
B 8010 120 49	75	6,20
B 8010 120 50	75	6,20
B 8010 130 01	91	17,00
B 8010 130 02	91	30,00
B 8010 130 03	91	20,00
B 8010 130 04	91	NO MORE AVAILAB
B 8010 130 05	91	91,00
B 8010 130 06	91	30,00
B 8010 130 07	93	23,00
B 8010 130 08	91	15,00
B 8010 130 09	91	15,00
B 8010 130 10	91	55,00
B 8010 130 11	91	31,00
B 8010 130 13	91	26,00
B 8010 130 15	91	16,00
B 8010 130 16	91	91,00
B 8010 130 17	91	73,00
B 8010 130 18	91	110,00
B 8010 130 21	91	30,00
B 8010 130 22	91	46,00
B 8010 130 23	91	190,00
B 8010 130 24	91	23,00
B 8010 130 25	91	24,00
B 8010 130 26	91	16,00
B 8010 130 27	91	110,00
B 8010 130 28	91	17,00
B 8010 130 29	91	23,00
B 8010 130 30	91	25,00
B 8010 130 31	92	180,00
B 8010 130 32	92	180,00
B 8010 130 33	92	60,00
B 8010 130 34	92	63,00
B 8010 130 35	92	9,90
B 8010 130 36	92	63,00
B 8010 130 37	92	60,00
B 8010 130 41	91	34,00
B 8010 130 42	91	28,00
B 8010 130 53	92	150,00
B 8010 130 54	92	91,00
B 8010 130 62	92	39,00
B 8010 130 63	92	30,00
B 8010 130 64	93	35,00
B 8010 130 65	93	16,00
B 8010 130 67	93	20,00
B 8010 130 68	92	24,00
B 8010 130 69	92	30,00
B 8010 130 71	92	23,00
B 8010 130 73	92	37,00
B 8010 130 74	92	37,00
B 8010 130 75	92	31,00
B 8010 130 76	92	25,00
B 8010 130 77	92	16,00
B 8010 130 78	92	23,00
B 8010 130 79	92	7,10
B 8010 130 81	92	17,00
B 8010 130 82	92	29,00
B 8010 130 84	92	29,00
B 8010 130 87	92	29,00
B 8010 130 88	92	62,00
B 8010 130 89	92	17,00
B 8010 130 90	92	18,00
B 8010 130 91	92	17,00
B 8010 130 92	92	17,00
B 8010 130 93	92	58,00
B 8010 130 94	92	29,00
B 8010 130 95	92	78,00
B 8010 130 96	92	120,00
B 8010 130 97	93	59,00
B 8010 130 98	93	30,00
B 8010 130 99	93	22,00
B 8010 131 11	93	32,00
B 8010 131 12	93	26,00
B 8010 131 13	93	21,00
B 8010 131 14	93	54,00
B 8010 131 17	93	16,00
B 8010 131 18	93	55,00
B 8010 131 19	93	83,00
B 8010 131 20	93	44,00
B 8010 131 21	93	37,00
B 8010 131 22	93	49,00
B 8010 131 23	93	34,00
B 8010 131 24	93	26,00
B 8010 131 25	93	65,00
B 8010 131 26	93	30,00
B 8010 131 27	93	37,00
B 8010 131 28	93	55,00

PART-NUMBER	PAGE	CAT.	PRICE SFR
B 8010 131 29	93		23,00
B 8010 131 31	93		47,00
B 8010 132 00	93		30,00
B 8010 140 17	99		19,00
B 8010 140 18	99		11,00
B 8010 140 19	99		26,00
B 8010 140 20	98		93,00
B 8010 140 21	99		20,00
B 8010 140 22	99		17,00
B 8010 140 23	99		19,00
B 8010 140 24	99		31,00
B 8010 140 25	99		33,00
B 8010 140 26	99		29,00
B 8010 140 27	103		34,00
B 8010 140 28	103		35,00
B 8010 140 31	103		33,00
B 8010 140 32	103		34,00
B 8010 140 33	103		34,00
B 8010 140 34	104		38,00
B 8010 140 35	103		34,00
B 8010 140 36	104		38,00
B 8010 140 39	114		8.200,00
B 8010 140 40	114		ON REQUEST
B 8010 140 41	114		ON REQUEST
B 8010 140 42	114		ON REQUEST
B 8010 140 43	114		ON REQUEST
B 8010 140 44	53		520,00
B 8010 140 45	53		470,00
B 8010 140 46	12		600,00
B 8010 140 47	12		42,00
B 8010 140 48	114		3.200,00
B 8010 140 75	99		34,00
B 8010 140 76	99		6,50
B 8010 140 77	99		41,00
B 8010 140 78	99		31,00
B 8010 140 91	99		330,00
B 8010 140 96	99		6,50
B 8010 140 97	99		6,20
B 8010 140 98	99		8,00
B 8010 140 99	99		6,20
B 8010 141 01	104		38,00
B 8010 141 02	104		38,00
B 8010 141 03	104		38,00
B 8010 141 04	104		38,00
B 8010 141 05	104		38,00
B 8010 141 06	104		38,00
B 8010 160 00	103		97,00
B 8010 160 01	103		67,00
B 8010 160 02	103		48,00
B 8010 160 03	103		48,00
B 8010 160 04	103		48,00
B 8010 160 05	103		42,00
B 8010 160 06	103		42,00
B 8010 160 07	103		42,00
B 8010 160 08	103		42,00
B 8010 160 09	103		42,00
B 8010 160 11	103		42,00
B 8010 160 12	103		42,00
B 8010 160 14	103		42,00
B 8010 160 15	104		42,00
B 8010 160 16	104		42,00
B 8010 160 17	104		42,00
B 8010 160 18	104		42,00
B 8010 160 19	104		40,00
B 8010 160 20	104		40,00
B 8010 160 21	104		40,00
B 8010 160 22	104		40,00
B 8010 160 23	104		40,00
B 8010 160 24	104		40,00
B 8010 160 31	105		120,00
B 8010 160 32	105		120,00
B 8010 160 33	105		120,00
B 8010 160 34	105		120,00
B 8010 160 35	105		120,00
B 8010 160 36	105		120,00
B 8010 160 41	105		120,00
B 8010 160 42	105		120,00
B 8010 160 43	105		120,00
B 8010 160 44	105		120,00
B 8010 160 52	105		150,00

PART-NUMBER	PAGE	CAT.	PRICE SFR
B 8010 160 53	105		150,00
B 8010 160 54	105		150,00
B 8010 160 60	23		550,00
B 8010 160 61	114		42,00
B 8010 160 62	114		9,90
B 8010 160 63	101		13.800,00
B 8010 160 64	101		14.100,00
B 8010 160 65	101		14.400,00
B 8010 160 66	101		14.400,00
B 8010 160 67	101		350,00
B 8010 160 68	101		200,00
B 8010 160 69	101		670,00
B 8010 160 80	18		51,00
B 8010 160 81	18		180,00
B 8010 160 82	19		290,00
B 8010 160 84	21		72,00
B 8010 160 85	54		11,00
B 8010 160 87	18		27,00
B 8010 160 88	18		35,00
B 8010 160 90	18		26,00
B 8010 160 91	101		5,00
B 8010 160 94	19		72,00
B 8010 160 95	19		72,00
B 8010 161 00	103		230,00
B 8010 161 01	103		230,00
B 8010 161 02	103		200,00
B 8010 161 03	103		99,00
B 8010 161 04	103		85,00
B 8010 161 05	103		70,00
B 8010 161 06	103		51,00
B 8010 161 07	103		51,00
B 8010 161 08	103		51,00
B 8010 161 09	103		230,00
B 8010 161 10	103		190,00
B 8010 161 11	103		85,00
B 8010 161 12	103		70,00
B 8010 161 13	103		57,00
B 8010 161 14	103		42,00
B 8010 161 15	103		42,00
B 8010 161 16	103		42,00
B 8010 161 17	103		42,00
B 8010 161 18	103		51,00
B 8010 161 19	103		51,00
B 8010 161 20	103		110,00
B 8010 161 21	103		57,00
B 8010 161 22	103		54,00
B 8010 161 23	103		39,00
B 8010 161 24	103		37,00
B 8010 161 25	103		37,00
B 8010 161 26	103		33,00
B 8010 161 27	103		33,00
B 8010 161 28	103		33,00
B 8010 161 29	103		33,00
B 8010 161 30	103		35,00
B 8010 161 31	103		35,00
B 8010 161 32	103		130,00
B 8010 161 33	103		68,00
B 8010 161 34	104		47,00
B 8010 161 35	103		47,00
B 8010 161 36	104		40,00
B 8010 161 37	103		33,00
B 8010 161 38	104		39,00
B 8010 161 39	104		39,00
B 8010 161 40	104		39,00
B 8010 161 41	103		34,00
B 8010 161 42	104		40,00
B 8010 161 43	105		35,00
B 8010 161 44	103		130,00
B 8010 161 45	103		73,00
B 8010 161 46	103		70,00
B 8010 161 47	103		41,00
B 8010 161 48	103		41,00
B 8010 161 49	103		40,00
B 8010 161 50	103		40,00
B 8010 161 51	103		40,00
B 8010 161 52	103		34,00
B 8010 161 53	103		34,00
B 8010 161 54	103		35,00
B 8010 161 55	103		35,00
B 8010 161 56	104		90,00

PART-NUMBER	PAGE	CAT.	PRICE SFR
B 8010 161 57	104		68,00
B 8010 161 58	104		42,00
B 8010 161 59	104		42,00
B 8010 161 60	104		40,00
B 8010 161 61	104		40,00
B 8010 161 62	104		37,00
B 8010 161 63	104		37,00
B 8010 161 64	104		37,00
B 8010 161 65	104		37,00
B 8010 161 66	104		37,00
B 8010 161 67	104		37,00
B 8010 161 68	104		110,00
B 8010 161 69	104		70,00
B 8010 161 70	104		55,00
B 8010 161 71	104		55,00
B 8010 161 72	104		51,00
B 8010 161 73	104		51,00
B 8010 161 74	104		130,00
B 8010 161 75	104		84,00
B 8010 161 76	104		62,00
B 8010 161 77	104		62,00
B 8010 161 78	104		55,00
B 8010 161 79	104		55,00
B 8010 161 80	104		160,00
B 8010 161 81	104		70,00
B 8010 161 82	104		42,00
B 8010 161 83	104		42,00
B 8010 161 84	104		42,00
B 8010 161 85	104		51,00
B 8010 161 86	104		190,00
B 8010 161 87	104		140,00
B 8010 161 88	104		57,00
B 8010 161 89	104		37,00
B 8010 161 90	104		37,00
B 8010 161 91	104		37,00
B 8010 161 92	104		42,00
B 8010 161 93	104		67,00
B 8010 161 94	104		51,00
B 8010 161 95	104		35,00
B 8010 161 96	104		35,00
B 8010 161 97	104		34,00
B 8010 161 98	104		34,00
B 8010 161 99	104		31,00
B 8010 162 00	104		31,00
B 8010 162 01	104		31,00
B 8010 162 02	104		33,00
B 8010 162 03	104		33,00
B 8010 162 04	104		68,00
B 8010 162 05	104		40,00
B 8010 162 06	104		39,00
B 8010 162 07	104		39,00
B 8010 162 08	104		37,00
B 8010 162 09	104		37,00
B 8010 162 10	104		35,00
B 8010 162 11	104		35,00
B 8010 162 12	104		35,00
B 8010 162 13	104		35,00
B 8010 162 14	104		37,00
B 8010 162 15	104		88,00
B 8010 162 16	104		65,00
B 8010 162 17	104		59,00
B 8010 162 18	104		59,00
B 8010 162 19	104		58,00
B 8010 162 20	104		59,00
B 8010 162 21	104		110,00
B 8010 162 22	104		66,00
B 8010 162 23	104		46,00
B 8010 162 24	104		46,00
B 8010 162 25	104		44,00
B 8010 162 26	104		44,00
B 8010 162 27	104		51,00
B 8010 162 28	104		37,00
B 8010 162 29	104		37,00
B 8010 162 30	104		57,00
B 8010 162 31	104		44,00
B 8010 162 32	104		44,00
B 8010 162 33	104		70,00
B 8010 162 34	104		74,00
B 8010 162 35	104		74,00
B 8010 162 36	104		76,00

PART-NUMBER	PAGE	CAT.	PRICE SFR
B 8010 162 37	104		43,00
B 8010 162 38	104		39,00
B 8010 162 39	104		37,00
B 8010 162 40	104		37,00
B 8010 162 41	104		37,00
B 8010 162 42	104		38,00
B 8010 163 60	73		550,00
B 8010 170 01	107		14,00
B 8010 170 03	106		15,00
B 8010 170 04	108		9,40
B 8010 170 05	108		7,80
B 8010 170 07	108		8,80
B 8010 170 08	109		3,30
B 8010 170 10	109		12,00
B 8010 170 11	107		24,00
B 8010 170 12	107		31,00
B 8010 170 13	106		5,80
B 8010 170 15	107		5,00
B 8010 170 16	107		8,80
B 8010 170 17	107		7,10
B 8010 170 19	107		7,10
B 8010 170 20	107		5,80
B 8010 170 21	107		9,90
B 8010 170 22	107		3,50
B 8010 170 23	107		6,90
B 8010 170 24	107		4,20
B 8010 170 27	108		6,40
B 8010 170 28	108		6,40
B 8010 170 30	106		9,50
B 8010 170 31	105		12,60
B 8010 170 32	108		12,00
B 8010 170 33	106		660,00
B 8010 170 35	106		28,00
B 8010 170 37	106		22,00
B 8010 170 38	105		25,00
B 8010 170 40	107		5,50
B 8010 170 42	108		32,00
B 8010 170 43	105		16,00
B 8010 170 44	108		16,00
B 8010 170 45	108		5,20
B 8010 170 47	107		200,00
B 8010 170 53	105		380,00
B 8010 170 54	106		1.200,00
B 8010 170 55	106		1.100,00
B 8010 173 33	106		660,00
B 8010 173 53	106		380,00
B 8010 173 55	106		1.100,00
B 8010 180 15	111		650,00
B 8010 180 16	112		21,00
B 8010 180 17	112		9,90
B 8010 180 20	112		230,00
B 8010 180 22	113		13,00
B 8010 180 23	113		11,00
B 8010 180 24	113		13,00
B 8010 180 25	113		8,30
B 8010 180 27	112		17,00
B 8010 180 36	112		35,00
B 8010 180 39	111		77,00
B 8010 180 40	111		57,00
B 8010 180 41	113		4,80
B 8010 180 42	113		5,80
B 8010 180 43	111		260,00
B 8010 180 44	112		120,00
B 8010 180 45	112		48,00
B 8010 180 46	112		25,00
B 8010 180 48	112		25,00
B 8010 180 49	112		25,00
B 8010 180 50	113		25,00
B 8010 180 51	113		25,00
B 8010 180 52	113		25,00
B 8010 180 53	112		770,00
B 8010 180 57	110		760,00
B 8010 181 71	113		15,00
B 8031 053	48		500,00
B 8031 054	48		370,00

BB...

PART-NUMBER	PAGE	CAT.	PRICE SFR
BB 002 758	35		BU 007 200 -T
BB P01 500	37		25.200,00
BB P01 510	38		26.700,00
BB P01 511	69		32.200,00
BB P01 520	38		29.900,00
BB P01 521	38		31.800,00
BB P01 522	38		30.600,00
BB P01 523	39		33.700,00
BB P01 526	69		37.600,00
BB P02 000	61		61.700,00
BB P02 001			62.500,00
BB P02 003	61		72.700,00
BB P02 004			75.300,00
BB P02 006	61		ON REQUEST
BB P02 250	71		10.100,00
BB P02 251			10.100,00
BB P02 500	59		45.500,00
BB 113 142 -1	72		6,30
BB 113 142 -2	72		6,30
BB 113 375 -U	75		370,00
BB 146 004 -T	36		ON REQUEST
BB 146 005 -T	36		230,00
BB 146 006 -T			BB 146 555 -T
BB 146 007 -T	51		510,00
BB 146 008 -T	51		17.500,00
BB 146 009 -T	52		86,00
BB 146 010 -T	52		170,00
BB 146 011 -T	52		190,00
BB 146 012 -T	52		190,00
BB 146 013 -T	52		6.900,00
BB 146 014 -T	52		6.900,00
BB 146 015 -T	52		7.300,00
BB 146 016 -T	52		7.300,00
BB 146 017 -T	35		7.400,00
BB 146 022 -T			340,00
BB 146 024 -T			290,00
BB 146 028 -T			290,00
BB 146 036 -T			95,00
BB 146 068 -T			57,00
BB 146 070 -T			570,00
BB 146 071 -T			510,00
BB 146 098 -T			1.100,00
BB 146 140 -T			310,00
BB 146 161 -T			500,00
BB 146 225 -T			530,00
BB 146 226 -T			950,00
BB 146 270 -T			300,00
BB 146 278 -T			260,00
BB 146 517 -T			ON REQUEST
BB 146 518 -T			ON REQUEST
BB 146 519 -T			ON REQUEST
BB 146 520 -T			360,00
BB 146 521 -T			390,00
BB 146 540 -T			3.700,00
BB 146 555 -T			ON REQUEST
BB 146 564 -T			2.100,00
BB 146 570 -T			ON REQUEST
BB 163 006 -T	35		ON REQUEST
BB 172 039 -T	67		3.900,00
BB 172 048 -W	63		BB 146 521 -T
BB 172 049 -W	67		2.030,00
BB 172 050 -T	64		1.100,00
BB 172 056 -U			230,00
BB 172 058 -U			450,00
BB 172 065 -X			160,00
BB 172 074 -R			23,00
BB 172 075 -T	65		580,00
BB 172 076 -T	67		1.800,00
BB 172 078 -T			290,00
BB 172 095 -T	50		770,00
BB 172 103 -T	36		BB 146 564 -T
BB 172 104 -T	36		2.600,00
BB 172 110 -T	67		780,00
BB 172 120 -T	64		2.200,00
BB 172 127 -T			580,00

PART-NUMBER	PAGE	CAT.	PRICE SFR
BB 172 133 -T	65		750,00
BB 172 140 -T	45		170,00
BB 172 160 -T	63		220,00
BB 172 178 -T	45		600,00
BB 172 194 -R			23,00
BB 172 202 -T	63		650,00
BB 172 218 -X			140,00
BB 172 221 -T	63		470,00
BB 172 222 -T	63		5.650,00
BB 172 223 -T	62		8.500,00
BB 172 224 -T	64		1.300,00
BB 172 225 -T	63		1.800,00
BB 172 226 -T	62		5.500,00
BB 172 227 -T	64		600,00
BB 172 228 -T	63		9.000,00
BB 172 231 -W	64		1.600,00
BB 172 232 -T	64		5.100,00
BB 172 233 -T	66		500,00
BB 172 350 -T	62		16.900,00
BB 172 490 -T	63		1.900,00
BB 172 490 -T	63		BG M79 350
BB 172 491 -T	64		BB 146 014 -T
BB 172 492 -T	66		BB 146 015 -T
BB 172 493 -W	68		950,00
BB 172 494 -T	70		14.400,00
BB 172 495	73		13,00
BB 172 496 -T			ON REQUEST
BB 172 497 -T	70		6.900,00
BB 172 518 -T			250,00
BB 172 522 -T			230,00
BB 172 524 -T			260,00
BB 172 550 -T	63		6.100,00
BB 172 581 -T	66		1.200,00
BB 172 585 -T	51		230,00
BB 172 590 -W	63		BB 146 161 -T
BB 172 612 -T	62		370,00
BB 172 626 -T	36		1.100,00
BB 172 635 -T	51		510,00
BB 172 686 -T	64		2.700,00
BB 172 704 -T			1.100,00
BB 172 751 -T			200,00
BB 172 825 -T	63		7.800,00
BB 172 880 -T	60		1.100,00
BB 172 909 -T	60		600,00
BB 172 911 -T			ON REQUEST
BB 172 914 -T	60		2.800,00
BB 172 917 -T	60		4.000,00
BB 172 935 -T	60		1.500,00
BB 176 036 -T			340,00
BB 176 041 -T	68		BB 146 016 -T
BB 176 042 -T	69		17.900,00
BB 176 046 -T	60		350,00
BB 176 090 -T	65		190,00
BB 176 114 -T	66		17.400,00
BB 176 251 -T	51		480,00
BB 176 290	75		49,00
BB 176 292 -T	70		750,00
BB 176 293 -T	70		1.500,00
BB 176 294 -W	65		240,00
BB 176 296 -W	51		540,00
BB 176 298	73		12,00
BB 176 300 -T	62		470,00
BB 176 301 -T	66		1.900,00
BB 176 302 -T	66		2.100,00
BB 176 303 -T	67		5.900,00
BB 176 423 -T	75		52,00
BB 176 440 -T	62		18.300,00
BB 176 442 -T	62		2.300,00
BB 176 585 -T	41		230,00
BB 176 590 -T	50		720,00
BB 176 600 -T	63		1.200,00
BB 176 610 -T			670,00
BB 176 694 -W	68		6.600,00
BB 176 727 -U	35		290,00
BB 176 731	35		30,00
BB 176 743 -X	36		130,00
BB 176 746 -X	36		130,00
BB 176 749 -X	36		130,00
BB 176 752 -T	36		840,00

PART-NUMBER	PAGE	CAT.	PRICE SFR
BB 176 770 -T	36		2.300,00
BB 176 771 -T	36		260,00
BB 176 772 -T	36		210,00
BB 176 773 -T	36		210,00
BB 176 794 -T	36		330,00
BB 176 807 -T			280,00
BB 176 810	73		15,00
BB 176 812	66		520,00
BB 176 813 -T			110,00
BB 176 814 -T			340,00
BB 176 830 -T	51		320,00
BB 176 865 -T			960,00
BB 176 871 -T	65		300,00
BB 176 872 -T	73		59,00
BB 176 874 -T	50		130,00
BB 176 924 -T			ON REQUEST
BB 176 926 -W	36		680,00
BB 176 941 -T			580,00
BB 176 942 -W			960,00
BB 176 962 -T			4.200,00
BB 176 963 -T			6.100,00
BB 176 964 -T			4.600,00
BB 176 965 -T			8.600,00
BB 176 980 -T			14.400,00
BB 176 982 -T			16.100,00
BB 176 984 -T			14.700,00
BB 176 986 -T			19.000,00
BB 181 017 -T	45		470,00
BB 181 021 -W			51,00
BB 183 700	68		4.100,00
BB 186 205 -W	35		1.200,00
BB 187 035 -T	65		1.600,00
BB 187 036 -T	67		2.500,00
BB 187 038 -T	65		1.800,00
BB 187 040 -T	37		960,00
BB 187 041 -T	45		220,00
BB 187 042 -T	45		5.000,00
BB 187 104 -X	74		290,00
BB 187 195	38		220,00
BB 187 200 -T	65		420,00
BB 187 200	73		15,00
BB 187 201	73		15,00
BB 187 202	73		15,00
BB 187 407 -T	66		2.500,00
BB 187 477 -T			570,00
BB 187 548 -T	37		2.100,00
BB 187 578 -T	37		340,00
BB 187 579 -T	38		600,00
BB 187 580 -T	38		320,00
BB 187 581 -T	38		1.700,00
BB 187 627 -T	70		1.900,00
BB 187 638 -T	51		320,00
BB 187 655 -T	37		1.600,00
BB 187 656 -T	37		3.900,00
BB 187 665 -T	41		130,00
BB 187 741 -T			690,00
BB 187 775 -T	66		2.700,00
BB 187 776 -T	66		5.900,00
BB 187 780 -T	40		190,00
BB 187 795 -T	37		230,00
BB 187 950 -U	66		580,00
BB 187 993 -T	39		4.400,00
BB 192 047 -T	36		1.200,00
BB 192 063 -T	35		590,00
BB 192 068 -T	74		170,00
BB 192 069 -T	73		270,00
BB 192 070 -T	55		220,00
BB 192 071 -T	55		420,00
BB 192 115 -T	35		110,00
BB 192 153 -T	41		2.000,00
BB 192 200 -T	55		420,00
BB 192 201 -T	55		340,00
BB 192 203 -T	45		220,00
BB 192 204 -T	45		220,00
BB 192 205 -T	45		650,00
BB 192 206 -T	45		650,00
BB 192 210 -T	65		420,00
BB 192 219 -T	66		6.200,00
BB 192 224 -T	42		2.700,00
BB 192 226 -T	42		2.400,00

PART-NUMBER	PAGE	CAT.	PRICE SFR
BB 192 227 -T	42		3.500,00
BB 192 229 -T	42		670,00
BB 192 233 -T	42		3.300,00
BB 192 239 -T	43		1.100,00
BB 192 241 -T	43		3.200,00
BB 192 243 -T	43		5.100,00
BB 192 245 -T	43		4.400,00
BB 192 246 -T	43		2.900,00
BB 192 247 -T	44		1.500,00
BB 192 248 -T	44		1.300,00
BB 192 249 -T	44		550,00
BB 192 275 -T	39		1.400,00
BB 192 276 -T	39		2.100,00
BB 192 277 -T	39		520,00
BB 192 278 -T	40		1.900,00
BB 192 279 -T	40		5.100,00
BB 192 280 -T	40		920,00
BB 192 281 -T	40		2.100,00
BB 192 282 -T	40		3.200,00
BB 192 283 -T	40		1.800,00
BB 192 284 -T	41		1.500,00
BB 192 285 -T	41		2.100,00
BB 192 288 -T	39		1.200,00
BB 192 289 -T	42		3.100,00
BB 192 290 -T	44		5.400,00
BB 192 291 -T	44		1.700,00
BB 192 292 -T	44		1.500,00
BB 192 293 -T	44		1.400,00
BB 192 295 -T	41		76,00
BB 192 296 -T	41		87,00
BB 192 297 -T	41		530,00
BB 192 298 -T	41		530,00
BB 192 390 -T	41		76,00
BB 192 432 -T	39		2.800,00
BB 192 444 -T	45		3.100,00
BB 192 445 -T	45		4.700,00
BB 192 477 -T	64		5.900,00
BB 192 481 -T	43		5.600,00
BB 192 501 -T	74		87,00
BB 199 976 -T	35		3.900,00
BB 241 502 -T	51		BG 241 502 -T
BB 241 503 -T	51		BG 241 503 -T
BB 800 004 -D	115		42,00
BB 845 352 -T	62		BN 845 352 -T

BD...

PART-NUMBER	PAGE	CAT.	PRICE SFR
BD 481 068 -T	54		54,00
BD 481 082 -T	54		93,00
BD 481 177 -T	54		ON REQUEST
BD 481 222 -T	54		24,00
BD 481 282 -T	54		23,00
BD 481 382 -T	54		44,00
BD 481 437 -T	54		29,00
BD 481 505	54		7,00
BD 481 900	56		12,00
BD 481 901	56		12,00
BD 481 902	56		110,00
BD 482 020	55		1,70
BD 482 056	54		12,00
BD 483 300			ON REQUEST
BD 484 049	51		8,20
BD 484 055	53		5,20
BD 484 056			31,00
BD 484 058			31,00
BD 484 059	53		69,00
BD 484 060	53		21,00

BG...

PART-NUMBER	PAGE	CAT.	PRICE SFR
BG G12 750	52		550,00
BG G12 751	52		620,00
BG M05 000	67		2.200,00
BG M05 001			2.200,00
BG M05 750	62		4.500,00
BG M13 250			BG M13 256
BG M13 256			2.600,00
BG M25 000	50		6.600,00
BG M35 500			980,00
BG M41 010			1.400,00
BG M66 500	60		1.700,00
BG M67 000	60		3.900,00
BG M79 250			7.650,00
BG S04 250	52		5.400,00
BG 241 502 -T	51		400,00
BG 241 503 -T	51		240,00
BG 242 454 -T			1.700,00
BG 513 333 -U	52		220,00
BG 519 939 -T	52		120,00
BG 519 940 -T	52		86,00
BG 519 941 -T	52		86,00
BG 519 944 -T	52		99,00
BG 521 300 -U	60		1.600,00
BG 530 700 -T			3.700,00
BG 530 752 -W			2.600,00
BG 530 753 -W			2.700,00
BG 542 531 -T	52		500,00

BK...

PART-NUMBER	PAGE	CAT.	PRICE SFR
BK J02 750	60		3.100,00
BK 202 181 -T	50		BG 242 454 -T
BK 202 215 -R			BD 484 049
BK 203 161	51		2,00
BK 203 190 -X	51		180,00
BK 203 191 -X	51		180,00
BK 203 192	51		76,00
BK 204 001 -T	50		2.500,00

BN...

PART-NUMBER	PAGE	CAT.	PRICE SFR
BN 845 100 -T	51		1.200,00
BN 845 101 -T	51		1.800,00
BN 845 104 -T	52		380,00
BN 845 126 -T	70		2.800,00
BN 845 131 -T	51		350,00
BN 845 350 -T	51		720,00
BN 845 351 -T			1.500,00
BN 845 352 -T	75		490,00

PART-NUMBER	PAGE	CAT.	PRICE SFR
BP...			
BP 004 750	62		860,00
BP 004 753	77		590,00
BP 004 501	59		18.300,00
BP 004 502	59		24.900,00
BP 012 220	60		ON REQUEST
BP 014 630	76		720,00
BP 213 611 -T			620,00
BP 213 950 -T			4.000,00
BP 220 735 -X			830,00
BP 330 976 -T	37		1.600,00
BP 330 977 -T	35		1.600,00
BP 335 716 -T	77		BP 335 787 -T
BP 335 787 -T			ON REQUEST
BU...			
BU 003 024 -R	14		110,00
BU 003 025 -T	14		110,00
BU 003 026 -T	15		300,00
BU 003 027 -T	23		310,00
BU 003 028 -T	23		340,00
BU 003 036	15		36,00
BU 003 043 -T	17		9,70
BU 003 044 -T	17		9,70
BU 003 045 -T	17		9,70
BU 003 063	20		16,00
BU 003 064 -T	20		16,00
BU 003 066 -X	20		130,00
BU 003 071 -T	20		33,00
BU 003 072 -T	22		130,00
BU 003 082 -T	22		39,00
BU 003 087 -X	18		43,00
BU 003 094 -T	20		26,00
BU 003 098 -T	23		27,00
BU 003 099 -T	23		5,60
BU 003 100 -T	23		5,60
BU 003 101 -T	23		5,60
BU 003 104 -R	14		39,00
BU 003 105 -T	23		360,00
BU 003 116 -T	15		8,50
BU 003 121 -T	19		120,00
BU 003 122 -T	19		430,00
BU 003 124 -T	24		140,00
BU 003 146 -T	24		79,00
BU 003 151 -T	20		26,00
BU 003 161 -T			250,00
BU 003 162 -T			290,00
BU 003 326 -T	15		300,00
BU 003 327 -T	23		310,00
BU 003 328 -T	23		340,00
BU 004 021 -T	26		1.500,00
BU 004 023 -T	25		570,00
BU 004 321 -T	26		1.500,00
BU 005 016 -T	29		7,50
BU 005 017 -T	29		7,50
BU 005 018 -T	29		8,10
BU 005 019 -T	29		8,10
BU 005 020 -T	29		8,10
BU 005 021 -T	29		8,10
BU 005 022 -T	29		6,90
BU 005 023 -T	29		6,90
BU 005 030 -T	29		11,00
BU 005 038 -T	30		21,00
BU 005 065 -T	31		15,00
BU 005 066 -T	31		14,00
BU 005 067 -T	31		8,50
BU 005 068 -T	31		7,50
BU 005 069 -T	31		8,50
BU 006 006 -T	32		21,00
BU 006 007 -T	32		21,00
BU 006 011 -T	32		63,00
BU 006 017 -T	32		91,00
BU 006 019 -T	32		640,00
BU 006 020 -T	32		91,00
BU 006 021 -T	33		75,00
BU 006 022 -T	33		220,00
BU 006 025 -T	34		560,00
BU 006 026 -T	33		590,00
BU 006 027 -T	33		38,00
BU 006 028 -T	33		52,00
BU 006 029	33		13,00
BU 006 030 -T	34		170,00
BU 006 031 -T	33		16,00
BU 006 032 -T	34		620,00
BU 006 033 -T	32		22,00
BU 006 034 -T	32		90,00
BU 006 035 -T	32		24,00
BU 006 319 -T	32		640,00
BU 006 326 -T	33		580,00
BU 006 382 -W	34		620,00
BU 007 001 -T	46		2.700,00
BU 007 002 -T	46		190,00
BU 007 003 -T	46		610,00
BU 007 004 -T	46		1.700,00
BU 007 005 -T	46		1.300,00
BU 007 006 -T	47		1.300,00
BU 007 007 -T	47		1.980,00
BU 007 009 -T	47		220,00
BU 007 009 -T	47		520,00
BU 007 010 -T	48		B 8031 054
BU 007 011 -T	48		430,00
BU 007 012 -T	47		1.100,00
BU 007 013 -T	47		860,00
BU 007 014 -T	47		1.600,00
BU 007 015 -T	47		1.700,00
BU 007 016 -T	48		3.500,00
BU 007 017 -T	48		420,00
BU 007 018 -T	48		ON REQUEST
BU 007 021 -T	48		550,00
BU 007 053 -T	52		7.100,00
BU 007 054 -T	52		7.100,00
BU 007 055 -T	52		6.700,00
BU 007 061 -T	53		9,80
BU 007 062 -T	53		9,80
BU 007 063 -T	53		9,80
BU 007 064 -T	53		41,00
BU 007 066 -T	53		46,00
BU 007 067 -T	53		7,30
BU 007 068 -T	53		2,50
BU 007 069 -T	53		23,00
BU 007 070 -T	53		34,00
BU 007 071 -T	53		45,00
BU 007 072 -T	53		46,00
BU 007 073 -T	53		13,00
BU 007 074 -T	53		34,00
BU 007 075 -T	53		43,00
BU 007 076 -T	53		64,00
BU 007 077 -T	53		19,00
BU 007 078 -T	53		3,10
BU 007 079 -T	55		79,00
BU 007 081 -T	56		45,00
BU 007 098	56		9,30
BU 007 101 -T	55		29,00
BU 007 102 -T	54		16,00
BU 007 104 -T	54		15,00
BU 007 107 -T	55		62,00
BU 007 110 -T	46		150,00
BU 007 111 -T	46		660,00
BU 007 112	46		340,00
BU 007 115 -T	55		58,00
BU 007 116 -T	50		7.800,00
BU 007 120 -T	95		7.800,00
BU 007 121 -T	96		820,00
BU 007 122 -T	96		110,00
BU 007 123 -T	96		110,00
BU 007 124 -T	96		110,00
BU 007 126 -T	96		250,00
BU 007 127 -T	96		77,00
BU 007 128 -T	96		870,00
BU 007 129 -T	96		820,00
BU 007 143 -T	52		730,00
BU 007 144 -T	52		730,00
BU 007 145 -T			510,00
BU 007 150 -T	95		ON REQUEST
BU 007 151 -T	95		ON REQUEST
BU 007 152 -T	95		120,00
BU 007 153 -T	95		640,00
BU 007 155 -T	95		ON REQUEST
BU 007 156 -T	95		ON REQUEST
BU 007 157 -T	95		ON REQUEST
BU 007 158 -T	95		ON REQUEST
BU 007 160 -T	96		2.600,00
BU 007 161 -T	49		20,00
BU 007 162 -T	96		1.300,00
BU 007 163 -T			240,00
BU 007 164 -T			360,00
BU 007 165 -T			3.000,00
BU 007 170 -T	49		4.900,00
BU 007 200 -T			ON REQUEST
BU 007 222	96		55,00
BU 007 223	96		110,00
BU 007 224	96		55,00
BU 007 227	96		55,00
BU 007 250 -T			17.400,00
BU 007 252 -T			910,00
BU 007 254 -T			1.100,00
BU 007 255 -T			1.200,00
BU 007 257 -T			830,00
BU 007 258 -T			860,00
BU 007 259 -T			14.200,00
BU 007 260 -T			6.700,00
BU 007 271 -T			430,00
BU 007 273 -T			1.100,00
BU 007 274 -T			690,00
BU 007 280 -W			2.000,00
BU 007 281 -T			690,00
BU 007 282 -T			360,00
BU 007 283 -T			450,00
BU 007 284 -T			190,00
BU 007 285 -T			160,00
BU 007 286 -T			2.300,00
BU 008 001 -T	57		16,00
BU 008 002 -T	57		25,00
BU 008 004 -T	57		6,80
BU 008 007 -T	57		23,00
BU 008 013 -T			300,00
BU 008 015 -T			540,00
BU 008 016 -T			550,00
BU 008 017 -T	57		72,00
BU 008 019 -T	58		21,00
BU 008 020 -T	58		6,60
BU 010 021 -T	93		4,40
BU 011 006 -T	79		17,60
BU 011 010 -T	83		31,00
BU 011 013 -T	80		970,00
BU 011 014 -T	80		11,00
BU 011 015 -T	80		2.100,00
BU 011 016 -T	80		47,00
BU 011 017 -T	80		12,00
BU 011 019 -T	88		7,10
BU 011 022 -T	81		3.100,00
BU 011 024 -T	83		15,00
BU 011 025 -T	83		15,00
BU 011 026 -T	83		15,00
BU 011 027 -T	84		15,00
BU 011 028 -T	84		9,90
BU 011 029 -T	84		9,90
BU 011 030 -T	84		9,90
BU 011 031 -T	84		9,90
BU 011 032 -T	84		9,90
BU 011 034	84		19,00
BU 011 035	84		28,00
BU 011 036	84		31,00
BU 011 039	84		34,00
BU 011 040	84		52,00
BU 011 041 -T	85		1.300,00
BU 011 043 -T	85		45,00
BU 011 044 -T	85		900,00
BU 011 045	84		46,00

PART-NUMBER	PAGE	CAT.	PRICE SFR
BU 011 046	84		33,00
BU 011 048	84		43,00
BU 011 049 -T	86		410,00
BU 011 050 -T	85		130,00
BU 011 052	84		20,00
BU 011 053 -T	85		29,00
BU 011 054 -T	86		150,00
BU 011 060 -T	85		47,00
BU 011 061 -T	85		47,00
BU 011 064 -T	85		2,50
BU 011 072 -T	86		16,00
BU 011 074 -T	86		95,00
BU 011 077 -T	87		57,00
BU 011 078 -T	87		13,00
BU 011 079 -T	87		13,00
BU 011 080 -T	87		360,00
BU 011 081 -T	87		44,00
BU 011 082 -T	89		130,00
BU 011 085 -T	88		290,00
BU 011 091 -T	89		12,00
BU 011 093 -T	90		390,00
BU 011 096 -T	89		69,00
BU 011 098 -T	81		810,00
BU 011 099 -T	81		560,00
BU 011 100 -T	81		82,00
BU 011 103 -T	83		6,40
BU 011 104 -T	83		8,70
BU 011 105 -T	83		11,00
BU 011 106 -T	83		16,00
BU 011 107 -T	87		2,90
BU 011 108 -T	87		9,90
BU 011 109 -T	87		5,50
BU 011 111 -T	87		16,00
BU 011 115 -T	79		12,00
BU 011 116 -T	79		12,00
BU 011 117 -T	79		12,00
BU 011 118 -T	79		12,00
BU 011 119 -T	83		2,80
BU 011 120 -T	94		5.300,00
BU 011 121 -T	94		120,00
BU 011 122 -T	94		130,00
BU 011 123 -T	94		130,00
BU 011 124 -T	94		40,00
BU 011 125 -T	94		25,00
BU 011 126 -T	94		38,00
BU 011 127 -T			200,00
BU 011 133 -T	82		39,00
BU 011 139 -T	82		7,10
BU 011 140 -T	80		5.000,00
BU 011 145 -T	83		14.700,00
BU 011 146 -T			11.700,00
BU 011 147 -T			3.400,00
BU 011 315 -T	80		2.100,00
BU 011 320 -T	94		5.300,00
BU 011 322 -T	81		3.100,00
BU 011 340 -T	81		5.000,00
BU 011 341 -T	85		1.300,00
BU 011 344 -T	85		900,00
BU 011 471 -T	94		190,00
BU 012 005 -T	73		250,00
BU 012 015 -T	74		60,00
BU 012 017 -T	74		9,70
BU 012 023 -T	75		130,00
BU 012 024 -T	71		10.100,00
BU 012 029 -T	73		310,00
BU 012 033 -T	75		41,00
BU 012 034 -T	75		5.000,00
BU 012 035 -T	76		1.100,00
BU 012 037 -T	76		440,00
BU 012 040 -T	76		400,00
BU 012 041 -T			66,00
BU 012 043 -T	73		390,00
BU 012 044 -T	74		130,00
BU 012 045 -T	74		360,00
BU 012 051 -T	72		1.200,00
BU 012 052 -T	72		360,00
BU 012 053	72		23,00
BU 012 054	72		23,00
BU 012 055	72		23,00
BU 012 056	72		23,00
BU 012 057	72		23,00
BU 012 061 -T			1.700,00
BU 012 335			1.100,00
BU 013 051 -T	92		180,00
BU 013 055 -T	92		130,00
BU 013 056 -T	92		140,00
BU 013 057 -T	92		130,00
BU 013 058 -T	92		160,00
BU 013 059 -T	92		250,00
BU 013 060 -T	92		110,00
BU 013 061 -T	92		120,00
BU 013 066 -T	92		97,00
BU 014 001 -T	96		28,00
BU 014 002 -T	96		25,00
BU 014 003 -T	96		28,00
BU 014 004 -T	96		28,00
BU 014 005 -T	96		28,00
BU 014 006 -T	96		34,00
BU 014 007 -T	97		5,30
BU 014 008 -T	97		14,00
BU 014 009 -T	97		26,00
BU 014 010 -T	98		25,00
BU 014 011 -T	98		31,00
BU 014 012 -T	97		24,00
BU 014 013 -T	97		24,00
BU 014 014 -T	98		1.400,00
BU 014 015 -T	98		33,00
BU 014 016 -T	98		250,00
BU 014 029 -T	102		650,00
BU 014 030 -X	102		29,00
BU 014 038 -T	97		43,00
BU 014 049 -T	98		9,90
BU 014 050 -T	98		400,00
BU 014 051 -T	98		450,00
BU 014 052 -T	97		24,00
BU 014 053 -T	98		290,00
BU 014 054 -T	96		28,00
BU 014 055 -T	97		68,00
BU 014 056 -T	97		41,00
BU 014 057 -T	97		26,00
BU 014 058	97		5,00
BU 014 059	97		5,00
BU 014 060 -T	103		170,00
BU 014 061 -T	103		170,00
BU 014 062 -T	103		170,00
BU 014 063 -X	103		140,00
BU 014 064 -T	103		170,00
BU 014 065 -X	103		140,00
BU 014 069 -T	102		280,00
BU 014 070 -X	102		15,00
BU 014 073	97		32,00
BU 014 074 -T	97		150,00
BU 014 079 -T	102		650,00
BU 014 080 -X	102		29,00
BU 014 088 -T			500,00
BU 014 089 -T	102		140,00
BU 014 090 -X	102		12,00
BU 014 092 -T	97		14,00
BU 014 093 -T	97		27,00
BU 014 095 -T	99		8,80
BU 014 110 -X	102		29,00
BU 014 112 -X	102		29,00
BU 014 119 -X	102		29,00
BU 014 130 -T			14,00
BU 014 131 -T			14,00
BU 014 314 -T	98		1.400,00
BU 014 449			53,00
BU 015 001 -T	100		8.300,00
BU 015 301 -T	100		8.300,00
BU 016 070 -X	102		470,00
BU 016 071 -X	102		450,00
BU 016 072 -X	103		470,00
BU 016 073 -X	103		450,00
BU 016 074 -X	103		470,00
BU 016 075 -X	103		450,00
BU 016 076 -X	103		450,00
BU 016 077 -X			470,00
BU 016 092 -T	19		7,40
BU 016 093 -T	19		690,00
BU 016 243	105		290,00
BU 016 244	105		310,00
BU 016 245	105		170,00
BU 016 246	105		790,00
BU 016 247 -T	105		700,00
BU 016 248 -T	105		800,00
BU 016 249 -T	105		800,00
BU 016 250 -T	105		35,00
BU 016 251 -T	105		530,00
BU 016 252 -T	105		350,00
BU 016 253 -T	105		66,00
BU 016 254 -T	105		500,00
BU 016 255 -T	105		600,00
BU 016 256 -T	105		460,00
BU 016 257 -T	105		330,00
BU 016 258 -T	105		140,00
BU 016 259 -T	105		270,00
BU 016 260 -T			ON REQUEST
BU 016 261 -T			110,00
BU 016 262 -X			29,00
BU 016 393 -T	19		690,00
BU 017 002 -T	106		240,00
BU 017 006 -T	108		7,80
BU 017 009 -T	109		110,00
BU 017 014 -T	107		8,30
BU 017 025 -T	108		16,00
BU 017 026 -T	108		10,00
BU 017 029 -T	105		27,00
BU 017 034 -T	106		9,90
BU 017 035 -T	106		180,00
BU 017 039 -T	109		49,00
BU 017 046 -T	107		130,00
BU 018 001 -T	110		29.200,00
BU 018 004 -T	110		1.400,00
BU 018 005 -T	111		130,00
BU 018 006 -T	111		130,00
BU 018 007 -T	111		2.200,00
BU 018 008 -T	111		4.400,00
BU 018 009 -T	111		130,00
BU 018 010 -T	111		160,00
BU 018 011 -T	111		160,00
BU 018 012 -T	111		160,00
BU 018 013 -T	111		140,00
BU 018 014 -T	111		630,00
BU 018 018 -T	112		9,60
BU 018 021 -T	111		430,00
BU 018 031 -T	113		1.300,00
BU 018 033 -T	112		50,00
BU 018 055 -T	110		360,00
BU 018 056 -T	110		330,00
BU 018 301 -T	110		29.200,00
BU 018 321 -T	111		430,00
BU 018 470 -T	113		44,00
BU 020 001 -T	77		46.200,00
BU 020 003 -T	78		7.800,00
BU 020 004 -T	77		2.400,00
BU 020 005 -T	78		3.400,00
BU 020 006 -T	78		12.600,00
BU 020 007 -T	78		16.100,00
BU 020 010 -T	78		2.300,00
BU 020 012 -T	78		750,00
BU 020 013 -T	78		650,00
BU 020 014 -T	78		1.100,00
BU 020 015 -T	78		750,00
BU 020 016 -T	78		6.800,00
BU 020 017 -T	78		310,00
BU 020 018 -T			1.100,00
BU 020 020 -T	77		30.000,00
BU 8007 027	24		26,00
BU 8007 028	24		86,00
BU 8007 099	24		23,00
BU 8012 022	24		29,00

PART-NUMBER	PAGE	CAT.	PRICE SFR
PK...			
PK 024 304	35		ON REQUEST
PK V40 003			ON REQUEST
PK Z90 012	78		ON REQUEST
PM...			
PM S01 450	59		ON REQUEST
PM E01 750			ON REQUEST
PM Z00 120			ON REQUEST
PM 003 413 -T			ON REQUEST

REPORT

Preparation and analysis of bulk specimens and thin films using the universal ion beam etching device IEU 100 from BALZERS

H. Bach

Short summary:

Using the IEU 100 areas of specimens measuring from several microns can be thinned to a thickness that allows transmission, and surfaces of several millimeters diameter can be evenly and uniformly etched for analysis in the electron microscope (TEM and SEM as well as TSEM). (In addition, by recording the current of the secondary ions and/or the intensity of the excited photons, both of which originate at the bottom of etch pits, compounds can be analyzed). Element analysis in the electron microsope can be supplemented by continuously recording the signal intensity of individual elements, and thus in-depth concentration profiles with high in-depth resolutions (sometimes better than 5 nm) can be obtained. Certain signal changes in the concentration profile can be attributed to changes in the structure and the crystal structure. All results for bulk specimens and light transparent films can be supplemented by an analysis of UV or IR absorption spectra.

A survey in table form of all the investigation possibilities with the combined use of the complete electron microscope analytical equipment (TEM and SEM or TSEM) and the IEU 100 shows that a comprehensive set of information on elements, structure and crystal structure in bulk specimens or their gradients in surface layers can be obtained.

Published in: Beitr. elektronenmikroskop. Direktabb. Oberfl. 12/1 (1979) S. 277 – 306 contributed at the 12th Kolloquium des Arbeitskreises fur Elektronenmikroskopische Direktabbildung und Analyse von Oberflächen (EDO) 9. bis 14. September 1979 in Tubingen. Editor: Prof. Dr. G. Pfefferkorn

Author's address:

Dr. H. Bach, Zentralbereich Forschung und Entwicklung des Jenaer Glaswerks Schott & Gen., Mainz Hattenbergstrasse 10, 6500 Mainz

1. Introduction:

Because of ion beam etching, investigations with the electron microscope of the structure and crystal structure of bulk specimens and thin surface films and coatings is made possible for specimens that could not be prepared for the electron microscope by any other method (such as liquid etching or cutting). Ion beam etching produces surfaces without any contamination or redeposition. Information about the structure can be gained from the etching. Information on grain boundaries, phase separation, and other phenomena can be taken directly from the contrasts of the secondary signals in scanning electron microscope (SEM). The replicas from transmission electron microscopy (TEM) make these features visible. Compare (1) – (5) and the papers quoted.

A focussed ion beam can even produce electron transparent thinned specimens of especially brittle material such as oxide ceramics and different types of glass (6) – (9) which can then be studied in the transmission electron microscope. Beyond this, information on the crystal structure of these thinned specimens can be obtained from electron diffraction patterns (2) – (4), (6) – (9). When there is no data available on the elements present in the sample to back up the results of the electron diffraction patterns, for example, the data can be obtained by energy dispersive X-ray analysis (EDS) or wavelength dispersive X-ray spectroscopy (WDS). Appropriate accessory devices are available for most scanning and transmission electron microscopes. Detection of elements with atomic numbers $Z < 10$ is difficult and sometimes impossible using energy dispersive or wavelength dispersive analysis (5) (10). In many cases electron microscopes are not equipped for the connection of an Auger electron spectrometer to identify the lighter elements. Then it is advantageous to have other element analysis methods available such as secondary ion mass spectrometry (11) – (13) or spectrochemical analysis (14) (compare 15), in addition to electron microscopy. At the same time there is the possibility of concentration analysis of surface profiles, which is often necessary in material analysis to clarify the construction of thin surface layers or diffusion and interdiffusion processes on surfaces and in multilayer systems, (compare, for example, (15) – (18).) Installation of these devices in the electron microscope is possible and sometimes unavoidable in order to carry out additional analyses in situ (compare also (15) – (19).) If, however, ion etching must be frequently used, for example in concentration profile analysis, installation of the etching device in the microscope can be disadvantageous because the area around the specimen sputtered by the ion beam becomes coated with the specimen material. In addition, a concentration profile analysis in the electron microscope limits the operation time for the analysis with the electron microscope itself. Thus, it is advantageous to have an additional instrument available which allows the specimen to be prepared for the electron microscope on the one hand and also allows the extension of material analysis possibilities with additional analytical equipment on the other. For this the construction of the equipment should be adapted to the requirements of the special application.

The following will show how these requirements are met by the BALZERS Universal Ion Etching Device IEU 100 because of its modular design which permits the system to be modified at any time. It will also be shown how the application possibilities of this device can be combined with analysis in the electron microscope to obtain a comprehensive set of information on bulk specimens and their surface layers and coatings.

2. Design and Principle of Operation of the Ion Etching Device IEU 100

2.1 Vacuum chamber and movement of the specimen

Fig. 1A shows the design of the IEU 100. Fig. 1B shows a view of the ion etching system without the accessory equipment for profile analysis. An ion source is built into the upper part of a vertical cylindrical chamber column measuring 100 nm in diameter (DN 100 ISO-K). From this source an ion beam is extracted and aimed at the specimen lying below. The specimen is mounted on a specimen disk in the spherical specimen chamber which is held away from the column itself. The specimen disk is mounted on a crosstable used as a specimen table which can be continuously rotated on its axis by a motor controlled from the outside. The specimen cross-table and its mechanism are fixed to a DN 100 port and flanged vertically to the specimen chamber axis (Fig. 1). The crosstable can be manually turned 360° around the axis of the port in which the crosstable mechanism is fixed. Because the rotation around the axis of the specimen plate is independant from that of its vertical axis, it is possible to adjust the angle of incidence of the ion beam to any desired value for the half-space above the specimen disk (upper side of the specimen). An additional motor driven mechanism that can be controlled from the outside permits the specimen mounted on the electron microscope disk to be moved on a plane – for example, when the angle of incidence of the ion beam is vertical to the specimen surface, the specimen can be moved in the plane vertical to the chamber axis. This possibility of sliding the specimen on a plane makes it possible to direct the ion beam axis to any point on the specimen surface and because of the rotation possibilities already described, at any desired angle of incidence. When the specimen is appropriately mounted, for example (20), it is also possible to etch the bottom part of the specimen with the ion beam because the cross-table can be rotated 360°. This is at least possible for the specimen surface area of 40 x 16 mm defined by

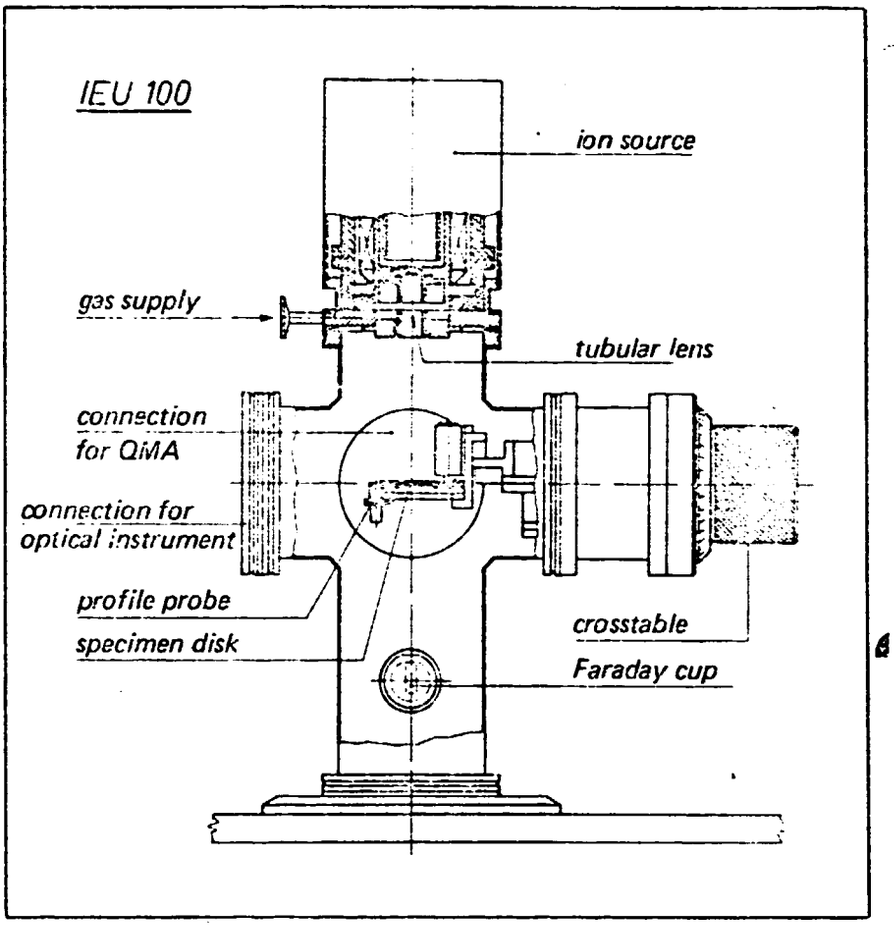


Fig. 1B
View of the BALZERS universal ion etching device IEU 100

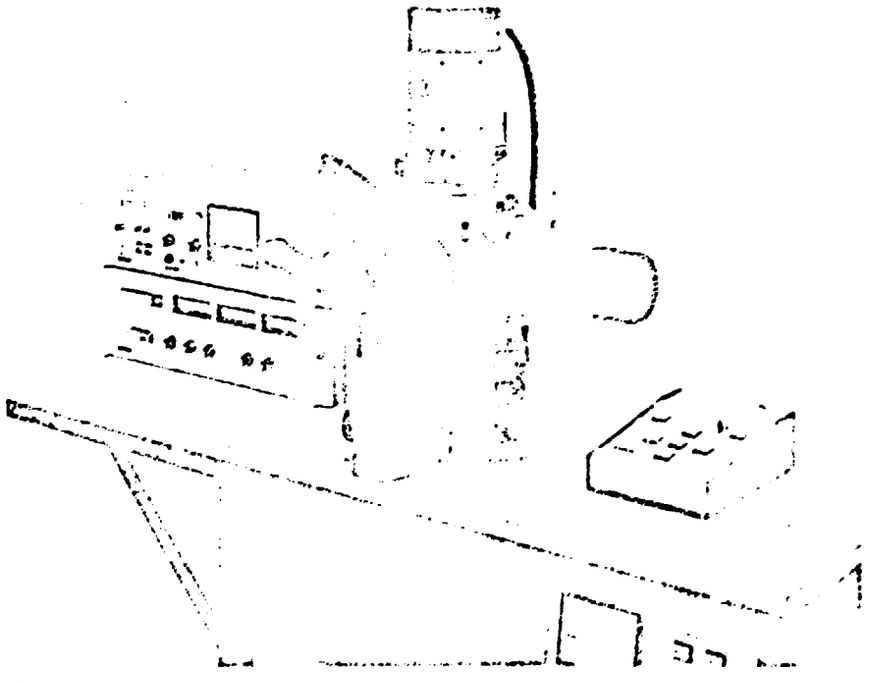


Fig. 1A
Design of the IEU 100

the lift of the planar movement mechanism. Because the inner area around the specimen is well lighted, the specimen can be observed through a window and the position of the specimen can be exactly and reproducibly determined to within approx. ± 30 µm using a binocular microscope with reticle.

The lift of the planar crosstable movement which is vertical to the direction of view through the window (and vertical to the ion beam) has been generously enough chosen that it is sufficient to check the chosen current density profile of the ion beam with an ion beam probe mounted on the crosstable (for choice of current density profile and for ion beam probe, see below).

In addition to the viewing window and the port for the installation of the crosstable the spherical specimen chamber is provided with two further ports. These are also DN 100 ISO-K and their axes are perpendicular to one another and to the crosstable port and are on the same plane as the crosstable and the viewing window. Fig. 1. One of these ports is for the attachment of a BALZERS quadrupole mass spectrometer from the QMG 311 series, or a QMG 511 for the analysis of the secondary ions resulting from ion etching (compare, for example (21). The entrance optics of a monochromator which focuses the optical radiation excited on the surface of the sputtered specimen into the entrance slit of a spectrograph can be mounted on the remaining port (17). In some cases it is sufficient to use a combination of a narrow bandwidth filter and a photomultiplier instead of a spectrograph to register the radiation. The radiation produced on the surface can be guided for convenience with a light pipe in this case. As the flanges of all the ports measure the same (with the exception of the viewing window) the placement of the crosstable, quadrupole mass spectrometer, and device for registering the optical radiation can be interchanged as desired.

When insulators are etched with the ion beam they usually become charged. A discharge device was thus developed. It consists of an electron source that produces a wide beam of low energy electrons. This discharge device can be so mounted in the chamber that the axis of the beam of low energy electrons hits the specimen at its intersection with the axis of the ion beam.

The spherical enlargement of the specimen chamber has, in addition to the flanges already mentioned, further openings which can be used to mount another viewing window and further current feedthroughs. There is also a port located under the specimen plane for the attachment of an additional monitor which shuts off the system once the specimen has been punctured during the ion thinning process.

2.2. Ion source and beam profile

The ion source (23) consists of a Penning glow discharge from which the projectile ions are extracted by a special tubular lens and then focussed to an ion beam. Gas is supplied to the Penning ion source by a dosing valve which, together with further features such as stabilized glow discharge current and the acceleration voltage, guarantee exact, reproducible adjustment of the beam energy and the profile of the ion current density. It is usually advantageous to supply the ion source with noble gas to avoid chemical reactions on the specimen surface. Other inert gases can as a rule be used for projectile ions and, with an appropriate combination of dosing valves, mixtures of inert gases and oxygen can be used, for example, to raise the probability of the sputtered ion excitation (compare (24).) When sputtering metal surfaces, the yield of ions or photons can usually be increased simply by increasing the partial pressure of the oxygen in the specimen chamber (25) (26).

The extraction lens for thinning is so dimensioned that the ion beam for projectile energies from 2 to 6 keV is focussed on the surface of the specimen. The current density distribution in the focussed ion beam of the IEU 100 is symmetrical to the rotation and closely resembles a Gaussian bell shaped curve. The current density in the core of such an ion beam is, depending on the profile adjusted for extraction voltages of 2 to 6 keV, between 0.05 and 1 mA/cm^2. By changing the current voltage supply to the glow discharge as well as the ion acceleration voltage, the permissible current density peak value can be reproducibly adjusted (also refer to 2.3), for instance when the specimen cannot tolerate heavy thermal loads.

For the production of even bottomed etch pits the extraction system is so dimensioned that a beam of parallel ions or a slightly diverging ion beam results. The degree of focussing can be easily adjusted by exchanging the two pole pieces of the tubular lens.

The beam of parallel ions produces elliptical etch pits in specimens with an even surface, or round edged pits with even bottoms if the angle of beam incidence is perpendicular.

The density of the ions in the IEU 100's parallel beam is so homogeneous across its several mm diameter that the deviations in the depth of the etch pits is not more than ± 2.5% from the mean value. Fig. 2 shows three multiple interference pictures taken from such etch pits.

The current densities of the parallel ion beam can be reproducibly adjusted between 0.5 – 100 µA/cm^2 depending on the choice of the operating parameters and the gases used.

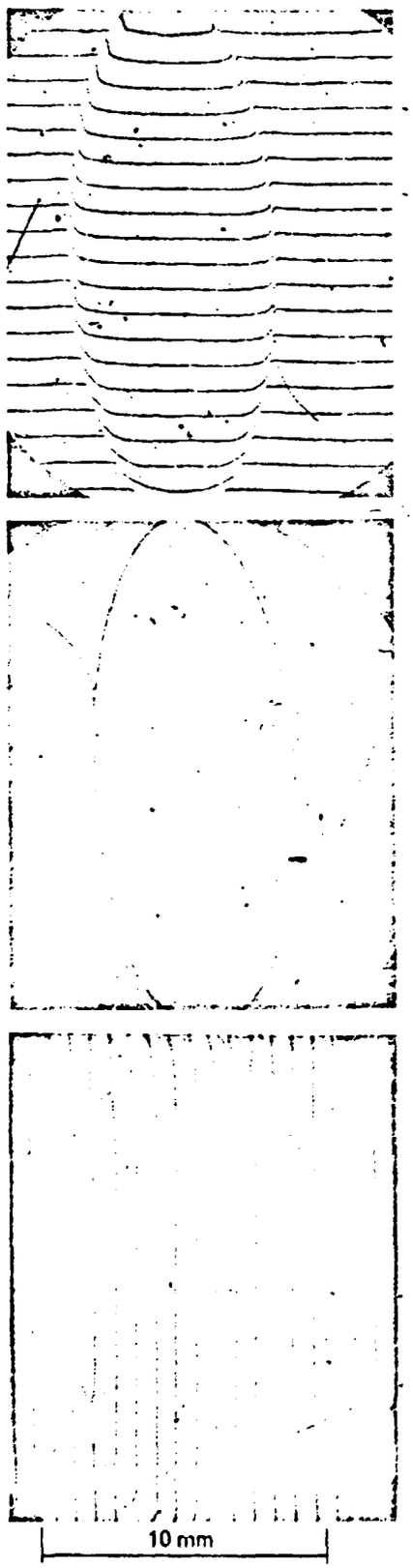


Fig. 2
Magnifications of multiple interference pictures of the etch pits at the surface of the SCHOTT glass BASF 13

2.3. Probe to check the beam current density profiles

The IEU 100 can be equipped with an "ion beam profile probe" to check the distribution of the beam current density. This probe consists of a Faraday cup with an opening (0.3 mm) that is small compared to the beam diameter. Using the crosstable described in 2.1. the Faraday cup is moved at a constant speed along the plane perpendicular to the beam axis in order to make the probe. In this, the movement of the Faraday cup is so adjusted with reference to the planar movement of the crosstable that the axis of the Faraday cup is lead through the axis of the ion beam when making the probe.

Fig. 3 shows the result of a recorder registration of the beam current density profile of an ion beam focussed for thinning. The current densities plotted on the coordinates are the mean local current densities determined by using a diaphragm with a special opening measuring 0.3 mm in diameter. The maximum current densities attainable with the IEU 100 are so high that the use of a second ion beam is not usually necessary for thinning. Compare for this also (8) (20). There is even the danger that the thermal load for fragile specimens is too high. (8) The thermal load on the specimen can be reduced without any special effort by using smaller beam current densities for smaller ion energies when thinning. The etching time, in such a case, would be necessarily longer.

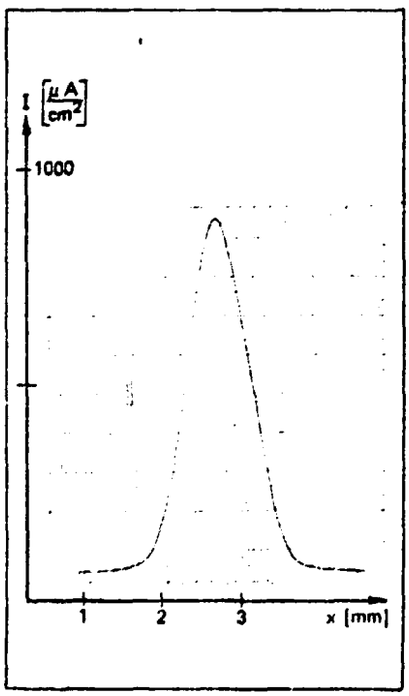


Fig. 3
Cross-section of the ion current density distribution in the axis of the focussed 5 keV – Ar^+ – ion beam.

On the IEU 100 the ion density can be reduced by lowering the acceleration voltage. The ion current extracted from the Penning glow discharge is then smaller. The degree to which the beam is focussed, as shown by the current density distribution in Fig. 3, can be reached again by appropriate readjustment of the Penning glow discharge each time. In addition, by appropriately regulating the glow discharge and the acceleration voltage it is possible to adapt the shape of the profile for special applications, checking it with the beam current density probe.

The slope of the wall of the crater eroded by the ion beam on the surface of the specimen is not only dependant on the ion current density but also on the angle of incidence of the beam hitting the edge of the crater and on the material, because the angle dependence of the sputtering yield is dependent on the material. By using a conical diaphragm the ion beam effective in the etching process can be limited to the beam core while retaining the same ion current density. Because of this the slope of the etch pit walls, as shown in Fig. 2 can be adjusted.

The in-depth resolution when making concentration profiles for the analysis of homogeneous surface layers is determined largely by the excitation depth distribution of luminescene or photoemission or photon emission or by the origin distribution of the secondary ions. The mean values of these distributions are, for the projectile ion energies used of several keV, several nm (17) (18) (27) (28). Compare (11) (29) for the influence of the etch pit shape on the in-depth resolution. Often the influence of the inhomogeneities within the material itself also limits the in-depth resolution, refer to (18) (20) (30).

3. Information obtained by combining the IEU 100 with analytical instruments for the electron microscope

The survey in Tables 1.1 —1.3 and 2.1 – 2.3 show in detail what information can be obtained using the IEU 100 and both types of electron microscopes — transmission electron microscope (TEM) and scanning electron microscopes (SEM) or an appropriately equipped STEM scanning transmission electron microscope. The survey is based on the assumption that the most important types of analytical instruments for both types of microscopes are available, namely:

for TEM the device for electron diffraction, selected area electron diffraction, and reflection diffraction.

for SEM, detectors for secondary electrons, backscattered electrons, the inner specimen current, and cathode luminescence plus equipment for X-ray analysis by energy dispersive X-ray spectroscopy (EDS) or wavelength dispersive X-ray spectroscopy (WDS) (it is also possible to successfully use the energy analysis of secondary electrons (10) (31).)

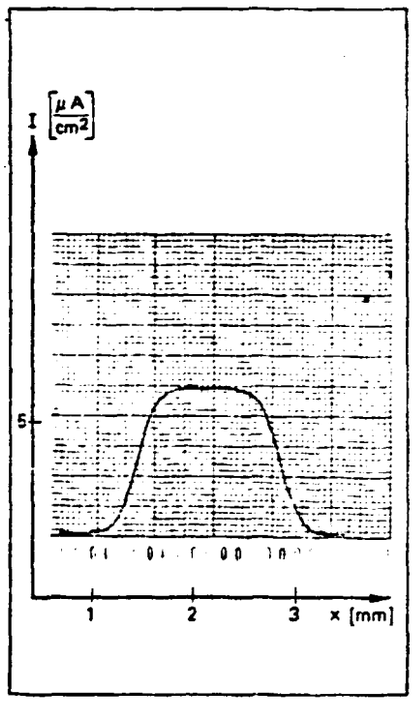


Fig. 4
Cross-section of the ion current density distribution in the axis of the parallel ion beam for 4.25 keV Ar^+ – ions.

In order to be able to carry out all the preparation and analytical techniques described in the tables, the IEU 100 must be equipped with:

the ion density profile probe for controlled adjustment of the focussed beam and a beam of parallel ions
and
a BALZERS quadrupole mass spectrometer QMG 511[x] (on the right in Fig. 5) or QMG 311 for element analysis or for the analysis of the concentration profile and

x) QMS is used in the table as the symbol for quadrupole mass spectrometer

a spectrograph (left in Fig. 5) and in appropriate instances, a combination of line filters and light guiding fiber optics/ photomultiplier device for spectrochemical analysis (1)[xx],

a discharge device: when a discharge device is used nonconducting materials can also be included in the survey

Fig. 6 shows a view of the complete set of equipment. In order to be able to carry out all the measurements shown on the chart there is an additional prerequisite. Either an interference microscope or the possibility of measuring the etch pits with interference and multiple interference monochromatic light must be available (27): also refer to Fig. 2. A device for the registration of IR and UV absorption spectra should also be available.

Details of the preparation cannot be discussed here. Please refer to earlier publications for preparation with ion beams (1) – (9) (20).

Concerning concentration profile analysis with the mass spectrometer compare, for example, (11) – (13) (15) and with spectrochemical analysis (14) (16) – (18). Compare for example (16) (18) (20) for combination of concentration profile analysis and investigation with the electron microscope. References to further literature are included in the table.

xx) also available from the BALZERS AG. It could become necessary to simultaneously register the secondary electron current detected by the quadrupole mass spectrometer with the intensity of the excited elements lines (32) (33).

The lines of the table have been catagorized according to preparation and analytical possibilities with the focussed or parallel ion beam. The columns give the information that can be obtained from analysis in the electron microscope.

The entries in the grid of the table give which of the TEM and SEM analytical methods can be best combined with the preparation and analysis by ion beam etching to investigate the material characteristics mentioned in the columns. Refer to (2) – (5) (34) and (35).

The summaries make clear that various types of preparation make it possible to obtain the desired information on the material characteristics. For this reason one has a certain flexibility in the choice of accessories when purchasing the ion beam etching device. Important criteria for this choice are the time spent for each preparation method and how often a certain specimen will probably be investigated in that laboratory. Also important is that sometimes several preparation methods must be used at the same time so that the results are assured. For this compare the examples in the text and the works cited.

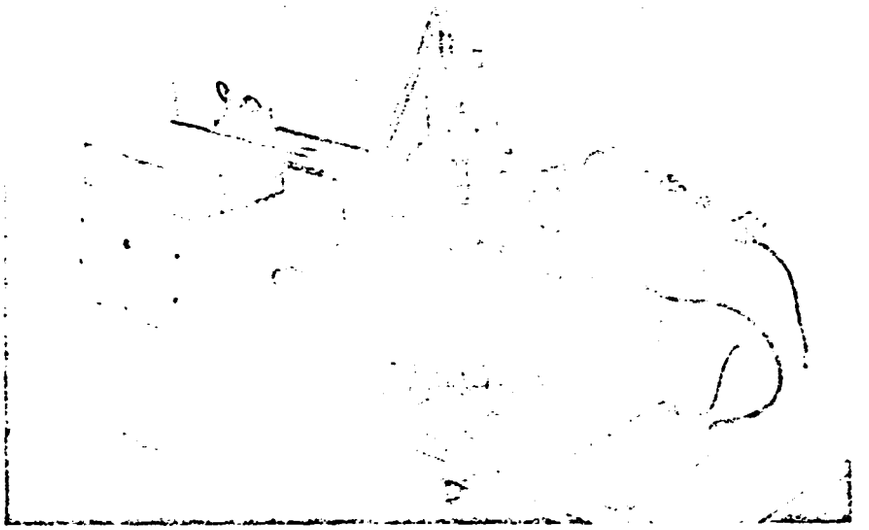


Fig. 5
IEU 100 equipped with QMG 511 and monochromator, refer to text.

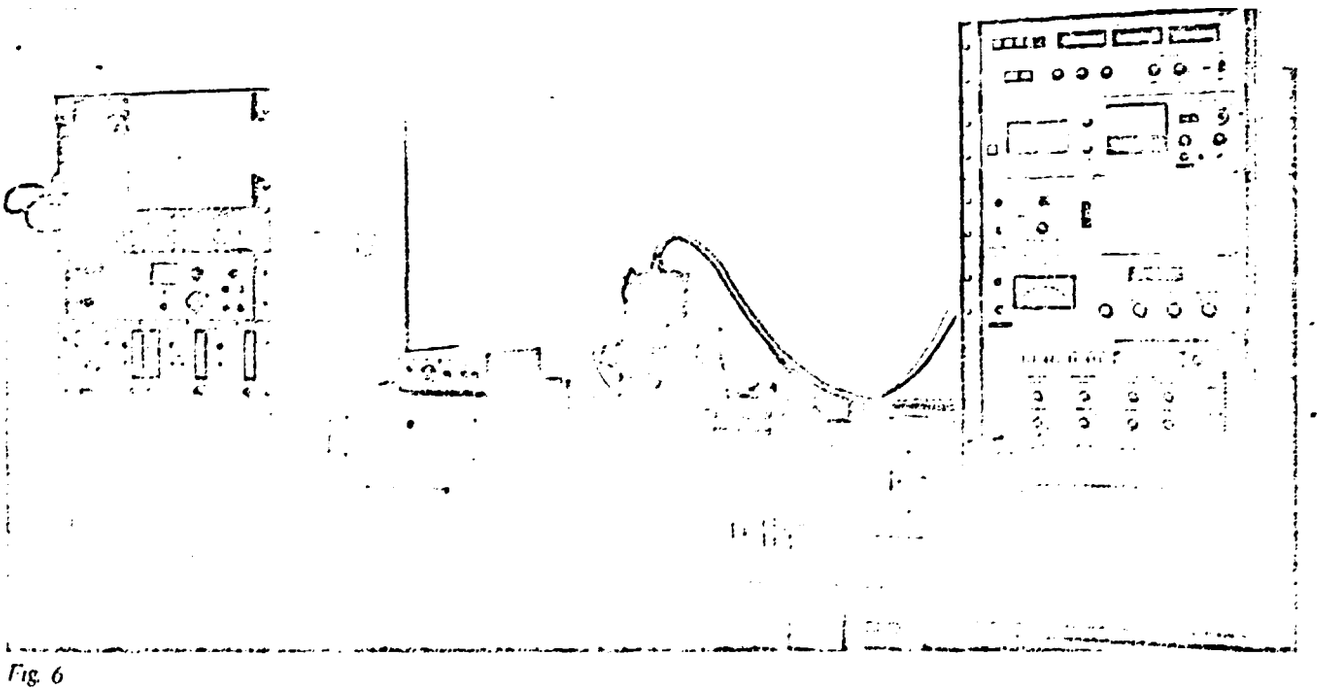


Fig. 6
View of the completely equipped BALZERS IEU 100

Preparation of bulk specimens:

Tables 1.1 and 1.3 give an overview of the possibilities of analyzing bulk specimens with a focussed or parallel ion beam. Please note that in addition to the information on analysis given in Table 1.1 it may be necessary to make an analysis of the secondary ions or the excited photons during etching with the focussed ion beam when the components of the sample are not know. Knowledge about the elements in a specimen gained from an analysis other then electron diffraction is often a supplement to the results obtained from electron diffraction analysis and sometimes indispensible for checking results. Sometimes the arrangement and the intensities of the lines of the electron diffraction patterns taken from files is not reliable enough. It can happen for example that the crystallization had just begun in the specimen to be examined and that non-crystalline phases had just started to crystallize or that there are still non-crystalline or partially crystalline phases left. Thus, element analysis with the IEU 100 can be particularly worthwhile when the electron microscope equipment in the particular laboratory does not include EDS or WDS and only a transmission electron microscope with electron diffraction analysis is available.

Using the quadrupole mass spectrometer or the spectrographs from the IEU 100, elements with an atomic weight of $Z < 10$ can also be detected, something which is not possible by analysis of excited X-rays (Compare) (5) (10).) The comparison of results obtained from the analysis of characteristic X-rays with those from secondary ion or spectral line analysis makes the evaluation easier. Use of secondary ion mass spectrometry simultaneously with the spectral analysis of the radiation excited by the ion beam helps, in addition, to eliminate ambiguity of the mass spectrum. For example, it could be questionable whether a peak appearing at $M = 28$ is Si or N_2. The spectral line of the excited or sputtered ionized atoms can be usually distinguished from one another without a great deal of effort.

Ion beam preparation \ Analysis in the SEM and TEM		Preparation and analysis of bulk specimens/1			
		Crystal structure	Structure and distribution of grains, phases, and defects	Element detection	Element distribution
Focussed ion beam	Thinned areas of several µm diameter	Transmission electron diffraction (3) (4) (7) (8) (39) (44) (49)	TEM: contrasts of electron transparent specimens and of replicas (1) – (4) (9) SEM: picture signal contrasts (5) (10) (31) (36) (41) (43) (44)	Through: electron diffraction, (3) (4) (6) – (8) (39) (40) (49) EDS or WDS (10) (34) (41) – (43) Complete (text) with spectrography (14) (17) and mass spectrography (11) (12) (15) (28)	Contrast in TEM magnifications from transparent specimens and selected area electron diffraction (3) (4) (6) – (9) (34) (35) (43) (49) (54) EDS and WDS (5) (36) (41) – (43)

Table 1.1

Ion beam preparation \ Analysis in SEM and TEM		Preparation and analysis of bulk specimens/2			
		Crystal structure	Structure and distribution of grains, phases, and defects	Element detection	Element distribution
Beam of parallel ions 3 – 25 mm diam.	Etching of the surface	Reflection electron diffraction (2) (3) (8) (39) (50), also refer to text	Magnification of replica in TEM (1) – (3) (8) SEM picture signal contrast (5) (36) (41)	Reflection electron diffraction (2) (3) (44) (45) refer to text EDS and WDS (10) (35) (36) (41) – (43)	Combination of TEM and SEM magnification diffraction, refer to text EDS and WDS (10) (35) (41)
	Thinning for taking absorption spectra (UV to IR)	Absorption spectra thinned specimens in IR transmission (46) and reflecton	–	Identification of elements and molecules from absorption spectra in the visible and UV	–

Table 1.2

Ion beam preparation and analysis with the IEU 100 \ Analysis in SEM and TEM		Preparation and analysis of bulk specimens/3			
		Crystal structure	Structure and distribution of grains, phases, and defects	Element detection	Element distribution
Parallel ion beam from 3 – 25 mm diam.	Quadrupole mass spectrometer (QMS)	Reflection electron diffraction (2) (3) (49) (50) and element analysis with QMS (11) (12) (21) refer to text	Comparison profile analysis with TEM or SEM and EDS or WDS refer to text	Reflection electron diffraction (2) (3) (49) (50) EDS or WDS (10) (41) element analysis with QMS (11) (12) (21) (28) also $Z < 10$	Reflection electron diffraction in TEM and SEM, refer to text and EDS or WDS (10) (41) as well as element and profile analysis with the QMS (11) (12) (21) (28) for $Z < 10$, refer to text
	Line filter and/or spectrograph	Reflection electron diffraction (3) (49) (50) and element analysis (14) (17), refer to text	Refer to Table 1.1 and text	As in the 1st line but: element analysis with line filter and spectrograph $Z < 10$ (14) (17) (59) also refer to text	As in the 1st line but: element and profile analysis with line filter and spectrograph (14) (17) (59), $Z < 10$, also refer to text

Table 1.3

The excitation of the series of spectal lines makes the evaluation highly accurate. The intensity of the molecules or parts of molecules excited by the beam is usually at a value under the detection limit. But with mass spectrometry one usually gets many lines, especially those of fragments of molecules with smaller molecular weights. Fig. 7A is an illustration of a partial spectrum obtained from a soda lime glass sample bombarded by an ion beam. The spectrum lies in the range 260 nm $< \lambda <$ 460 nm. Fig. 7B is the mass spectrum obtained from the same glass. It lies in the mass range $1 \leq M \leq 60$.

To find out if there is an inhomogeneous distribution of the element in a multiphase specimen the spectrometric analytical equipment in the IEU 100 can be of use with bulk specimens such as when the lateral resolution of the EDS or WDS is not sufficient (or the atomic number is $Z < 10$). If, for example, one can see in the electron microscope magnification that one phase has been preferentially etched by the ion beam, then its composition during the etching can be determined by registering the intensity changes of the secondary ions or of photons until a stable condition has been reached i.e. until the signal intensity of the excited lines remains constant. Those elements having first a higher sputter rate and thus a higher signal intensity belong to the less resistant materials, and those having a lower rate i.e. that at first have a smaller signal intensity belong to the resistant phase. This interpretation is, however, based on the prerequisite that these two phases of the material are homogeneously distributed throughout the surface being investigated. In this case both the signal intensities I are chiefly a function of the sputtering yields of both the phases, i.e., $I \sim S$. In general the following is valid for a fixed

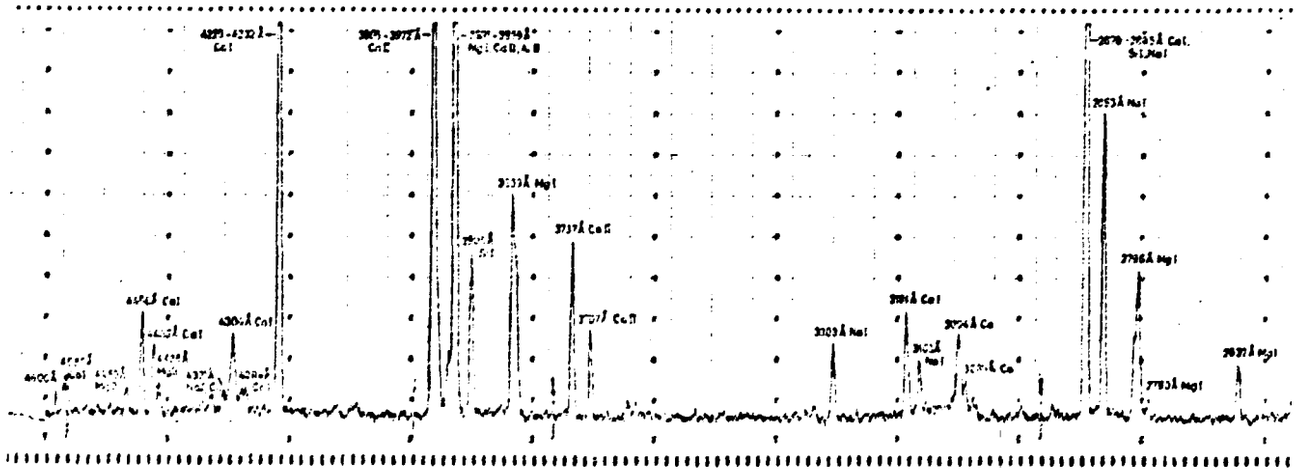


Fig. 7A
Emission spectrum of Na_2O-CaO-SiO_2 glass sample

angle of incidence of ions and a constant current of projectile ions I_p for the intensity of a spectral line of an element m (refer to (14) (37)):

$$I_n \sim i_p \cdot S \cdot \alpha_n \cdot C_m$$

whereby C_m is the concentration of the element and the material specific excitation coefficient of the spectral line. (The excitation coefficient whereby ϵ

$$\alpha_n = \epsilon \cdot \zeta \cdot p$$

is the degree of excitation quotient of the number of atoms sputtered and in an excited state divided by the total number of atoms sputtered ζ is the probability of a shift to a state of lower energy and p is the probability of radiative deexcitation).

The corresponding profile can also be obtained with the quadrupole mass spectrometer and is valid for a corresponding relationship for the secondary ion current $i_s \sim i_p$ S $\alpha \pm$ Cm whereby $\alpha \pm$ is the degree of ionization, that is the quotient of the number of ionized atoms or molecules divided by the total number of sputtered atoms or molecules, refer to (13) (21) (28). The in-depth resolution that can be reached for the concentration profile, as already mentioned, is within a few nm (17) (13) (27) (28). As an introduction in the problematic of ion sputtering also refer to (38) and for important results in the preparation to (3) (7) (8). Fig. 8A shows an example of the intensity/time profile obtained by registration of the excited NaI and SiI radiation of a two-phase Na_2 SiO_2 glass sample of the type mentioned above. The surface of the glass from which the profile was obtained is shown in a SEM magnificaion after being etched with the ion beam. (Fig. 8B). The magnification shows clearly that a more resistant phase was exposed by the ion beam. According to the intensity/time profile this more resistant phase contains more Na than its environment because the NaI signal intensity rise takes much longer than for Si. The more resistant phase of this glass is crystalline as Fig. 8C shows. For this reason the results can be supplemented by the evaluation of the reflection electron diffraction pattern. (Refer to Fig. 8C) from the ion beam etched planar surface areas.

As long as the phases, or at least one of them, are crystalline the preparation of an electron transparent thinned specimen is recommended additionally (refer to Table 1.1). This is particularly indispensible when the total concentration of crystalline substances is so small that X-ray deflection patterns of these phases that can be evaluated cannot be registered (39) (40). From thinned specimens quite a high lateral resolution

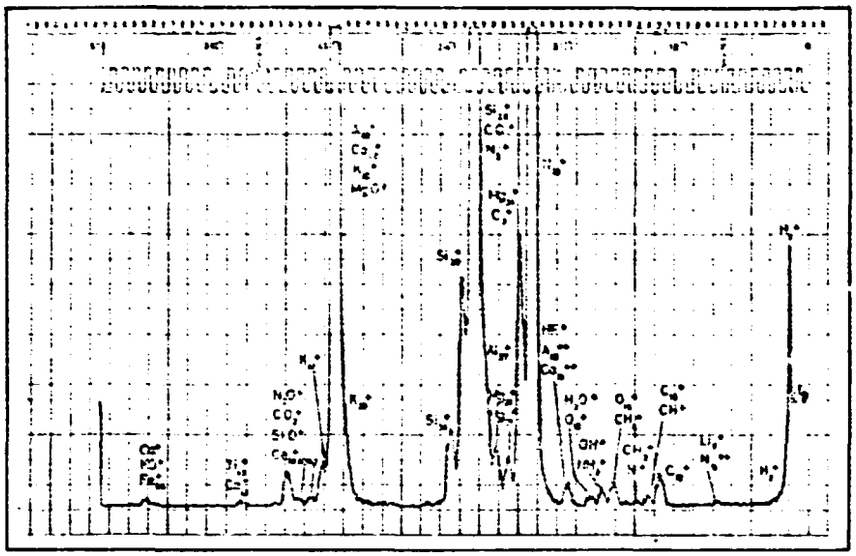


Fig. 7B
Mass spectrum of a Na_2 O-CaO-SiO_2 glass

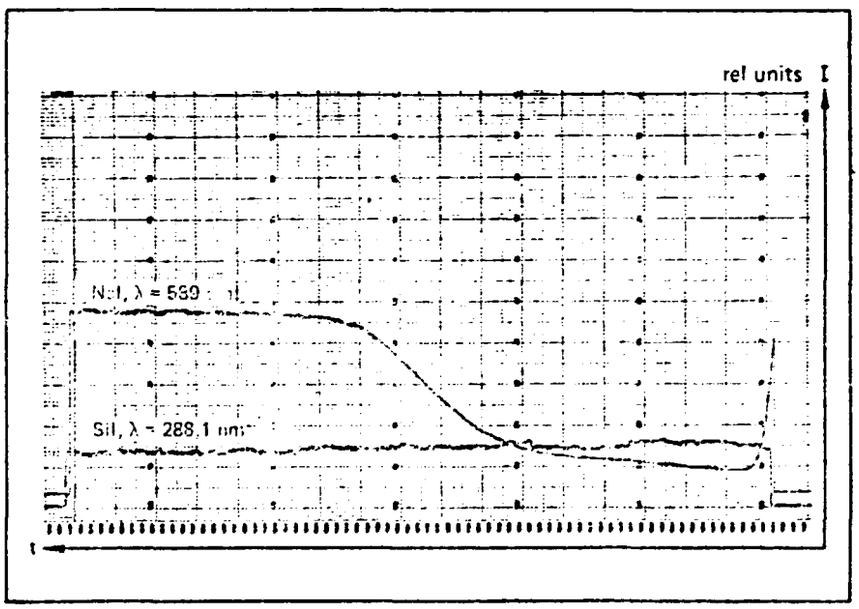


Fig. 8A
Intensity/time profile of the NaI and SiI line obtained by continuous etching of a Na_2 O-SiO_2 glass surface

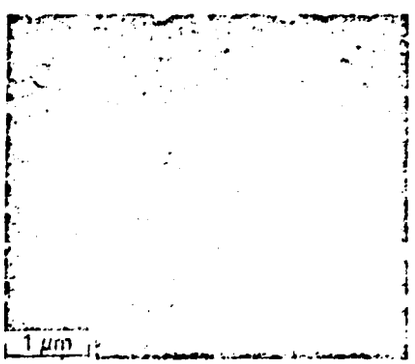


Fig. 8B
SEM magnification of the ion beam etched Na_2 O-SiO_2 glass surface

of better than 1 nm and selected area diffraction patterns of very small inclusions can be obtained in each case (39). Important for the decision to investigate a thinned specimen is the fact that the lateral resolution of the magnification with the electron microscope (41) and also that of the wave length dispersive or energy dispersive analysis of the characteristic X-rays is larger for thinned specimens than for bulk specimens (42) (43). The depth T to which the crystalline structure of the specimen is destroyed on the surface of the bombarded specimen is usually $T < 10$ nm (3) (40). It must however, be mentioned that destruction depths on, for example, $CaCO_3$ have already been observed down to 150 nm caused by chemical deterioration induced by the ion beam (44).

If the equipment for spectral analysis of the excited X-rays is available, then the results derived from the concentration profile analysis with the IEU 100 and the changes in the surface structure of a sputtered specimen concerning the higher Na contents of the resistant phase can be checked as long as the lateral resolution of these methods is sufficient. Based on the results taken from Fig. 8A – 8C no decision can be made as to whether in addition to the influence of the two phases on the profile another concentration gradient of the Na is present in the less resistant phase. To answer this question EDS or WDS analyses that investigate the matrix surrounding the resistant phase in various stages of the ion etching process must be carried out.

In the example explained using Fig. 8A – 8C one would, with the combination of WDS or EDS in the scanning electron microscope with the IEU 100 already have sufficient information for many purposes needing the identification of the total elements present and the element distribution in both different resistant phases. The information obtained in this special case would correspond, for this combination of instruments, approximately to the information obtained from the scanning ion microscope but obtained with much less expense as far as preparation is concerned. In cases where crystalline structure must be absolutely differentiated from phases, electron diffraction must also be used. For this refer to the above examples. If, in addition, highly resolved pictures of the phases are necessary, perhaps for the study of grain boundaries (36) the investigation of a thinned specimen in the TEM must be aimed for in any case, compare Table 1.1. Which investigation methods or combination of preparation and methods should be preferably used must be decided in each concrete case taking into account the type of specimen, the necessary preparation and analysis time and the information hoped to be obtained. For this purpose the table survey can give only some possibilities.

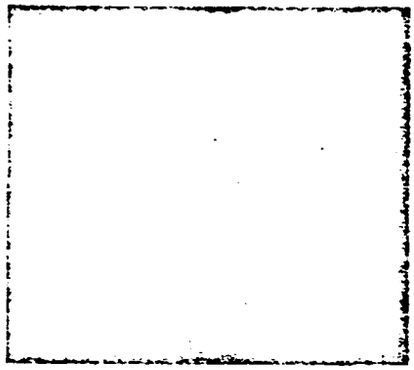


Fig 8C
Reflection diffraction pattern to Fig. 8B

Up to now ion beam etching has not often been used to prepare specimens for spectrometry, for example, to analyze elements from the absorption spectra or for the study of atomic arrangements (45). For different types of glass, for instance, information can be obtained on the mutual arrangement of the atoms from infrared spectroscopy. If, however, the absorption is so high that an IR absorption spectrum cannot be obtained by transmission through bulk specimens, then it is usually possible to etch the specimen so thinly that it becomes transparent in the infrared range. Results obtained from flint glass are shown in (46). Ion beam preparation can also be used in combination with absorption spectra for profile analysis, for example through the combination with UV spectrum measurement as shown, refer also to Table 2 and (47).

Preparing thin surface coatings and surface layers

Tables 2.1, 2.2, and 2.3 give an overview of the preparation and analytical possibilities for surface coatings and surface layers. Carrying out an element analysis with the WDS or EDS as well as with the analytical instruments to the IEU 100 is also an aid when evaluating the electron diffraction or reflection electron diffraction analysis. Investigations in which the detection of elements can be taken from the absorption spectrum have a special place in those the detection sensitivity of the other methods are not sufficient. Compare Table 2.2 and the works cited there. In the same way the above-mentioned methods for analyzing elements and their lateral resolution as well as the preferred sputtering of individual phases of bulk specimens can also be transferred to the preparation of thin surface coatings and layers. While preparation by ion etching and especially the use of ion beam thinning, has in the meantime found a great number of applications, the combined use of electron microscopy and element analysis or concentration profile analysis with the secondarily produced ions and photons, with electron diffraction or the IR or UV absorption has been used much less frequently. To illustrate the utility of such combined applications and to supplement Table 2.3 the results of an investigation are given here that were obtained from the application of the profile analysis in the IEU 100 and the reflection electron diffraction as well as the energy dispersive analysis of a surface layer.

The layer to be investigated consists of three oxide films: one TiO_2 one SiO_2 and TiO_2 each with an optical thickness of $\lambda/4$. The layers were taken from an organic solution and transferred to a soda lime glass substrate through pyrolysis. Refer to (48) for the production of such layers. In addition the bottom layer (compare earlier results in (43).) contained Na in a concentration of several mol %. This information could be taken from the intensity/time profiles abtained from spectral analysis in the visible at continuous ion beam etching, compare Fig. 9A. It is now also interesting to find out if the Na contained especially in the bottom layer is part of a compound and if this compound can be identified. Earlier investigations showed that at least a part of the Na occurs in the compound Na_xTiO_2 (49). By etching areas on the surface with the beam of parallel ions, it is possible to expose a plane of the bottom layer without the further use of liquid etching solvents.

Ion beam preparation \ Analysis in SEM and TEM		Preparation and analysis of surface coatings and surface layers/1			
		Crystal structure	Layer construction and structure, structure gradients	Element detection and element distribution, comp. also Tables 1.1 – 1.3	Concentration profile (perpendicular to the surface)
Focussed ion beam	Thinned areas of several µm diameter	Transmission electron diffraction on thinned areas and selected area electron diffraction (3) (4) (7) (8) (18) (49)	Contrast in TEM magnification and SEM signal contrast (3) (8) (49)	Transmission electron diffraction refer to column 1 EDS and WDS refer to (41) (42) QMS, line filter or spectrograph, compare text	Transmission electron diffraction by thinning the solid base (49) in combination with transversal sections and profile analysis, refer to Tables 2.2 and 2.3
	Transversal section	Selected area electron diffraction on transversal sections (3)	As 1st line, also TEM replicas (3) (8) (51) – (53)	Selected area electron diffraction (3) EDS or WDS as far as the lateral resolution is sufficient (42) (43) supplements QMS, refer to text	Selected area electron diffraction and micrograph contrasts (3) (8) (51) – (53) additional profile analysis, refer also to Tables 2.2 and 2.3

Table 2.1

Ion beam preparation \ Analysis in SEM and TEM		Preparation and analysis of surface coatings and surface layers/2			
		Crystal structure also compare Tables 1.1 – 1.3	Layer construction and structure, structure gradients	Element detection and element distribution, comp. also Tables 1.1 – 1.3	Concentration profile (perpendicular to the surface)
Beams of parallel ions from 3 – 25 mm in diameter	Step by step etching of the surface combined with depth measurement of the etch pits	Reflection electron diffraction on planes exposed by ion etching combined with depth calibration, refer to text and (44)	Magnification of planes exposed by ion etching to a defined depth with TEM and SEM (1)–(4) (8) refer to text	Reflection electron diffraction refer to text and (3) (49) EDS and WDS refer also to (15) (44) and text	Reflection electron diffraction on planes exposed by ion etching with depth calibration (3) (49) (50) EDS and WDS, refer to (15) and text
	Step by step etching of the surface combined with taking of absorption spectra (UV to IR) and perhaps also reflection spectra	Possibly as in line 1, and at the same time information about special arrangement of atoms or about elements from the absorption	As line 1 in addition: measurement of the transmission spectra (45) (47) (54)	As line 1 in addition: measurement of the transmission spectra (45) (47) (54) refer also to Table 2.3	As line 1 in addition correlation of the changes of the spectral transmission with the etch pit depth (44) (45)

Table 2.2

The depth of the exposed bottom of the etch pit, i.e. the position of the etched areas under the surface, can be adjusted using the concentration profile. Fig. 9B shows the Ti concentration profile obtained when the bottom TiO_2 layer is etched. A comparison of the entire profile in Fig. 9B with that in Fig. 9A shows clearly that a bit more than a third of the bottom layer was etched away[x]. Fig. 9C shows the reflection electron diffraction pattern of this plane of the specimen. Surprisingly, the reflection for Na_2O (according to ASTM chart 23-528 A) appears in this pattern. In a simultaneously conducted transmission investigation of the same layer, in contrast, the diffraction rings for Brookite or of Na_xTiO_5 were almost exclusively found and Na_2O only occured sporadically. This result was obviously caused by the different preparation methods.

x) If the film thickness is not known, the depth distribution can be calibrated by interferometric measurement of the etch pit depths. Refer to (17) (18) as examples.

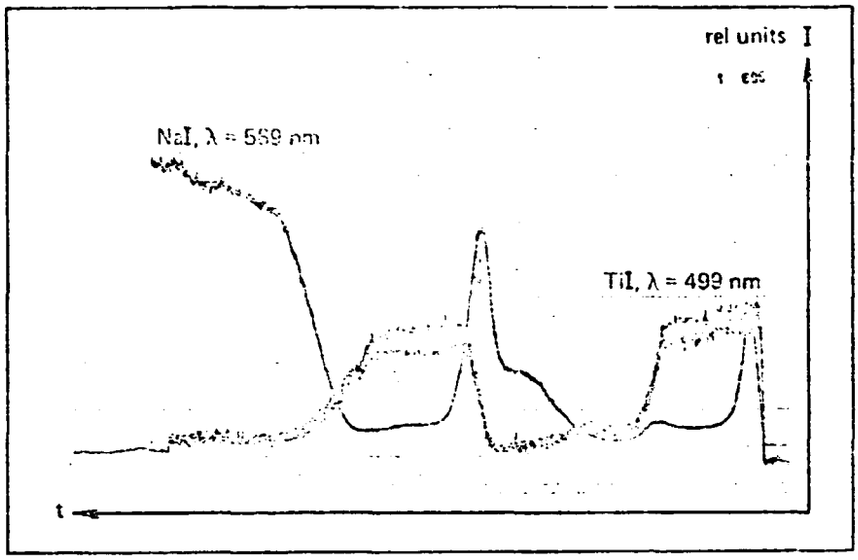


Fig. 9A
Concentration profile of Na and Ti in a triple coating of $TiO_2/SiO_2/TiO_2$ (refer to text)

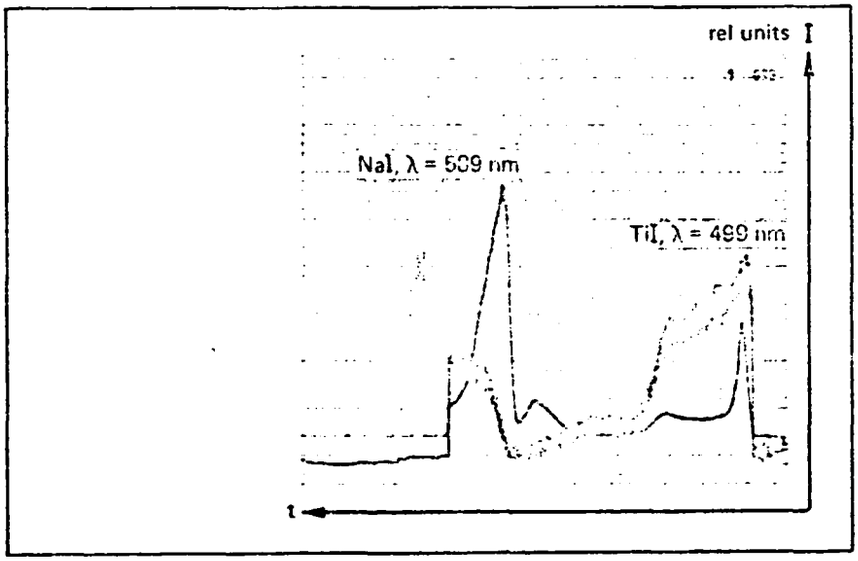


Fig. 9B
concentration profile to establish relative etching depths

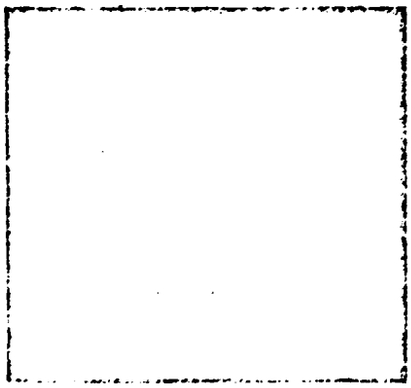


Fig. 9C
Reflection diffraction pattern of the surface shown in Fig. 9D (Na_2O)

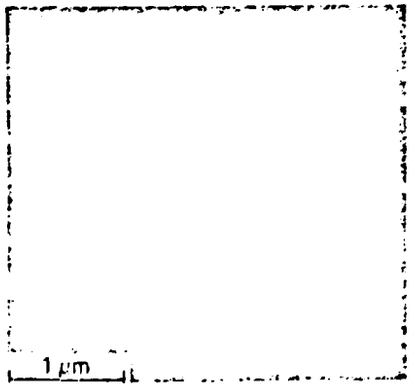


Fig. 9D
SEM magnification of the bottom film shown in the depth established after ion etching according to Fig. 9B, see text.

The bottom TiO_2 layer was prepared by removal first of the two upper layers and then the lower layer in a diluted HF solution. The remainders of the films were in the HF solution long enough to almost completely dissolve the Na_2O out of the layer. In contrast, the influence of any solvent whatsoever is missing from preparation by ion etching. The diffraction rings of the TiO_2 modification recede completely in the reflection diffraction picture because Na_2O has a much lower sputtering rate and thus rises out of the etched plane shielding the TiO_2 crystals during the taking of the reflection diffraction picture. Fig. 9D also illustrates this. It is a SEM magnification that, in addition, shows that the yield of secondary electrons from the Na_2O is much higher

Ion beam preparation and analysis with the IEU 100 / Analysis in the SEM or TEM		Preparation and analysis of surface coatings and surface layers/3			
		Crystal structure	Layer construction and structure, structure gradients	Element detection and element distribution, comp. also Tables 1.1 – 1.3	Concentration profile (perpendicular to the surface)
Parallel ion beam of 3 – 25 mm diameter	Continuous etching of surface combined with quadrupole mass spectrography (QMS)	Reflection electron diffraction on planes defined by concentration profile (3) (49) refer to text	Micrograph contrast of TEM and SEM of planes exposed by the ion beam and defined by the concentration profile, refer to text	Reflection electron diffraction (3) (49) EDS and WDS (10) (41), refer to text mass spectrum of elements and molecule fractions also for $Z < 10$ (11) – (13) (21) (28) (30) (56), refer to text	Reflection electron diffraction (3) (49), refer to text EDS and WDS (10) (41), refer to text. Mass spectrum of elements and molecules in a defined plane (11) – (13) (21) (22) (28) (30) (56) also refer to (15)
	Continuous etching of surface combined with line filter and/or spectrography	As line 1, refer to text (3) (49)	As in line 1, refer to text	As in line 1, but especially spectrum of excited neutral and ionized cations H, Li, B etc. (14) (16) – (18) (57) (58) (59)	As in line 1, but especially spectrum of excited neutral and ionized cations H, Li, B etc. (14) (16) – (18) (57) (58)

Table 2.3

than that of the environment.

The investigation of the lighter areas in the picture by energy dispersive analysis of the excited characteristic radiation confirms the correctness of this interpretation of the picture. Furthermore the same considerations are valid here as for bulk specimens. The intensity/time profile shown in Fig. 9A shows the concentration profile with a distortion caused by the different resistances of sputter rates TiO_2 and Na_2O. Meanwhile the convolution function taken from the intensity/time profile is relatively easy to find out. (27)

Further investigation, in which various analytical processes with the electron microscope were combined with profile analysis, can be found together with additional literature references in (15) (16) (18) (20) (27) (30). The results of these works show that an investigation with the electron microscope is often indispensible for the interpretation of the concentration profile. (18) (27) (30).

The survey in table form together with the results given in the text and in the publications cited can certainly give tips on which of the possible combinations of supplementary devices to the IEU 100 and the type electron microscope available promise success for each different preparation job. The modular system in which the IEU is designed makes possible an appropriate choice of the special accessories for certain jobs as well as an easy extension of the equipment for future preparation jobs.

Bibliography:

(1) Behrisch, R.: Festkörperzerstäubung durch Ionenbeschuss in: Ergebnisse der exakten Naturwissenschaften, Band XXXV (1964) Springer Verlag, Berlin, Gottingen, Heidelberg (1964) S. 295 – 443

(2) Wegmann, L.: Die Ionenätzung als Mittel zur Oberflächenuntersuchung. Schweizer. Arch. F. Wissenschaft und Technik, 30, (1964) S. 143 – 153

(3) Bach, H.: Die Anwendbarkeit des Ionenstrahlätzens bei der Präpartion für die Elektronenmikroskopie. Methodensammlung der Elektronenmikroskopie, 6. Lieferung (1973). Herausgeber: G. Schimmel und W. Vogell, Wissenschaftliche Verlagsgesellschaft mbH, Stuttgart (1973)

(4) Tighe, N.J., Experimental Techniques in: Electron Microscopy in Mineralogy, Ed. by H.-R. Wenk, P.E. Champness, J.M. Christie, J.M. Cowley, A.H. Heinen, G. Thon and N.J. Tighe, Springer Verlag Berlin, Heidelberg, New York (1976)

(5) Reimer, L., Pfefferkorn, G.: Rasterelektronenmikroskopie, Zweite neubearbeitete und erweiterte Auflage, Springer-Verlag, Berlin, Heidelberg, New York (1977)

(6) Bach, H.: Elektronenmikroskopische Durchstrahlungsaufnahmen und Feinbereichs-Elektronenbeugung an Al_2O_3-Keramik. Bosch Techn. Ber. 1, 10 – 13 (1964)

(7) Barber, D.J.: Thin Foils of Non-Metals Made for Electron Microscopy by Sputter-Etching, J. of Materials Science 5 (1970) S. 1 – 8

(8) Bach, H.: Application of Ion Sputtering in Preparing Glasses and Their Surface Layer for Electron Microscope Investigations, J. of Non-Cryst. Solids, 3 (1970) S. 1 – 32

(9) Müller, W.F.: Transmissionselektronenmikroskopie von gesteinsbildenden Mineralien, Naturwissenschaften 62 (1975) S. 223 – 230

(10) Holm, R.: Neuere Entwicklungen in der Rasterelektronenmikroskopie, G.I.T Fachz. Lab. 17 (1973) H. 4, S. 315 – 326 und H. 5, S. 453 – 459.

(11) Honig, R.E.: Analysis of Surfaces and Thin Films by Mass Spectrometry, Advances in Mass Spectrometry. Vol. 6, A.R. West, Ed. pp 337 – 362, Elsevier Applied Science, Publisher Ltd. Barking, England (1974)

(12) Benninghoven, A.: Development in Secondary Ion Mass Spectrometry and Applications to Surface Studies. Surface Science 53 (1975), S. 596 – 625.

(13) Benninghoven, A.: Characterization of Coatings. Thin Solid Films (1976) S. 3 – 23.

(14) Tolk, N.H., Tsong, I.S.T. and White, C.W.: In Situ Spectrochemical Analysis of Solid Surface by Ion Beam Sputtering, Analytical Chemistry 49 (1977), S. 16A – 30A.

(15) Holm, R. und Storp, S.: Methoden zur Gewinnung von Tiefeninformation in der Oberflächenanalyse. Vakuum-Technik, 25 (1976) Heft 2 und 3, S. 41 – 47 und S. 73 – 78.

(16) Bach, H. and Baucke, F.G.K.: Investigations of Reactions Between Glasses and Gaseous Phases by Means of Photon Emission Induced During Ion Beam Etching. Physics and Chemistry of Glasses 15 (1974) S. 123 – 129.

(17) Bach, H.: Ion Beam Induced Radiation Applied to Investigations of Thin Surface Layers on Glass Substrates. J. of Non-Crystalline Solids 19 (1975) S. 65 – 74.

(18) Bach, H., Schröder, H. und Schaeffer, H.: Reaction Behaviour of Thin PbO-Layers on SiO_2 Glass. Thin Solid Films, 48 (1978), S. 201 – 213.

(19) Bach, H., Blaschke, R., Bode, M., Pfefferkorn, G. und Umrath, W.: Präparationsmöglichkeiten in einer erweiterten Objektkammer am Raster-Elektronenmikroskop. Beitr. elektronenmikroskop. Direktabb. Oberfl. 4 (1971), S. 363 – 372.

(20) Bach, H.: Das Ionenstrahlätzen – Anwendungsmöglichkeiten bei elektronenmikroskopischen Untersuchungen und der Analyse von Festkörperflächen. Beitr. Elektronenmikroskop. Direktabb. Oberfl. 5 (1972) S. 479 – 553.

(21) Buhl, R., Huber, W.K. und Löbach, E.: Messung von Konzentrationsprofilen dünner Schichten mit der Sekundärionenmassenspektrometrie (SIMS). Vakuum-Technik 24 (1975) S. 189 – 194.

(22) Magee, C.W. and Harrington, W.L.: Depth Profiling of Sodium in SiO_2 Films by Secondary Ion Mass Spectrometry. Appl. Phys. Lett., 33 (1978) S. 193 – 196.

(23) DE-Gbm Nr. 74 10 342, CH-PS 582 423 und US-PS 3949230.

(24) Bach H.: Photon Emission Intensity and Sputtering Efficiency Related to Drift Mechanisms Below the Ion Beam Bombarded Surfaces of Na_2O-SiO_2 Glasses. Radiation Effects 25 (1975) S. 209 – 211.

(25) Kerkdijk, C.B. and Kelly, R.: Oxygen Dependent Photon Emission From Ne^+-Bombarded Mg. Radiation Effects 38, (1978) S. 73 – 81.

(26) Benninghoven, A. and Müller, A.: Investigation of the Surface Oxidation of Metals in the Sub-Monolayer and Monolayer Range with the Static Method of Secondary Ion Mass Spectrometry. Thin Solid Films 12 (1972) S. 439 – 442.

(27) Bach, H.: Zur Bestimmung der Reichweiten von beschleunigten Ionen in dünnen Oxydschichten. Z. angew. Physik 28, 239 – 244 (1970).

(28) Werner, H.W.: Theoretical and Experimental Aspects of Secondary Ion Mass Spectrometry. Vacuum 24 (1975), S. 493 – 504.

(29) Hofmann, S.: Evaluation of Concentration – Depth Profiles by Sputtering in SIMS and AES. Appl. Phys. 9 (1976) S. 59 – 66

(30) Hofer, W.O. and Liebl, H.: Depth Profiling of Cu-Ni-Sandwich Samples by Secondary Ion Mass Spectrometry. Appl. Phys. 8 (1975) 359 – 360.

(31) Milferstädter, D. und Schmelzer, F.: Auger-Spektroskopie am konventionellen Raster-Elektronenmikroskop – ein praktisches Analysenverfahren. Nr. GKSS 76/E/4 (03/220525/23 Analyse) Gesellschaft für Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht (1976).

(32) Martin, P.J., Baily, A.R. and Macdonald, R.J. Tolk, N.H., Clark, G.J. and Kelly, J.C.: Deexitation Processes near the Surface of Ion Bombarded SiO_2 and Si. Surface Science 60 (1976) S. 349 – 364.

(33) Bach, H.: Ionenstrahl-Ätzen zur Material-Untersuchung. Schott-Information (1979), Heft 1, S. 11 – 14.

(34) Reimer, L.: Elektronenmikroskopische Untersuchungs- und Präparationsmethoden, zweite erweiterte Auflage, Springer Verlag, Berlin, Heidelberg, New York (1967).

(35) Pfefferkorn, G., (Hrsg.): Beiträge zur elektronenmikroskopischen Direktabbildung von Oberflächen, Eigenverlag Münster, bis jetzt erschienen: Band 1, (1968) – Band 11 (1978).

(36) Blaschke, R.: Spezifische Oberflächen und Grenzflächen der Mineralphasen als Gefügeparameter. Fortschr. Miner. 47, 197 – 241 (1970).

(37) Bach, H.: Distortion of Na-Concentration Profiles in Thin Glassy Surface Layers by Ion Bombardment. Rad. Effects 28 (1976) S. 215 – 226.

(38) Oechsner, H.: Sputtering – a Review of Some Recent Experimental and Theoretical Aspects. Appl. Phys. 8 (1975) S. 185 – 198.

(39) Bach, H. und Gliemeroth, G.: Phase Separation in Phototropic Silver-Halide-Containing Glasses.J. Amer. Cerm. Soc.-Disc. Notes 54 (1971) S. 528 – 529.

(40) Bach, H.: Über Möglichkeiten und Grenzen, Gläser, Nichtleiter und deren Oberflächenbeläge zur elektronenmikroskopischen Analyse durch Ionenzerstäubung zu präparieren. Glastechn. Ber. 44 (1971) S. 99 – 109.

(41) Blaschke, R.: Materialanalyse mit dem Raster-Elektronenmikroskop, dem Photonenemissions-Mikroskop und dem Elektronenstrahl-Röntgenmirkoanalysator. Beitr. elektronenmikr. Direktabb. Oberfl. 3 (1970) S. 17 – 36

(42) König, R.: Quantitative X-ray Microanalysis of Thin Foils in: Electron-Microskopy in Mineralogy. Ed. by H.R. Wenk, P.E. Champness, J.M. Christie, J.M. Cowley, A.H. Heiner, G. Thon and N.J. Tighe, Springer Verlag, Berlin-Heidelberg-New York (1976).

(43) Suter, M. Nissen, H.-U., Wessicken, R. u. Wiederkehr, P.: X-ray Microanalysis Using a Scanning Electron Microscope in: Electron Microscopy in Mineralogy, Ed. by H.R. Wenk, P.E. Champness, J.M. Christie, J.M. Cowley, A.H. Heiner, G. Thon und N.J. Tighe. Springer Verlag, Berlin-Heidelberg-New York (1976).

(44) Adetunji, J. and Barber, D.J.: The Sputtering Behaviour of Calcite. J. Mater. Science 13 (1978) S. 627 – 638.

(45) Kortüm, G.: Kolorimetrie, Photometrie und Spektrometrie, 4. Auflage, Springer Verlag, Berlin, Göttingen, Heidelberg (1962)

(46) Bach, H., Haspel, R. und Neuroth, N.: Ion Beam Milling of Silica for IR Transmissions. J. of Physics E.: Scientific Instruments, 9 (1976), S. 557 – 559.

(47) Duffy, J.A. and Bach, H.: Use of Ultraviolett Spectroscopy for Studying Interdiffusion Reactions of PbO on Vitreous Surfaces. Thin Solid Films, 48 (1978) S. 377 – 383.

(48) Schröder, H.: Oxide Layers Deposited From Organic Solutions. Physics of Thin Films, Vol. V. Hrsg. v. Hass, G. und Thun, R., New York, London: Academic Press 87 – 141 (1969)

(49) Bach, H. und Schröder, H.: Kristallstruktur und optische Eigenschaften von dünnen organogenen Titanoxydschichten auf Glasunterlagen. Thin Solid Films 1 (1967/68). S. 255 – 276.

(50) Ladage, A.: Elektroneninterferenzen an elektrolytisch polierten Oberflächen nach Kathodenzerstäubung, Z. f. Phys. 144, 354 – 372 (1956).

(51) Bach, H.: Elektronenmikroskopische Untersuchung von Transversalschnitten dünner Schichten auf festen Unterlagen. Z. Physik 224, (1969) S. 122 – 125.

(52) Günther, K.H. and Pulker, H.K.: Electron Microskopic Investigations of Cross Sections of Optical Thin Films. Applied Optics 15 (1976) S. 2992 – 2997.

(53) Sheng, T.T. and Marcus, R.B.: Gate Oxide Thinning at the Isolation Oxide Wall. J. Electrochem. Soc. 125 (1978) S. 432 – 434.

(54) Bach, H. and Duffy, J.A.: Study of PbO Films on Sodium Borate Glasses – (I) Penetration of Pb^{2+} Ions Deeply into the Glass. J. Non-Crystalline Solids, 29 (1978) S. 77 – 83

(55) Bach, H. and Duffy, J.A.: Study of PbO Films on Sodium Borate Glasses III (in Vorbereitung f. J. Non-Crystalline Solids)

(56) Gossink, R.G. de Grefte, H.A.M. and Werner, H.W.: SIMS Analysis of Aqueous Corrosion Profiles in Soda-Lime-Silica Glass. J. Amer. Ceramic. Soc. 62 (1979) S. 4 – 9.

(57) Covington, A.K. and Flynn, A.: Concentration Profiles in the Surface Layer on Glass Electrodes by Argon-Ion Beam Sputtering. J. Chem. Soc. Commun. 21 (1977) S. 792 – 793.

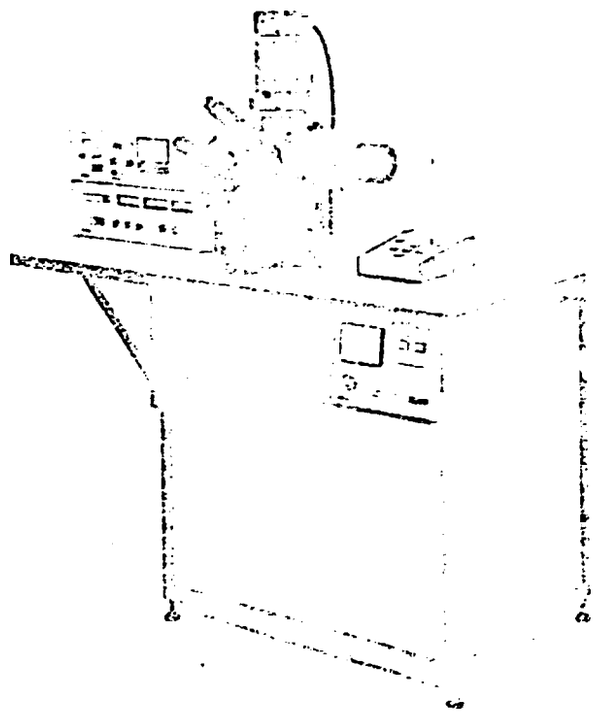
(58) Baucke, F.G.K.: Contribution to the Electrochemistry of pH Glas Electrode Membranes in: Ion Selective Electrodes, E. Pungor Ed., Elsevier Scientific Publishing Comp., Amsterdam, Oxford, New York (1978).

(59) Tsong, I.S.T. and Yusuf, N.A.: Absolute Photon Yields in the Sputter Induced Optical Emission Process. Appl. Phys, Lett. 33 (1978) S. 999 – 1002.

BALZERS

Universal Ion Beam Etching Device IEU 100

- **Fully automatic pumping system**
  with oil diffusion or turbomolecular pump and exact vacuum measurement over the whole working range with automatic display of fore and high vacuum
- **Universal application**
  because of the modular system. Quick release flanges as well as easily exchangeable rotary specimen table
- **Any spot on the specimen can be moved under the ion beam**
  because of the crosstable that can be moved in two directions
- **Specimen can be etched on both sides**
  because the rotating specimen table can be turned 360°
- **Etching angle from 0° to 89° continuously adjustable**
- **Etching process can be clearly observed**
  through 30 x binocular microscope
- **Specimen can be easily centered under the ion beam**
  because of reticle, object lighting, as well as a specimen table that can be controlled from outside the device
- **Constant etching rates and reproducible etching depth**
  thanks to stable operating parameters and automatically regulated gas inlet
- **Flat or pointed etching profiles**
  through continuously adjustable beam cross section
- **No thermal damage to specimen**
  thanks to continuously adjustable beam density
- **Ion source can be safely removed**
  because the high voltage supply line disconnects at removal
- **Simple placement and measurement of the ion beam**
  using the built in beam probe
- **Automatic cutout if the specimen is perforated**
  for the interesting, electron transparent edges of the hole remain intact. In addition, this feature allows rational time use without supervision e.g. at night
- **Handling of nonconductive materials**
  because of the neutralization of the specimen charge through electron bombardment



IEU 100 with BALZERS oil diffusion pumping station PWS 100 A

- **Evaporation coating of the substrate immediately after etching**
  without breaking the vacuum
- **Surface element analysis and concentration profiles**
  using the quadrupole mass spectrometer
- **Spectral analysis**
  with monochromator
- **Long service life**
  thanks to the Penning principle ion source and the titanium extraction lens

APPLICATION POSSIBILITIES

With the basic model described in the next section the following applications are possible:

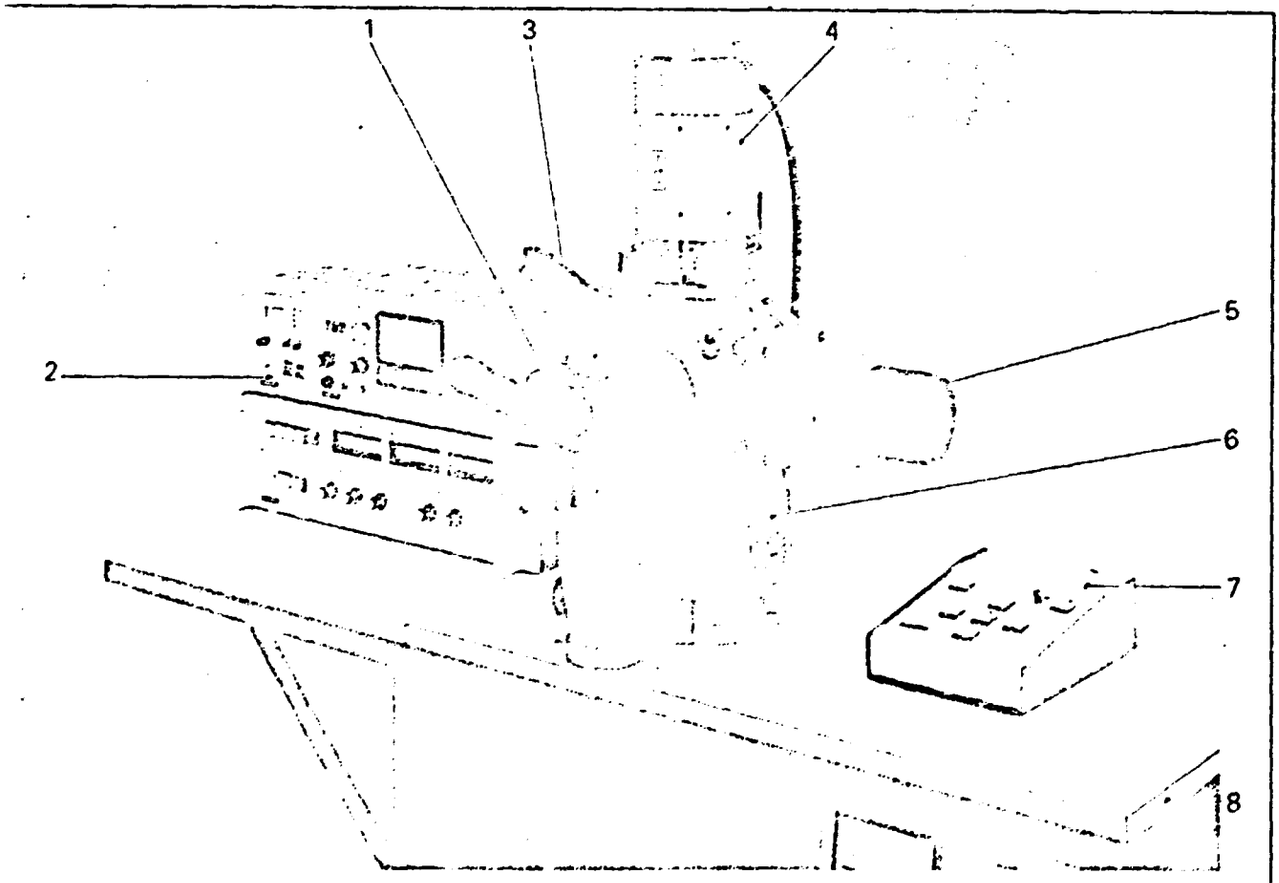
- production of atomically clean specimen surfaces through exact etching away of foreign, reaction, and gas desorption films as well as films resulting from various preparation methods
- exact exposure of inhomogeneities and surface layers for analysis in light and scanning electron microscope
- Preparation for absorption spectroscopy in transmission and reflection
- production of chemical surface reactions by using an appropriate ionization gas
- production of electron transparent specimen areas for analysis in the transmission electron microscope

By extending the IEU 100 equipment with the field proven BALZERS quick release flange system the following can be performed on the already etched specimen without breaking the vacuum:

- evaporation coating of nonconductive or rapidly oxidating specimens for examination in the SEM
- preparation of surface replicas for examination in the TEM
- general preparation work

With additional equipment such as mass spectrometer, monochromator, or narrow bandwidth interference filter the field of application for the IEU can be greatly enlarged:

- Surface element analysis with the aid of mass spectrometric and/or emission spectrometric examination devices
- Mass spectrometric and/or emission spectrometric analysis of element concentration gradients (in depth concentration profile)



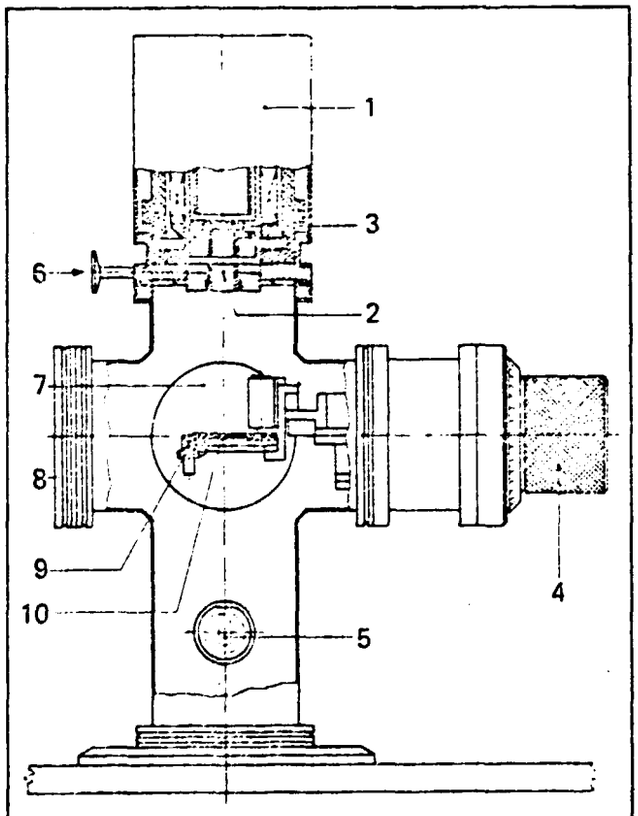
1 Binocular microscope (11)
2 Control unit (see Fig. 6)
3 Specimen lighting (8)
4 Ion source (4)
5 Specimen table (2)
6 2 connections for electron source and hole detector
7 Specimen table control unit (3)
8 Pumping station PWS 100 A (21)
9 Console (22)

SPECIFICATION OF THE BASIC MODEL

1. Working chamber

Double cross chamber of stainless steel containing:

- pumping system connection flange DN 100 ISO
- four further DN 100 ISO connection flanges for the installation of ion source, specimen table, and quick release flanges in any desired arrangement
- two DN 40 KF flanges for the installation of the perforation detector and the high voltage feedthrough for the electron source
- four sight glasses ϕ 10 for lighting the specimen on all sides as well as a sight glass DN 52 ISO with rapid fasteners and protective glass for observing the specimen during etching. The connection flanges DN 100 ISO are blanked off.



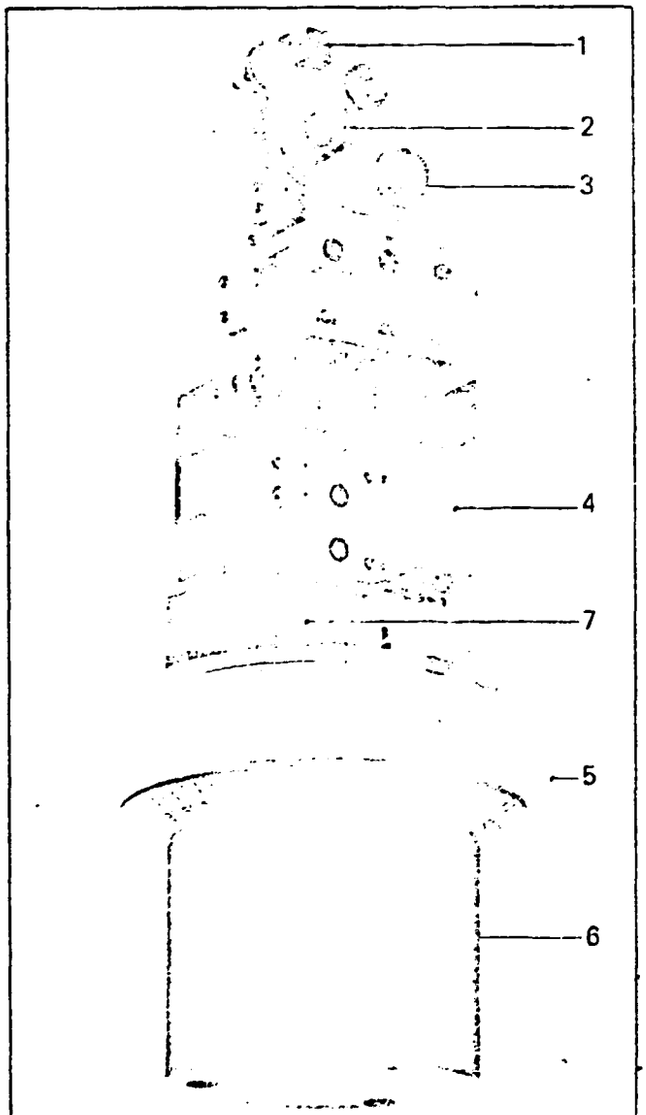
1 Ion source
2 Tubular lens
3 Extraction lens
4 Specimen table
5 Perforation detector
6 Gas supply
7 Connection for mass spectrometer analyzer
8 Connection for optics
9 Beam probe
10 Specimen plate

Fig. 3 Design IEU 100

2. Specimen table

consisting of:

- cross table to hold various, disk-shaped specimen holders
- motor drive for the specimen plate, rotational speed between 0 and 5 rpm, continuously adjustable
- two separately controlled drive motors for exact positioning of the beam probe or the specimen under the ion beam
- beam probe for location and measurement of the ion beam
- two disk shaped standard specimen holders
- rotating handle with angle scale makes it possible to turn the table 360° manually



1 Beam probe
2 Specimen plate
3 Motor for rotating plate drive
4 Motor drive for x-axis movement
5 Flange with angle scale
6 Rotary handle
7 Motor drive for y-axis movement

Fig. 4 Specimen table

3. Specimen table control unit PTC 101

consisting of:

- all necessary operating elements for controlling the cross-table positioning motor
- automatic cutoff with display lamp for the table movement end position
- rotational speed control for the specimen plate, speed can be controlled between 0 and 5 rpm, continuously adjustable
- On/off switch and power supply (6 V) for the specimen lighting

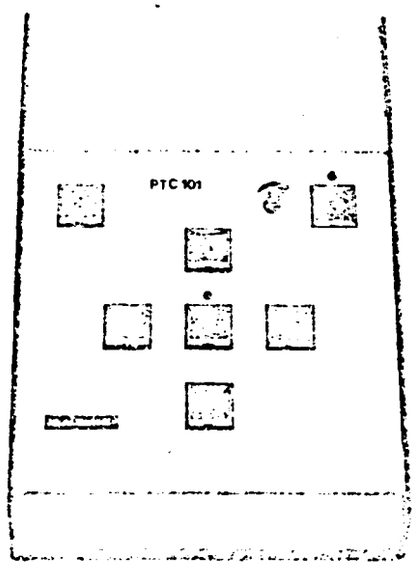


Fig. 5 Specimen table control unit

4. Ion source (Bach system)

Penning type, connection flange DN 100 ISO
Easily exchanged extraction diaphragm (ϕ 1 – 3 mm), a continuously adjustable tubular lens and a series connected conical diaphragm for the adjustment of the desired degree of ion beam focussing. Beam density to 600 $\mu A/cm^2$.

Integrated high voltage disconnect when the ion source is removed, for personnel safety.

Adjustment attachment for precise, mechanical alignment of the ion source as to conical diaphragm and specimen table coordinates.

Connection for gas inlet valve: DN 10 KF

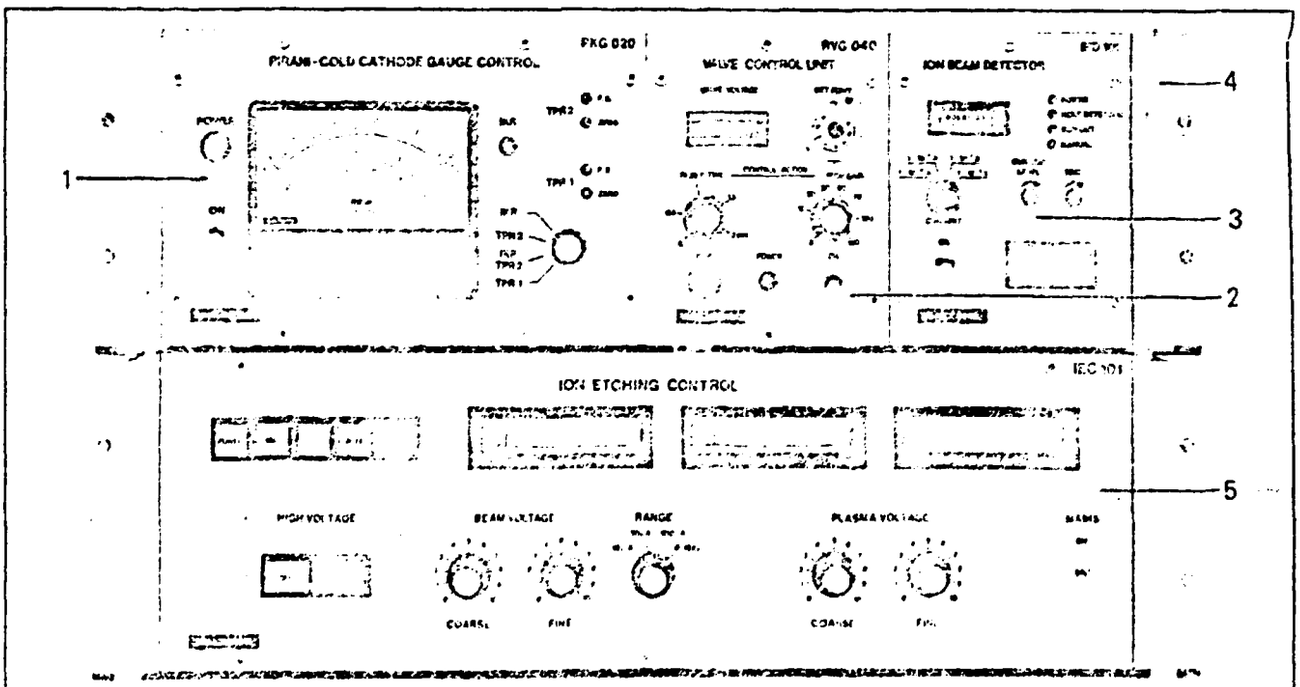
5. Gas inlet valve EVN 010 H1

for manual adjustment of the gas supply to the ion source
Gas flow adjustable from 1 x 10^{-5} to 130 mbar l/s

6. Supply and control unit IEC 101

19" rack module for high voltage supply and control of the ion source, containing:

- mains on/off
- pushbutton on/off for the high voltage
- two potentiometers for coarse and fine adjustment of the plasma voltage between 0 and 1000 V
- two potentiometers for coarse and fine adjustment of the post acceleration voltage between 0 and 10,000 V
- preselection switch for setting the measurement range 10 μA, 30 μA, 100 μA, or 0 – 10 kV
- double scale display instrument to show the measured values in the range set on the preselection switch
- a display instrument each for the plasma current and the plasma voltage
- various signal lamps for displaying the operating status



1 Vacuum gauge PKG 020 (accessory)
2 Control unit RVG 040 (accessory)
3 Control unit IBD 101 (accessory)
4 Installation frame (accessory)
5 Supply and control unit IEC 101

Fig. 6

7. Vacuum relay

prevents the high voltage in the ion source supply from being turned on before a certain pressure has been reached in the vacuum chamber. Thus it serves, in addition to the integrated disconnect (refer to section 4) as an additional element for personnel safety.

Connection flange for the vacuum relay depends on the brand of pump (give flange size when ordering)

8. Specimen lighting

with 6 V/15 W lamp and rotatable mount for optimal adjustment of the light

9. Set of tools

contains all the tools necessary for maintenance of the IEU 100

10. Set of spare parts

consisting of:

- fuses and spare lamps for the control unit
- spare lamp 6 V/15 W for specimen lighting
- O-ring seal for the working chamber, ion source, and specimen table
- parts subject to wear such as insulators, sight glasses, cathode plates
- two standard specimen holders with exchangeable clamping disks and centering device for standard specimens ϕ 3 mm and 2.3 mm (other dimensions on request)

ACCESSORIES

11. Binocular microscope

30 x magnification for good observation and an ocular with reticle for exact adjustment of the specimen area under the ion beam, stand with microscope holder that can be inclined, as well as height and depth adjusted.

12. Automatic gas inlet system

consisting of:

- automatic regulation valve RME 010
- control unit RVG 040
- vacuum gauge TPG 060 (only for oil diffusion pumping systems)
- Vacuum gauge PKG 020 (only for turbomolecular pumping systems)
- Pirani medium vacuum gauge head TPR 010

The RME 010 is installed additionally to the gas inlet valve EVN (refer to section 5) or in place of it. You can find further information in a separate catalog sheet.

13. Electron source

Simultaneous bombardment of the specimen with electrons during ion etching prevents charging and thus makes etching of nonconductive materials possible.

The electron source consists of:

- electron source EGN 101 with fixation device and high voltage feedthrough
- control unit EGS 101

14. Control unit IBD 101

Either the perforation detector as per section 16 or the beam probe (refer to section 2) can be connected as desired.

The device consists of:

- a display instrument and a measurement range switch for the ion current
- potentiometer for the continuous adjustment of the ion current limitation value at which the automatic cutoff should respond
- potentiometer for the continuous adjustment of the response time (1 to 15 s) after which the automatic cutoff should respond once the ion current limitation value has been reached.

15. Electrometer amplifier EP 511

This amplifies the ion current registered in the beam probe or in the perforation detector and sends it on to the IBD 101. Measuring range 10^{-5} A, 10^{-7} A, 10^{-9} A, 10^{-11} A.

16. Perforation detector

for the automatic interruption of the etching process when the specimen is perforated. It is necessary for thinning specimens and consists of an ion collector (Faraday cup) and a fixation flange DN 40 KF.

The ions passing through the specimen are collected in this detector, the ion current is amplified in the electrometer amplifier EP 511, and then registered in the control unit EBD 101.

18. Evaporation coating device

This device is designed on a BALZERS quick release flange and can be connected to the working chamber using an adapter flange. You can find further information in "Application possibilities" and in the separate catalog sheet "Quick release flanges DN 80".

17. Recorder HP 680 M

can be directly connected to the control IBD 101 and records the ion density distribution measured by the beam probe.

19. Mass spectrometric and spectral analytical material analysis

BALZERS manufactures several suitable mass spectrometers for such examinations. Please send for separate documentation.

20. Installation frame

Several partial rack modules can be installed next to one another in one installation frame with handles. If the frame is not completely filled with instruments it can be completed with blanking panels. The installation frame has, for example, space for the IBD 101 (section 14), RVG 040 (section 12), and PKG 020 (section 12.)

: High vacuum pumping stations

diffusion and turbomolecular pumping systems with pump-speeds of at least 200 l/s are suited.

example, BALZERS oil diffusion table pumping station PWS 100 A with integrated vacuum measurement

BALZERS turbomolecular table pumping station TSH 270 with separate vacuum measurement

u can find more detailed information in separate catalog ets.

. Console

assembly on encased pumping stations; serves as surface placing the control units.

:CHNICAL DATA

n source supply	
asma voltage ntinuously adjustable	0 – 1000 V, 30 mA
st acceleration voltage ntinuously adjustable	0 – 10,000 V
n source	
ojectile ion energy	2 – 8 keV
eam diameter continuously justable	1 – 25 mm
ojectile ion density for flat etching for focussed etching	0.25 – 200 μA/cm^2 to 600 μA/cm^2
n density fluctuations of e beam profile for flat etching	< 5% in the middle
uttering rate (dependent on aterial, ionization gas, etch- gle, degree of focus, and am intensity)	1 – 30 μm/h
as supply	
nization gas (usually argon) as supply line	free choice 0.2 – 0.5 bar
orking pressure in the chamber	10^{-3} – 10^{-4} mbar
orking chamber	
orking pressure	2 x 10^{-5} to 1 x 10^{-6} mbar
quired pumping speed	> 200 l/s

CONNECTION DATA

(without pumping system)

Electrical Voltage	220 V
Frequency	50 Hz
Rating	100 W
Other voltages and frequencies	on request

ORDERING DATA

	Spec. Pos.	Order Nr.
Basic system as per specification	1 – 10	BB P02 500
Accessories		
Binocular microscope	11	B 7302 250 ZB
Autom. gas inlet system –for diffusion pumping systems –for turbomolecular pump. systems	 12 12	 BB 172 917 -T BB 172 914 -T
Electron source EGN 101 includ. high voltage feedthrough and fixation **Control unit EGS 101** to the electron source	 13 13	 BK J02 750 BG M67 000
Control unit EBD 101	14	BG M60 500
Electrometer amplifer EP 511	15	BG 521 300 -U
Perforation detector	16	BB 172 880 -T
Recorder HP 680 M	17	B 5294 211 AA
Evaporation coating device	18	+)
Mass spectrometer QMG	19	++)
Installation frame 19"	20	BB 176 046 -T
High vacuum pumping station	21	++)
Console	22	BB 172 900 -T

+) Refer to separate catalog sheet "Quick release flanges DN 80"

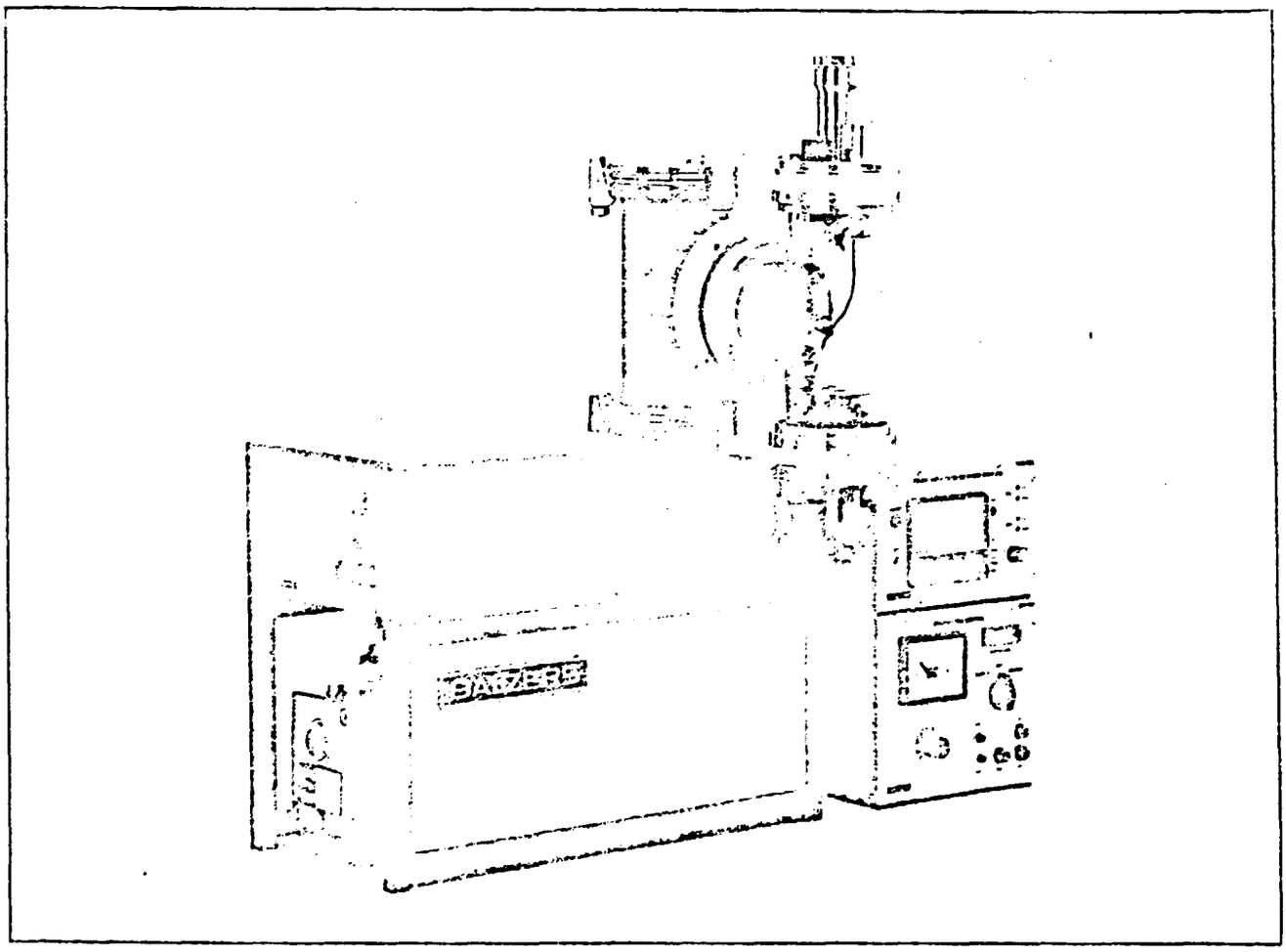
++) Refer to BALZERS catalog "Vacuum Components"

roduct of BALZERS AG, Balzers DN 9189 Printed in Liechtenstein Subject to change without notice.

BALZERS Aktiengesellschaft – FL-9496 Balzers, Fürstentum Liechtenstein – Tel.: 075 / 4 41 11 – Telex: 77 841
PFEIFFER Vakuumtechnik Wetzlar GmbH – Postfach 1280 – D-6334 Asslar, BRD – Tel.: 0 64 41 / 80 21 – Telex: 48 3859
BALZERS – 8 Sagamore Park Road – Hudson, NH 03051 U.S.A. – Phone: 603 / 889 6888 – Telex: 94 3479

BALZERS

High vacuum system for research and specimen preparation BAE 080 T



- Extremely clean vacuum conditions assured by turbomolecular pumping
- Well suited for education and training because of safe, reliable operation of the high vacuum pumping system
- Portable bench-top model fits on any laboratory bench
- Robust and reliable – accidental introduction of air cannot damage the system
- Easy and inexpensive maintenance
- A choice of four different vacuum chambers assures adaptation to specific requirements
- Maximum flexibility results from a range of auxiliary equipment fitted on quick release flanges
- Both conventional resistance evaporators and electron beam guns can be used for evaporation of carbon, SiO, and metals
- Highly universal modular system ideally suited for a variety of tasks in research and education

. High vacuum pumping stations

diffusion and turbomolecular pumping systems with pump-speeds of at least 200 l/s are suited.

example, BALZERS oil diffusion table pumping station PWS 100 A with integrated vacuum measurement

BALZERS turbomolecular table pumping station TSH 270 with separate vacuum measurement

u can find more detailed information in separate catalog ets.

. Console

assembly on encased pumping stations; serves as surface placing the control units.

CHNICAL DATA

n source supply	
sma voltage ntinuously adjustable	0 – 1000 V, 30 mA
st acceleration voltage ntinuously adjustable	0 – 10,000 V
n source	
ojectile ion energy	2 – 8 keV
eam diameter continuously justable	1 – 25 mm
ojectile ion density for flat etching for focussed etching	0.25 – 200 μA/cm^2 to 600 μA/cm^2
n density fluctuations of e beam profile for flat etching	< 5% in the middle
uttering rate (dependent on aterial, ionization gas, etch- gle, degree of focus, and am intensity)	1 – 30 μm/h
s supply	
nization gas (usually argon) s supply line	free choice 0.2 – 0.5 bar
orking pressure in the chamber	10^{-3} – 10^{-4} mbar
orking chamber	
rking pressure	2 x 10^{-5} to 1 x 10^{-6} mbar
quired pumping speed	> 200 l/s

CONNECTION DATA

(without pumping system)

Electrical Voltage	220 V
Frequency	50 Hz
Rating	100 W
Other voltages and frequencies	on request

ORDERING DATA

	Spec. Pos.	Order Nr.
Basic system as per specification	1 – 10	BB P02 500
Accessories		
Binocular microscope	11	B 7302 250 ZB
Autom. gas inlet system –for diffusion pumping systems –for turbomolecular pump. systems	 12 12	 BB 172 917 -T BB 172 914 -T
Electron source EGN 101 includ. high voltage feedthrough and fixation **Control unit EGS 101** to the electron source	 13 13	 BK J02 750 BG M67 000
Control unit EBD 101	14	BG M60 500
Electrometer amplifer EP 511	15	BG 521 300 -U
Perforation detector	16	BB 172 880 -T
Recorder HP 680 M	17	B 5294 211 AA
Evaporation coating device	18	+)
Mass spectrometer QMG	19	++)
Installation frame 19"	20	BB 176 046 -T
High vacuum pumping station	21	++)
Console	22	BB 172 900 -T

+) Refer to separate catalog sheet "Quick release flanges DN 80"

++) Refer to BALZERS catalog "Vacuum Components"

oduct of BALZERS AG, Balzers DN 9189 Printed in Liechtenstein Subject to change without notice.

BALZERS Aktiengesellschaft – FL-9496 Balzers, Fürstentum Liechtenstein – Tel.: 075 / 4 41 11 – Telex: 77 841
PFEIFFER Vakuumtechnik Wetzlar GmbH – Postfach 1280 – D-6334 Asslar, BRD – Tel.: 0 64 41 / 80 21 – Telex: 48 3859
BALZERS – 8 Sagamore Park Road – Hudson, NH 03051 U.S.A. – Phone: 603 / 889 6888 – Telex: 94 3479

BAE 080 T is a sample preparation system consisting of ıle, proven Balzers components. Balzers quick release flan- – specimen preparation tools fitted on standard flanges can be connected to the vacuum chamber as required – part of the overall system. The great variety of quick se flanges makes the BAE 080 T a highly flexible and tile unit for sample preparation. In addition, the system is d to general vacuum and coating work in research labora- s and educational institutions.

BAE 080 T system has a tube-shaped (standard) and cross ped (optional) vacuum chamber with DN 80 connecting s. Also available are both tube-shaped and cross-shaped mbers with DN 120 connecting ports – this ensures that all k release flanges of the larger Balzers BAE 120/121 sample aration system can be used with the BAE 080 T equip- it.

pumping system of the BAE 080 T is controlled by a le switch. An automatic safety valve in the backing pump es when the pumping system is turned off or in the event a power failure; and so that back-streaming of oil vapors the vacuum chamber will be prevented, the backing pump ented immediately. When the pumping system is switched again, the safety valve opens with a time delay. Venting of vacuum chamber is accomplished with a manually opera- valve that can be furnished with an air drying device.

ECIFICATION OF THE BASIC SYSTEM

HIGH VACUUM PUMPING SYSTEM TSH 110

. Turbomolecular pump TPH 110

mping speed for air, 110 l/s;
imate pressure with DUO 1.5, $< 5 \cdot 10^{-8}$ mbar;
ver rating, 300 VA
oling water consumption, 15 l/h.

. Two stage rotary vane pump DUO 1.5 A

h built-in safety valve;
mping speed, 1.5 m^3/h.

. Manually operated vent valve VFH 005

. Splinter protection

prevent parts from entering the rotor space
the turbomolecular pump

T-PIECE

nsists of standard BALZERS part mounted directly onto DN 100 ISO-K throat of the TPH 110. Has a DN 10 KF nnecting port for the Pirani gauge head, a DN 40 KF con- cting port for the high vacuum gauge head, a sealed connect- port for installation of a cold trap (optional) and a DN 100 O-K connecting port for the vacuum chamber. The connect- T is also available individually without blind flange or with ee sealed connecting ports (DN 10 KF, DN 40 KF, and DN 0 KF). (See ordering Guide).

VACUUM CHAMBER

ilable in DN 80 and DN 120, T-shaped or cross-shaped. ex glass cylinder with two or four connecting ports for ck release flanges (bayonet catch) and a connecting port for pumping system. See accessory specification Items 8, 9, , 11.

4. EVAPORATION AND GLOW DISCHARGE EQUIPMENT consisting of:

4.1. High current transformer

1 kVA continuous rating with secondary windings adjustable for 0 – 4, 0 – 8, and 0 – 16 volts and high voltage transformer of 60 W at 2500 V/24 mA.

4.2. Combined high current and high voltage control unit BSV 080

with mains power ON-OFF switch, potentiometer for controlling the primary voltage of the high current and high voltage transformer, ammeter, and glow discharge and evaporation selection switch.

4.3. Two high current cables

of 1 m length with connectors on both ends.

4.4. Power cable

5. VACUUM MEASURING EQUIPMENT

5.1. Indicating instrument PKG 020

with automatic switch-over from fore to high vacuum; measuring range, $100 - 5 \cdot 10^{-8}$ mbar.

5.2. High vacuum gauge head IKR 010

for measuring high vacuum in the chamber; measuring range, $5 \cdot 10^{-8}$ mbar.

5.3. Vacuum gauge head TPR 010

for measuring high vacuum in the chamber; measuring range, $5 \cdot 10^{-6}$ mbar.

5.4. Cable for gauge head and power connections.

6. SAFETY INTERLOCK

for high voltage consumers, consisting of disconnect plug for each connection opening of the chamber as well as a distribution box for the connection cables.

SPECIFICATIONS OF VARIANTS

7. PREPATATION UNIT (without turbomolecular pumping system)

Recommended for setting up a preparation system when pumping system is already at hand, using DN 100 connecting ports and a pumping speed of at least 100 l/s. As indicated in the ordering guide, the preparation unit is available in different variants. It consists of:

- Preparation set according to specification, Item 7
- Evaporation and glow discharge equipment according to specifications, Item 4
- With or without vacuum measuring equipment according to specifications, Item 5

8. PREPARATION SET

The preparation set will enable you to set up a preparation system according to your own needs and wishes, with the possibility to use equipment already at hand, such as pumping system, vacuum measuring equipment, high current transformer, etc. The set consists of:

Vacuum chamber (at DN 120, including splinter protection) according to specifications in Item 2

T-piece without blanking flange according to specification, Item 2

Installation set for vacuum chamber

One set of seals, blind flanges, clamp rings and screws.

SPECIFICATIONS OF INDIVIDUAL PARTS AND ACCESSORIES

9. T-shaped chamber DN 80

Inside diameter, 80 mm; length, 250 mm; inside diameter of the pumping port, 70 mm.

10. Cross-shaped chamber DN 80

Inside diameter, 80 mm; length in both directions 250 mm; inside diameter of the pumping port, 70 mm.

11. T-shaped Chamber DN 120

Inside diameter, 120 mm; length, 300 mm; inside diameter of the pumping port, 120 mm.

12. Cross-shaped Chamber DN 120

Inside diameter, 120 mm; length in both directions 300 mm; inside diameter of the pumping port, 120 mm.

13. Splinter protection

For T-shaped or cross-shaped chamber DN 120. Recommended for glass chambers over 100 diameter.

14. Heating blanket

For T.shaped or cross-shaped chamber DN 120. For degassing the chamber through bake-out. Connected wattage: T-chamber, 150 W; cross-shaped chamber, 200 W.

15. Cold trap

To shorten pumping time through additional pumping action for condensable gases or to improve ultimate pressure. It is installed in the top connection port DN 100 ISO-K of the connecting T.

16. Heating sleeve

For heating the turbomolecular pump, thereby reaching the ultimate pressure faster. Heater power rating, 60 W. Connected voltage, 220 – 240 V.

17. Air drying device TTV 001

Consists of a glass tube filled with zeolite mounted on the air-inlet valve; for drying air admitted to the vacuum chamber.

18. Work table

For fitting two quick release flanges DN 80 or DN 120. For mounting the evaporation sources and carbon electrodes and attaching the specimen supports on the specimen table.

19. Test object holder

Permits visual checking of film thickness. Holds a test object.

20. Front panel for TSH 110

To cover front of pumping system.

Please refer to separate literature regarding other accessories such as electron beam evaporation component EVM 052, and quartz film thickness moniator QSG 301.

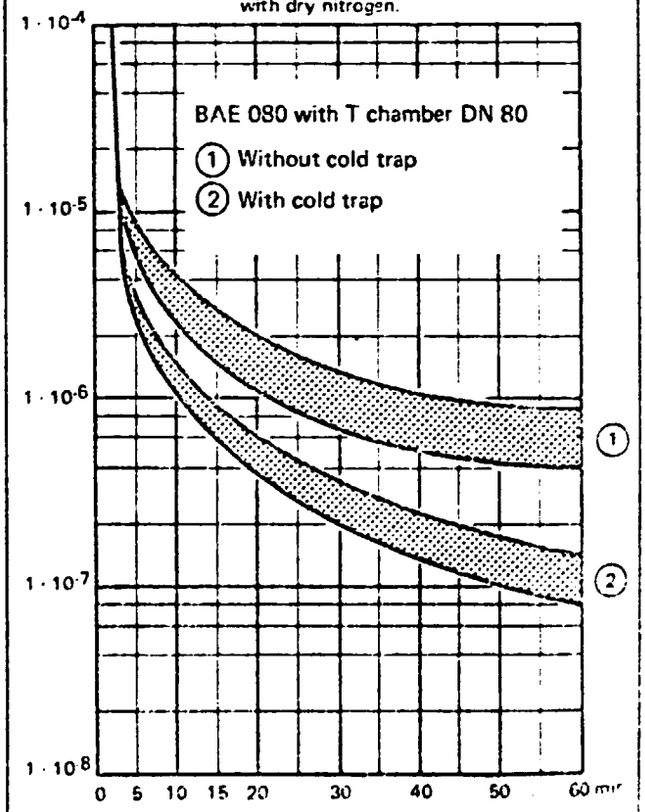
TECHNICAL DATA

PUMPING SYSTEM

Backing pump DUO 1.5 A	
Pumping speed at 10 mbar	1.5 m^3/h
Ultimate pressure, total without gas ballast	$< 6 \cdot 10^{-3}$ mbar
Nominal motor rating	110 W
Turbomolecular pump TPH 110	
Pumping speed for air	110 l/s
Ultimate pressure with DUO 1.5	$< 5 \cdot 10^{-8}$ mbar
Nominal motor rating	200 W
Cooling water consumption	15 l/h
Heater power rating (heater is optional)	60 W
DIMENSIONS	See scale drawing
WEIGHTS	
Preparation unit plus pumping system	39 kg
Transformer unit	28 kg
Control unit BSV 080	5 kg
Vaccum gauge PKG 020	3 kg
CONNECTION DATA	
Electrical	
Voltage (P+N+E)	220 V
Frequency	50 Hz
Rating (depending on equipment)	to 1.5 kW
Other voltages and frequencies	on request
Cooling water	
Cooling water consumption at 15 °C	15 l/h
Outlet	Gravity flow
Exhaust	
Connection flange for backing pump	DN 10 KF

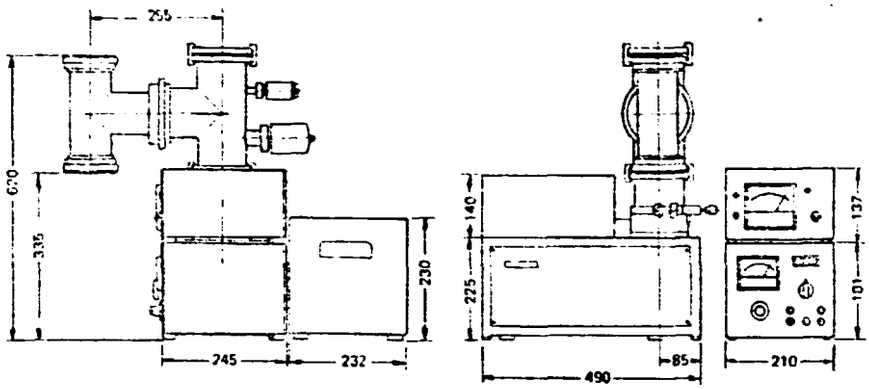
PUMP-DOWN CURVES

measured with a cold cathode gauge head in an empty and clean vacuum chamber, thoroughly pre-degassed after a pumping time of 24 hours and afterwards vented with dry nitrogen.



ORDERING GUIDE

	Item	with T-chamber DN 80	with cross-shaped chamber DN 80	with T-chamber DN 120	with cross-shaped chamber DN 120
System BAE 080 T, complete	1 – 6	BB P01 520	BB P01 521	BB P01 522	BB P01 523
Preparation unit, consisting of	7	BB 176 980 -T	BB 176 982 -T	BB 176 984 -T	BB 176 986 -T
– preparation set (see below)	8				
– evaporation and glow discharge equipment	4				
– vacuum measuring equipment	5				
as above, but without measuring equipment		BB 176 981 -T	BB 176 983 -T	BB 176 985 -T	BB 176 987 -T
Preparation set, consisting of	8	BB 176 962 -T	BB 176 963 -T	BB 176 964 -T	BB 176 965 -T
– chamber (DN 120 including splinter protection)	3				
– connecting T without blind flange	2				
– installation set for chamber					
– one set of seals, blind flanges, clamping rings and screws					
Evaporation and glow discharge equipment, consisting of	4				
– control unit BSV 080	4.2		BG M13 250		
– transformer unit with high current and high voltage transformer, complete	4.1		BG 530 700 -T		
Alternative					
– transformer unit with high current transformer			BG 530 752 -W		
or					
– transformer unit with high voltage transformer			BG 530 753 -W		
– two high current cables	4.3		B 4564 491 DB		
– one power cable	4.4		BG 519 170 -T		
Vacuum measuring equipment, complete, consisting of	5				
– indicating instrument PKG 020	5.1		BG D06 257 -1		
– high vacuum gauge head IKR 010	5.2		BG G01 002		
– vacuum gauge head TPR 010	5.3		BG G02 250		
– gauge head connection cable for IKR 010	5.4		BK 372 318 -T		
– gauge head connection cable for TPR 010	5.4		BK 186 221 -T		
– power cable	5.4		BG 519 170 -T		
Individual parts and accessories					
– T-chamber DN 80	9		BB 187 655 -T		
– Cross-shaped chamber DN 80	10		BB 187 656 -T		
– T-chamber DN 120	11		BB 187 581 -T		
– Cross-shaped chamber DN 120	12		BB 187 993 -T		
– Splinter protection for T-chamber DN 120	13		BB 187 195		
for cross-shaped chamber DN 120	13		BB 187 580 -T		
– T-piece, 3 sealed connecting ports	2		BB 176 865 -T		
– T-piece, without blind flange	2		BP 220 735 -X		
– Installation set for chamber DN 80			BB 176 941 -T		
– Installation set for chamber DN 120			BB 176 610 -T		
– Heating blanket for T-chamber DN 80	14		B 5170 062 CZ		
– Heating blanket for cross-shaped chamber DN 120	14		B 5170 063 CZ		
– Cold trap	15		BB 176 942 -T		
– Heating sleeve for TPH 100	16		PM 003 413 -T		
– Air drying device	17		PM Z00 120		
– Working table DN 80	18		BB 187 780 -T		
DN 120	18		BB 181 017 -U		
– Test object holder	19		BB 181 021 -U		
– Front panel for TSH 100	20		BB 176 807 -T		
– Vent valve	1.3		PK V40 003		



Dimensions drawing BAE 080 -T

Guide to equipping the BALZERS specimen preparation plant BAE 080 T with chamber DN 80

Preparation method	Quick relase flanges																Other accessories									
	WF 201	WF 202	WF 203	WF 204	WF 206	WF 207	WF 208	WF 209	WF 210	WF 211	WF 213	WF 214	WF 215	WF 224			Cold trap	High voltage power supply	Specimen table PT 812/813	Specimen table PT 814	Carbon sharpener KS 611	Carbon sharpener KS 625	Working table	Sputter device	EVM 052	OSG 301	
Carbon support films	A			B	B	B				B				A			C					A	A		B	C	
Regular and conical shadowing (metal)		B		A	B					A							C		A				A		B	C	
Regular and conical shadowing (Pt-C)				A	B					A				B			C		A		A	A	A		B	C	
Surface replicas				A	B					A				B			C					A	A		B	C	
Envelope replicas				A	B					A				B			C					A	A		B	C	
Sample coating for the microprobe				A		A				B							C					C	A			C	
Specimen coating for the scanning microscope				A						B	A						C			B		A	A				
Phase contrast using interference film		A							A														A				
Coating temperature sensitive specimens		B		A	B			A						B			A					A	A		B		
Carbon films from a gas atmosphere												A	A					A									
Cathode etching												A	A					A									
Sputtering scanning microscope specimens												A	A					A						A			
General vacuum and coating research		A		B	B		A						A				C	A				C	A		B		
Long-term coating experiments			A			A	B	B		B			B				C	B					A			C	
Freeze-drying								A									A										
Cleaning Mo apertures			A																				A				
W-Ta Shadowing					A					A							C		A				C		A	C	

Key: A Required B Optional C Recommended

Guide to equipping the BALZERS specimen preparation plant BAE 080 T withchamber DN 120

Preparation on method	Quick release flanges																	Other accessories								
	WF 001	WF 002	WF 003	WF 004	WF 005	WF 006	WF 007	WF 008	WF 009	WF 010	WF 011	WF 012	WF 013	WF 014	WF 015	WF 024	WF 025	Working table	Specimen table PT 802/803	Specimen table PT 804	Carbon sharpener KS 611	Carbon sharpener KS 625	Sputtering device	High voltage power supply	EVM 052	QSG 301	Cold trap
arbon support films	A			B	B	B	B				B	B				A		A				A			B	C	C
gular and conical adowing (metal)		B		A		B					A	B						A	A					B	C	C
egular and conical adowing (Pt-C)				B	A	B					A	B						A	A		A	A			B	C	C
-Ta shadowing						A					A	B						C	A						A	C	C
urface replicas				A	B	B					A	B						A				A			B	C	C
nvelope replicas				A	B	B					B	A						A				A			B	C	C
ample coating for e microprobe				A			A				B	B						A				C			C	C
pecimen coating for e scanning microscope				A							B	B	A				B	A		B		A			C	C
ase contrast using terference film		A								A								A								
oating temperature-ensitive specimens				A	B	B			A									A				A			B	C	A
arbon films from gas atmosphere														A	A									A			
athode etching														A	A									A			
puttering scanning icroscope specimens														A	A								A	A			
eneral vacuum and oating research		A		B		B	B	A			B	B			A			A						A	B	C	C
ong-term coating xperiments			A				A	B	B		B	B			B			A						B		C	C
reeze-drying									A																		A
leaning Mo-apertures			A															A									

Key: A required B Optional C Recommended

duct of BALZERS AG, Balzers DN 8532 Printed in Liechtenstein Subject technical to change without notice

BALZERS Aktiengesellschaft – FL-9496 Balzers, Fürstentum Liechtenstein – Tel.: 075 / 4 41 11 – Telex: 77 841
PFEIFFER Vakuumtechnik Wetzlar GmbH – Postfach 1280 – D-6334 Asslar, BRD – Tel.: 0 64 41 / 80 21 – Telex: 48 3859
BALZERS – 8 Sagamore Park Road – Hudson, NH 03051 U.S.A. – Phone: 603 / 889 6888 – TWX 710 228 7431

PART II

SPECIAL REPORT TO PREFEASIBILITY REPORT OF KUROSAKI

Dr.-Ing.
BIEHLER

COMMENTS TO THE PREFEASIBILITY REPORT FOR LANKA REFRACTORIES BY KUROSAKI REFRACRORY JAPAN

The Kurosaki Refractories is one of the big Japanese refractory companies which specially produces magnesite stones, castables, plastic and ramming masses out of high alumina silicon carbide and zircon.

During my stay in Meepe I have got a prefeasibility study done by the above mentioned company concerning Lanka Refractories. Now I shall give some personal comments to this study.

- Generally most of the proposals are good and useful.

- Concerning High Sophisticated Products

  I do not believe that there is a big chance for Lanka Refractories to produce and export high sophisticated magnesium oxid carbonite to the world market. For the whole refractory industry also in Japan has big overcapacity concerning production.

  Those high sophisticated products have normally less than 20 % personnel costs even in Europe which has the highest wages all over the world. Therefore there is no advantage to produce those products in Sri Lanka. Only if Kurosaki Refractories guarantees the management of the production and the selling of the products it might be a chance.

Dr.-Ing.
BIEHLER

Most of the products are used in the steel industry but the forecast for the steel industry all over the world is not good at all. The growing rates are rather small therefore the use of refractory material will decrease in future.

- Concerning Magnesite Line

The installation of a new line for magnesite would be rather good. But before installing a new line the market of magnesite and magnesite chrome in Sri Lanka has to be proved . We are rather sure that the market is not so big that a new line will bring profit.

- Concerning Pressing

The installation of a high pressure forming machine specially for magnesite or kiln furniture is necessary after having get good results of the market research.

But we propose not to install friction presses because the pressure could not be influenced sufficiently during processing. We propose to choose hydraulic presses which allow to produce better qualities.(See annex, some different sorts of presses.)

Dr.-Ing.
BIEHLER

- Concerning Burning System

We agree with the plan to erect a high temperature shuttle kiln for a temperature of 1,750 °C. This kiln could only be installed if the market survey shows that those expensive stones could be sold.

These shuttle kilns need much more energy for burning than tunnel kilns. The tunnel kiln of Lanka Refractories has a consumption which is a little bit too high. This high consumption depends on the changing of the temperature for burning so such a lot of different products.

In meantime an expert of UNIDO is in Sri Lanka to control the burning system of Meepe and to reduce the energy consumption of this kiln.

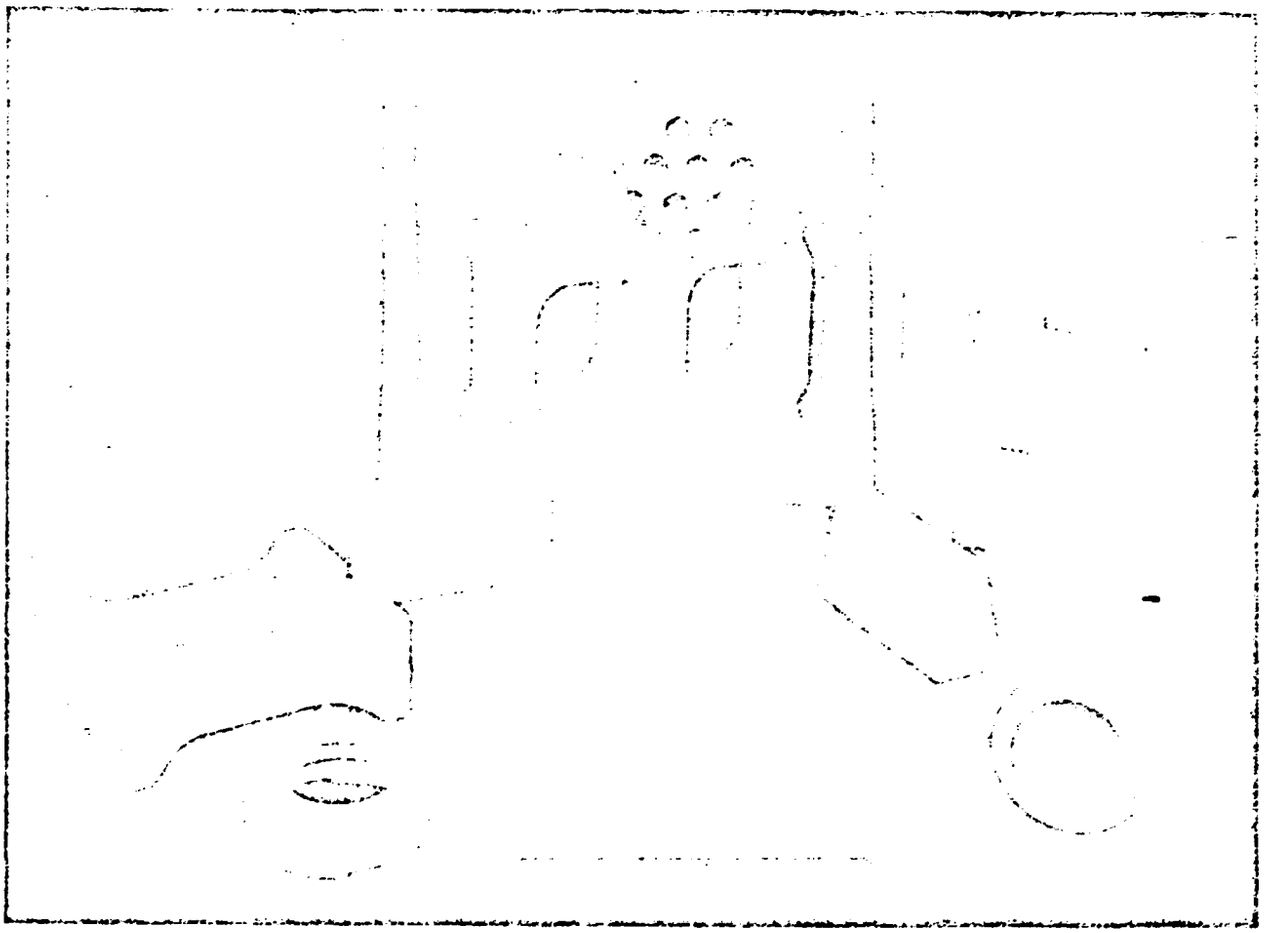
- Concerning Laboratory

The laboratory is working rather good. But the results would become better if there is a link between the laboratory of Meepe and the Central Laboratory.

- Concerning Cleaning Of The Factory

The installation of the dust collecting equipment is absolutely necessary and we propose to do this very soon.

Mit einer HORN Presse können Sie mehr machen als nur Normalsteine.
With a HORN press you can make more than standard bricks only.
Avec une presse HORN vous pouvez faire plus que des briques normales.
Con una prensa HORN Ud. puede hacer más que ladrillos normales.



FRIEDRICH HORN
MASCHINENFABRIK GMBH & CO KG
D-6520 WORMS AM RHEIN
Hafenstraße 6 · Tel. (06241) 6211 · Telex 0467830 · gegründet 1860

Printed in the Federal Republic of Germany

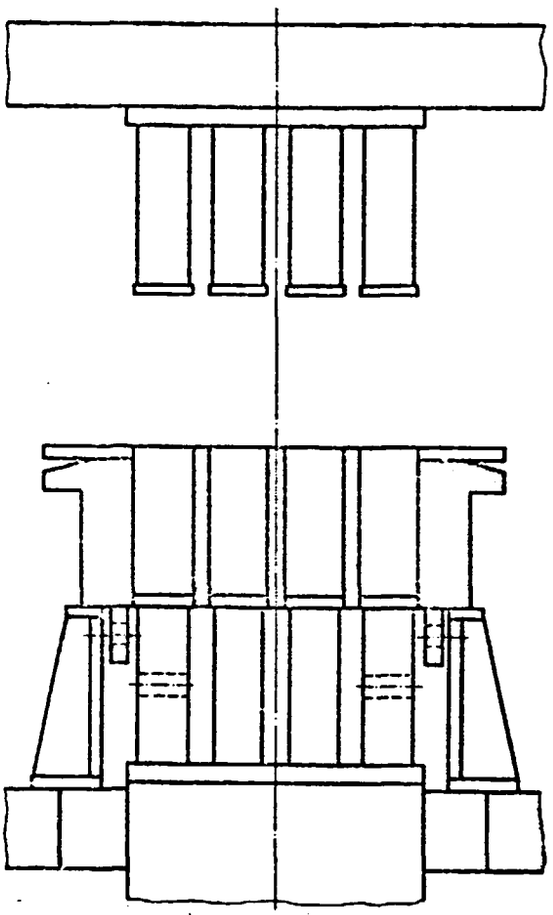


Bild 1

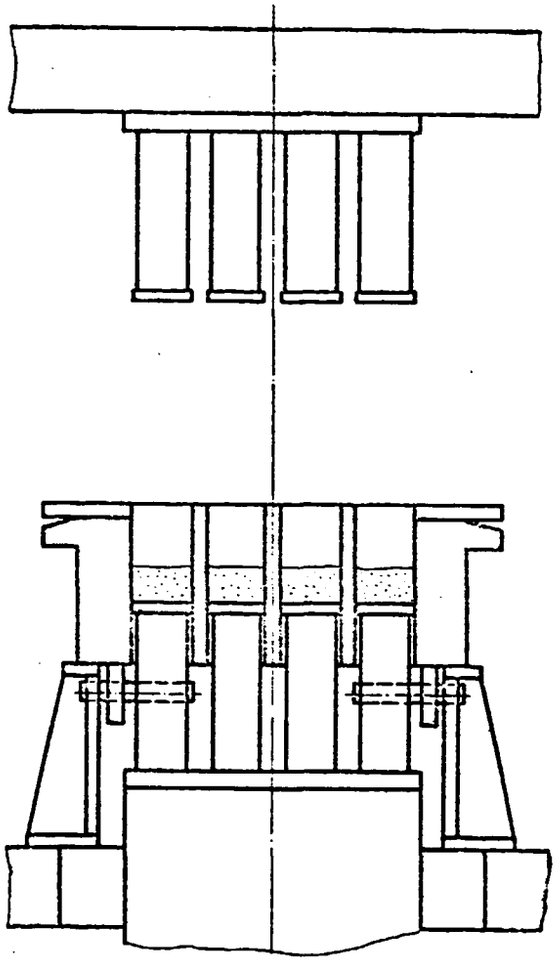


Bild 2

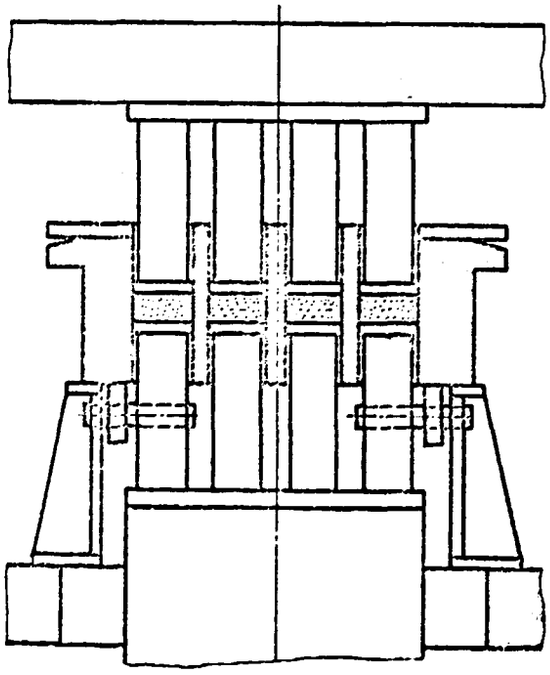


Bild 3

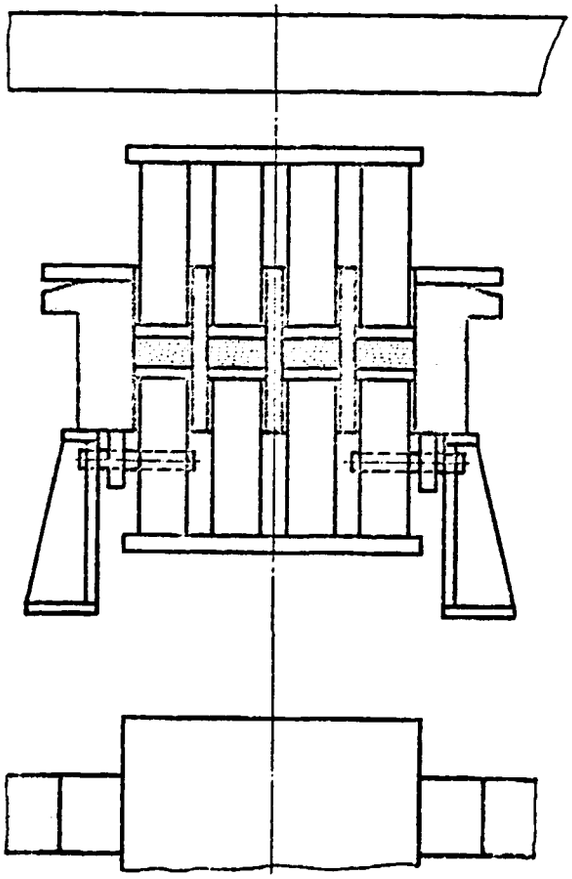


Bild 4

Schneller Formenwechsel

1. Formabbau

Der Formkasten hat an seiner Unterseite an zwei Seiten eine Lasche mit Bohrung. Entsprechende Bohrungen weisen die äußeren Unterstempel und die Formkastenstützen auf. (Bild 1) – Alle Bohrungen liegen in einer vertikalen Ebene.
Der Formkasten wird abgesenkt, bis alle Bohrungen fluchten. Ein Stahlbolzen wird auf jeder Seite durch die Bohrungen geschoben, so daß Formkasten und Unterstempel verbunden sind. (Bild 2)
Die Befestigungsschrauben der Unterstempel-Sammelplatte werden herausgeschraubt. Etwas Preßmasse oder gleich hohe Holzstücke werden in die Formöffnungen gegeben. Der Preßschlitten wird abgesenkt, bis die Oberstempel auf der Preßmasse bzw. den Holzstücken aufsitzen. (Bild 3)
Die Befestigungsschrauben der Oberstempel-Sammelplatte werden herausgeschraubt. Die Befestigungsschrauben der Formkasten-Stützen werden herausgeschraubt. Mittels der Pratzen am Formkasten wird der gesamte Formaufbau von einem Gabelstapler aus der Presse herausgefahren. (Bild 4)

2. Formaufbau

Die Unterstempel-Sammelplatte wird auf eine Richtplatte gelegt. Die Unterstempel werden auf ihr befestigt, die Befestigungsschrauben jedoch noch nicht fest angezogen.
Der Formkasten wird auf die beiden Formkasten-Träger aufgesetzt, die Befestigungsschrauben werden jedoch noch nicht fest angezogen.
Der Formkasten wird vorsichtig über die Unterstempel abgesenkt, bis die Formkasten-Träger auf der Richtplatte aufsitzen. Holzstücke gleicher Höhe werden in die Formöffnungen gelegt.
Die Oberstempel-Sammelplatte mit den darauf befestigten Oberstempeln, deren Befestigungsschrauben jedoch noch nicht fest angezogen sind, wird vorsichtig so abgesenkt, daß die Oberstempel auf den Holzstücken im Formkasten aufsitzen.
Der Formkasten wird angehoben, bis sich die Stahlbolzen durch die Bohrungen in den Unterstempeln, in den Formkasten-Stützen und Laschen des Formkastens schieben lassen.
Der Gabelstapler transportiert den gesamten Formaufbau in die Presse. Die Befestigungsschrauben der Unterstempel-Sammelplatte und der Formkasten-Stützen werden auf Anschlag eingeschraubt, jedoch noch nicht fest angezogen.
Der Preßschlitten wird so weit abgefahren, daß die Befestigungsschrauben der Oberstempel-Sammelplatte eingeschraubt werden können. Alle diese Befestigungsschrauben werden nun fest angezogen.
Im Einrichtbetrieb werden probeweise Ober- und Unterstempel vorsichtig einmal auf- und abgefahren, wobei eine exakte Selbstzentrierung erfolgt.
Die Befestigungsschrauben der Stempel zu ihren Sammelplatten werden dann jeweils fest angezogen.
Bei anderen Formaufbauten kann sinngemäß verfahren werden.
Ist eine höhenverstellbare volumetrische Beschickung am Formentisch der Presse angebracht, so wird diese mittels Knopfdruck in Minutenschnelle auf exakt gleiche Höhe mit der Oberseite des Formenkastens gefahren, womit ein mühsames und zeitraubendes Unterbauen von Formkasten und/oder Formkasten-Stützen entfällt. Diese Art von Formwechsel ist jeder anderen Art überlegen und kommt unübertreffbar mit dem geringsten Zeitaufwand aus.
Hilfsmaßnahmen, wie ein nach einer Seite offener Formentisch oder umständliche und teure Einfahrvorrichtungen für Formkästen, können daher entfallen. Auch der Nachteil von Form-Adaptern, die stets gleiche Formabmessungen bedingen, ist vermieden.
Eine ganz wesentliche Erleichterung beim Formwechsel ist außerdem, daß HORN-Pressen im Einbaubereich der Formen sehr viel Bewegungsraum zum schnellen Arbeiten der Formwechsel-Mannschaft aufweisen, wie er bei keiner anderen Presse gegeben ist.

Extra-Fast Mould Change

1. Dismantling of the mould

On the bottom section the mould box is on two sides provided with a shackle with bore (locating hole). The outer bottom punches and the mould box supports come with the corresponding bores (picture 1) – All bores are on a vertical level.
The mould box is lowered until all bores are aligned. On each side a steel pin is then inserted into the bores so that the mould box and the bottom punches are firmly connected (picture 2).
The fixation bolts for the bottom punch collector plate are undone. Some pressing material or wood pieces of identical height are inserted in the mould openings.The crosshead is then lowered until the top punches are seated on the pressing material or on the pieces of wood (picture 3).
The fixation bolts for the top punch collector plate are undone. The fixation bolts for the mould box supports are also undone.
By means of the claws on the mould box the entire mould assembly is removed from the press by fork lift truck (picture 4).

2. Assembly of the mould

The bottom punch collector plate is placed on a levelling block. The bottom punches are affixed to same, however, the fixation bolts are not as yet tightened.
The mould box is placed onto the 2 mould box carriers, the fixation bolts, however, are not as yet tightened.
The mould box is carefully lowered over the bottom punches until the mould box carriers are seated on the levelling block. Wood pieces of identical height are placed in the mould openings.
The top punch collector plate with the attached top punches (fixing bolts not as yet tightened!) is carefully lowered in a way that the top punches are seated on the wood pieces in the mould box.
The mould box is raised until the steel pins can be inserted into the bores in the bottom punches, the mould box supports and the shackles of the mould box.
The fork lift truck now transports the whole mould assembly to the press. The fixation bolts of the bottom punch collector plate and of the mould box supports are fixed in place, however, not as yet fully tightened.
The crosshead is lowered so far that the fixation bolts of the top punch collector plate can be bolted in place.
Now all these fixing bolts are fully tightened up but not those referring to the punches to the punch collector plates.
In setting up trial operation on a dry run, top and bottom punches are carefully and slowly raised and lowered one time, this results in a precise self-centering. Now the fixing bolts of the punches to the collector plates are fully tightened up.
In the case of other mould assemblies, please proceed correspondingly.
If a height-adjustable volumetric charger is affixed to the mould table, by push button the charger can within a few minutes be moved to exactly the same height as the top side of the mould box.
Thus the need for underpinning mould box and/or mould box supports is obviated and a great lot of trouble and time is saved.
This method of mould charge is by far superior to any other method and requires in an ideal way only a minimum of work time.
Therefore with this method there is no need for supportive measures such as a mould table being open on one side or for cumbersome and most expensive move-in apparatus for mould boxes.Besides, the disadvantage of mould adaptors which always call for the same mould dimensions has thus been eliminated.
Another important feature rendering mould changes much easier is the aspect that HORN presses offer plenty of moving space to the mould change crew around the mould installation area of the press, enabling them to carry out this job most rapidly. No other press offers these special easy working and cost reducing facilities.

Changement de Moules très rapide

1. Démontage du moule

Le dessous du châssis de moulage est muni sur deux cotés d'une attache avec alésage. Les poinçons inférieurs extérieurs ainsi que les supports du châssis de moulage ont les mêmes alésages. (illustration 1) – Tous les alesages se trouvent sur un même plan vertical.
Le châssis de moulage est abaissé jusqu'à l'alignement de tous les alésages.
De chaque coté un boulon d'acier est poussé par les alésages, ainsi le châssis de moulage et les poinçons inférieurs sont raccordés. (illustration 2)
Les vis de fixation de la plaque collectrice pour les poinçons inférieurs sont dévissées. Un peu de matériel de pressage ou bien des pièces de bois à hauteur égale sont placés dans les ouvertures du moule.
Le sommier de presse est abaissé jusqu'à ce que les poinçons supérieurs s'appuient sur le matérial de pressage ou bien sur les morceaux de bois. (illustration 3)
Les vis de fixation de la plaque collectrice pour les poinçons supérieurs sont dévissées. Les vis de fixation pour les supports du châssis de moulage sont également dévissées.
Se servant des griffes au châssis de moulage tout l'ensemble moule est transporté hors de la presse par un chariot élévateur à fourche. (illustration 4)

2. Montage du moule

La plaque collectrice pour les poinçons inférieurs est placée sur une plaque à dresser. Les poinçons inférieurs y sont fixés, cependant les vis de fixations ne sont pas encore serrées. Le châssis de moulage est placé sur les deux porteurs du châssis de moulage, les vis de fixation ne sont pas encore serrees.
Le châssis de moulage est abaissé avec precaution au-dessus des poinçons inférieurs jusqu'à ce que les porteurs du châssis de moulage s'appuient sur la plaque à dresser. Des morceaux de bois à hauteur égale sont placés dans les ouvertures du moule.
La plaque collectrice des poinçons supérieurs avec les poinçons supérieurs y fixés (dont les vis de fixation n'ont pas encore été serrées) est abaissée avec précaution jusqu'à ce que les poinçons supérieurs s'appuient sur les morceaux de bois dans le châssis de moulage.
Le châssis de moulage est soulevé jusqu'à ce que les boulons en acier peuvent être poussés dans les alésages dans les poinçons inférieurs, dans les supports du châssis de moulage et dans les attaches du châssis de moulage.
Le chariot élévateur à fourche transporte l'ensemble installation de moule dans la presse. Les vis de fixation de la plaque collectrice pour les poinçons inférieurs et des porteurs pour le châssis de moulage sont vissées à butée, mais pas encore serrées.
Le sommier de presse est abaissé de manière à pouvoir visser les vis de fixation de la plaque collectrice des poinçons supérieurs.
Maintenant toutes ces vis de fixation sont serrées.
Pour l'ajustage à titre d'essai on fait monter et descendre les poinçons supérieurs une fois avec précaution, il en resulte un auto-centrage très précis.
Ensuite les vis de fixation des poinçons à leurs plaques collectrices sont bien serrées.
Pour d'autres ensembles moules on procédera de façon correspondante.
Si une alimentation volumétrique à hauteur ajustable est montée à la table-moule de la presse, on appuie sur un bouton et dans peu de minutes l'alimentation prend vite sa position exacte à la même hauteur que le coté supérieur du châssis de moulage.
Ainsi on n'a plus besoin de placer des substructions sous le châssis de moulage et/ou bien sous les supports du châssis de moulage ce qui coûterait beaucoup d'efforts et de temps.
Cette méthode pour le changement de moules est nettement supérieure à toute autre méthode et nécessite vraiment un minimum de temps, elle est donc imbattable!
Pour cette raison des mésures accessoires telles que la table-moule ouverte d'un coté ou bien des dispositifs mobiles très coûteux pour la mise en place des châssis de moulage ne sont plus necessaires.
De plus, on évite le désavantage d'utiliser des adaptateurs de moules qui exigent toujours les mêmes dimensions.
Un allégement supplémentaire très important lors du changement de moules est le fait que les presses réfractaires HORN offrent beaucoup d'espace d'utilisation dans le secteur d'installation de moules au personnel chargé d'effectuer le changement, donnant donc au personnel de faire son travail très vite. Aucune autre presse n'offre tant d'espace d'utilisation pour ce travail.

Cambio Rápido de Moldes

1. Desmontaje del molde

La caja de moldes tiene en su parte inferior, en dos lados, una brida con taladro. Los punzones inferiores exteriores y los soportes de la caja tienen taladros correspondientes.
Todos los taladros están en un plano vertical.
La caja será bajada hasta que todos los taladros estén en linea. Se introduce un perno de acero en cada lado, así quedan unidos punzón inferior y caja.
Se destornillan los tornillos de fijación de la placa colectora de punzones inferiores.
Se introduce algo de masa o piezas de madera de idéntica altura dentro de las aperturas del molde. Se baja el carro de prensado hasta que el punzón superior descanse sobre la masa o los tacos de madera.
Se destornillan los tornillos de fijación de la placa colectora de los punzones superiores. Se destornillan los tornillos de fijación de los soportes de la caja. Por medio de las garras de la caja se saca el molde completo con una carretilla elevadora.

2. Montaje del molde

La placa colectora de punzones inferiores será colocada sobre una placa de enderezar. Se fijan los punzones sin apretar los tornillos.
Se coloca la caja sobre los dos soportes de la caja sin apretar los tornillos.
Se baja cuidadosamente la caja sobre los punzones inferiores hasta que los soportes estén colocados sobre la placa de enderezar. Se colocan los tacos de madera de altura idéntica, dentro de las aperturas del molde.
La placa colectora de los punzones superiores con sus punzones colocados, con los tornillos sin apretar será bajada cuidadosamente hasta que los punzones superiores descansen sobre los tacos de madera dentro de la caja
Se levanta la caja hasta que se pueda pasar los pernos de acero por los taladros del punzón inferior, soportes y bridas de la caja.
La carretilla elevadora transporta todo el molde hasta dentro de la prensa. Se atornillan los tornillos de la placa colectora de los punzones inferiores los de los soportes de la caja al tope, pero sin apretar
Se baja el carro de prensado hasta que se pueda atornillar los tornillos de fijación de la placa colectora de los punzones superiores.
Ahora se aprietan todos estos tornillos de fijación.
En la operación de enderezamiento se sube y baja cuidadosamente los punzones superiores e inferiores, una sola vez; se autocentralizan con exactitud. Ahora se aprietan los tornillos de fijación de las placas colectoras de punzones. (Punzones - placas)
En el caso de otros tipos de moldes, se procede en el mismo sentido.
Si a la mesa de la prensa está acoplada una instalación de alimentación volumétrica con ajuste de la altura, se sube esta en pocos minutos a la altura exacta del canto superior de la caja de moldes, pulsando un botón. Así se evita el trabajo muy lento de sobreponer la caja y/o los soportes.
Este sistema de cambio de molde es superior a todos los otros y se emplea solamente un mínimo de tiempo.
No existen trabajos auxiliares, ni la necesidad de tener la mesa abierta por un lado, ni instalaciones de acoplamientos caras.
Tampoco se emplean adaptadores, que exigen medidas de los moldes siempre uniformes.
Otra ventaja del cambio de moldes dentro de la prensa HORN es el gran espacio existente, superior a todas las otras prénsas, que facilita el movimiento del personal que cambia los moldes.

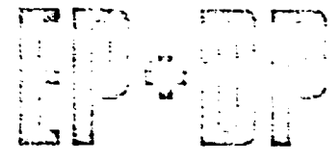
ab 13.09.1994
neue Telefon-Nr.:
new phone-number:
nouveau no. de téléphone:

06241-4211

HYDRAULISCHE HOCHLEISTUNGSPRESSEN

EP = einfachwirkende Presse mit Doppeldruck-Effekt

DP = doppeltwirkende Presse mit vollem Doppeldruck



Fundament:

Alle EP und DP Pressen werden auf ebenem Boden aufgestellt und benötigen keine Fundamentgrube.

Konstruktion und Funktion:

Seit Jahrzehnten bewährte robuste 4-Säulen-Konstruktion. Preßschlitten und Formenaufspannrahmen sind in den 4 Säulen verkantungsfrei geführt.

Die EP Pressen haben nur einen hydraulischen Druckzylinder, der im Oberteil der Presse eingebaut ist und von oben wirkt. Er ist mit Eilgang in beiden Hubrichtungen versehen. Die mit dem Preßschlitten stabil verbundene, stark dimensionierte Kolbenstange ist in großem Abstand durch eine untere Führungsbüchse im Zylinder und Führungsringe im Kolben sicher geführt.

Die DP Pressen sind zusätzlich mit einem zweiten hydraulischen Druckzylinder ausgerüstet, der im Fußteil der Presse eingebaut ist und von unten nach oben wirkt.

Bei den EP Pressen liegt der Unterstempel unbeweglich fest auf einem Amboß, bei den DP Pressen hingegen wird der Unterstempel von der Kolbenstange des unteren Druckzylinders auf und ab bewegt.

DER AUSSTOSS wird bei allen Pressen durch zwei hydraulische Ausstoßzylinder bewirkt, die am Kopfteil der Presse montiert sind. Die Kolbenstangen beider Ausstoßzylinder drücken nach dem Pressen den in den 4 Säulen geführten Aufspannrahmen samt der Form so lange nach unten, bis der auf dem Unterstempel liegende Preßling abgenommen werden kann.

DER FORMENAUFSPANNRAHMEN kann über Wahlschalter wie folgt gesteuert werden:

- Er kann unbeweglich blockiert werden
- Er kann „frei schwebend" eingestellt werden. Bei beginnender Wandungsreibung gibt der Rahmen mit der aufgespannten Form in Preßrichtung nach. Die Form schiebt sich über den Unterstempel. Dadurch wird indirekt von unten ein nahezu gleich großer Preßdruck wie von oben erzielt (Schwebeform-Prinzip).

  Bei den DP Pressen wird die Form beim zusätzlichen Preßvorgang von unten durch die Wandungsreibung wieder nach oben geschoben (Doppelschwebeverfahren).
- Er kann nach jeder Vorpressung bei Druckentlastung um ein vorgegebenes Maß nach unten verschoben werden. Hierdurch wird der Formenverschleiß erheblich verringert.

VORPRESSEN: Ebenfalls über Wahlschalter können 1, 2 oder 3 Vorpressungen progressiv eingestellt werden. Die Wahlschalter sind so ausgelegt, daß das Umschalten nach jeder Vorpressung entweder wegeabhängig über Endschalter oder druckabhängig über Kontaktmanometer erfolgt.

ENDPRESSDRUCK: Das Ende des Preßvorgangs erfolgt, einstellbar über Wahlschalter, wegeabhängig mittels Endschalter oder druckabhängig mittels Kontaktmanometer.

AUSSTOSS UNTER AUFLAST kann ebenfalls über Wahlschalter eingestellt werden. Der Oberstempel bleibt dann mindestens so lange auf dem Preßling stehen, bis die Oberkante der Form bei der Abwärtsbewegung die Oberkante des Preßlings erreicht hat.

VOLLAUTOMATISCHER BETRIEB wird durch die am Formenaufspannrahmen angebaute robuste volumetrische Beschickungsanlage ermöglicht. Um eine gleichmäßige Befüllung der Form zu erzielen, können bei schwierigen Preßmassen mehrere Rüttelbewegungen des Füllwagens eingeschaltet werden. Die Preßlinge werden von pneumatisch betätigten Greifern ausgetragen und abgesetzt. Die Greifbreite der Greifer ist leicht verstellbar. Falls erforderlich, können die Greifer rasch abgebaut werden. Außer den normalen Greifern für Rechteck-Formate können auf Wunsch auch Spezialgreifer für ROHRE geliefert werden.

Für die Herstellung von KEILSTEINEN wird auf Wunsch eine Steuerung vorgesehen, welche die Bewegungen des Füllwagens einerseits und des Formenaufspannrahmens andererseits so koordiniert, daß eine keilige Befüllung der Form erzielt wird. Damit die keiligen Preßlinge auch beschädigungsfrei gegriffen und abgesetzt werden können, wird auf Wunsch für die Greifer eine Kippvorrichtung mitgeliefert.

SPRÜHEN: Zum Besprühen der Oberstempel und der hohlen Form kann auf Wunsch eine automatische, pneumatisch betätigte Sprühvorrichtung geliefert werden, die am Füllwagen angebaut wird.

REGULIERUNG DER FÜLLHÖHE erfolgt durch eine elektro-hydraulische Steuerung. Je nach Einstellung eines Endschalters bleibt der Formenaufspannrahmen mit der Form beim Füllvorgang höher oder tiefer stehen.

REGULIERUNG DER FÜLLHÖHE VON HAND: Der Bedienungsmann kann über einen ferngesteuerten Stellmotor den betreffenden Endschalter verstellen und das gewünschte ± Verstellmaß an einer im Bedienungspult eingebauten Skala ablesen.

AUTOMATISCHE REGULIERUNG DER FÜLLHÖHE: Das Kommando für die Betätigung des Stellmotors kann auch automatisch gegeben werden, und zwar alternativ in einer der beiden nachstehend beschriebenen Weisen:

- Der Endpreßdruck wird als Sollwert an einem Kontaktmanometer vorgegeben, und die Preßlingshöhe wird kontrolliert. Zu diesem Zweck wird der Bereich der zulässigen Höhentoleranz mittels zweier gegeneinander verstellbarer Endschalter eingestellt. Bei Erreichen des Endpreßdrucks wird der Abstand zwischen Ober- und Unterstempel, also die tatsächliche Preßlingshöhe, gemessen und mit dem eingestellten Toleranzbereich verglichen.
- Die Preßlingshöhe wird als Sollwert mittels eines Endschalters vorgegeben, und der Endpreßdruck wird kontrolliert. Zu diesem Zweck wird der Toleranzbereich des zulässigen Endpreßdrucks an einem Manometer mit zwei Kontakten eingestellt. Sobald der durch den Endschalter vorgegebene Abstand zwischen Ober- und Unterstempel, also die Preßlingshöhe, erreicht ist, wird der dabei herrschende Endpreßdruck mit dem eingestellten Toleranzbereich verglichen. Vorteil: Höhenmaß und Dichte des Preßlings werden gleichzeitig kontrolliert.

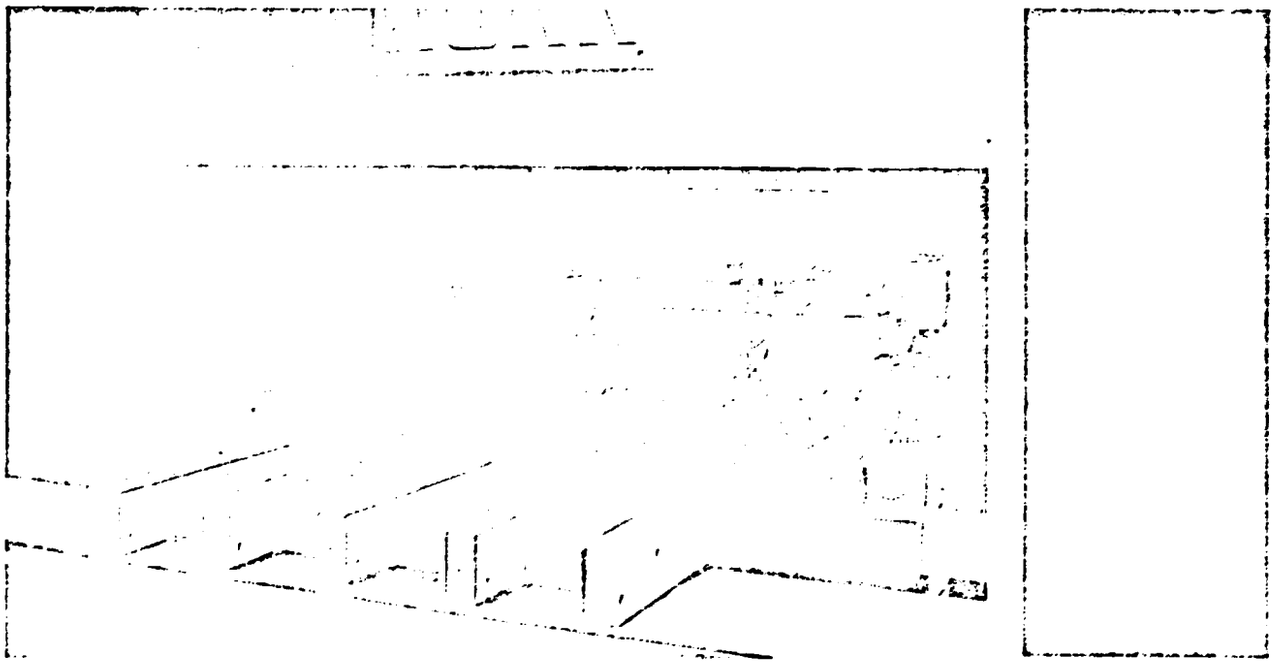
In beiden Fällen wird bei Über- oder Unterschreiten des zulässigen Toleranzbereiches die Füllhöhe um einen bestimmten, jedoch einstellbaren Betrag verändert. Bei homogen aufbereiteten Massen wird der Sollwert nach einer oder zwei automatischen Korrekturen der Füllhöhe wieder erreicht. Zusätzlich kann der Befehl gegeben werden, die unzulänglichen Preßlinge automatisch zu markieren oder auszusondern.

ELEKTRONISCHE MESS- UND VERSTELLVORRICHTUNG FÜR DIE FÜLLHÖHE: Auf Wunsch kann eine vollautomatische elektronische Meß- und Verstellvorrichtung geliefert werden. Der Sollwert der Preßlingshöhe, der Bereich der Höhentoleranz und das Verdichtungsverhältnis werden eingestellt und elektronisch gespeichert. Der Befehl für den Beginn der Messung wird bei Erreichen des Endpreßdrucks vom Kontaktmanometer gegeben. Nach Druckentlastung wird der Abstand zwischen Ober- und Unterstempel, also die Höhe des Preßlings im entspannten Zustand, von einem Wegaufnehmer gemessen. Meßwert und Sollwert werden elektronisch verglichen. Auf einem Anzeigegerät kann abgelesen werden, ob der Meßwert innerhalb oder außerhalb des markierten Toleranzfeldes liegt und wie hoch der Preßling tatsächlich ist. Über- oder unterschreitet der Meßwert die Toleranzgrenze, wird die Füllhöhe stufenlos in einem Schritt entsprechend korrigiert. Der kleinste elektronisch gesteuerte Korrekturschritt ist 0,1 mm. Vorteil: Höhenmaß und Dichte des Preßlings werden gleichzeitig kontrolliert und eine Korrektur der Füllhöhe stufenlos in einem Schritt vorgenommen. Dadurch wird die Ausschußquote auf ein Minimum verringert. Außerdem kann zusätzlich der Befehl gegeben werden, die unzulänglichen Preßlinge automatisch zu markieren oder auszusondern. Der Anschluß eines Schreibgerätes ist ebenfalls möglich.

ZENTRALSCHMIERUNG: Alle Pressen sind mit einer motorisierten, auf geringste Dosierung eingestellten Zentralschmierpumpe ausgerüstet, die alle Schmierstellen kontinuierlich und ausreichend versorgt.

ENDSCHALTER: Alle Endschalter sind berührungslos und geben bei Funktion ein Leuchtsignal.

DIE HYDRAULIK ist gut zugänglich in einem separaten staubdicht abgeschlossenen Aggregat untergebracht, das rechts oder links von der Presse, auch unter Flurhöhe versenkt, aufgestellt werden kann. Alle eingebauten Hydraulikteile haben sich bei den typischen Betriebsbedingungen der Feuerfest-Industrie bestens bewährt. Große Luftfilter mit kleiner Maschenweite sorgen für den Luftaustausch. Das Öl wird kontinuierlich über einen Ölfilter mit leicht aus-



wechselbarem Filtereinsatz mit kleiner Maschenweite gefiltert. Verschmutzung des Filters wird optisch angezeigt. Ventile und Pumpen sind weitgehend für alle Pressentypen die gleichen. Eine rationelle Ersatzteilhaltung ist optimal gewährleistet.

Heizstäbe sowie ein Wasser-Ölkühler sorgen thermostatgesteuert für optimale Öltemperatur.

SCHALTSCHRANK: Die elektrische Steuerung ist serienmäßig mit bewährten konventionellen Bauelementen bestückt.

Auf Wunsch kann statt dessen eine elektronische Steuerung geliefert werden. Sie besteht aus einem integrierten Halbleiter-Schaltkreis-System, das binäre Funktionsglieder und digitale Funktionseinheiten umfaßt.

Die Steuerung ist unter Berücksichtigung der Worst-Case-Bedingung ausgelegt. VORTEILE: extrem kurze Schaltzeiten, leichte Austauschbarkeit der einzelnen Einschübe in Flachbauweise, Sicherheit gegen Spannungseinbrüche, zerstörungssicher gegen Überspannungen, extrem hohe Störsicherheit durch Ansprechverzögerung von 3 ms bei allen Zeit- und Speichergliedern, Signalstand „0" bei Drahtbruch und Erdschlüssen.

SCHALTPULT: Für die Pressenbedienung ist ein separates Schaltpult vorgesehen. Es enthält alle Schalter, die zum Betrieb der Presse notwendig sind, ferner die Kontaktmanometer und das Anzeigegerät für die Regulierung der Füllhöhe.

BESONDERE VORTEILE:

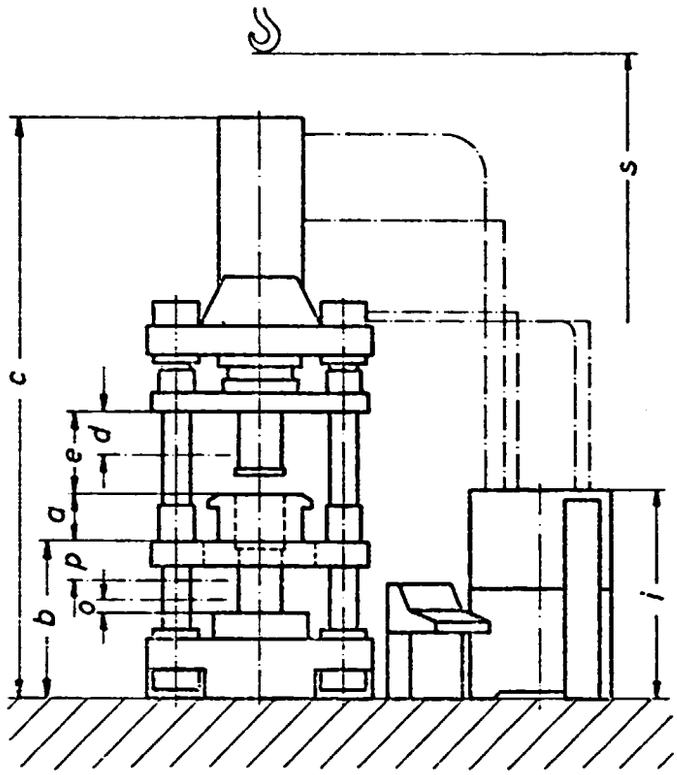
- Für jede gewünschte Steinqualität kann die optimale Preßtechnik gewählt werden.
- Die Kombination von: Schwebeform, Hochdruckpumpe mit sehr weitem Regelbereich, progressivem Vorpressen, Ausstoßen unter Auflast und, bei besonders schwierigen Preßmassen, das Vorhandensein eines unteren Preßzylinders ermöglicht die rationelle Herstellung von Steinen unter automatischer Anpassung der Verdichtungskurve an die spezifische Preßkurve der jeweiligen Masse.
- Wann immer vollautomatischer Betrieb sich nicht lohnt oder technisch nicht möglich ist, kann die volumetrische Beschickung ausgeschaltet oder ohne großen Zeitverlust demontiert werden.

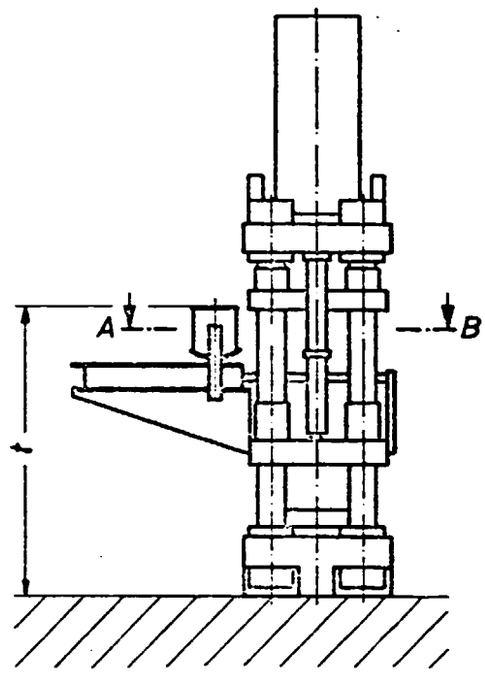
SONDERZUBEHÖR:

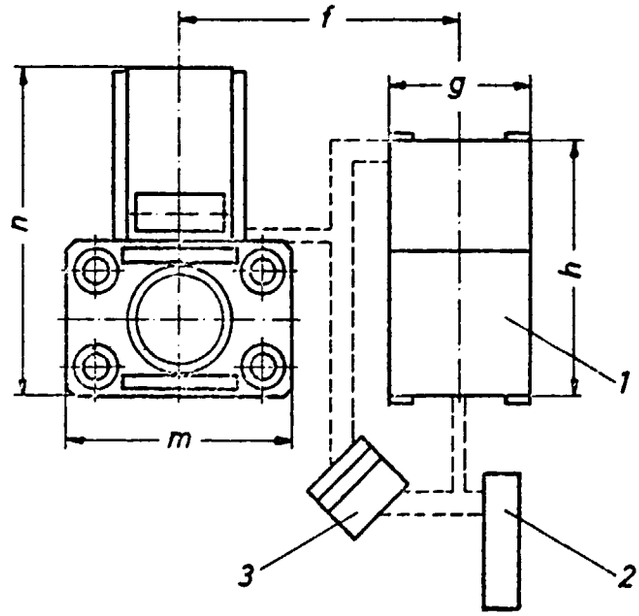
Auf Wunsch können zusätzliche Einrichtungen geliefert werden, z. B.:

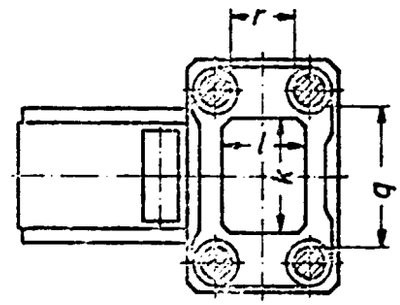
- ein Rührwerk, das oberhalb der volumetrischen Beschickung angeordnet wird. Es dient zum Nachmischen der Preßmasse, die auf dem Transportweg zur Presse möglicherweise entmischt hat.
- Transportband für die Zufuhr der Preßmasse zur Presse. Das Band wird von einer Füllstandsonde in der Beschikkungsanlage der Presse gesteuert.
- Transportband für das Abtragen der fertigen Preßlinge. Das Band wird vom Pressentakt gesteuert.
- automatische Greifer für Rohre
- automatische Vorrichtung für die Herstellung von Stopfen
- komplette Formen für alle gängigen Formate
- Spezialformen für Stopfen, Schieberplatten, Kassetten etc.

EP Einfachwirkende Pressen	DP Doppeltwirkende Pressen	Preßkraft (MN)	Ausstoßkraft (MN)	Füllhöhe (mm)	Gewicht Presse + Aggregat (t)	Ölmenge (l)	Motoren- leistung (kW)
200/22	200/22	2000	670	220	19 + 3	1800	56
200/52	200/52	2000	670	520	21 + 3	1800	56
200/70	200/70	2000	1000	700	22 + 3	1800	56
300/22	300/22	3000	670	220	20 + 3	1800	56
300/52	300/52	3000	670	520	22 + 3	1800	56
300/70	300/70	3000	1000	700	23 + 3	1800	56
400/22	400/22	4000	670	220	21 + 3	1800	56
400/52	400/52	4000	670	520	23 + 3	1800	56
400/70	400/70	4000	1200	700	24 + 3	1800	56
500/22	500/22	5000	670	220	22 + 3	1800	56
500/52	500/52	5000	670	520	24 + 3	1800	56
500/70	500/70	5000	1200	700	25 + 3	1800	56
600/22	600/22	6000	670	220	23 + 3	1800	74
600/52	600/52	6000	670	520	25 + 3	1800	74
600/70	600/70	6000	1200	700	27 + 3	1800	74
800/52	800/52	8000	2000	520	30 + 3,5	2800	74
800/70	800/70	8000	2000	700	32 + 3,5	2300	74
1000/52	1000/52	10000	2000	520	45 + 3,5	3200	86
1000/70	1000/70	10000	2000	700	47 + 3,5	3200	86
1200/52	1200/52	12000	2000	520	65 + 4	3200	109
1200/70	1200/70	12000	2000	700	67 + 4	3200	109
1400/52	1400/52	14000	2000	520	72 + 4	3200	129
1400/70	1400/70	14000	2000	700	74 + 4	3200	129
1600/52	1600/52	16000	2000	520	80 + 4	3200	129
1600/70	1600/70	16000	2000	700	82 + 4	3200	129
2000/52	2000/52	20000	4000	520	95 + 4	3200	151
2000/70	2000/70	20000	4000	700	98 + 4	3200	151





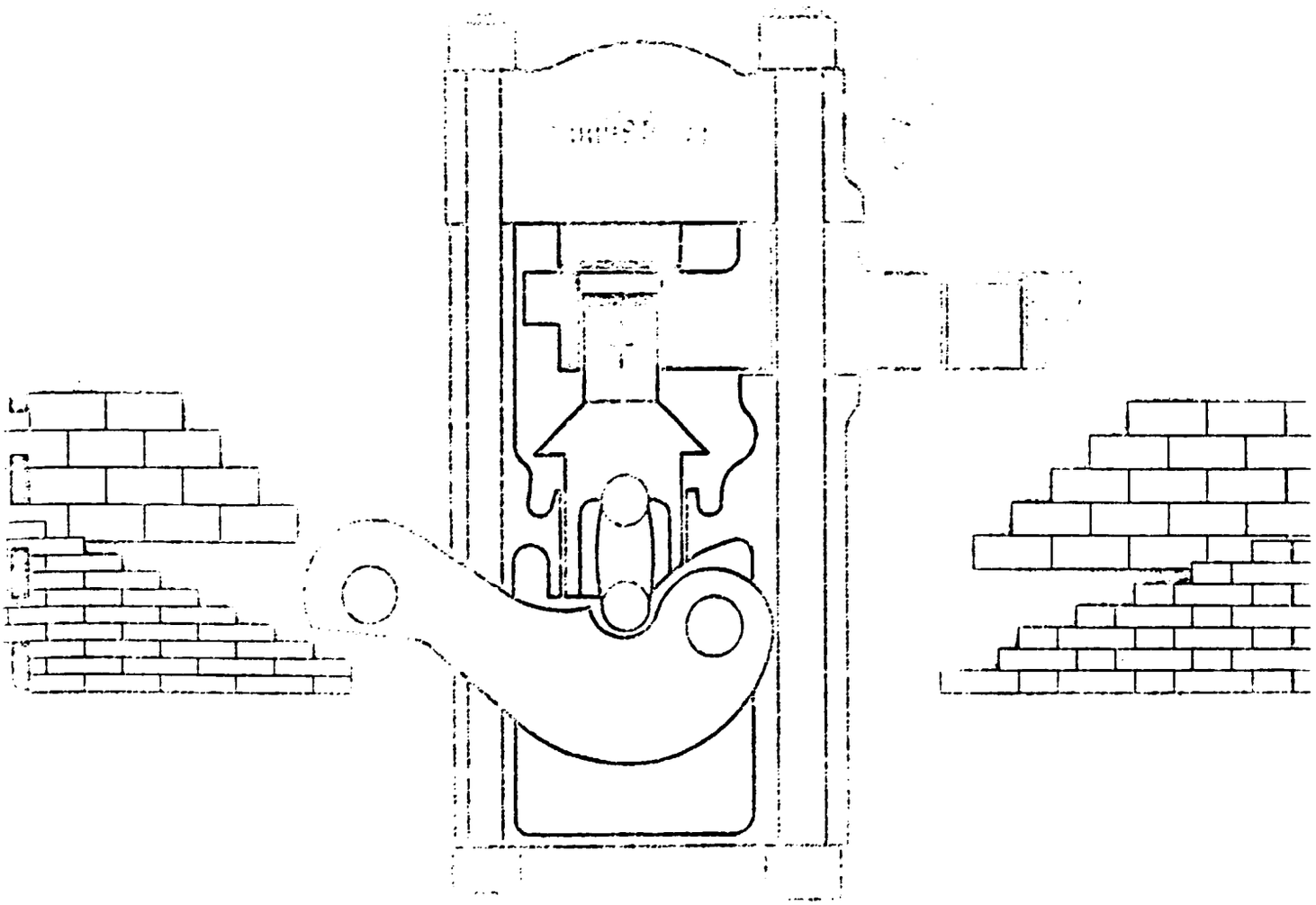




A - B

EP DP	a	b	c	d	e	f	g	h	i	k	l	m	n	q	r	s	t	u
200/22	220	1000	3500	270	430											4750	1760	
200/52	520	1350	4950	570	730	2300	1250	2380	2045	1200	500	2000	2500	1400	380	6300	2570	900
200/70	700	1600	5860	760	920											7100	3200	
300/22	220	1000	3500	270	430											4750	1780	
300/52	520	1350	4950	570	730	2300	1250	2380	2045	1200	500	2000	2500	1400	380	6300	2570	900
300/70	700	1600	5860	760	920											7100	3200	
400/22	220	1000	3500	270	430											4750	1760	
400/52	520	1350	4950	570	730	2300	1250	2380	2045	1200	500	2000	2500	1400	380	6300	2570	900
400/70	700	1600	5860	760	920											7100	3200	
500/22	220	1000	3500	270	430											4750	1780	
500/52	520	1350	4950	570	730	2300	1250	2380	2045	1200	500	2000	2500	1400	380	6300	2570	900
500/70	700	1600	5860	760	920											7100	3200	
600/22	220	1000	3600	270	430											4850	1790	
600/52	520	1350	5100	570	730	2300	1600	2630	2200	1200	500	2000	2800	1330	630	6400	2570	900
600/70	700	1600	6000	760	920											7300	3200	
800/52	520	1500	5500	570	800	2500	1600	2630	2200	1340	740	2000	2800	1330	630	6800	2720	1000
800/70	700	1700	6600	760	990											7900	3300	
1000/52	520	1500	5500	570	800	3000	1900	3130	2220	1400	800	2500	3500	1530	730	6900	2720	1000
1000/70	700	1700	6600	760	990											7900	3300	
1200/52	520	1600	5800	570	800	3000	1900	3130	2220	1400	900	2500	3500	1510	710	7200	2820	1000
1200/70	700	1800	6700	760	990											8100	3400	
1400/52	520	1600	5800	570	800	3000	1900	3130	2220	1400	900	2500	3500	1490	690	7200	2820	1000
1400/70	700	1800	6700	760	990											8100	3400	
1600/52	520	1600	5900	570	800	3000	1900	3130	2220	1400	900	2500	3500	1450	650	7300	2820	1000
1600/70	700	1800	6800	760	990											8200	3400	
2000/52	520	1800	6000	570	800	3500	1900	3130	2220	1900	1030	3100	3700	1950	850	7400	3020	1400
2000/70	700	2000	6900	760	990											8300	3600	

Änderungen vorbehalten



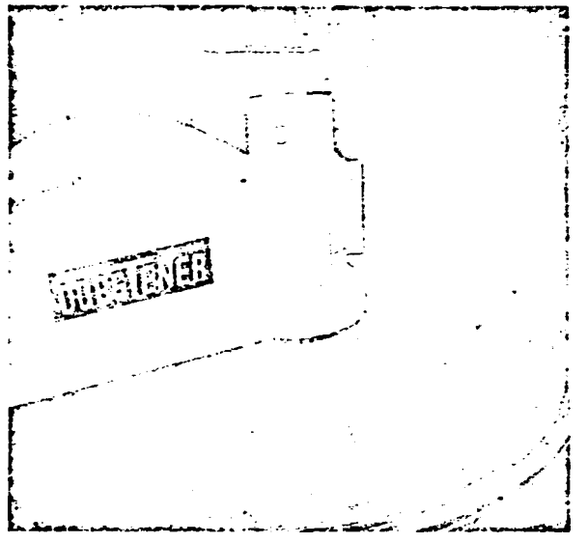
DORSTENER DREHTISCHPRESSE MDP 250

die kompakte Maschine mit der großen Leistung -bewährt seit Jahrzehnten-

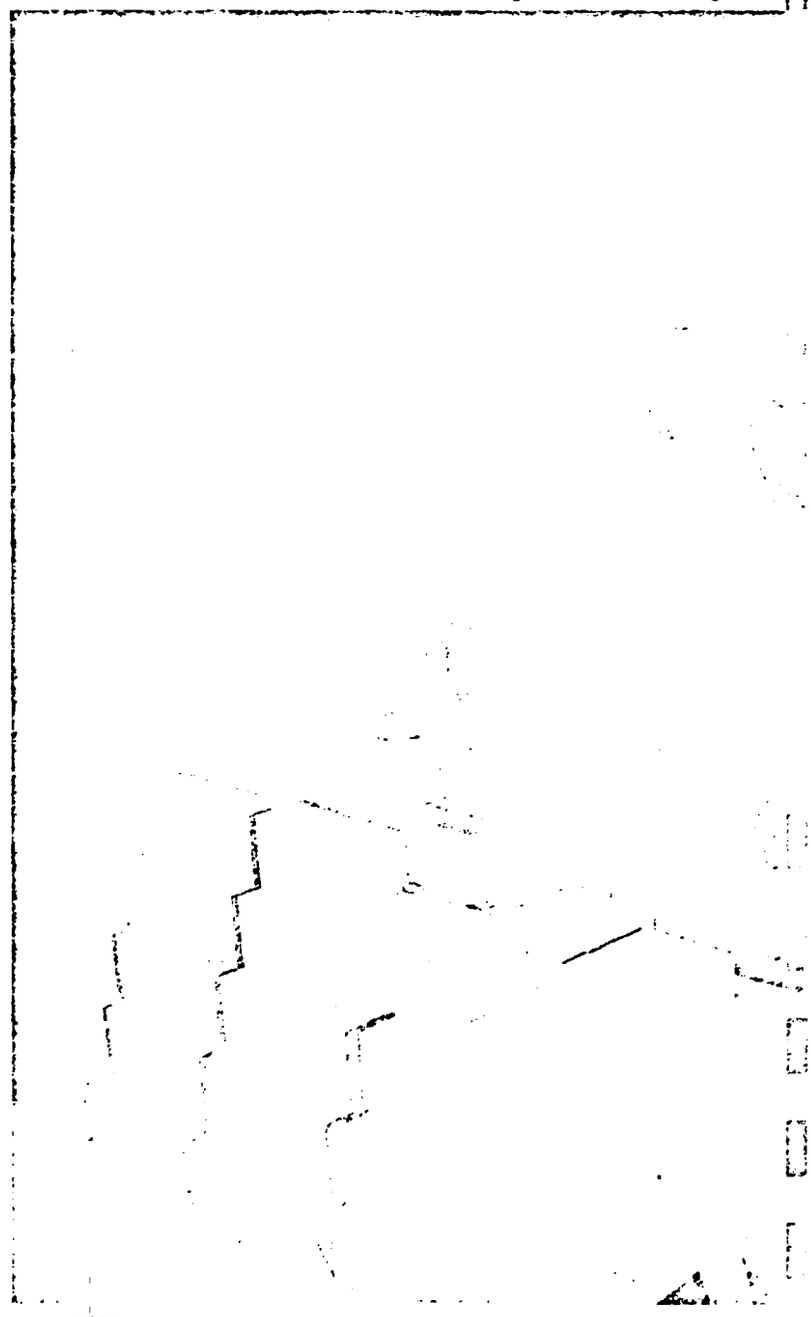
Mit der DORSTENER **MDP 250** steht der Baustoffindustrie eine bewährte **Hochleistungs-Drehtischpresse** zur Verfügung, die durch ihre unkomplizierte, robuste Bauweise die wirtschaftliche Herstellung einwandfreier Bausteine aus **Kalksand-Gemisch, Schlackensand, Trockenschiefer, Flugasche** und **vergleichbaren Grundstoffen** gewährleistet.
Die mechanische DORSTENER Presse **MDP 250** arbeitet als Drehtischpresse mit **12 bzw. 18 Preßformen** nach dem Revolverprinzip. Während der Tisch-Stillstandszeiten werden an verschiedenen Positionen gleichzeitig:

- Preßmasse eingefüllt,
- Preßmasse gepreßt,
- Preßlinge ausgestoßen,
- Preßlinge abgenommen,
- Stempelplatten gereinigt.

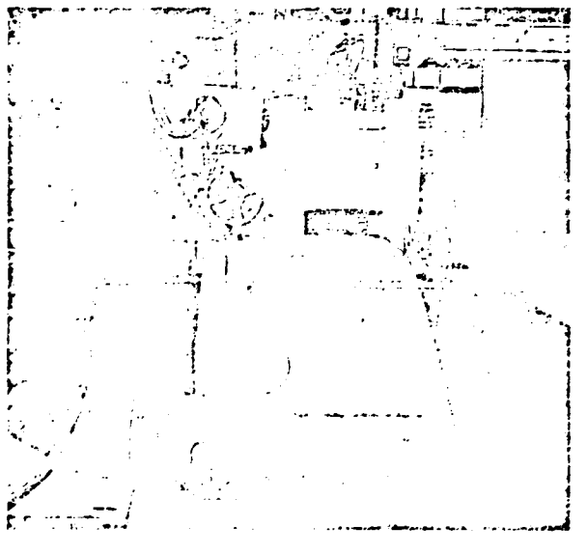
Diese optimale Arbeitsweise gewährleistet eine sehr hohe Ausstoßleistung.
Die Presse ist eingerichtet für **Handabnahme** der Steine und läßt sich durch einfachen Anbau eines Steinabnahme- und Stapelgerätes für den **Automatikbetrieb** mit elektromechanischer Steuerung umrüsten.
Die Produktionsleistung beträgt je Stunde bei Handabnahme 2800 Preßlinge z. B. im Format NF = 240/115/71 mm. Bei Einsatz eines Steinabnahme- und Stapelgerätes ergibt sich eine Produktionsleistungserhöhung auf ca. 4200 Steine pro Stunde.
Die Steine können flach gepreßt zur Handabstapelung oder seitkant gepreßt zur automatischen Abstapelung hergestellt werden.
Die Formanordnung bei Handabnahme gestattet auch die Herstellung von Steinen mit Mörtelmulden.
Die gepreßten Steine sind scharfkantig, maßhaltig und als Sichtmauersteine verwendbar.



Manuelles Abnehmen und Absetzen der Preßlinge auf die Härtewagen



Oben links: Pressendrehtisch mit Steinrohlingen
Unten links: Das stabile Pressengehäuse mit Inspektionsöffnungen zur leichten Pflege und Wartung der Innenteile
Oben rechts: Bestapelte Wagen werden in einen geöffneten Härtekessel gezogen
Unten rechts: Auswahl DORSTENER Qualitäts-Verschleißteile



DORSTENER

DORSTENER ROTARY TABLE PRESS MDP 25

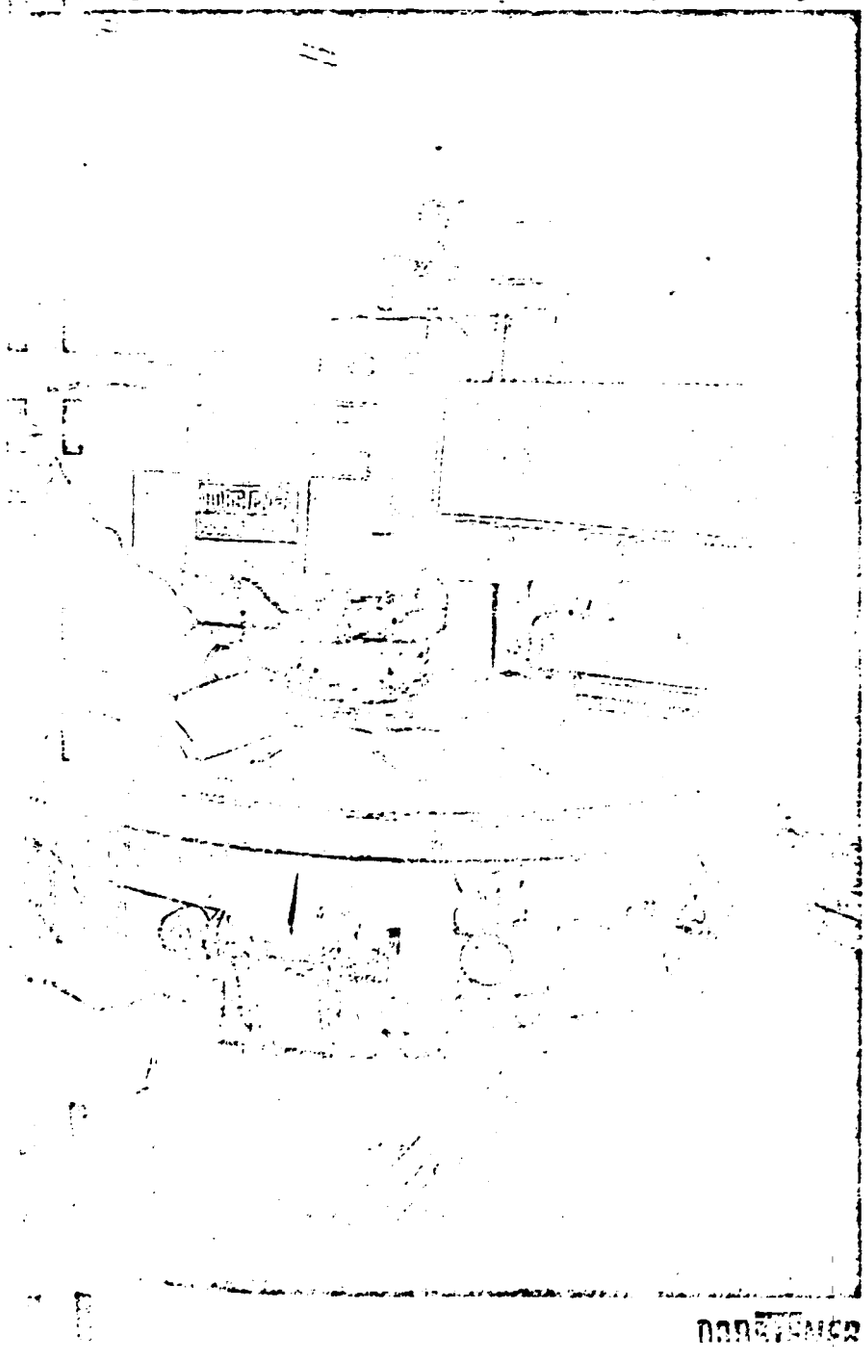
the compact machine giving a high output - proven for decades -

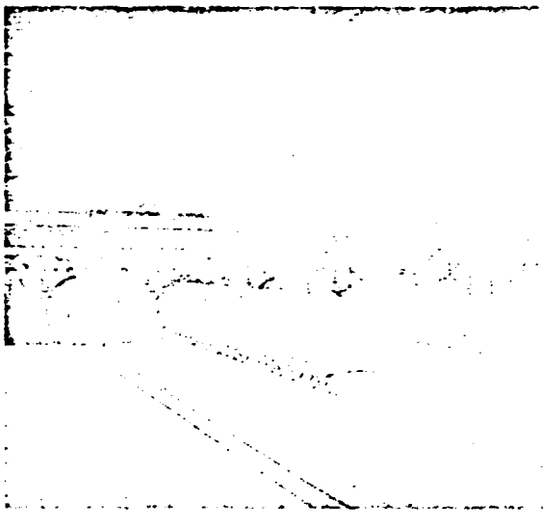
The building material industry has at its disposal the **high-output rotary table press** *DORSTENER* **MDP 250** *guaranteeing the economic production of bricks made of a* **sand and lime mixture, slagsand, dry slate, flyash** *or similar* **materials.** *The mechanic DORSTENER press* **MDP 250** *uses* **12 moulds and 18 moulds** *resp. in the revolving table.*
At the stopping points of the revolving press-table

1. *moulds are filled,*
2. *bricks are pressed,*
3. *green bricks are ejected,*
4. *green bricks are taken-off,*
5. *ram plates are cleaned at the same time.*

This optimum operation guarantees a very high output. The press can easily be converted from **manual operation** *to* **automatic operation** *by installing a brick take-off and stacking device with electro-mechanic controls.*
The manual-operation output is 2,800 bricks of size NF (240/115/71 mm, for example. The output can be increased to 4,200 bricks per hour appr by installing a take-off and stacking device.
Bricks can be pressed in the moulds flat for manual take-off or upright for automatic stacking.
The flat-pressing arrangement permits the production of frog-bricks.
Bricks produced on this machine have sharp arrises, are accurate to size and have facing-brick quality.

green bricks being taken-off and stacked manually on hardening cars





top, left: rotary table with green bricks
bottom, left: sturdy press housing with inspection doors for easy servicing and maintenance of the interior parts
top, right: stacked cars being drawn into an open autoclave
bottom, right: selection of DORSTENER quality wearing parts

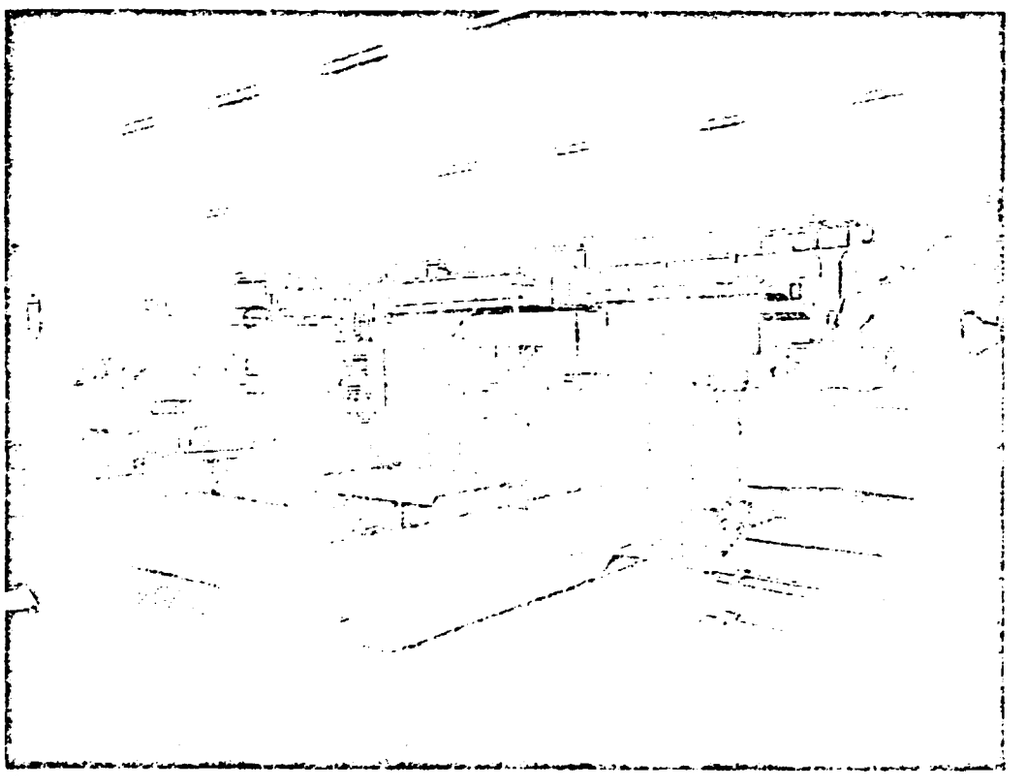
Vorteile der DORSTENER MDP 250

- HÖCHSTE PRODUKTIVITÄT
  durch gleichzeitiges Füllen, Pressen, Ausstoßen und Abnehmen,
- GERINGSTER PFLEGE- UND WARTUNGSAUFWAND
  durch kompaktes Pressengehäuse, das die beweglichen Teile der Mechanik schützt,
- MINIMALE WARTUNGSZEITEN
  da durch zentrale Fettschmierungsanlagen die Schmierstellen während des Betriebes automatisch versorgt werden,
- JAHRZEHNTELANGE NUTZUNG
  aufgrund der stabilen, robusten Konstruktion,
- EINFACHE BEDIENUNG
  bei Hand- oder auch bei Automatik-Betrieb.

Advantages of DORSTENER MDP 250

- *HIGHEST PRODUCTIVITY*
  by means of simultaneous filling, pressing, ejecting and take-off operation,
- *MINIMUM MAINTENANCE*
  required due to a compact press housing protecting the press mechanism,
- *MINIMUM MAINTENANCE TIME*
  thanks to a central lubricating system supplying all greasing points automatically during operation of the press,
- *WORKING LIFE FOR DECADES*
  due to the sturdy construction,
- *SIMPLE HANDLING*
  of the machine in manual and also automatic operation.

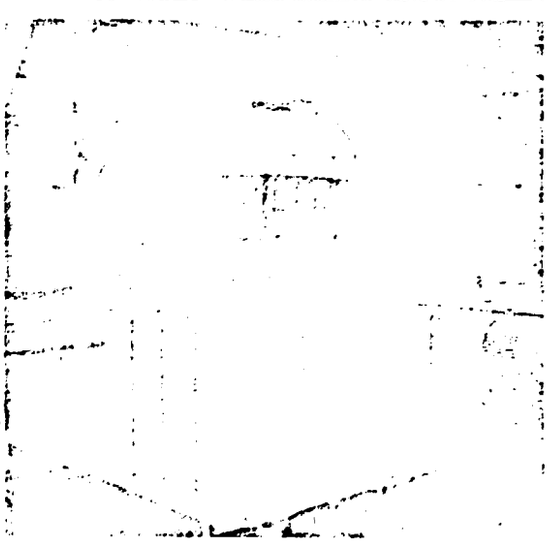
Mit einer DORSTENER **MDP 250** erzeugt eine Kalksandstein-Herstellungsanlage **11 Millionen Kalksandsteine** im Normalformat pro Jahr. Durch Einbau einer zweiten Presse und entsprechender Härtekessel kann ohne größere Umbauten die Kapazität der Anlage auf **22 Millionen** erweitert werden, die sich durch automatische Steinabnahme und Stapelung auf **33 Millionen** Normalformatsteine erhöhen läßt. Aufgrund der übersichtlichen Anordnung der Bedienungselemente können bei automatischem Betrieb **2 Pressen** von **einem Bedienungsmann** beaufsichtigt werden.



DORSTENER 2-Pressen-Anlage
mit Automatikbetrieb
und elektromechanischer Steuerung

A calcium-silicate brick-making plant equipped with one DORSTENER **MDP 250** *produces* **11 million standard-size bricks** *per year. The output of the plant can be doubled to* **22 million** *bricks without major modifications by installing a second press and additional autoclaves.* **33 million** *bricks per year can be produced if an automatic brick take-off and stacking device is introduced. Thanks to a neat grouping of all control elements for automatic operation,* **two presses** *can be supervised by* **one operator.**

Plant equipped with 2 DORSTENER presses (autom. operation and electromechanic controls)



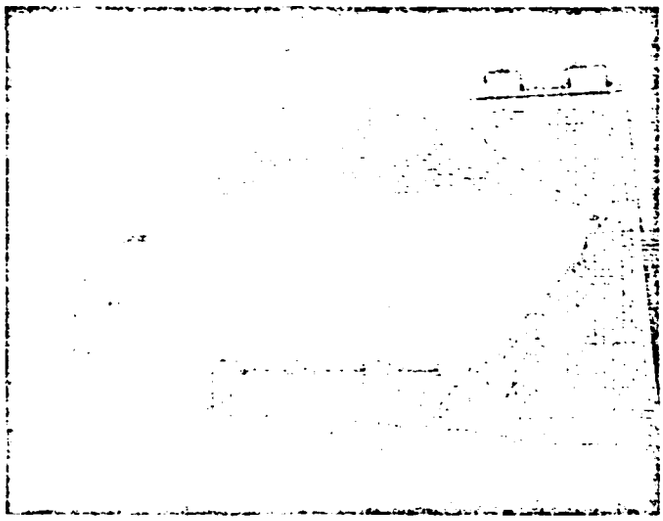
Mechanisches Abnehmen und Absetzen der Preßlinge auf die Härtewagen

mechanic take-off and stacking of green bricks on hardening cars

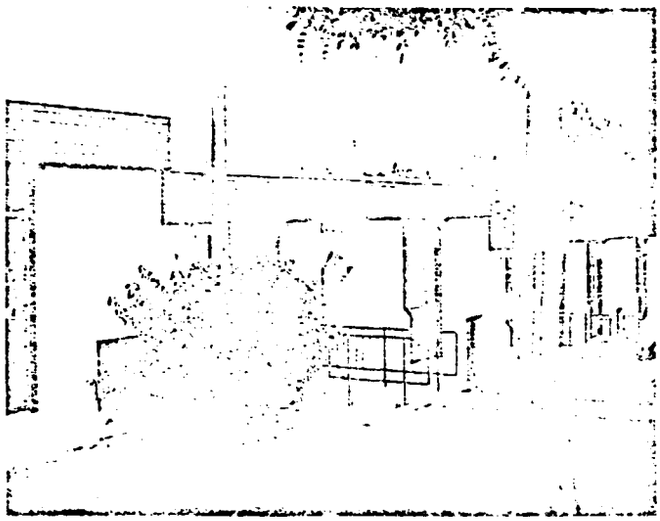
DORSTENER

BAUANWENDUNGEN VON KALKSANDSTEINEN

CALCIUM-SILICATE BRICK APPLICATIONS



Wohnhaus, erbaut aus Kalksandsteinen
dwelling house in calcium-silicate brickwork

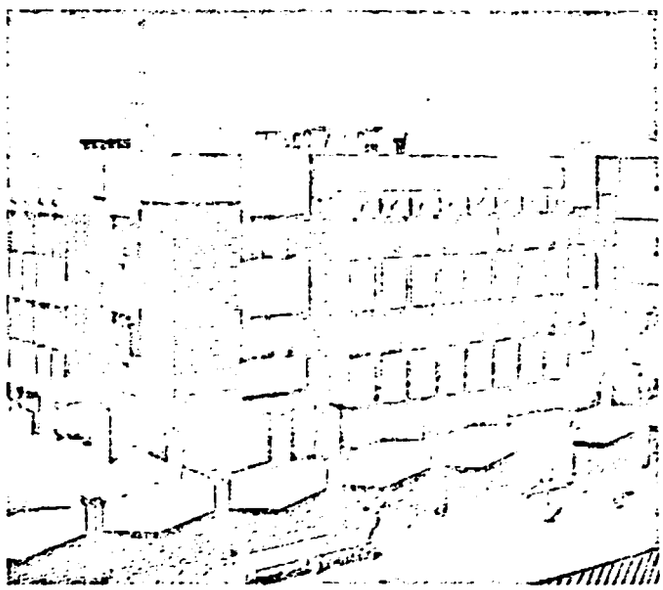


Reihenhäuser
aus Kalksandsteinen

back-to back houses made in
calcium-silicate brickwork

Verwaltungsgebäude
aus farbigen Kalksandsteinen

administrative building
in colored calcium-silicate brickwork



Wohnviertel aus farbigen
Kalksandsteinen in Kuwait

dwelling house with colored
calcium-silicate brickwork in Kuwait

Technische Daten / Technical Data

Statische Belastbarkeit / *static rating:*	kN	2500
Max. Formöffnung / *max. mould opening:*	mm	250 x 125
Max. Preßhöhe / *max. pressing height:*	mm	115
Max. Füllhöhe / *max. filling height:*	mm	200
Max. Hubzahl / max. no. of strokes:		1400

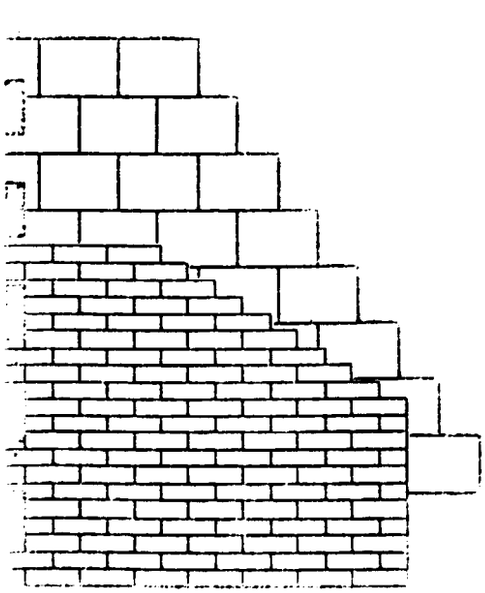
Steinmaße brick size	Handabnahme manual take-off		Automatikabnahme automatic system	
	Stück/h bricks/h	Mauerwerk brickwork	Stück/h bricks/h m³/h	Mauerwerk brickwork m³/h
190x 90x90 mm	2800	4,31 m³/h	2800	4,31 m³/h
190x 90x57 mm	2800	2,72 m³/h	4200	4,07 m³/h
230x115x75 mm	2800	5,57 m³/h	4200	8,36 m³/h
9" x 4½" x 3"	2800	5,54 m³/h	4200	8,32 m³/h
8" x 4" x 2½"	2800	3,70 m³/h	4200	5,55 m³/h

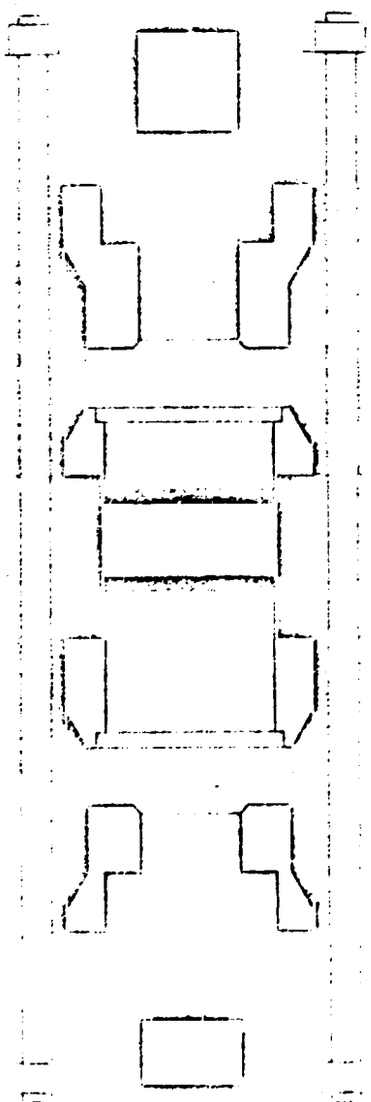
Technische Änderungen vorbehalten — Subject to techn. modifications

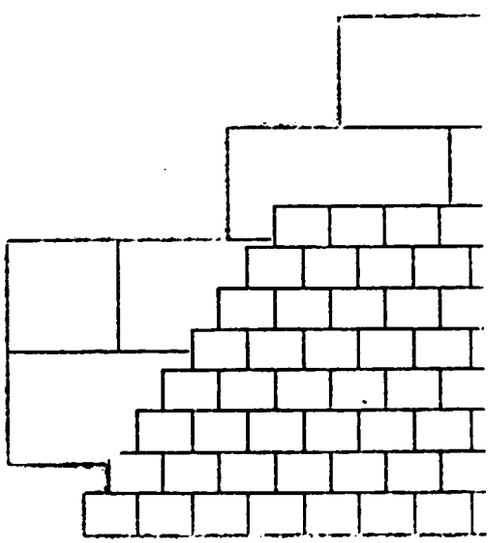
Reihenhäuser
aus Kalksandsteinen

back-to back houses made in
calcium-silicate brickwork

DORSTENER







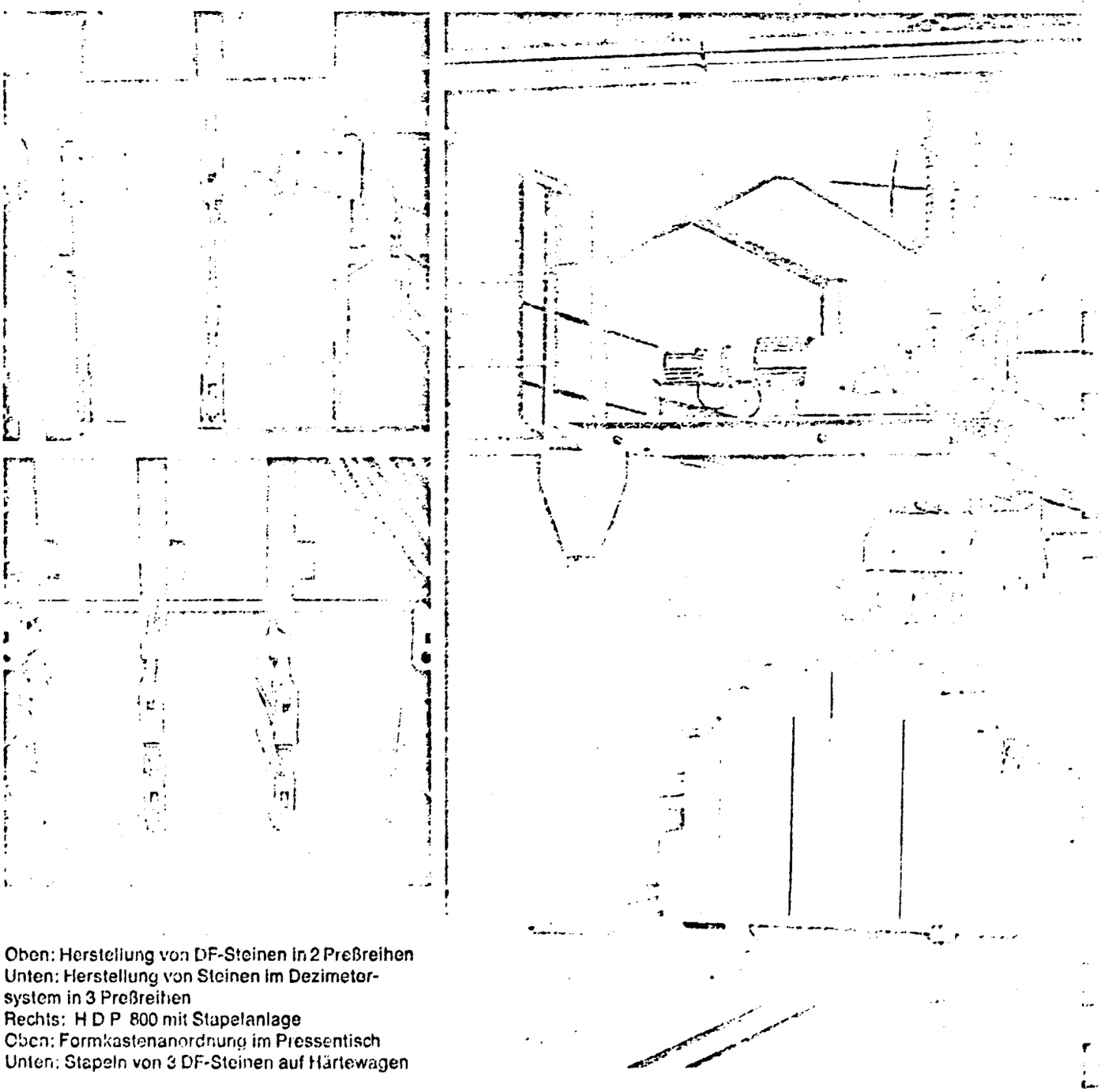
Hydraulische DORSTENER Pressen HDP 600-800-1200-1200 Jumbo

Der Baustein-Industrie stehen heute DORSTENER Pressen zur Verfügung, mit denen im gesamten Format-Bereich vom kleinsten Stein bis zum großen Element – 1000 mm Länge x 600 mm Höhe x Wandstärke bis 600 mm – alle Größen wirtschaftlich hergestellt werden können.
DORSTENER bietet mit den Typen H D P 600, 800, 1200 und 1200 Jumbo eine anspruchsvolle Pressenpalette, deren wesentliches Merkmal **doppelseitige Verdichtung** ist.

Die doppelseitige Verdichtung garantiert:

* Herstellung von Steinen und Elementen mit gleichmäßiger Dichte über die gesamte Preßhöhe,
* Wirtschaftliche Produktion aller Steinformate in vorhandenen und zukünftigen Maßsystemen,
* Herstellung aller Oberflächenformen wie Nut-Feder-Ausbildung oder Einpressung von Installationskanälen und dergleichen,
* Herstellung von extrem leichten Bauelementen durch hohen Hohlraumanteil.

H D P 800
Mit der H D P 800 können Blöcke bis zu den Abmessungen 600 mm Länge x 300 mm Höhe x Wandstärke – von 90–600 mm – hergestellt werden.
Hohe Ausstoßleistungen werden z. B. beim Format NF durch einen Ausstoß von 16 Steinen je Preßhub erzielt.
Die Umstellung auf verschiedene Steinmodule – z. B. vom Oktametersystem auf das Dezimetersystem – ist problemlos.



Oben: Herstellung von DF-Steinen in 2 Preßreihen
Unten: Herstellung von Steinen im Dezimetersystem in 3 Preßreihen
Rechts: H D P 800 mit Stapelanlage
Oben: Formkastenanordnung im Pressentisch
Unten: Stapeln von 3 DF-Steinen auf Härtewagen

Hydraulic DORSTENER presses HDP 600 - 800 - 1200 - 1200 Jumbo

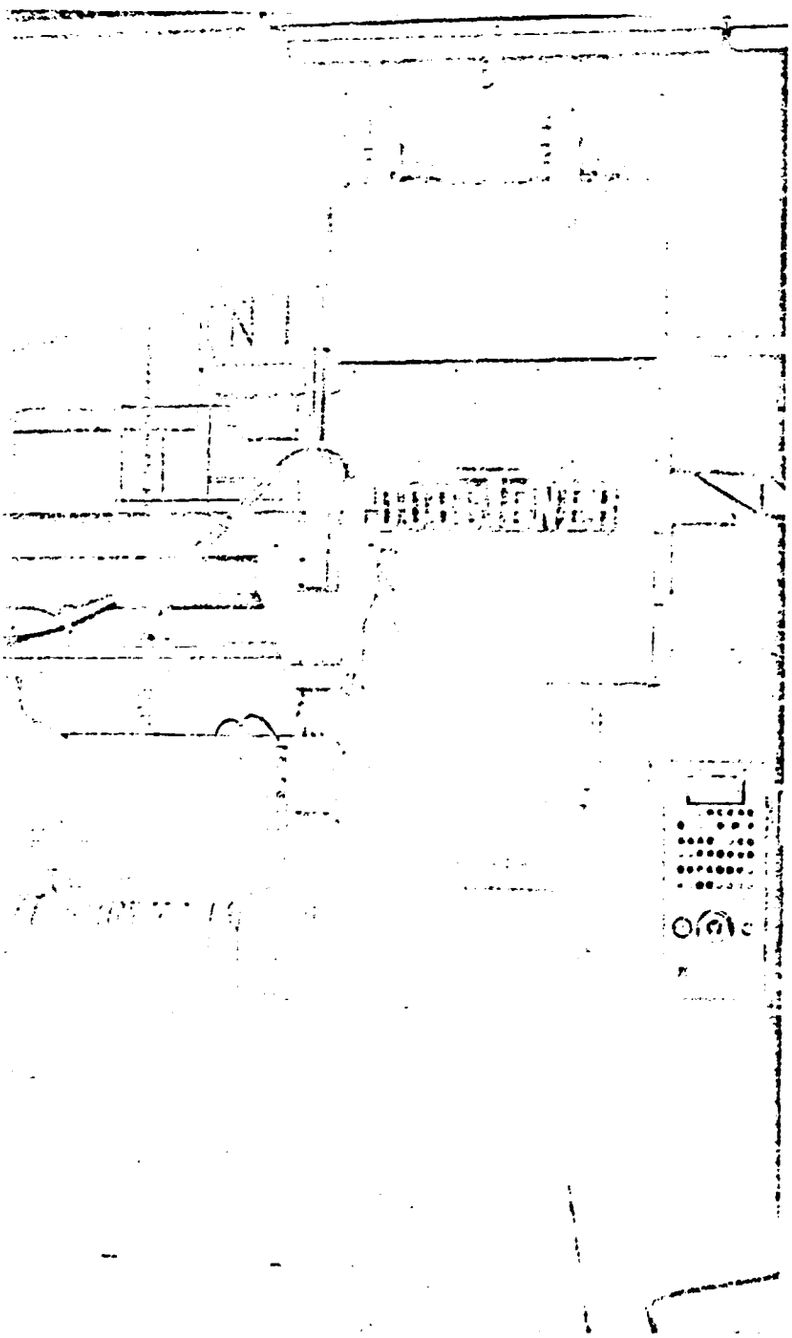
Today the building brick industries have at their disposal DORSTENER presses covering the whole range of sizes from the smallest brick to big elements – length 1,000 mm x height 600 mm x wall thickness up to 600 mm. With the types HDP 600, 800, 1200 and 1200 Jumbo DORSTENER offers a comprehensive range featuring **bi-directional compaction.**

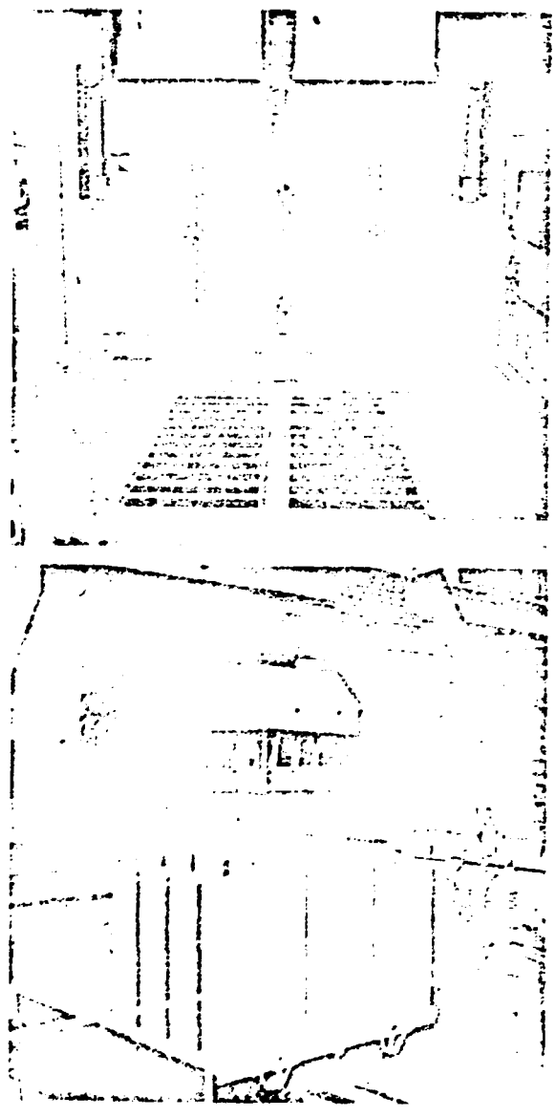
Bi-directional compaction *guarantees:*

- *production of bricks and elements of uniform density over the whole pressing height,*
- *efficient production of all brick sizes based on existing and future dimensional systems,*
- *manufacture of all shapes, as tongue and groove bricks, installation-groove bricks etc,*
- *production of extreme light-weight elements with a high share of cavities.*

H D P 800

With the HDP 800, blocks up to 600 mm length x 300 mm height x wall thickness – from 90 to 600 mm – can be produced. High outputs are achieved by multiple brick ejection per stroke, for example 16 bricks of NF-size are produced per stroke.
The press can be changed without problems to different brick modules – from the octameter to the decimeter system for example.





Above: Production of DF-standard size bricks in two rows
Below: Production of decimeter-system bricks in three rows
Right: HDP 800 with stacking installation
Above: Mould-box arrangement in the press table
Below: Stacking of 3 DF-bricks on hardening cars

DORSTENER HDP-Pressen – Maschinen mit durchdachten Details

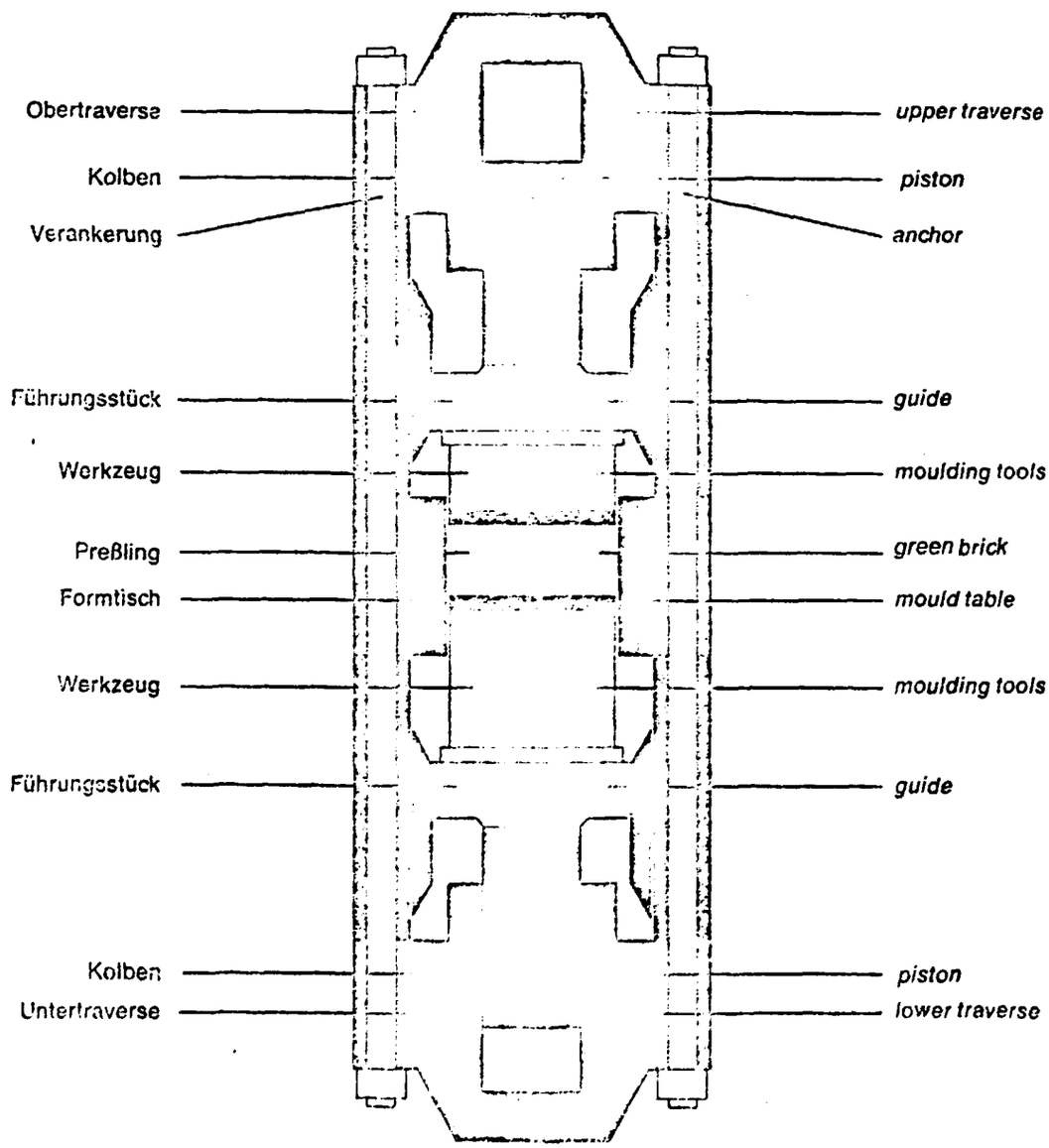
* Gleichzeitige und gleichstarke Verdichtung durch oberen und unteren Preßzylinder,
* Keine Dehnung im Ankersystem aufgrund eines vorgespannten Pressengestells,
* Optimale Führung der Preßwerkzeuge durch Gleitleisten,
* Wenige sich bewegende Maschinenteile, dadurch reduzierter Verschleiß,
* Reibungsfreies Eintauchen der Ober- und Unterstempel,
* Kein Verkanten der Stempel,
* Keine Verformungen des Pressentisches,
* Wartungsfreundliche Kompaktbauweise der Hydraulik.

DORSTENER HDP-presses – presses with well-considered details

* *simultaneous and uniform compaction by means of upper and lower pressing cylinders,*
* *no elongation in the anchor system due to the pre-stressed frame,*
* *optimum guidance of the moulding tools by means of slide strips,*
* *few moving parts; consequently reduced wear,*
* *non-abrasive moving of the upper and lower rams in the moulds,*
* *no tilting of the rams,*
* *no deformation of the press table,*
* *compact construction of the hydraulic system for easy maintenance.*

Systemschnitt der HDP-Presse

sectional view of the HDP-press



DORSTENER Formwerkzeuge

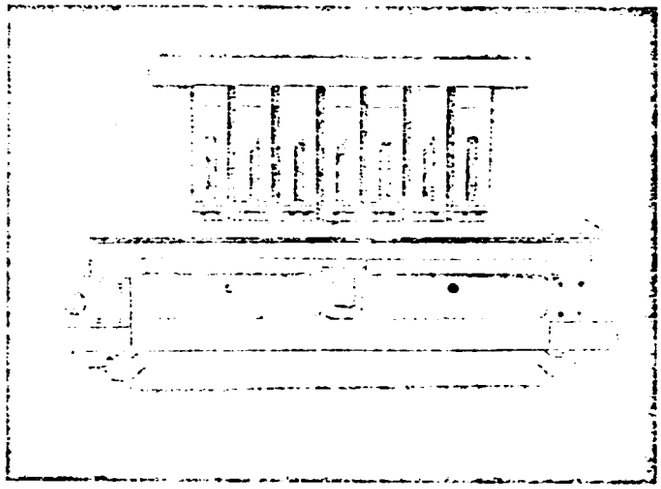
Was zeichnet die Formwerkzeuge der DORSTENER H D P - Pressen besonders aus?

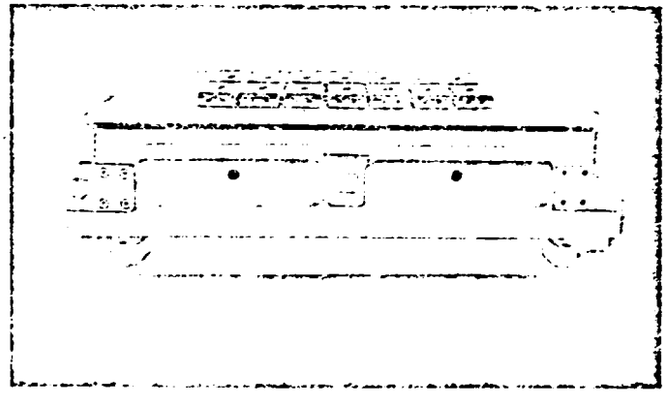
* KOSTENREDUKTION durch höhere Standzeiten der Formverschleißteile aufgrund geringerer Belastung bei doppelseitiger Pressung,
* PRODUKTIVITÄTSERHÖHUNG durch verminderte Stillstandzeiten z. B. infolge schnelleren und bequemeren Wechselns der kompletten Werkzeuge und Formplatten,
* LOHNKOSTENREDUZIERUNG durch elektrische Beheizung der Ober- und Unterstempel, dadurch Selbstreinigung von Masserückständen.

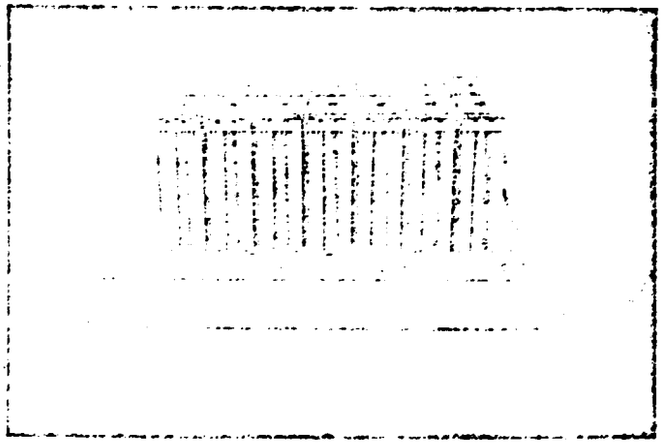
DORSTENER moulding tools

Which are the special advantages of the moulding tools of DORSTENER H D P - presses?

* *COST REDUCTION by longer service-life of the mould wearing parts on account of bi-directional compaction,*
* *INCREASE OF PRODUCTIVITY by reduced downtimes thanks to quick and easy exchange of the complete moulding tool and liners for example,*
* *LABOUR COST REDUCTION by electric heating of upper and lower rams; thus self-cleaning from sticking material.*

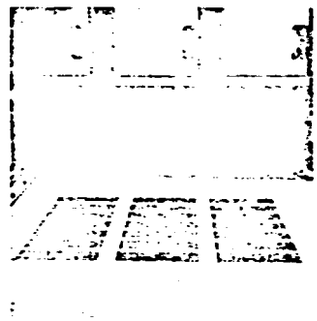






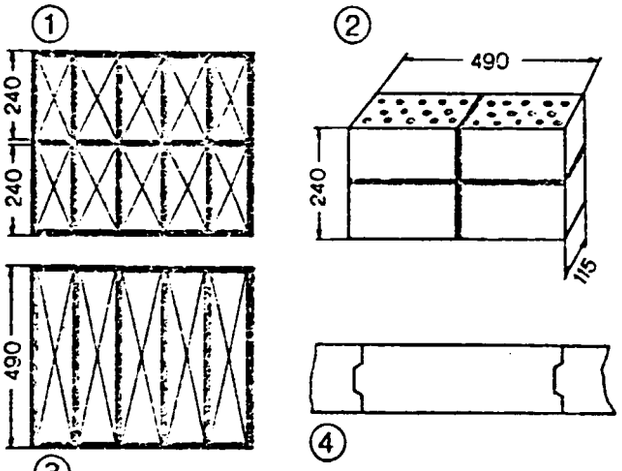
2-reihige Formenanordnung bis 327 mm lang

2-row mould arrangement up to 327 mm length



3-reihige Formenanordnung bis 220 mm lang

3-row mould arrangement up to 220 mm length



DORSTENER Formwerkzeugkombinationen

Bild 1) 2 DF-Werkzeuge normal im Pressentisch angeordnet.

Bild 2 und 3: Mit dem gleichen Werkzeug und Ergänzungsteilen können Steine in doppelter Länge und doppelter Höhe hergestellt werden.

Bild 4: Die Herstellung von Nut- und Federsteinen ist möglich.

DORSTENER moulding tool combinations

Fig. 1) 2 DF-moulding tools, normal arrangement in the press table.

Fig. 2 and 3: With the same moulding tools and additional parts double-length and double-height bricks can be produced

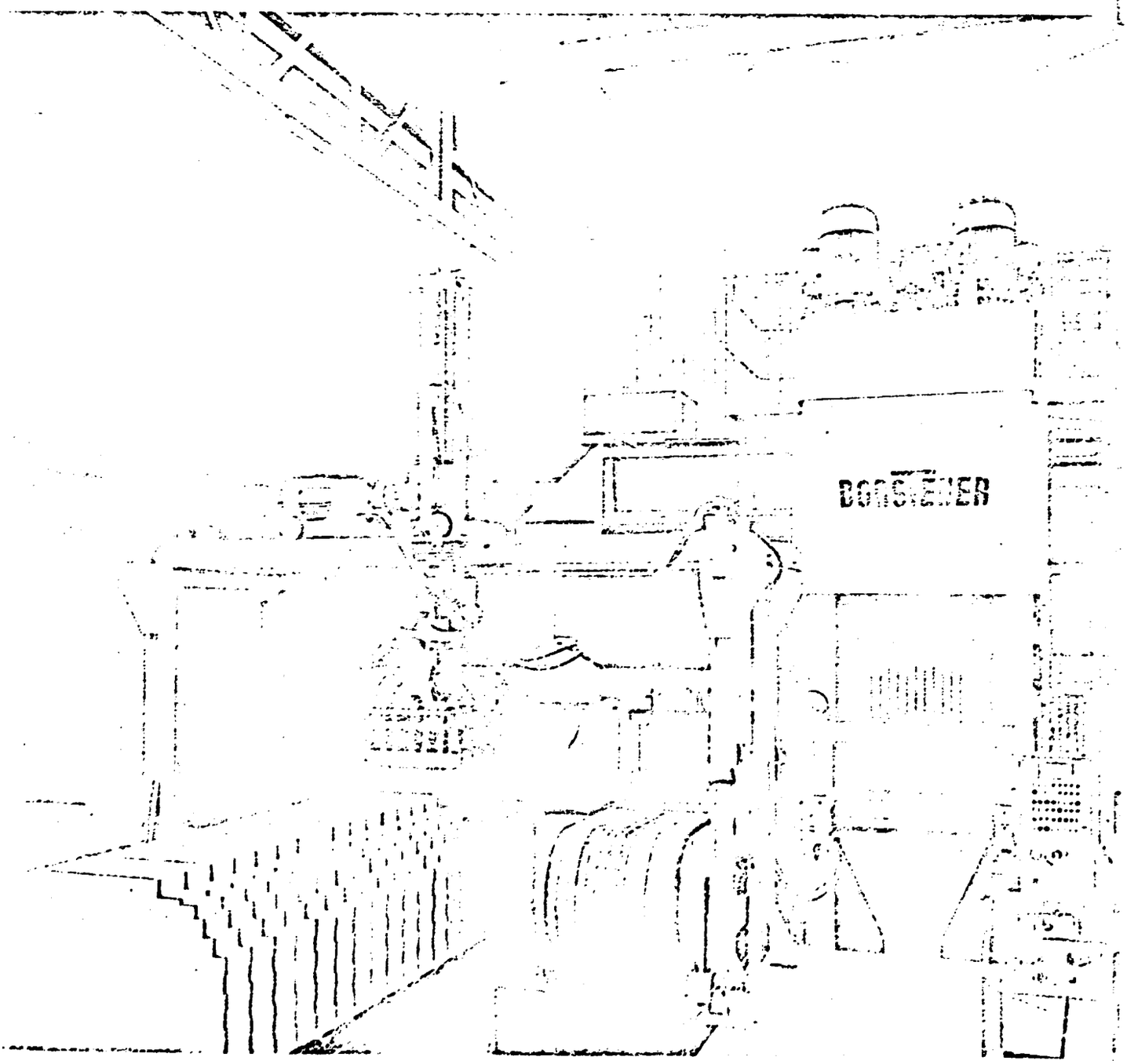
Fig. 4: production of tongue and groove bricks possible.

DORSTENER HDP-Presse 1200

Mit der Presse H D P 1200 wird gegenüber der H D P 800 eine um 20 % höhere Leistung erreicht. Darüber hinaus werden auf dieser Presse Elemente hergestellt bis 1000 mm Länge x 300 mm Höhe x Wandstärke.

DORSTENER HDP-press 1200

The output of the HDP 1200 is by 20 % higher compared with the HDP 800. Furthermore this press produces elements up to 1,000 mm length x 300 mm height x wall thickness.

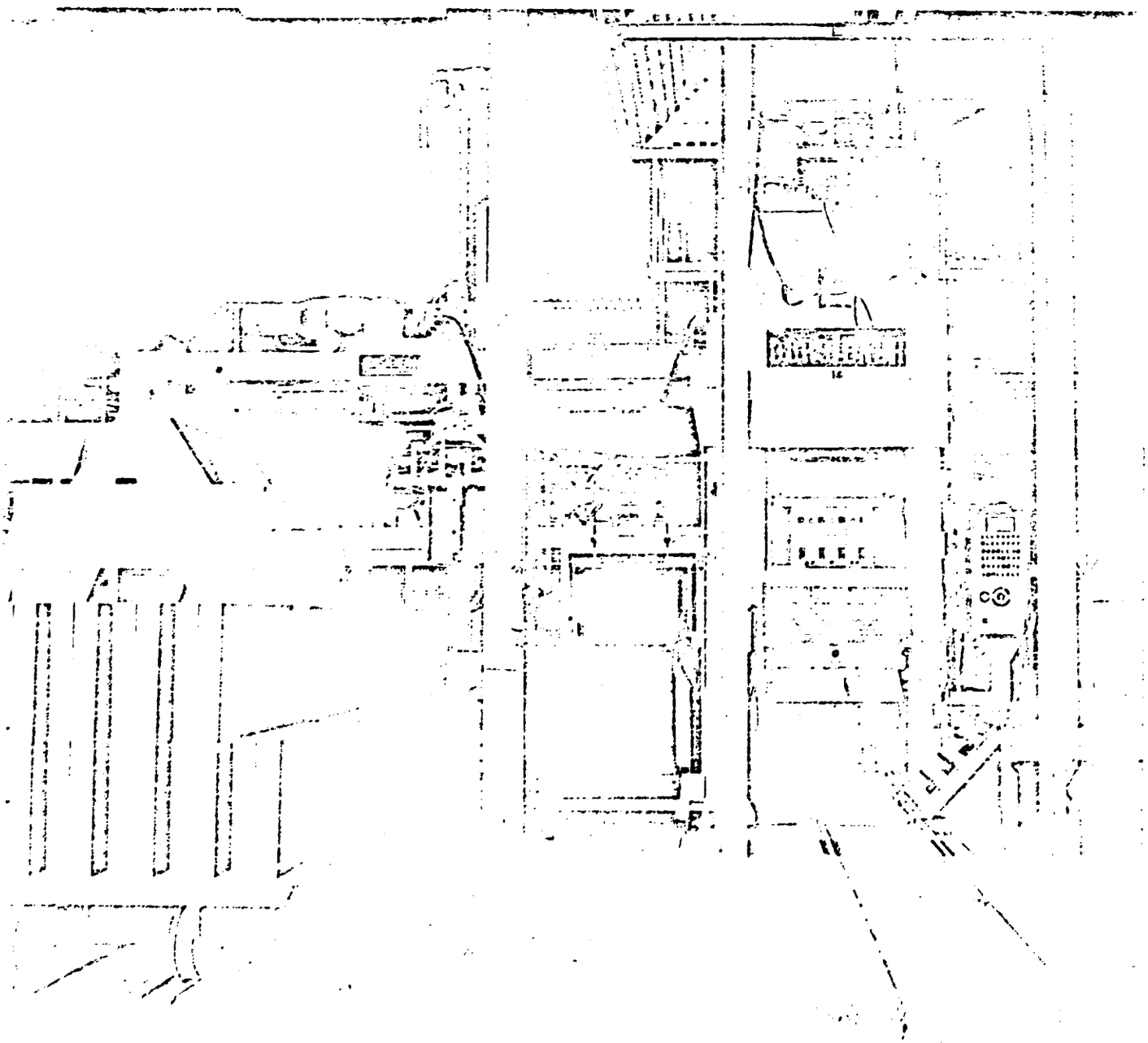


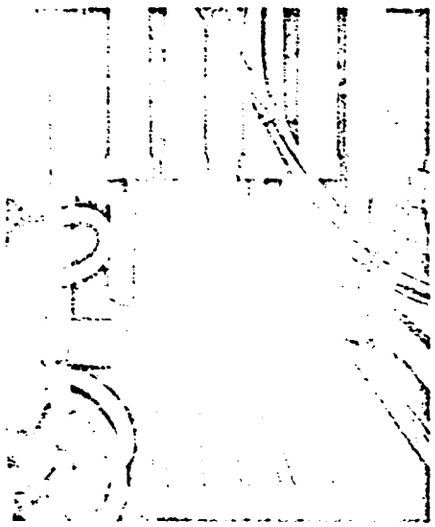
DORSTENER HDP-Presse 1200 Jumbo

Mit der Presse H D P 1200 Jumbo werden Elemente bis zu einer Größe von 1000 mm Länge x 600 mm Höhe x Wandstärke bis ca. 600 mm hergestellt.
Ohne Verminderung der Produktionsleistung gegenüber der H D P 1200 können selbstverständlich alle Standard-Formate hergestellt werden.

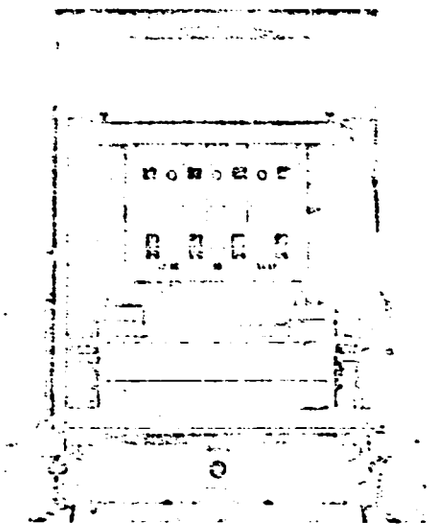
DORSTENER HDP-press 1200 Jumbo

The press of type HDP 1200 Jumbo produces elements up to a length of 1,000 mm x a height of 600 mm x a wall thickness up of to about 600 mm.
With regard to all standard-sizes the output is, of course, not reduced compared with the HDP 1200.

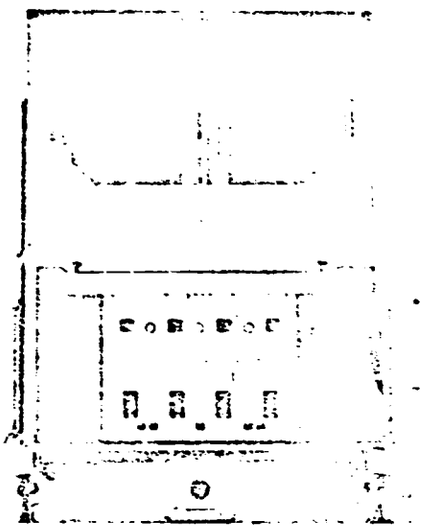




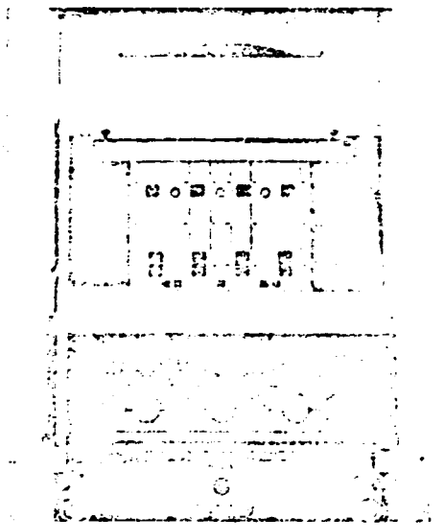
1. Formöffnung einfüllbereit
Mould opening ready to be filled



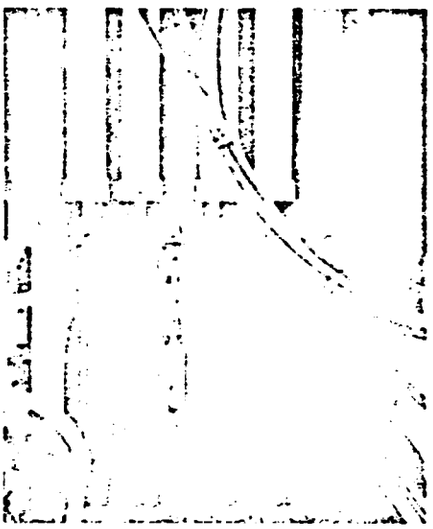
2. Füllen der Formen mit Preßmasse
Moulds being filled with mixture



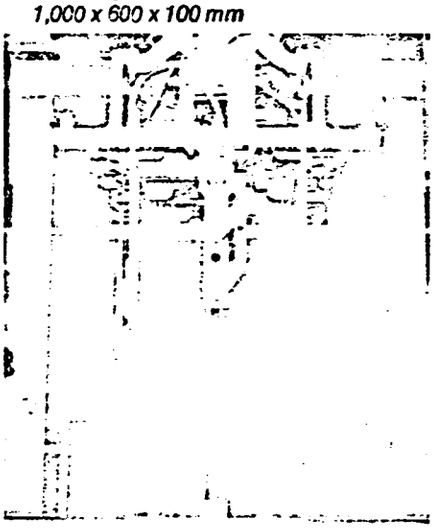
3. Pressen von vier Wandelementen 1000 x 600 x 100 mm
Pressing of four wall elements 1,000 x 600 x 100 mm



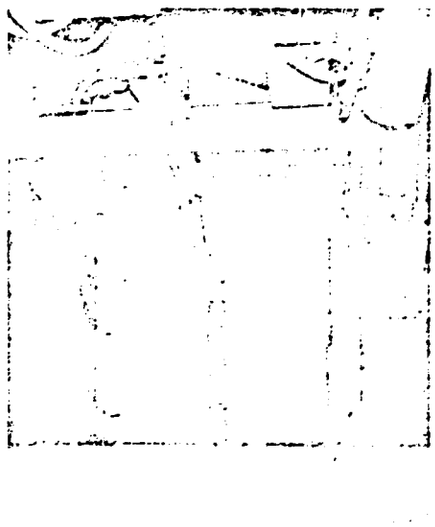
4. Ausstoß der Preßlinge
Ejection of the pressed elements



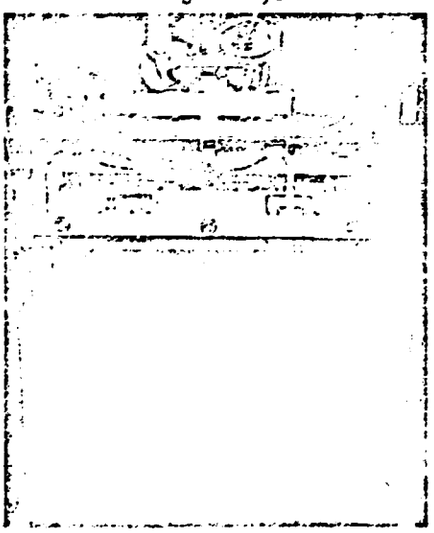
5. Umsetzen der Preßlinge zum Transportband
Transferring the green elements to the marshalling conveyor



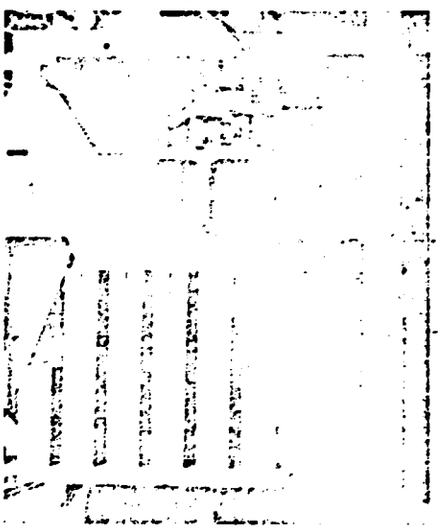
6. Absetzen der vier Wandelemente auf das Transportband
Placing the four wall elements on the marshalling conveyor



7. Greifen der Preßlinge
Gripping of green elements



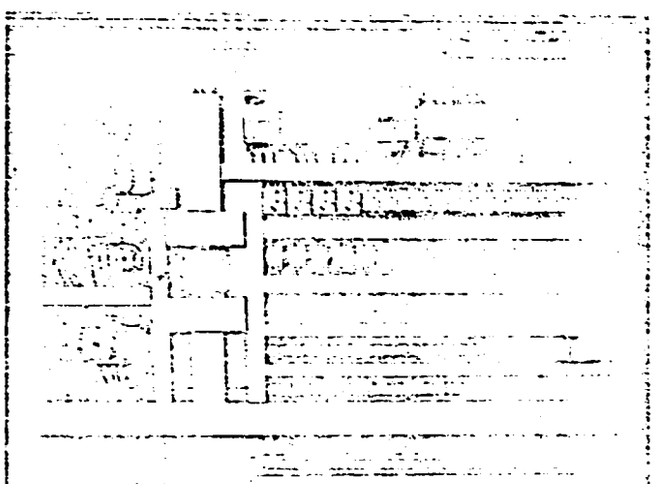
8. Stapeln auf dem Härtewagen
Stacking on hardening cars



9. Bestapelter Härtewagen
Loaden hardening car

Steuerung der HDP-Pressen

Control system of HDP-presses



* Freiprogrammierbarer Magnetspeicherkern, in dem sämtliche Steuervorgänge des Funktionsablaufes eingegeben werden,
* Abstimmung der Pumpenleistungen für die einzelnen Arbeitsgänge,
* Zusätzliche Eingabe von Steuerabläufen für Preßgutzufuhr, Rieselgut-Rücktransport etc.
* Automatische Störungsanzeige zum leichten Auffinden von Fehlerquellen,
* Automatische Anzeige der Hubgeschwindigkeit und Zählung der beladenen Härtewagen,

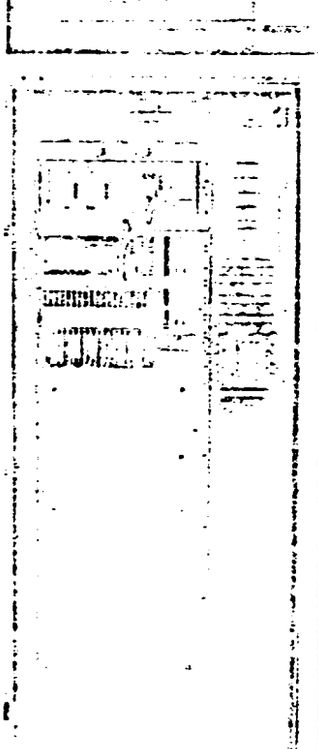
oder

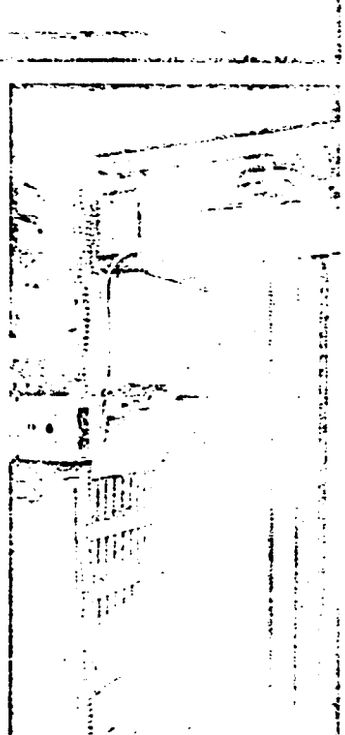
* Steuerung des Funktionsablaufes durch konventionelle Schütz-Steuerung und Endschalter.

* *free-programmable magnetic memory core for all control functions and operations,*
* *adaption of the pump output to the individual operations,*
* *additional input of control operations for mixture supply, tailings system etc,*
* *automatic faults indicator for easy localization of failures,*
* *automatic reading of stroke speed and counting of loaden hardening cars,*

or

* *control of operation by means of conventional contactor controls and limit switches.*



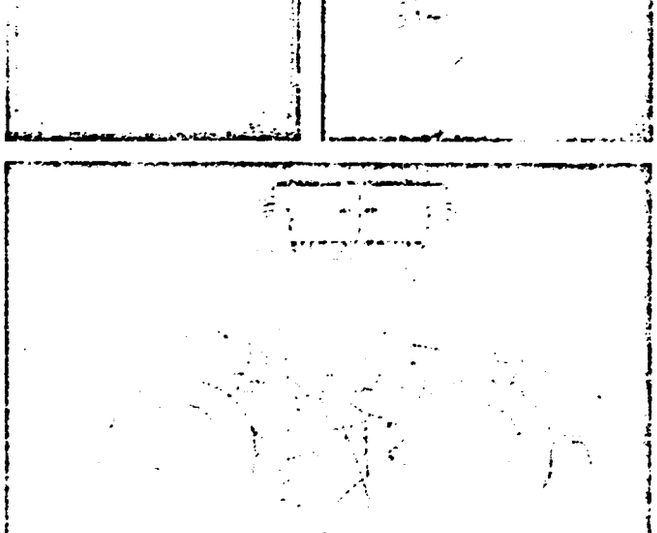


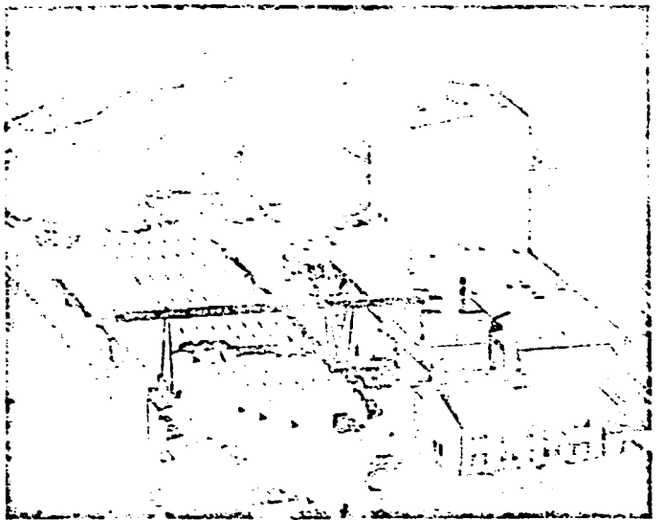
Vorteile durch DORSTENER Hydraulik:

* Raumsparende Unterbringung auf der Obertraverse,
* Getrennte Hydraulik für Ober- und Unterstempel,
* Überwachung und Steuerung der Öltemperatur,
* Aus- und Einfahren des Pressentisches zum Werkzeugwechsel.

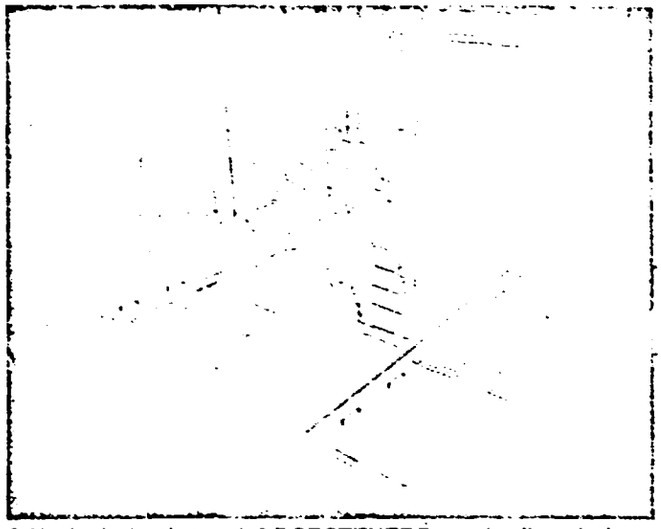
Advantages by the DORSTENER hydraulic system:

* *compact installation on top of the upper traverse,*
* *separate hydraulic system for upper and lower rams,*
* *control of the oil temperature,*
* *shifting out and in the press table for exchanging moulding tools.*

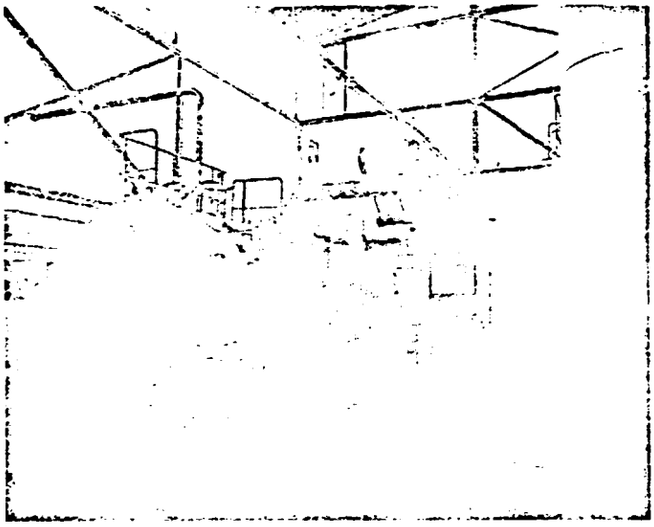




1. Gesamtansicht
View of the plant

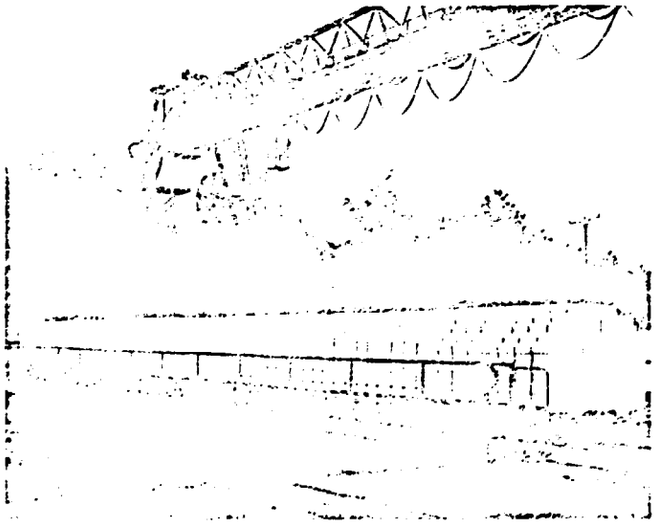


2. Nachmischanlage mit 2 DORSTENER Doppelwellenmischern
Re-mixer installation with two DORSTENER double-shait mixers



3. Dampfkesselanlage
Steam boiler section

4. Härtekesselanlage
Hardening installation



5. Schiebebühne mit kompletem Härtewagenzug
Transfer platform with a complete hardening car train

6. Verlade- und Stapelplatz
Loading and stacking yard

DORSTENER Formplatten

DORSTENER moulding plates

beste Qualität durch hohe Abriebfestigkeit

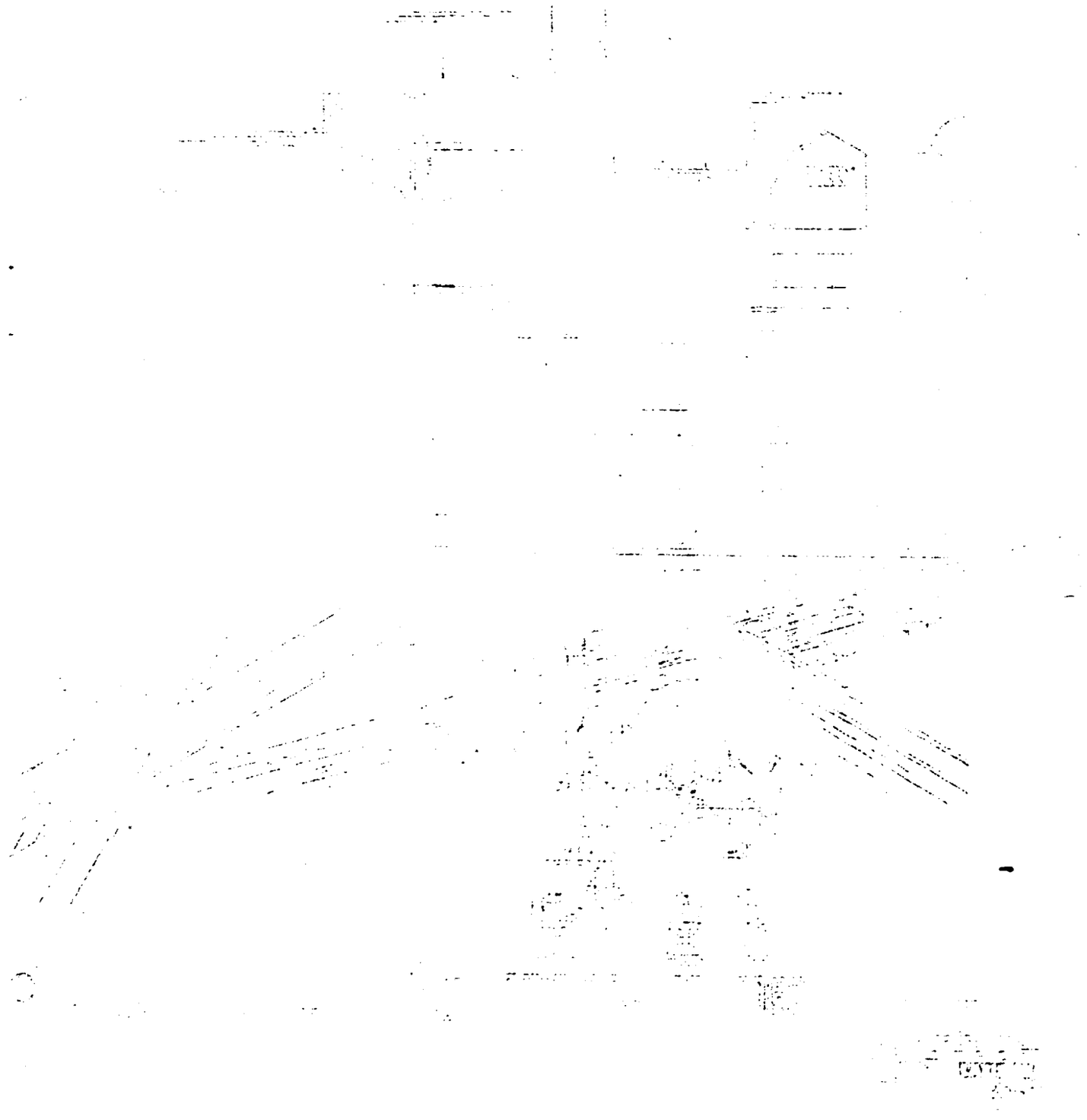
superior quality, high wearing resistance

Technische Daten / Technical Data

TYPE:		HDP 600	HDP 800	HDP 1200	HDP 1200 Jumbo
Statische Belastbarkeit *Stability rating*	MN Mp	6000 600	8000 800	12000 1200	12000 1200
Max. Formöffnung *Maximum mould opening*	mm	770 x 360	770 x 750	1085 x 750	1085 x 750
Max. Preßhöhe *Maximum pressing height*	mm	250	300	300	600
Max. Füllhöhe *Maximum filling height*	mm	450	550	550	1000
Max. Hubzahl/h *Maximum number of strokes/h*		415	415	300	280

Die Hubzahlen beziehen sich auf normale Betriebsbedingungen.

The stroke figures mentioned are based on normal conditions of operation.



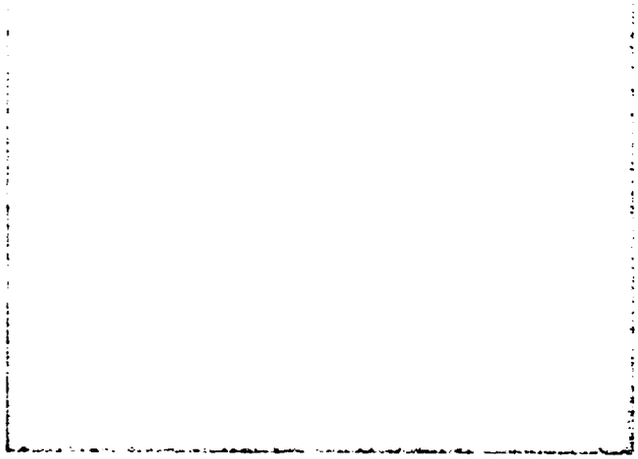
Anlagenbau für die Feuerfest-Industrie

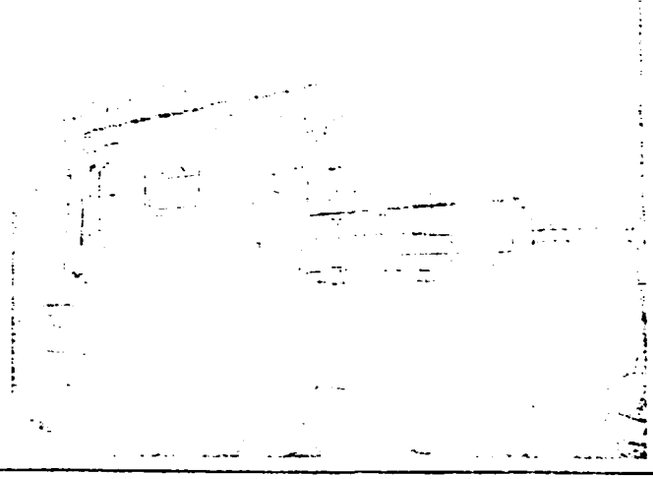
LAEIS

LAEIS

LAEIS-Anlagen erzeugen Qualitätsprodukte.
LAEIS plant, liefert und erstellt für die Feuerfest-Industrie: Maschinen und komplette Anlagen einschließlich Engineering und vermittelt das notwendige Know-How zur Herstellung von FF-Steinen aller genormten und Sonderformate, aus allen Materialarten wie z. B. Schamotte, Silika, Magnesit, Chromerz, Dolomit u.s.w.

Keramisch-, chemisch- oder teergebunden, Stampfmassen, Brennhilfsmittel sowie Verschleißmaterial für den Stahlwerksbetrieb. LAEIS hat weltweite und vielseitige Erfahrung auf dem Feuerfest-Sektor. Anlagen in aller Welt beweisen das. Lassen Sie sich von unseren Spezialisten beraten!





① **Hydraulisch-automatische Drehtischpresse 1200 Mp. mit volumetrischer Füllvorrichtung und automatischer Steinstapelvorrichtung in einer Dolomitanlage**

② **Steuer-Schaltwarte mit Blindschaltbild für zentrale Bedienung einer LAEIS-Anlage**

③ **Planetenmischkollergänge PMK für die Herstellung von Teer-Dolomit-Mischungen**

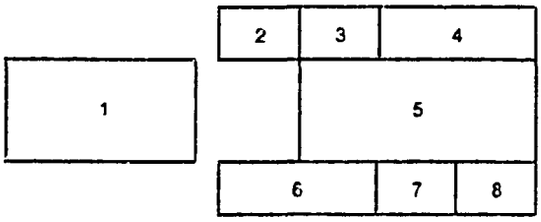
④ **Teer-Dolomit-Magnesitmischergruppe mit Planetenmischern PZMK in einer der größten europäischen Dolomitsteinfabriken**

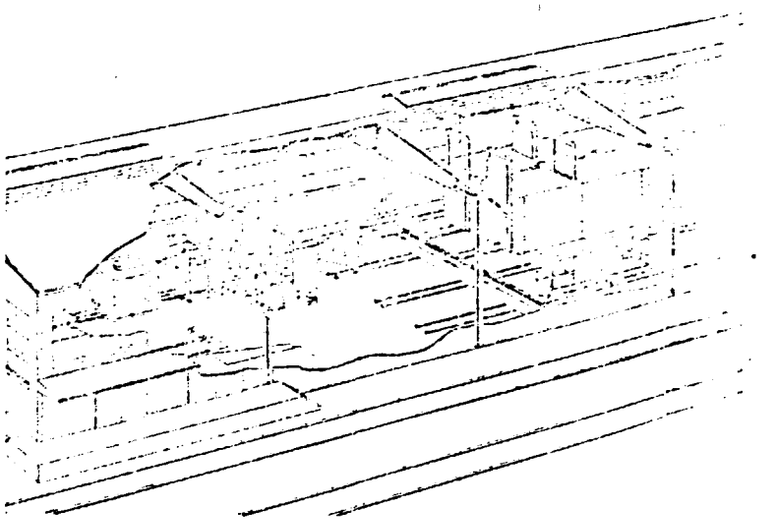
⑤ **Modell einer von LAEIS konzipierten Teer-Magnesit-Dolomitsteinfabrik mit automatischer Aufbereitung, automatischen Pressen, Temperofen, Palettier- und Schrumpffolien-Verpackungseinrichtung. Leistung ca. 12 t/h**

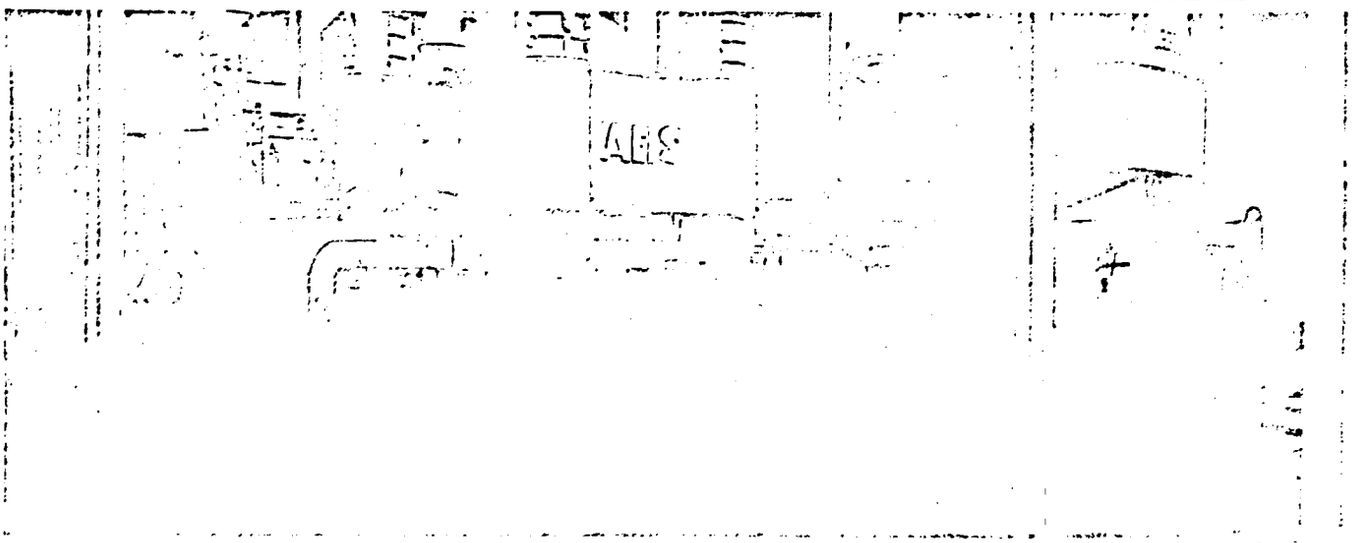
⑥ **Hydraulische Doppeldruck-Schiebeformpressen 2000 Mp. mit automatisch-gravimetrischer Füllvorrichtung und mit automatischer Steinabnahmevorrichtung**

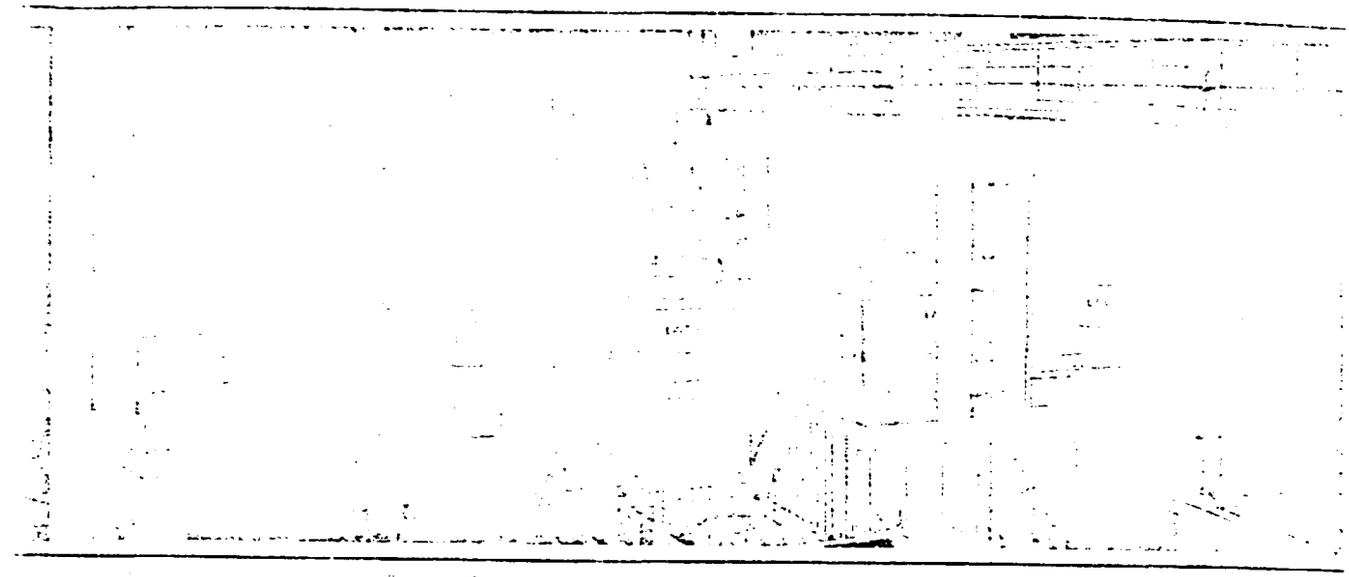
⑦ **Siebmaschinen innerhalb einer Aufbereitungsanlage**

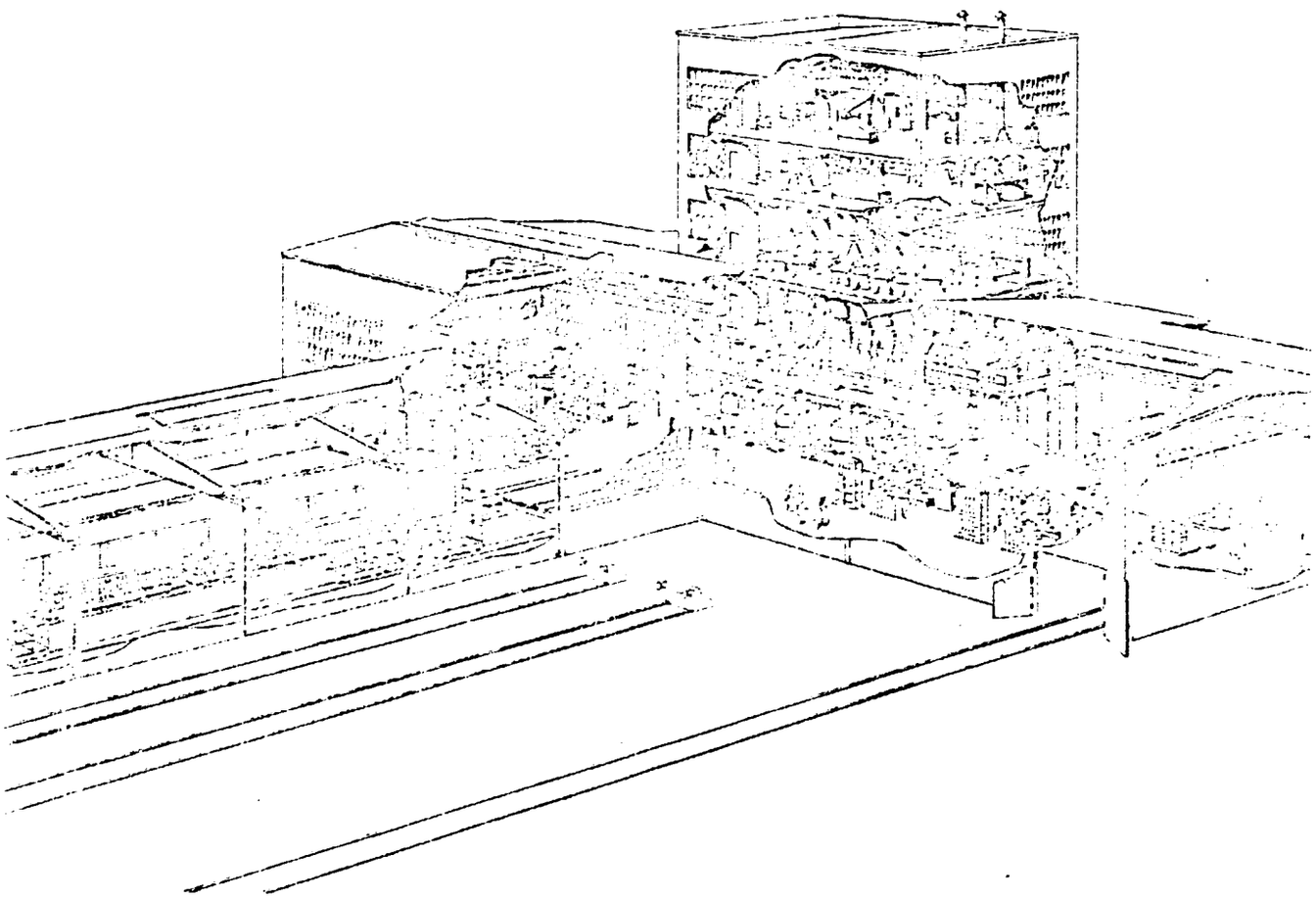
⑧ **Feinsiebmaschine zur Aufbereitungsanlage**

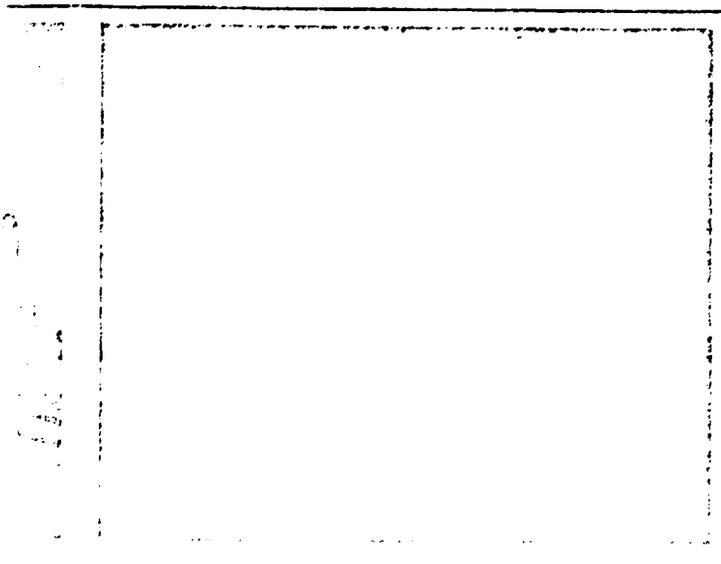


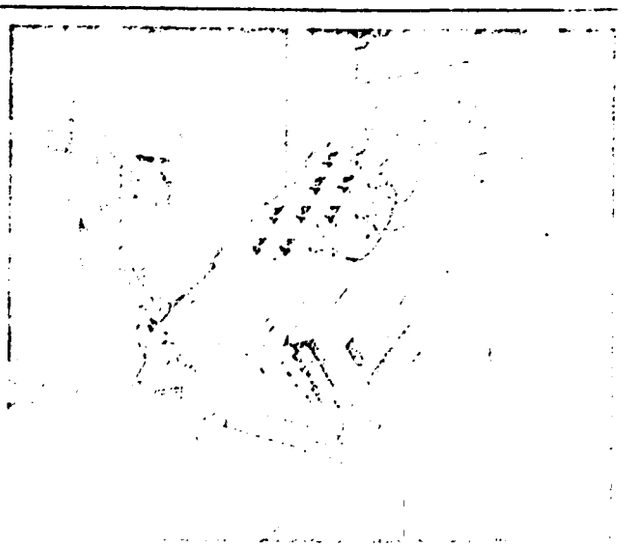


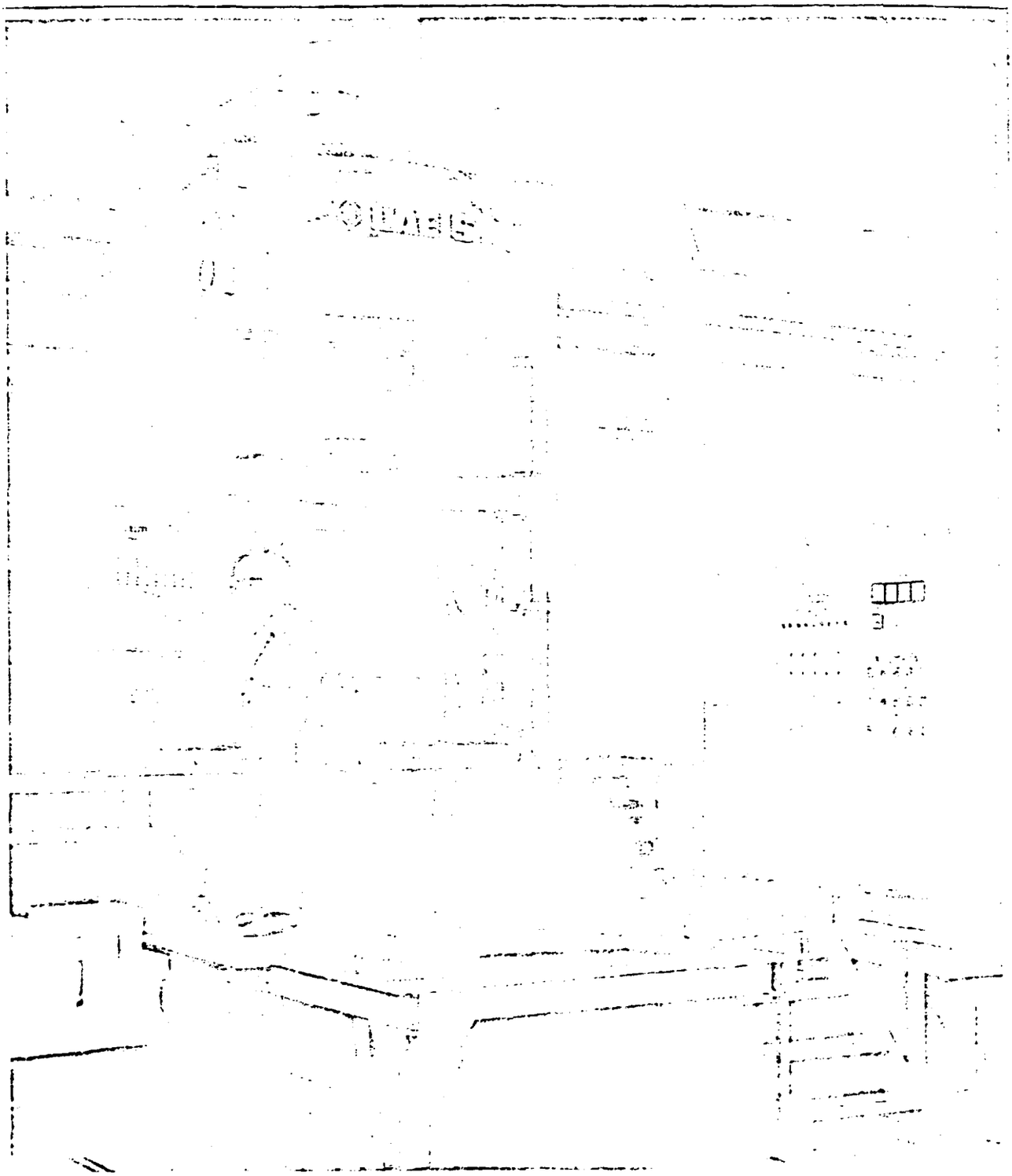












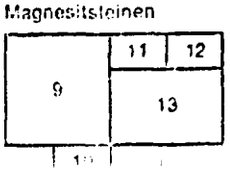
⑨ Hydraulisch-vollautomatische Einkolben-Roboterpresse 1250 Mp, bei der Herstellung von Magnesitsteinen

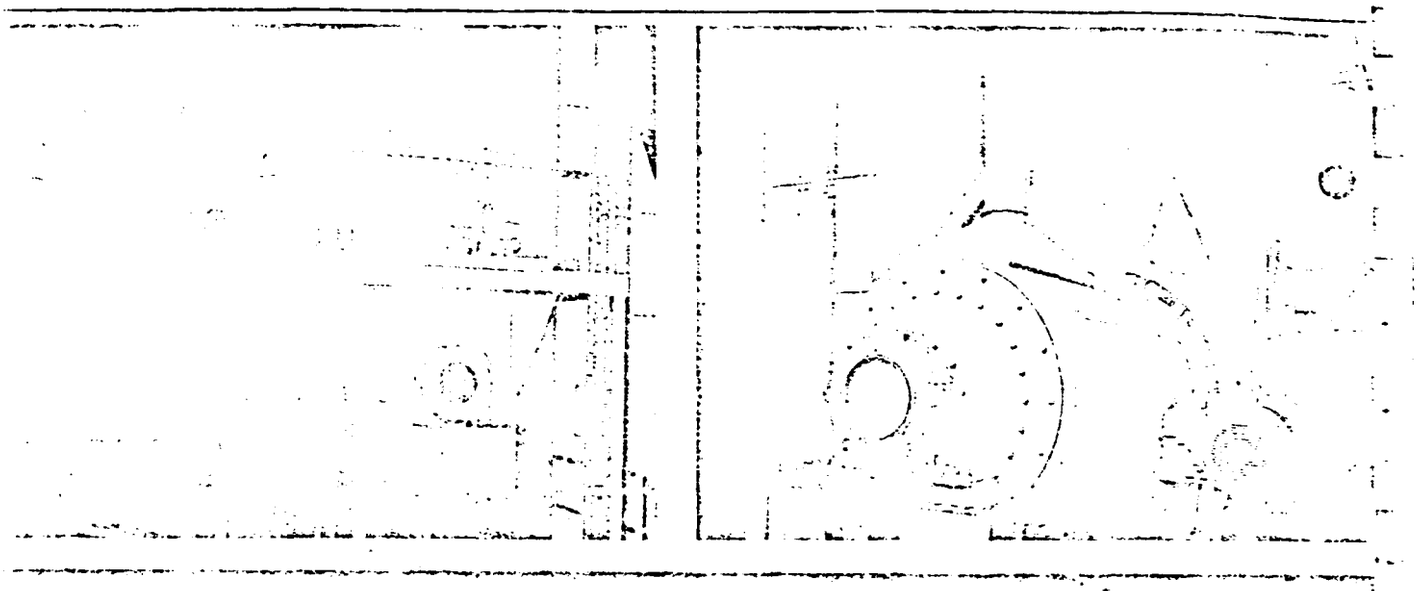
⑩ Schematische Darstellung einer vollautom. Ofenwagenbeladeanlage; diese Anlage kann auch an Pressen anderer Fabrikate vorgesehen werden

⑪ Automatische Chargenwaage für Feinmaterial

⑫ Doppelhartmühle für die Feinvermahlung

⑬ Hydraulisch-vollautomatische Doppelkolben-Roboterpresse bei der Herstellung von Magnesitsteinen; Schiebeformpressen bei der Herstellung von Teer-Magnesitsteinen





Das weitere Fertigungsprogramm unserer Abteilung Maschinenbau:

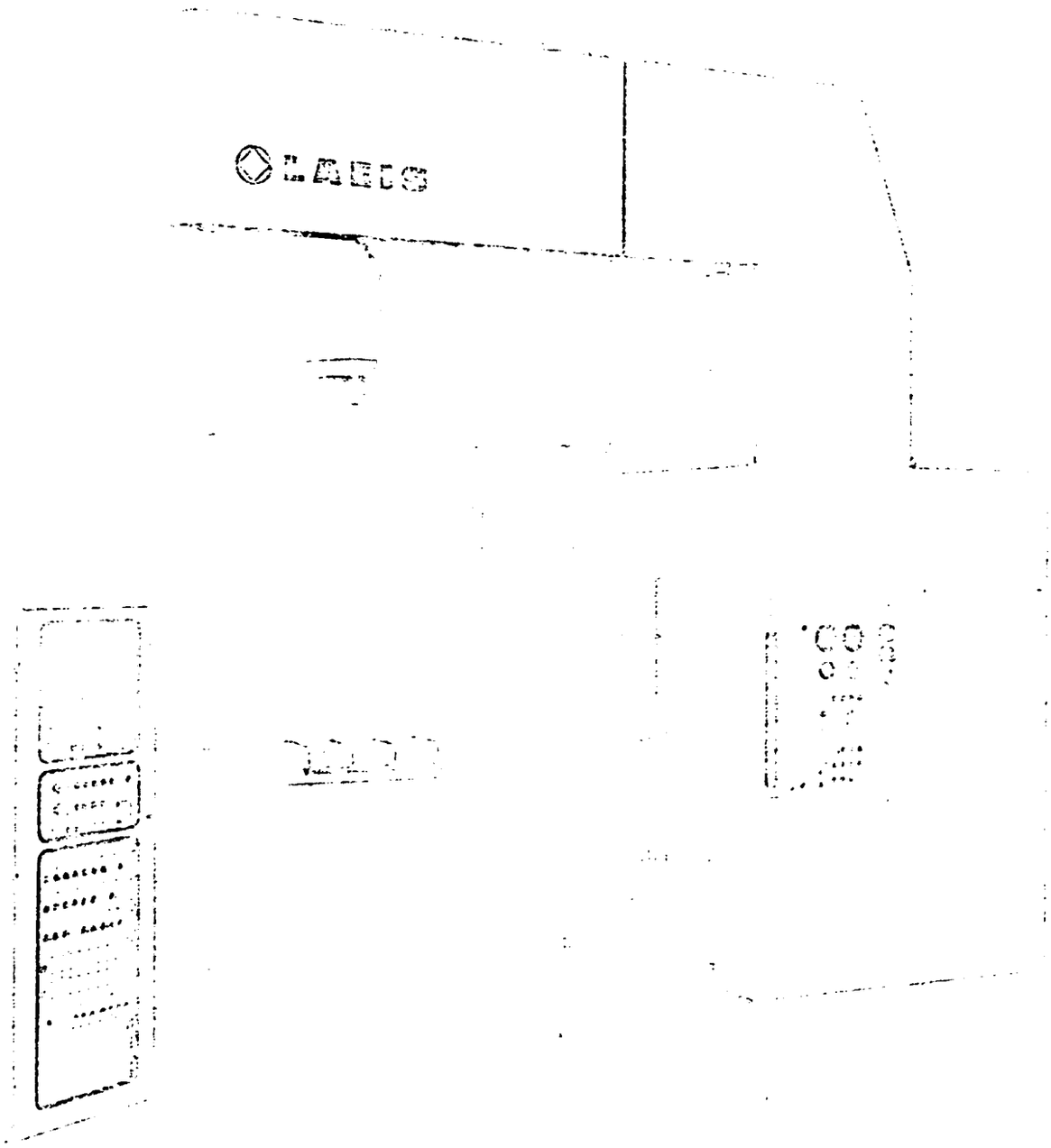
Hydraulische, halb- und vollautomatische Pressen als
ROBOTER-, Schiebeform- und Drehtischpressen
bis 2000 Mp Preßkraft zur Herstellung von:
Schamotte-, Silika-, Magnesit- und Dolomitsteinen.
Hydraulische Pressen zur Herstellung von Tellerkapseln,
KC-Platten etc.
Planeten-Zwangsmischer, Planeten-Mischkollergänge,
Tischkollergänge und sonstige Aufbereitungsmaschinen
für die Feuerfest- und Keramik-Industrie.

Hydraulische Fliesenpressen REKORD und RAPID zur Herstellung von Wand- und Fußbodenfliesen, einschichtig und zweischichtig.

Anlagen für glasierte Wand- und Bodenfliesen und für glasierte und unglasierte Mosaikplättchen in allen Formaten.

LAEIS

LAEIS-WERKE AG
55 Trier, Ostallee 3-5
Postfach 2560
Telefon (06 51) 7 68 81 (4 61 81)
Telex 04 72 871



Modernste CNC-Technik für ein
bewährtes Pressensystem

Vollautomatische Anlage zur Herstellung von teergebundenen Feuerfesterzeugnissen, bestehend aus 2 Pressen HPF 1600 mit automatischer Paletten- und Temperwagenbeladeanlage.

Die LAEIS-Werke AG in Trier,

gegründet 1860, sind bei ihren Industriepartnern weltweit durch spezielle Erfahrungen und Know-how bei der Entwicklung und Fertigung hochwertiger Spezial- und Serienpressen für die keramische und die Feuerfest-Industrie sowie durch Präzision und Zuverlässigkeit ihrer Pressen und Anlagen im härtesten täglichen Einsatz bekannt.

Aus Trier, im Herzen der EG und eingebettet in die liebliche geschichtsträchtige Landschaft der Mosel, exportieren die LAEIS-Werke AG ihre Pressen und Anlagen in die ganze Welt.

Über 120 Jahre Maschinenbau

Planung und Bau kompletter Anlagen für die Herstellung von feuerfesten Steinen aus Schamotten, Silika, Magnesit, Dolomit, Teer-Dolomit.

Ölhydraulische Pressen von 2000 bis 25000 kN Preßkraft.

Ofenwagenbeladeeinrichtungen und Setzsysteme mit frei programmierbarer Steuerung für alle Pressensysteme.

Brikettierpressen für Salz, Futtermittel, Glasgemenge, Edelerze.

Aufbereitungsmaschinen wie Planetenzwangsmischer, Mühlen, Dosieranlagen, Materialaufheiztrommeln. Teerimprägnieranlagen.

Ölhydraulische Pressen von 1000 bis 13500 kN für keramische Wand- und Bodenfliesen, Mosaik.

Hydraulisch-automatische Pressen von 6500 kN mit Putz- und Stapelmaschinen zur Herstellung von Geschirrteilen aus Porzellan, Steinzeug und Steingut im Trockenpreßverfahren.

Rohreinziehpressen von 300 bis 7500 kN sowie komplette Anlagen zum halb- oder vollautomatischen Kaltumformen und Warmanstauchen von Rohr- und Stabenden.

Weichenbau (Werk Ruwer) Lieferant der DB

Gleisanlagen, Weichen, Kreuzungen, Gleisverbindungen, Anschlußgleise für Haupt-, Neben- und Kleinbahnen. Industriewerke, Bergbau über und unter Tage, Bauindustrie und Straßenbahnen.

LAEIS

LAEIS-WERKE AG
Ostallee 3-5, D-5500 Trier
Postfach: 2560
Telefon: (06 51) 4 65-1, Telex: 4 72 871

11.1.83

LAEIS

HPF-Doppeldruck-Hochleistungs-Pressen (DBP) bis 25000 kN Preßkraft

HPF-Pressen

- haben ein robustes, auf lange Lebensdauer konstruiertes Pressengestell,
- alle Hydraulikzylinder im Oberholm, d. h. außerhalb der Schmutzzonen
- erfordern keinen Pressenkeller
- erfüllen höchste Ansprüche an Leistung, Qualität und Maßhaltigkeit der gepreßten Produkte durch die digitale Steindicken-Meß- und Füllhöhen-Regeleinrichtung (DBP)
- haben ein kompaktes, wartungsfreundliches Ölaggregat mit schallgedämmten Pumpen, Feinstfilterung und automatischer Heizung/Kühlung des Betriebsmediums
- sind mit elektrischen Steuerungen und Kontrollen ausgerüstet, welche den Kundenwünschen und örtlichen Gegebenheiten optimal angepaßt werden können
- haben speicherprogrammierbare Steuerungen
- digitale, kontaktlose Steuerung aller vertikalen und horizontalen Bewegungen – keine Endschalter
- elektronische Druckmessung mit digitaler Anzeige
- können nach wie vor auch noch mit konventioneller Schützensteuerung und Endschaltern geliefert werden
- haben viele Zusatzeinrichtungen, welche die Arbeit erleichtern

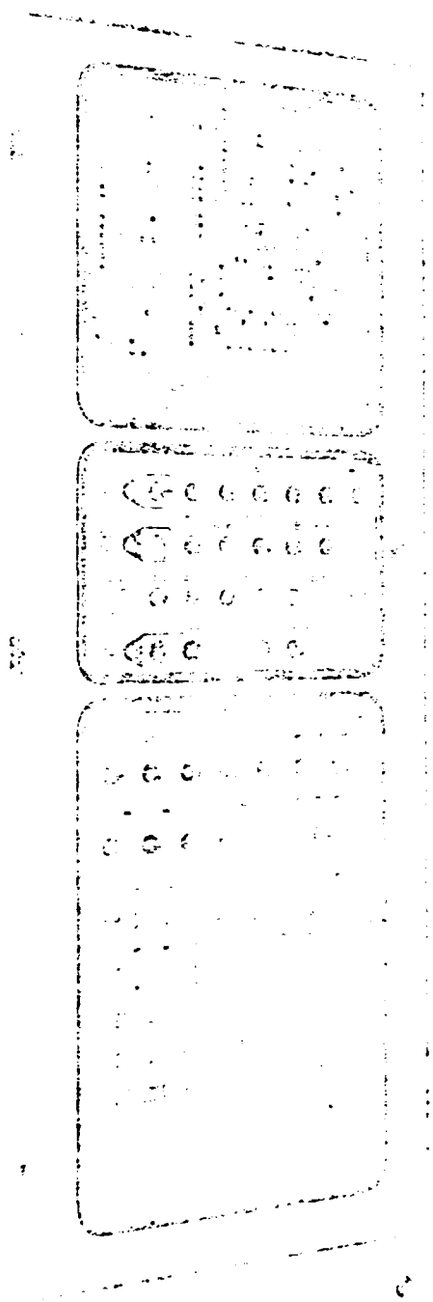
  z. B. hydraulische Schnellwechselvorrichtung für Formen und Stempel

  Schnellspannvorrichtungen für Formen und Stempel

  Steingreifer für die verschiedensten Preßprodukte

  Vakuumgreifer, insbesonders für großformatige Platten

- Automatische Ölsprühvorrichtungen zum Einsprühen der Preßform und der Preßstempel sowie eine automatische Zentralfettschmierung mit elektronischer Überwachung gehören ebenfalls zur Grundausstattung aller HPF-Pressen



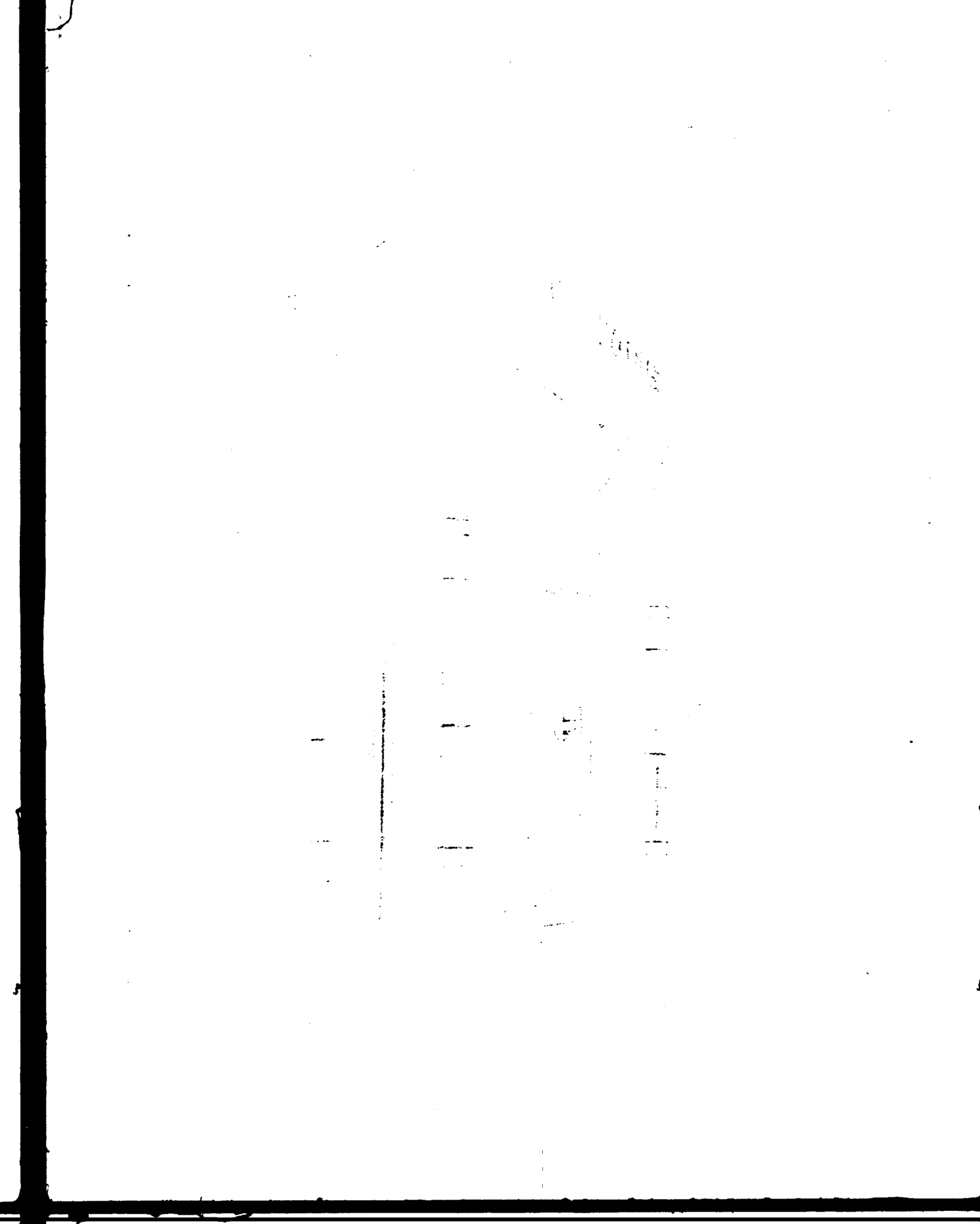
Steuerschrank mit speicherprogrammierbarer Steuerung unter Verwendung von SIMATIC-S5-Baugruppen und Mikroprozessoren

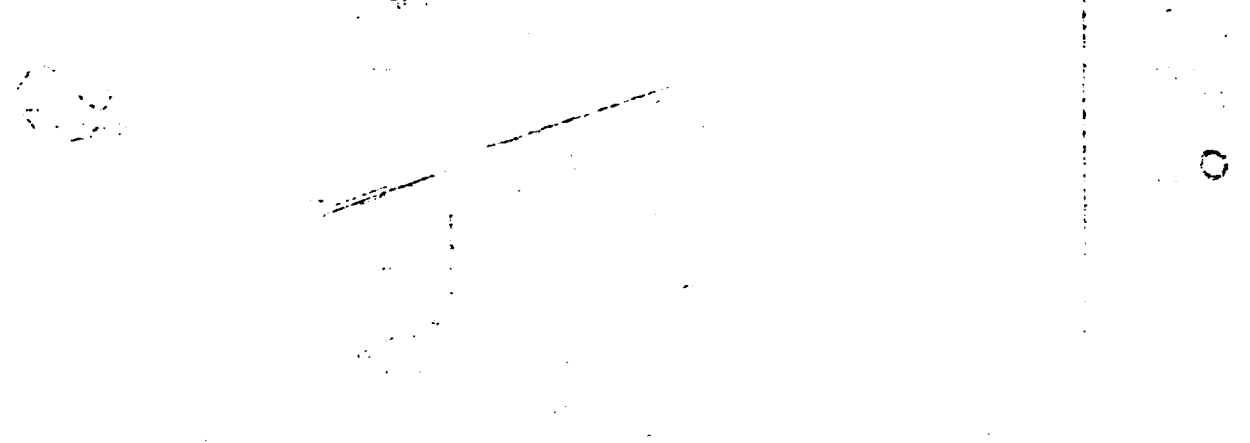
1 Bedienfeld mit Funktionsanzeige- und Programmschritt-Anzeige

2 [illegible]

3 [illegible]

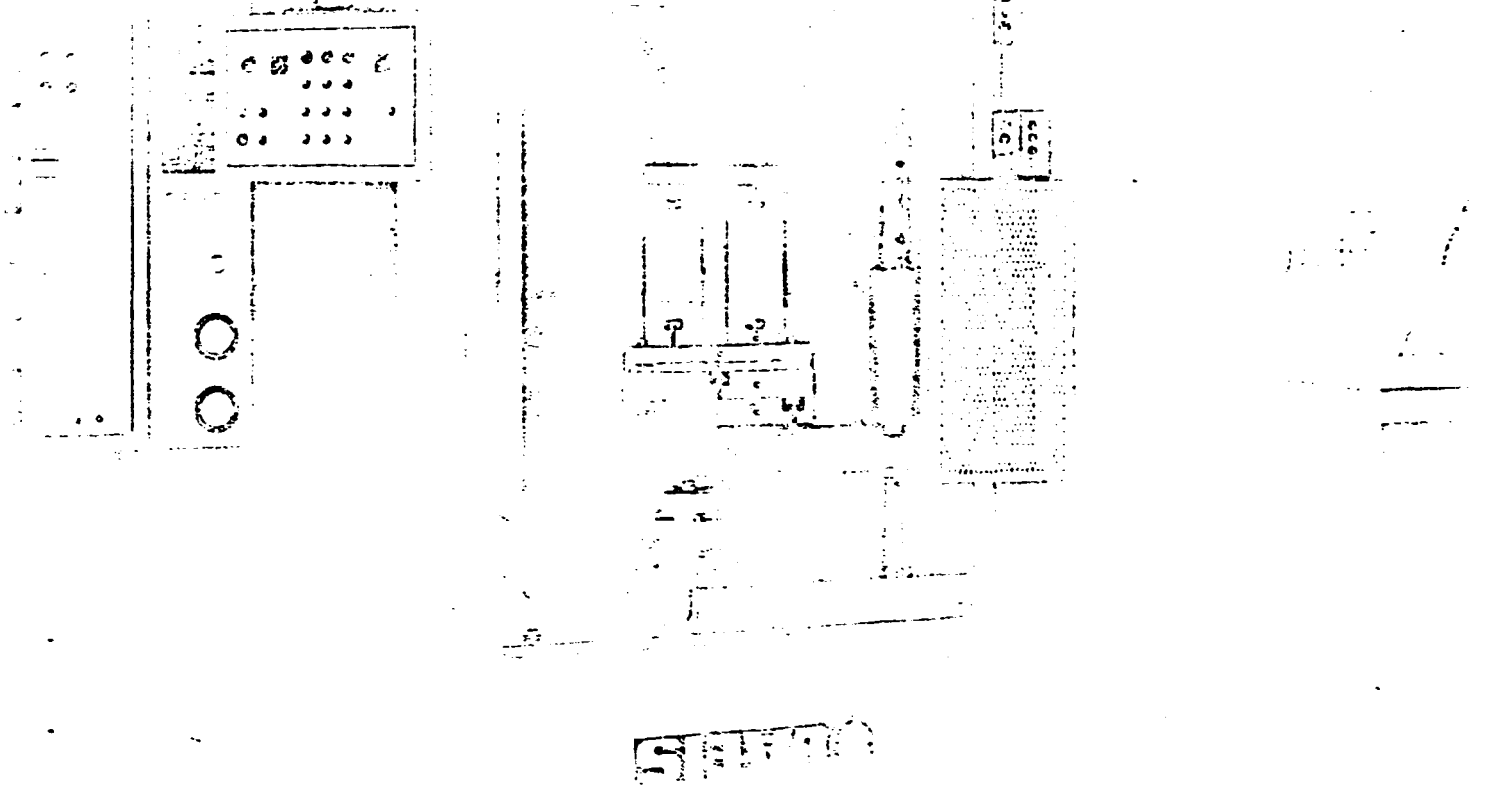
4 [illegible]





Technische Daten		HPF		200	200 S	300	300 S	400	400 S	630	630 S
Ø des Preßkolbens		mm		260/260	260/260	350/335	350/335	400/355	400/385	500/485	500/485
Betriebshochdruck		bar		325	325	315	315	320	320	325	325
Preßkraft		kN		2000	2000	3000	3000	4000	4000	6300	6300
Ausstoßkraft		kN		300	300	400	400	500	500	1000	1000
Füllhöhe		mm		300	300	300	300	500	500	500	500
maximales Formeneinbaumaß		mm		630/550	1250/550	630/550	1250/550	700/600	1250/550	930/600	1280/650
elektrischer Anschlußwert		kW		27	27	30	30	38	38	70	70
erforderliche Menge Hydrauliköl für eine Tankfüllung ca.		l		600	600	1150	1150	1150	1150	1300	1300
Kühlwasserbedarf bei 25° C Kühlwassereingangstemperatur ca.		m^3/h		0,5 - 1	0,5 - 1	0,5 - 1	0,5 - 1	0,5 - 1	0,5 - 1	0,5 - 1	0,5 - 1
erforderlicher Mindestluftdruck 5 bar, Preßluftbedarf hierbei ca.		l/min.		40	40	40	40	40	40	50	50
Praktische Leistung in Pressg./min. bis zu:				6	6	6	6	6	6	6	6
Abmessungen:	A	mm		1400	1980	1600	2200	1700	2000	2000	2350
	C	mm		1050	1150	1000	1150	1200	1250	1300	1560
	H	mm		3300	3500	3500	3800	3850	3900	4500	5400

Maße und Abbildung unverbindlich



Baureihe HPF 200—630 in Rahmenkonstruktion

Zur Herstellung von:

Normal- und Formsteinen, keramisch-, chemisch- und teergebunden, U- und Viereck-Kapseln, Brennunterlagen und Aufbau-Stützen für Ofenwagen sowie in Sonderausführung für Salzlecksteine mit hohem spezifischem Preßdruck.

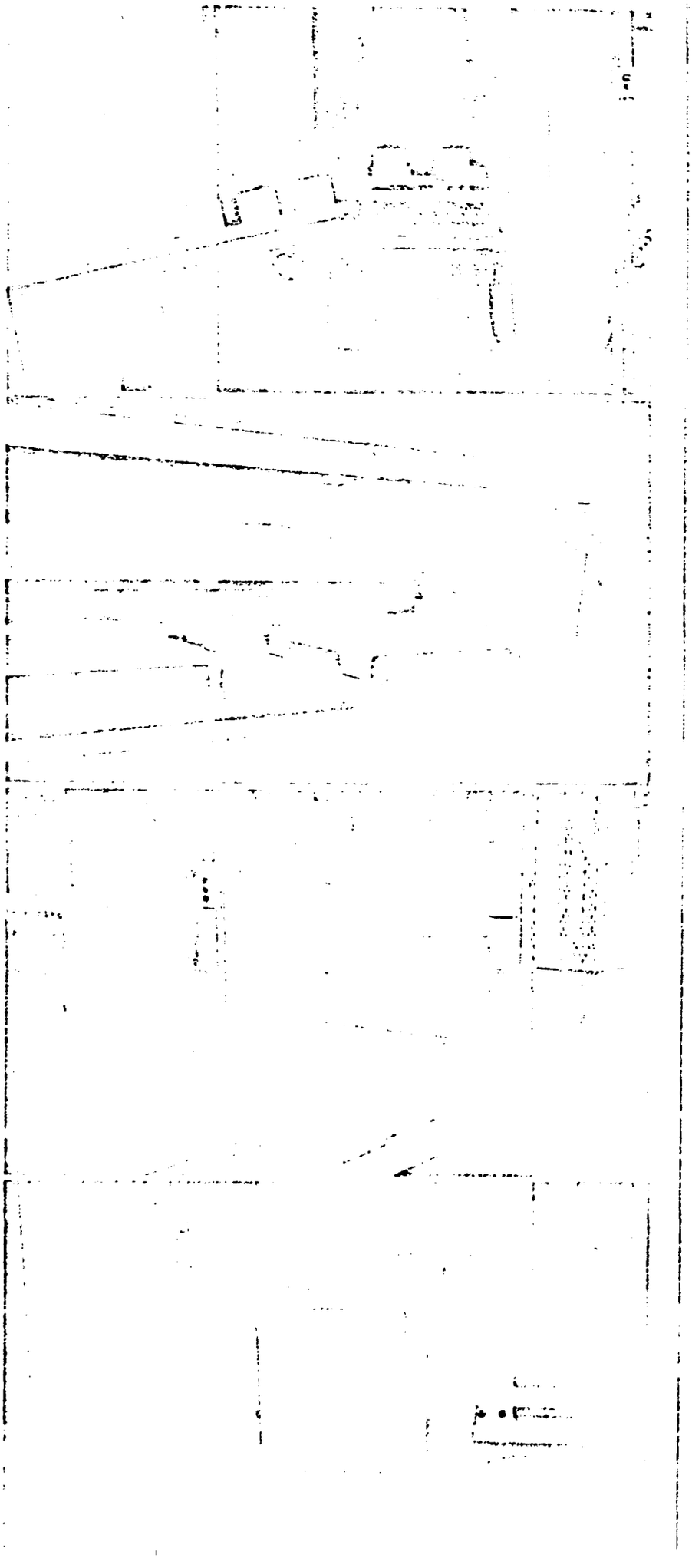
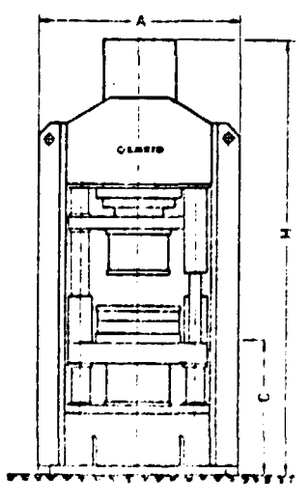


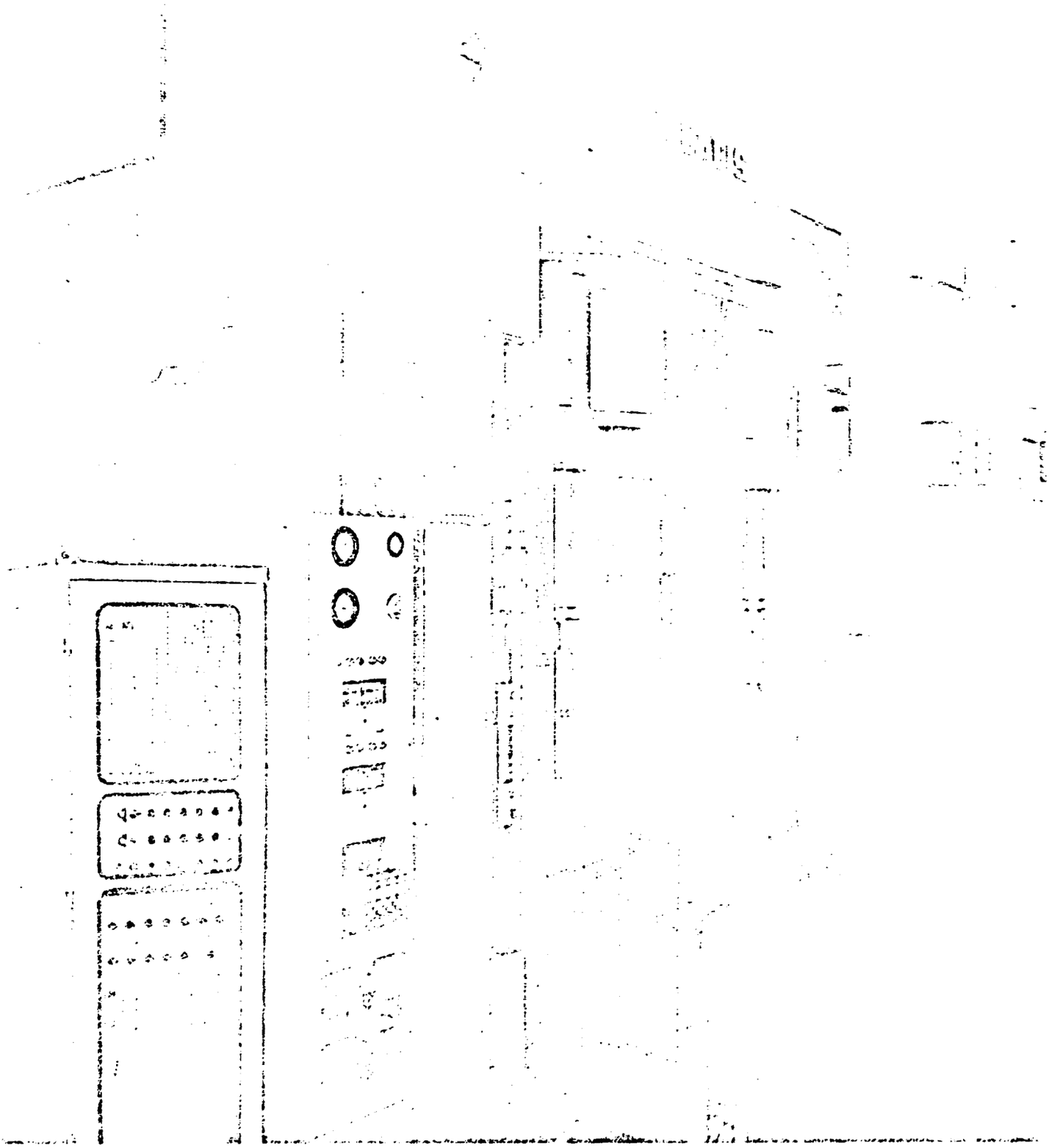
Abb. 1
HPF 630 bei der Herstellung von 5-kg-Salzlecksteinen

Abb. 2
HPF 400 bei der Herstellung von U-Kapseln

Abb. 3
HPF 400 bei der Herstellung von Brennunterlagen

Abb. 4
HPF 630 bei der Herstellung von Aufbau-Stützen für Ofenwagen

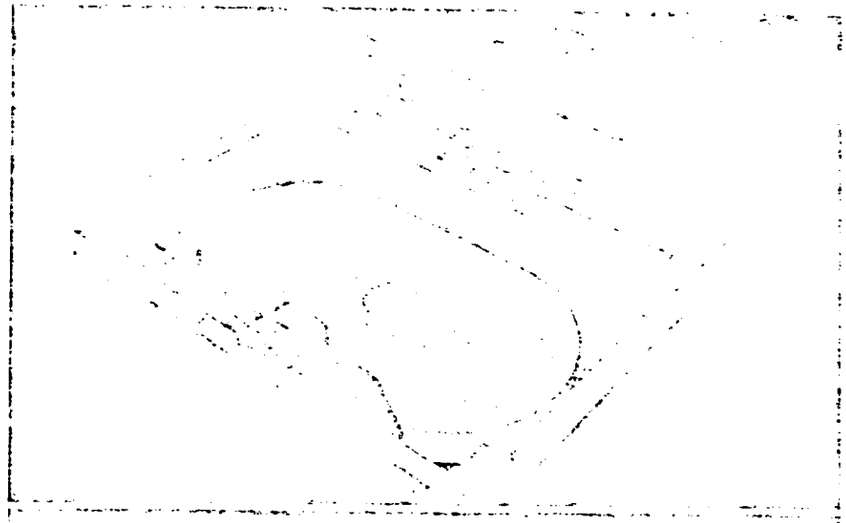


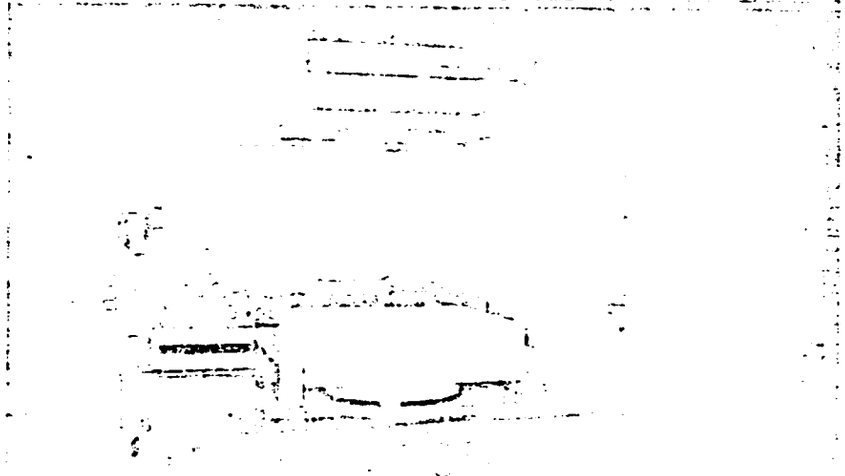


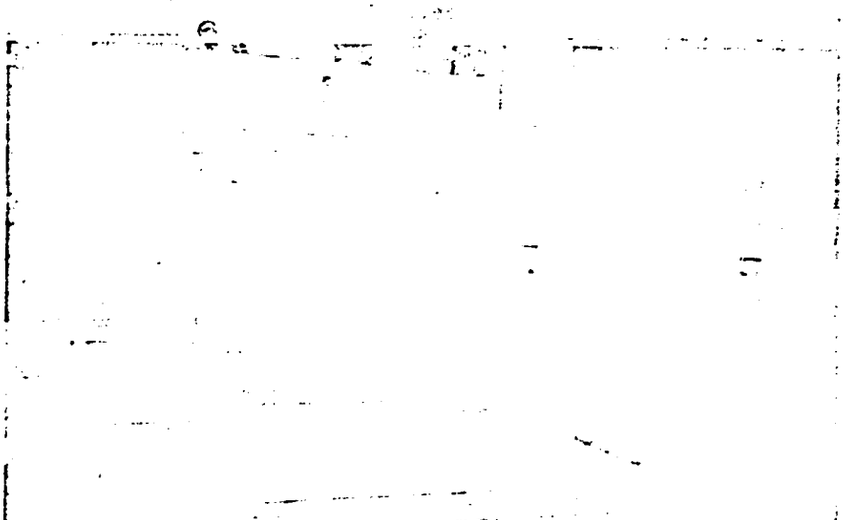
Technische Daten	HPF	800	800 S	900	1000	1250	1600	1600 S	2000	2500
Ø des Preßkolbens:	mm	560/530	560/530	630/570	630/600	700/670	800/775	900/780	900/870	1000/970
Betriebshochdruck:	bar	325	325	320	320	325	320	255	315	320
Preßkraft:	kN	8000	8000	9000	10000	12500	16000	16000	20000	25000
Ausstoßkraft:	kN	800	800	900	1000	1250	1600	1600	2000	2500
Fußhöhe:	mm	500	500	500	500	500	500	800	500	500
maximales Formeneinbaumaß:	mm	1020/800	1400/800	1050/850	1050/850	1220/950	1250/1060	1000/950	1320/1050	1500/1050
elektrischer Anschlußwert:	kW	80	80	80	95	117	123	125	150	184
Säulenmittenabstand	mm	1300/650	1600/850	1400/850	1400/850	1600/1000	1700/1000	2200/1480	1800/1200	2000/1300
erforderl. Menge Hydrauliköl für eine Tankfüllung ca.	l	2100	2100	2100	2500	2800	3500	3100	4000	4500
Kühlwasserbedarf bei 25 °C Kühlwasser-Eingangstemperatur ca.	m³/h	1–2	1–2	1–2	1–2	1–2	1,5–2,5	2–4	1,5–2,5	1,5–2,5
erforderlicher Mindestölfluß 5 bar, Preßluftbedarf hierbei ca.	l/min.	50	50	50	60	60	70	70	70	70
Praktische Leistung in Preßg./min bei zu:		5,5	5,5	5,5	5,5	5,0	4,5	3	4,0	3,5
Abmessungen H	mm	5500	4300	5500	5500	6000	6200	7300	6700	8000
Abmessungen C	mm	1410	1150	1180	1180	1710	1900	2400	2000	2400

Baureihe HPF 800–2500 in Viersäulenkonstruktion

Zur Herstellung von Normal-, Form- und Konvertersteinen, keramisch-, chemisch- oder teergebunden, Glaswannensteinen, Schieberplatten, großformatigen Brennunterlagen.







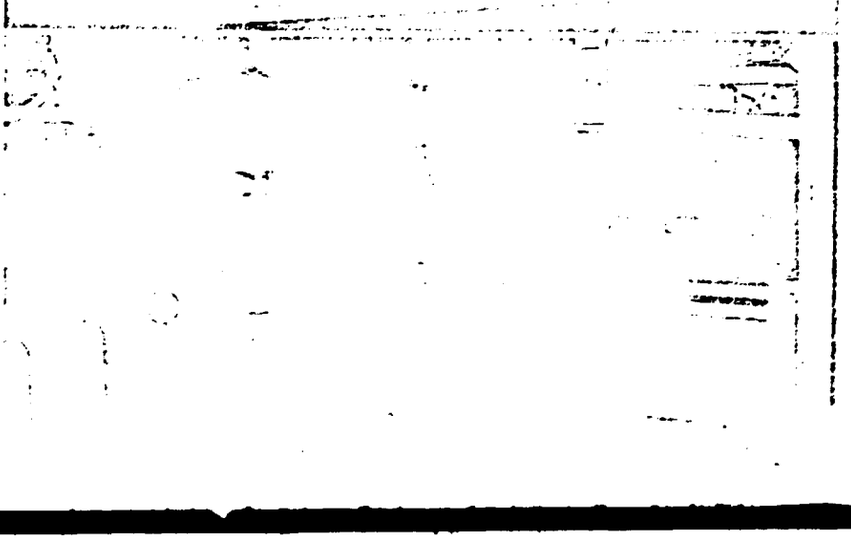
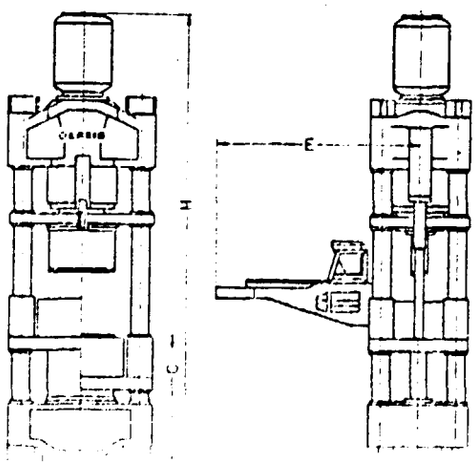


Abb. 1
Schieberplatte mit eingepreßtem Ausgußloch, ausgetragen mittels Spezialgreifer

Abb. 2
Pfannenlochstein, bereitstehend zur Abnahme

Abb. 3
großformatige Brennunterlagen, hergestellt mit hohem spezifischen Preßdruck und Oberstempel-Vibration, vor der Abnahme mit Vakuum-Saugkissen

Abb. 4
Auf den Keil gepreßte, teergebundene Konvertersteine in Doppelform, auf dem Ablagetisch, zur Übergabe in den Steinsetzautomaten



Technische Daten		HPF	150 A	200 SR	200 R	300 SR	300 R	400 SR	400 R	630 SR	630 R
Ø des Preßkolbens:		mm	250/250	260/260	260/260	350/335	350/335	400/385	400/385	500/485	500/485
Betriebshochdruck:		bar	310	325	325	315	320	320	325	325	325
Preßkraft:		kN	1500	2000	2000	3000	3000	4000	4000	6300	6300
Ausstoßkraft:		kN	300	500	500	600	600	1000	1000	1300	1300
Fallhöhe:		mm	200	700	700	700	700	700	700	700	700
maximales Formeneinbaumaß:		mm	Ø 350	630/550	630/550	630/550	650/550	700/600	700/600	930/600	930/600
elektrischer Anschlußwert:		kW	20	30	42	36	46	45	50	70	70
erforderl. Menge Hydrauliköl für eine Tankfüllung ca.		l	300	600	600	1150	1150	1300	1300	1800	1800
Kühlwasserbedarf bei 25 °C Kühlwasser-Eingangstemperatur ca.		m³/h	0,2–0,5	0,5–1	0,5–1	0,5–1	0,5–1,5	0,5–1,5	0,5–1,5	0,5–1,5	0,5–1,5
erforderlicher Mindestfülldruck 5 bar, Preßfüllvolumen hierbei ca.		l/min.	40	50	50	50	50	50	50	50	50
Praktische Leistung in Preßg./min bis zu:			2	3	3	3	3	3	3	3	3
Abmessungen:	A	mm	1000	1550	1550	1600	1600	1700	1700	2000	2000
	C	mm	600	1650	1050	1850	1650	1680	1680	1790	1790
	H	mm	2115	5700	5700	5360	5360	5360	5360	5900	5900
	T	mm	–	–	1760	–	1760	–	1760	–	1700

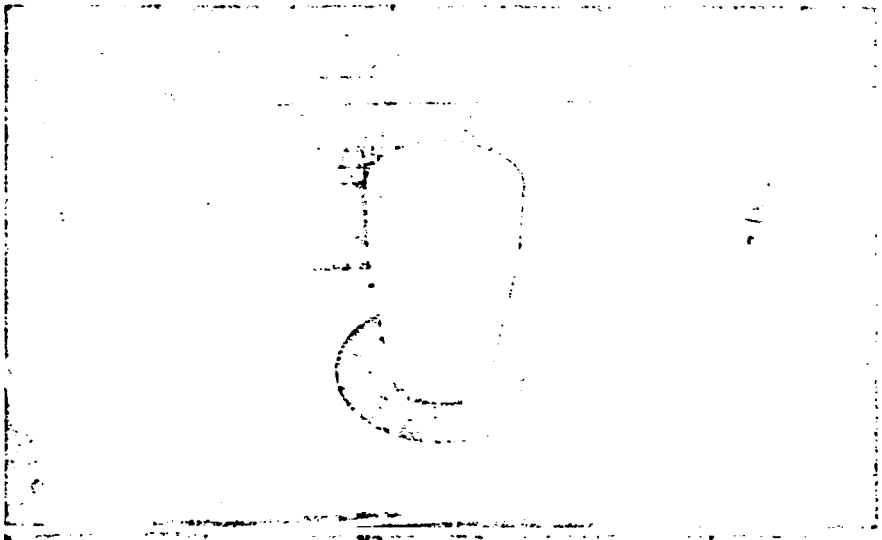
Sonder-Baureihe
HPF 150–630 (SR, R, A)

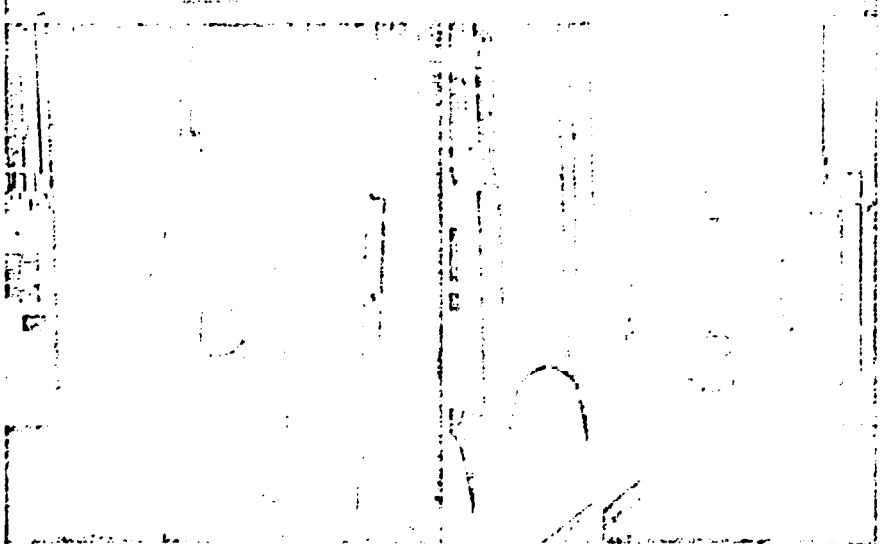
HPF–SR: für Stopfenstangenrohre SR 4–SR 6

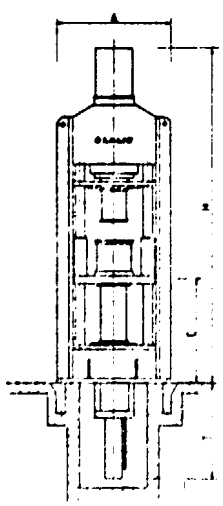
HPF–R: für Stopfenstangenrohre SR 0–SR 6, Stopfen mit und ohne Gewinde, Hülsen und Ausgüsse sowie dünnwandige Kaminrohre

HPF–A: für Düsen und kleine Ausgüsse

Auf allen Pressen der HPF-Sonder-Baureihe kann auch das normale ff-Steinprogramm produziert werden







Hydraulische HPF-Pressen der Sonder-Baureihe bei der Herstellung von Stahlwerks-Verschleißmaterial

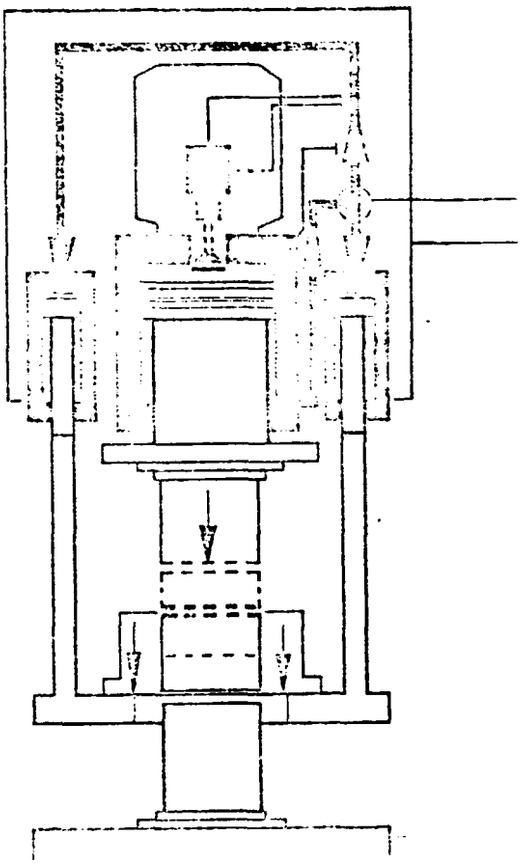
Abb. 1
HPF 400-R, Ausguß 8A in ausgestoßener Stellung vor der Abnahme

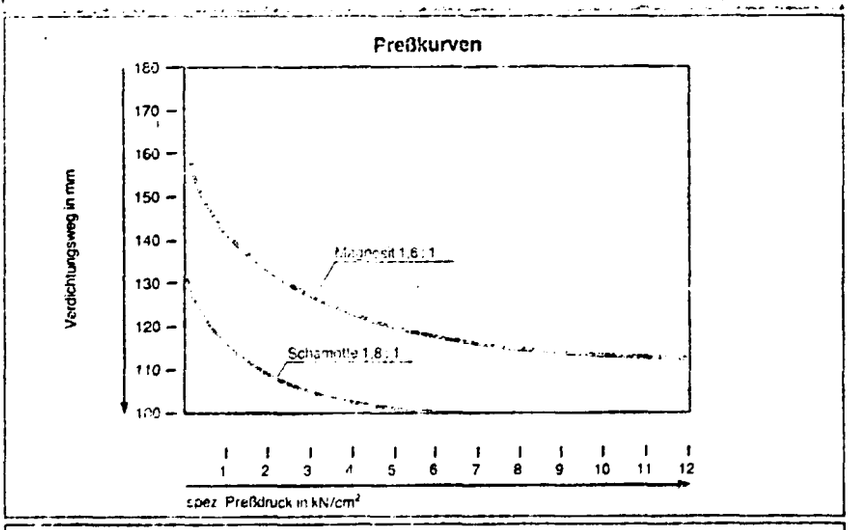
Abb. 2
HPF 400-R, Ausguß 6A in ausgestoßener Stellung vor der Abnahme

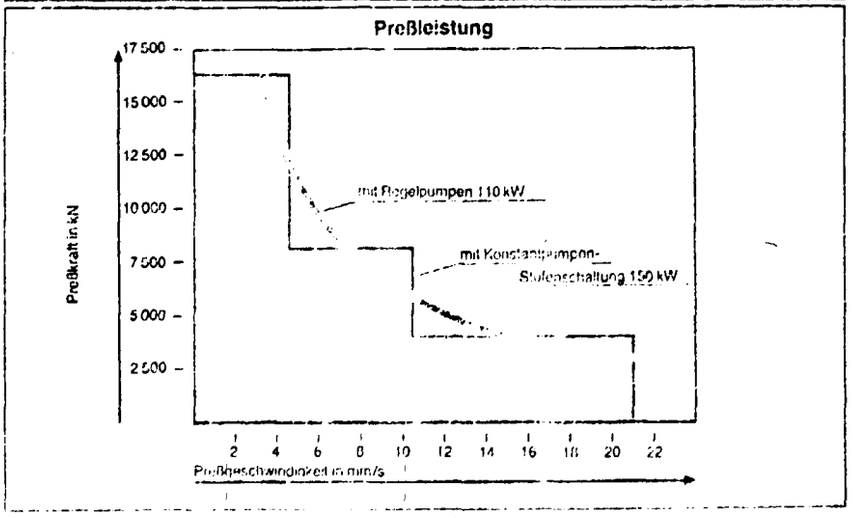
Abb. 3
HPF 400-R, Ausgüsse 6A, nach dem Ausstoßen um 180 Grad gedreht, auf dem Abnahmeband

Abb. 4
HPF 400-R, Stopfen S6 mit Innengewinde, nach dem Ausstoßen um 180 Grad gedreht, auf dem Abnahmeband

HPF-Preßsystem







Preßtechnik

HPF-Pressen arbeiten nach dem bewährten Doppeldruckprinzip (DBP) mit nur **einem** im oberen Holm der Presse angeordneten **Hauptpreßzylinder.** Zwei, ebenfalls oben angeordnete **Form-Verschiebezylinder** bewegen die Preßform mit halber Oberstempelgeschwindigkeit nach unten, sobald der Oberstempel die gefüllte Preßform geschlossen hat, so daß dann der bewegte Oberstempel und der auf dem Unterholm befestigte, unbewegte Unterstempel **mit gleicher Geschwindigkeit in die Form eindringen** und eine von beiden Seiten **gleichmäßige Verdichtung** bewirken.

Für spezielle Bedarfsfälle können der Beginn des Formabsenkens und die Geschwindigkeit über Wahlschalter im Steuerschrank der Presse verändert werden, wodurch eine gewollte Verschiebung der neutralen Zone erreicht werden kann.

Je nach Erfordernis können bei der Normalausführung **bis zu drei Entlüftungshübe** vorgewählt werden, wobei die Kombination von druck- und/oder wegabhängigen Entlüftungen beliebig variiert werden kann. Die Dauer jeder Entlüftung ist über Zeitschalter einstellbar. Die jeder Entlüftung folgende Preßkraftstufe kann ebenfalls entsprechend den Erfordernissen der Preßmasse und des herzustellenden Produkts beliebig eingestellt werden.

Das **HPF-Doppeldruckprinzip** im Zusammenhang mit den **stufenlos regelbaren Axialkolbenpumpen** gewährleistet **beste Preßergebnisse bei niedrigem Energieverbrauch,** da sich Förderstrom und Druck der stufenlos regelbaren Axialkolbenpumpen optimal der Verdichtungscharakteristik der Preßmasse anpassen.

Um eine möglichst **lange Lebensdauer der Formausfütterung** zu erreichen, kann bei jeder Entlüftung die Form in vertikaler Richtung bewegt werden. Hierdurch erfolgt jeweils eine Verlagerung der Preßzone, so daß der Verschleiß der Futterplatten über einen großen Bereich verteilt wird.

Hydraulik

Alle HPF-Pressen haben **ölhydraulische Antriebsaggregate.** Der Hauptöltank ist als **Zweikammertank** mit Rücklauföl- und Saugölkammer gebaut.

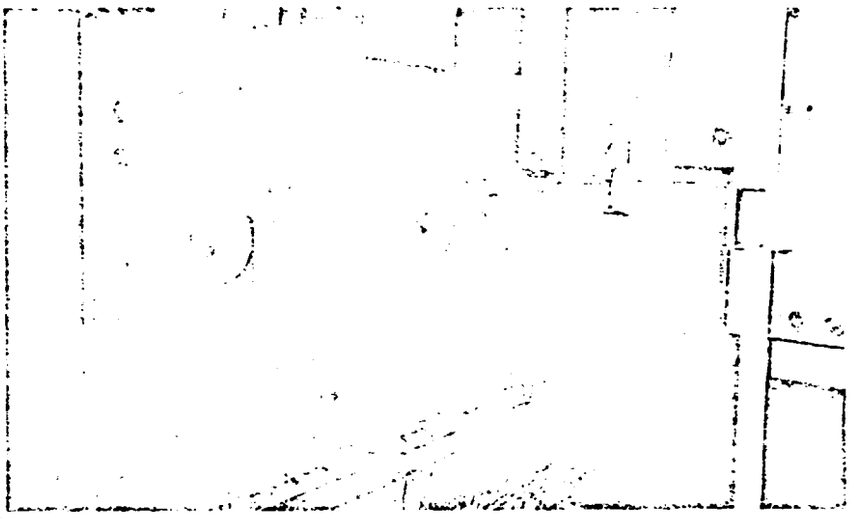
Eine reichlich dimensionierte **Umwälzpumpe** fördert das Rücklauföl ständig über **Hochleistungsfilter** mit Feinstfilterung und für extrem niedrigen Wasserdurchsatz ausgelegte **Wasser/Ölkühler** in den Saugraum der Hochdruck-Axialkolbenpumpen.

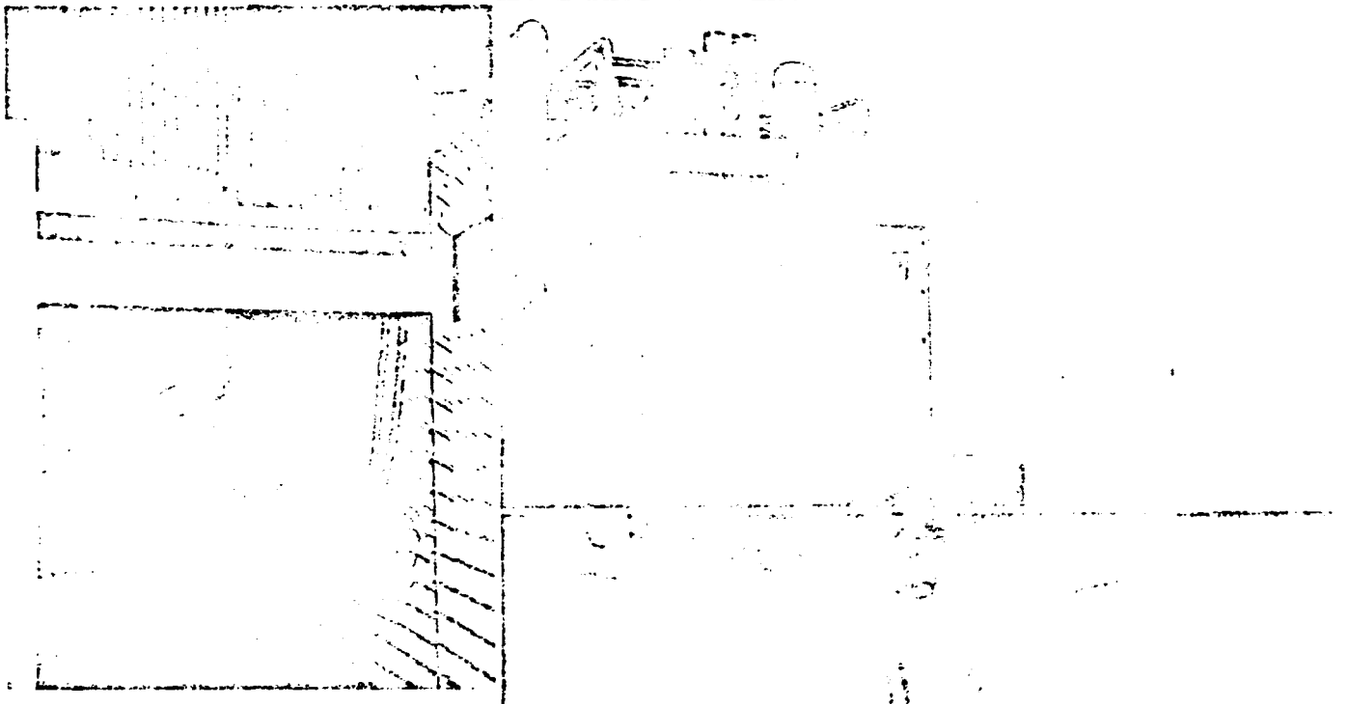
Die **stufenlos regelbaren Axialkolbenpumpen** haben sich in jahrelangem, härtesten Einsatz in der ff-Industrie bewährt. Durch die **stufenlose Regelung** passen sich diese **leistungsgeregelten Pumpen** der Verdichtungskurve der verschiedenen ff-Materialien an. Die Anordnung der Pumpen außerhalb des Öltanks gewährleistet **beste Zugänglichkeit** für Wartungsarbeiten und **leichte Austauschbarkeit** in Reparaturfällen, **ohne** daß das Hydrauliköl aus dem Tank abgelassen werden muß.

Die Vorschriften der **U.V.V.-Lärm** werden durch entsprechende Maßnahmen berücksichtigt und die **zulässige Grenzkurve mit Sicherheit unterschritten.**

Die gesamte **Ventilsteuerung**, welche dem neuesten Stand der Technik entspricht, ist als **Kompakt-Block-System leicht zugänglich** oben auf dem Öltank montiert.

Dieses bewährte, ständig weiter verbesserte Hydrauliksystem, welches selbstverständlich auch alle notwendigen Geräte zur automatischen Überwachung von Öltemperatur, Ölmangel, Anlaufsperre, Feinstfilterung, Kühlsystem usw. beinhaltet, garantiert **niedrigen Verschleiß** und damit **lange Lebensdauer** der verschiedenen Maschinen- und Steuerungskomponenten.





Optimale Abstimmung von Öldruck, Durchflußmenge, Schaltfunktionen und Schaltzeiten gewährleisten ein ruhiges, stoßfreies Arbeiten des ganzen Pressensystems mit genauer Wiederholbarkeit des vorgewählten Funktionsablaufes.

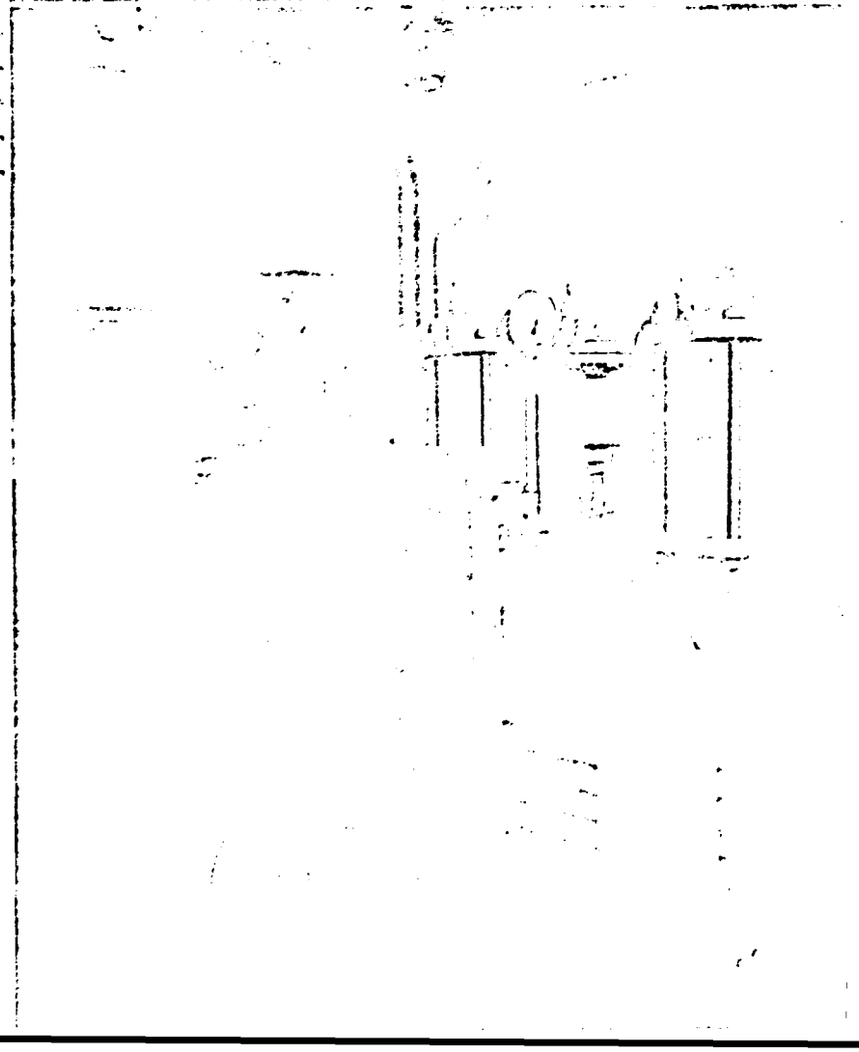


Abb. 1
Ventilblöcke auf einem Bohrwerk

Abb. 2
Ölhydraulisches Antriebsaggregat (Pumpenanordnung neben dem Öltank) mit Schallschutzisolierung

Abb. 3
Anordnung der Umwälzpumpe sowie der Kühl-, und Filtereinrichtung an der Seitenwand des Öltanks

Abb. 4
Außerhalb des Öltanks angeordnete Axial-Kolbenpumpe in einer gedämmten Schallschutzkabine

Elektrik

Alle HPF-Pressen können ausgerüstet werden mit:

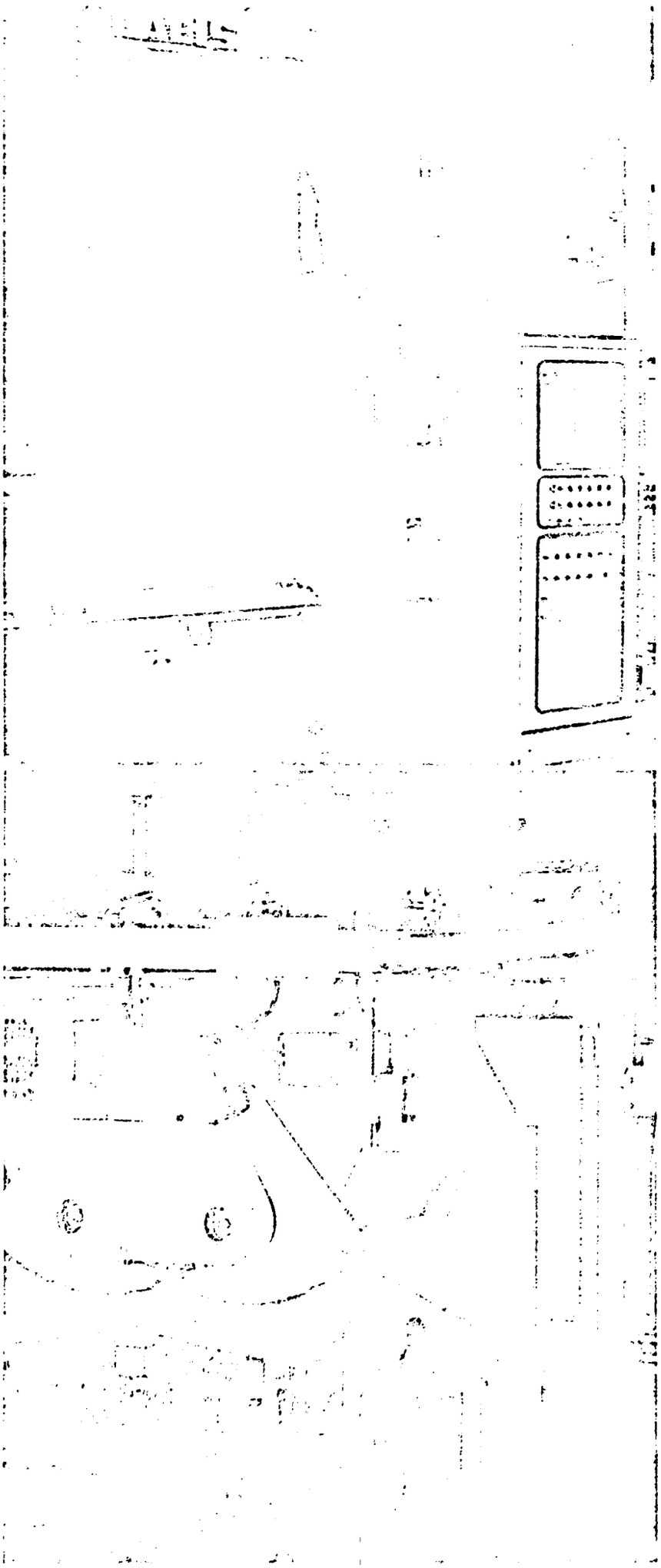
- speicherprogrammierbarer Steuerung
- elektronischer Druckmessung und digitaler Anzeige
- digitaler, kontaktloser Steuerung für Wegerfassung von Oberstempel, Preßform und Füllschieber
- in Verbindung hiermit elektronisch-digitale Steindickenmeß- u. Füllhöhen-Regeleinrichtung

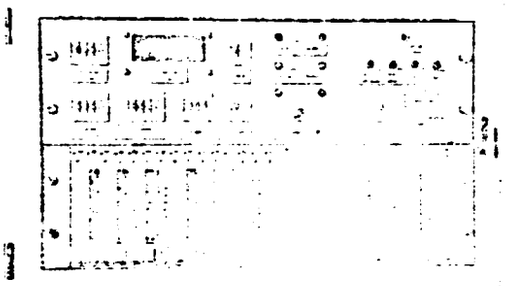
Abb. 1: HPF 800 bei der Produktion von Brennunterlagen. Abnahme mittels Vakuumgreifer

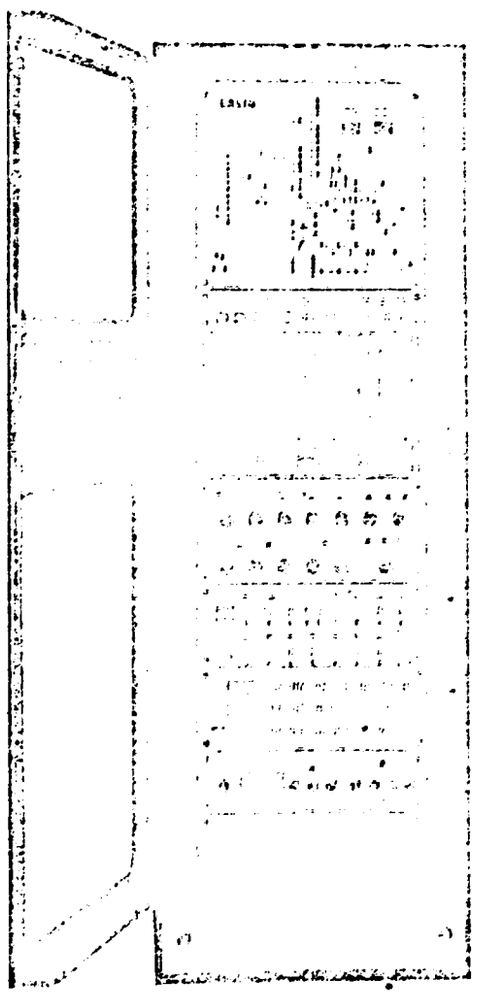
Abb. 2: Automatisch-volumetrische Formfüllvorrichtung für Doppelform

Abb. 3: Digitale Steindicken-Meß- und Füllhöhen-Regeleinrichtung, zum nachträglichen Anbau an vorhandene Pressen

Abb. 4: Steuerschrank mit speicherprogrammierbarer Steuerung, hier mit Einbau für die elektronische Druckmessung mit digitaler Anzeige (vergleiche auch Bild S. 2)







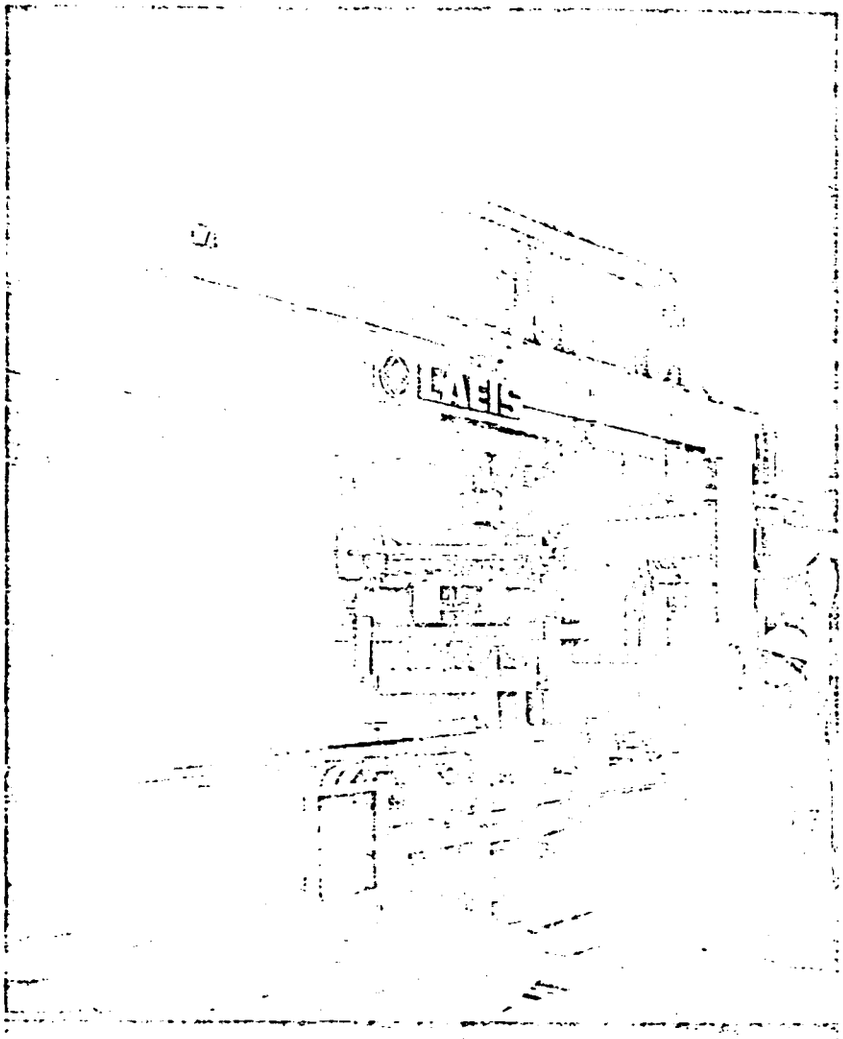
Ofenwagen-Beladeanlagen, Setzanlagen

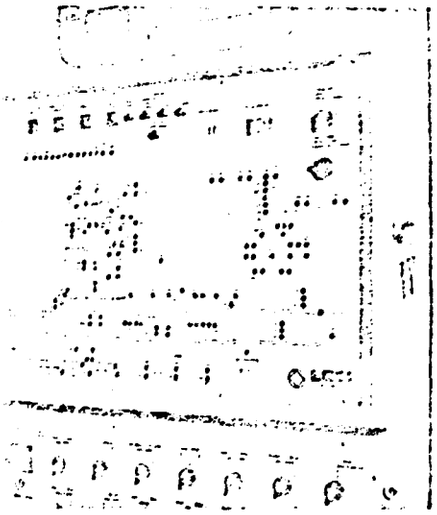
Vollautomatische Beladeeinrichtungen für Tunnelofen-, Temperofenwagen und Paletten als präzise arbeitende vollelektronisch gesteuerte Einheiten

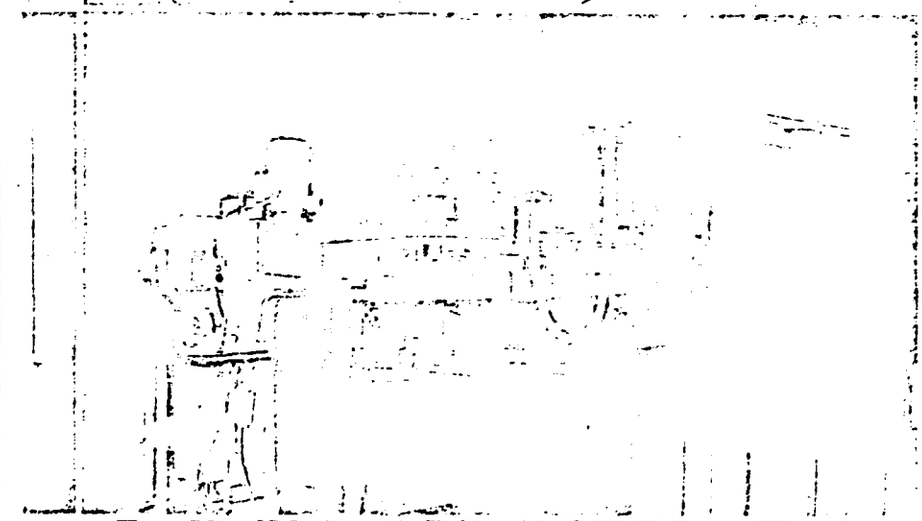
- zum Anbau an neue bzw. bereits vorhandene Pressen
- geeignet für vielfältige Setzprogramme der verschiedensten Steinformate

Besondere Vorteile

- Arbeitserleichterung
- Personaleinsparung
- kurzfristige Amortisation







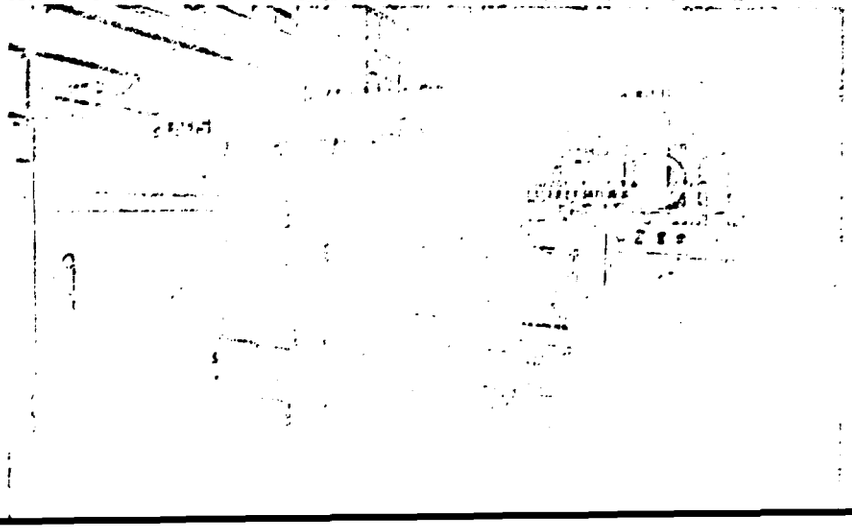
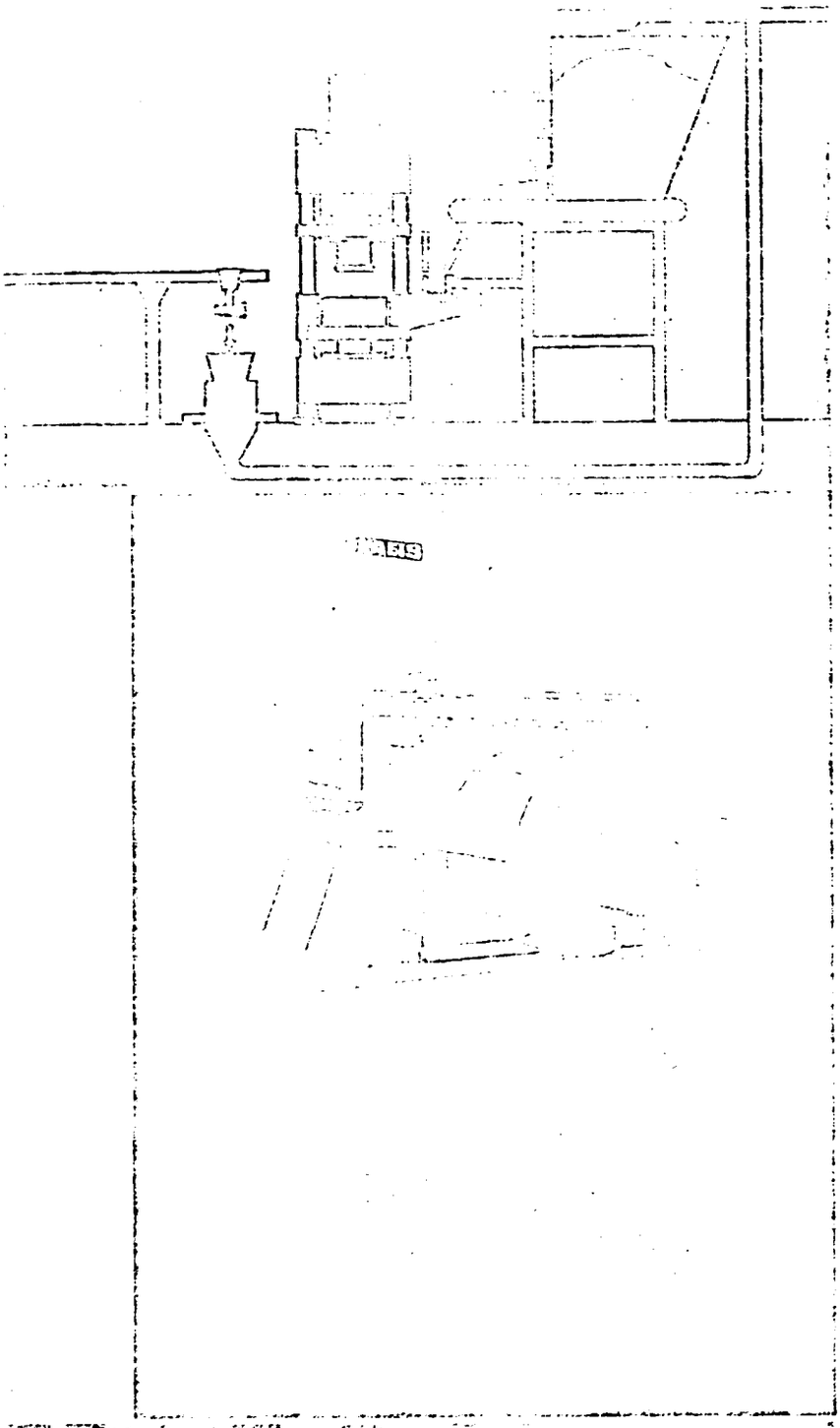


Abb. 1
Automatisches Laden von teergebundenen Konvertersteinen auf Paletten, bestimmt zum direkten Einbau in den Konverter

Abb. 2
Hochkantsetzen von teergebundenen Konvertersteinen auf Temperpaletten

Abb. 3
Beladen eines Tunnelofenwagens mit keramisch gebundenen Steinen

Abb. 4
Steuerschrank einer Setzanlage mit speicherprogrammierbarer Steuerung und Leuchtschaltbild



Recycling

Wiedergewinnung des Materials durch sofortiges **Granulieren von Ausschußsteinen** und direkter Rückführung des Mahlgutes in den Formgebungsprozeß.

Trotz modernster Preßtechnik mit elektronischen digitalen Steindickenmeß- und Füllhöhen-Regeleinrichtungen läßt es sich nicht 100 %ig vermeiden, daß auch Steine außerhalb der noch zulässigen Dickentoleranz gepreßt werden. Die Ursachen sind meistens Schwankungen der Kornfraktion, der Feuchte oder Temperatur von Charge zu Charge.

Solche Steine werden von der elektronischen Dickenkontrolle der Pressensteuerung erkannt und als Ausschuß dem Granulator zugeführt, von diesem in zwei Stufen zerkleinert und über ein Becherwerk in einen Vorratsbehälter gefördert, von wo aus das Granulat der frischen Preßmasse genau dosiert wieder beigefügt wird.

Steingranulator (DBPa)

als **Spezialbrecher für teer- und keramisch gebundene Ausschußsteine,** robust und in der Praxis bewährt.

Im Oberteil des Steingranulators befindet sich die Brecherwelle mit den verschleißfesten Brechzähnen für die Vorzerkleinerung, im unteren Teil die Brecherwelle, bestückt mit verschleißfesten Segmenten für die Feinzerkleinerung.

Der **Antrieb** der Brecherwellen erfolgt durch je einen **Hydromotor,** Hochdruckkonstantpumpen liefern den erforderlichen Öldruck. Das Öl kann aus dem Öltank einer Presse entnommen werden.

Dieser Antrieb bietet beste **Sicherheit gegen Überlastung** des Brechers.

Abb. 1
Schema Recycling

Abb. 2
Steingranulator mit Vor- und Feinzerkleinerung

Abb. 3
Abwurf von 2 teergebundenen Ausschußsteinen in den Steingranulator

Abb. 4
Granulator beim Zerkleinern von keramisch gebundenen Ausschußsteinen (zu sehen ist die Vorzerkleinerung)

LAEIS-Anlagenbau

LAEIS plant, liefert und erstellt für die Feuerfestindustrie:

Maschinen und komplette Anlagen einschließlich Engineering und vermittelt das notwendige Know How zur Herstellung von ff-Steinen aller genormten und Sonderformate, aus allen Materialarten wie z. B. Schamotte, Silika, Magnesit, Chrom-Magnesit, Dolomit usw., keramisch-, chemisch- oder teergebundenen, Stampfmassen, Brennhilfsmittel sowie Verschleißmaterial für den Stahlwerksbetrieb.

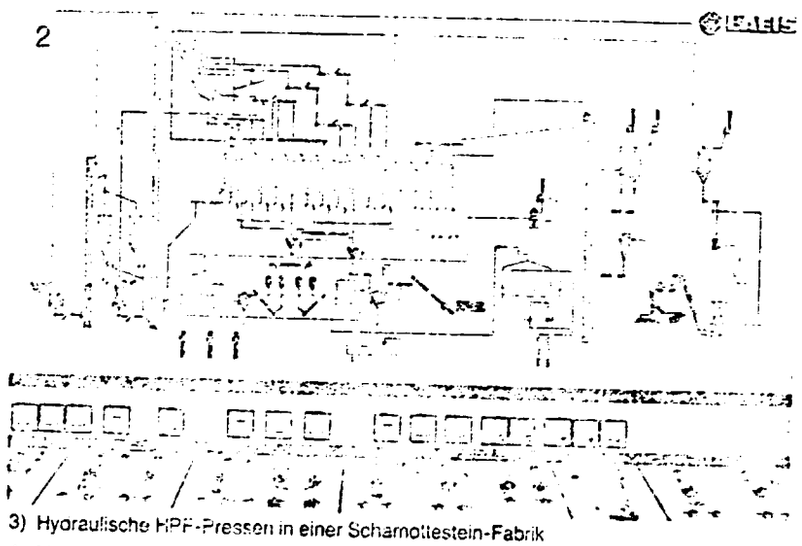
LAEIS hat weltweite und vielseitige Erfahrungen auf dem Feuerfest-Sektor, Anlagen in aller Welt beweisen das.

LAEIS-Anlagen erzeugen Qualitätsprodukte.

Lassen Sie sich von unseren Spezialisten beraten.

1) Von LAEIS gebaute Fabrik für ff-Massen und -Produkte

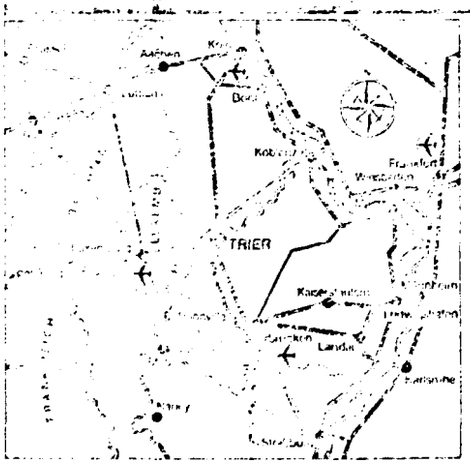
2) Leuchtschaltbild einer von LAEIS gebauten Anlage für Brennhilfsmittel



3) Hydraulische HPF-Pressen in einer Schamottestein-Fabrik

4) Material-Aufheiztrommel und beheizte Planeten-Zwangsmischer in einer Fabrik zur Herstellung teergebundener Konvertersteine

Ausschnitte aus der mechanischen Werkstatt, dem Konstruktionsbüro und der Montagehalle



Das LAEIS-Maschinenbau-Programm

Ölhydraulische Pressen von 2000 bis 25000 kN Preßkraft, mit speicherprogrammierbarer oder konventioneller Steuerung, zur Herstellung von Schamotte-, Silika-, Dolomit-, Magnesit-, Chrommagnesit-, Teerdolomit- und Teermagnesitsteinen.

Pressen in Spezialausführung für Ausgüsse, Schieberplatten, Rohre, Teller-, U- und Viereck-Kapseln, Kassetten, großformatige Platten und sonstige Brennhilfsmittel sowie Salzlecksteine.

Laborpressen bis 16000 kN Preßkraft.

Vollautomatische volumetrische und gravimetrische Formfülleinrichtungen für heiße und kalte Massen mit speziellen Zusatzeinrichtungen für die verschiedensten Programme.

Beladeeinrichtungen für Ofenwagen und Paletten, Wahl der Setzprogramme mittels Lochkarten oder Prozeßrechner möglich.

Planeten-Zwangsmischer, Mahl-, Misch- und Siebkollergänge, Glockenmühlen sowie sonstige Aufbereitungsmaschinen für die Feuerfest-Industrie.

Planung und Bau kompletter Anlagen für die Herstellung von feuerfesten Steinen.

Ölhydraulische Pressen von 1000 bis 8500 kN Preßkraft für Wand- und Bodenfliesen, Klinker, Mosaik und Flachgeschirr.

LAEIS

LAEIS-WERKE AG
Ostallee 3-5, D-5500 Trier
Postfach: 2560
Telefon: (06 51) 465-1, Telex: 4 72 871

10182

PART III

WORKING PROGRAMME FOR SRI LANKA REFRACTORIES

Dr.-Ing.
BIEHLER

W O R K I N G P R O G R A M

FOR

SRI LANKA REFRACTORIES

ENGINEERING AND CONSULTING
OFFICE DR.-ING. BIEHLER

Spitzackerstr. 90
Ch-4103 Bottmingen
Tel. 0041 /61/475575
Telex 65155 drbie ch

Bottmingen, 15. November 1984

WORKING PROGRAM:
FOR THE DGM AND THE SALES OFFICER OF LANKA REFRACTORIES

1. NEED OF KILN FURNITURE IN SRI LANKA

This working program is the base for the planning, the following tasks have to be done:

- List up all factories in Sri Lanka for ceramics and porcelain which need kiln furniture.

- Get informations about the production capacity and the quantity of ceramic products which have been produced in the last five years in every company.

- Write down how many kilns are working in every factory.

- List up the following facts for each of the kilns
  - Burning temperature
  - Quantity of the kiln cars
  - Travelling time of the cars in the kiln
  - Kind of kiln furniture
    (Take a photo of every sort of kiln cars)
  - Replacing of kiln furniture per year

- State the different experiences with the kiln furniture by asking
  - the director
  - the responsible burning man
  - the mason for kiln furniture
  - the laboratory

- List up the data of the imported kiln furniture for the last 7- 10 years concernig
  - Quality
  - Quantity
  - Price
  - Experiences
  - Time of use

- List up the production of the kiln furniture in Sri Lanka and also define the experiences concerning
  - Quality
  - Quantity
  - Price
  - Experiences
  - Time of use

- Define the specific use of kiln furniture per t of production for ceramics per year.
  (As for instance: 0.1 kg SiC per t of porcelain in Piliyandala Factory)

- Try to find out the development and the growth rate of the different ceramic companies

- Establish a budget for the need of kiln furniture in Sri Lanka for the next 2, 5 and 10 years by using all informations you have assembled.

Dr.-Ing.
BIEHLER

WORKING PROGRAM:
FOR LABORATORY MEEPE AND CENTRAL LABORATORY

2. BASE WORK FOR CONTROLLING AND DEVELOPPING KILN FURNITURE AND INSULATING BRICKS

- Compare the results of the Central Laboratory with the results of the laboratory of Meepe concerning
  - Chemical data of the raw materials
  - Physical data of the raw materials
  - Fired items

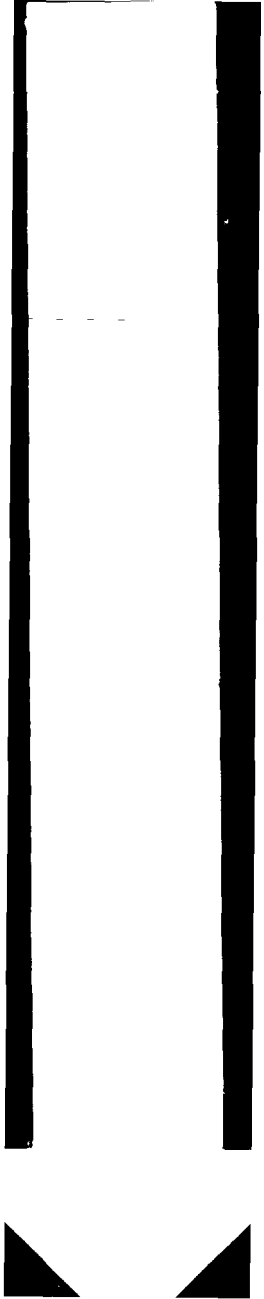
  Tabulate these data and designe a graphic scheme

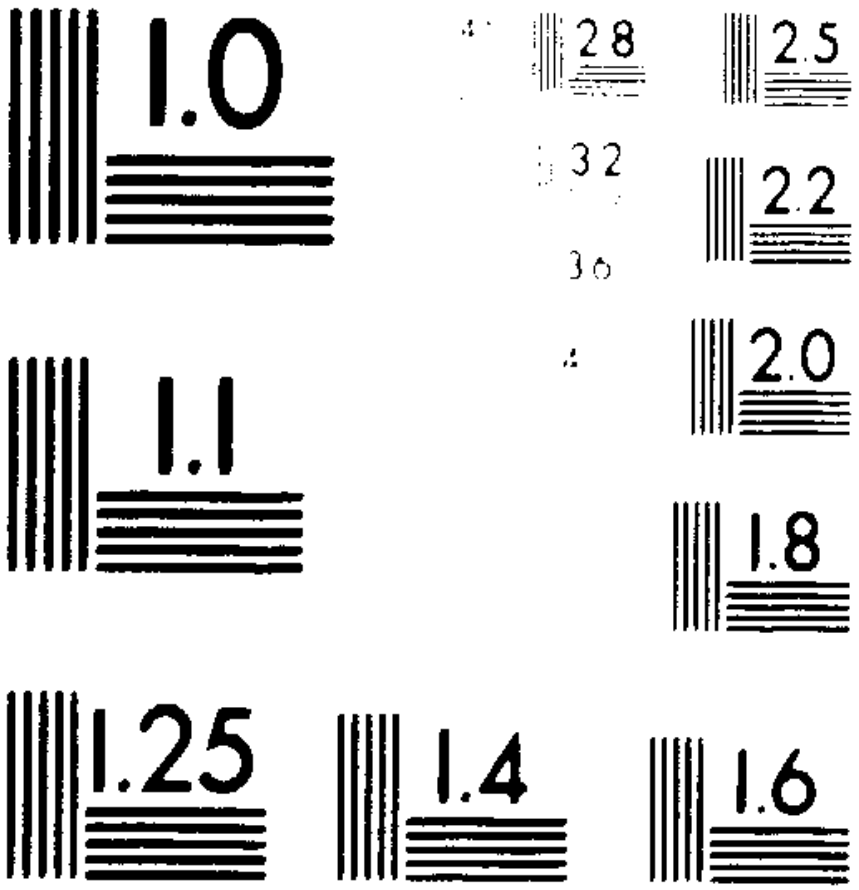
- Mark big differences of the data out of the normal range of analyses and define the reason for the differences. If no reason can be found for the differences new analyses have to be done in both laboratories in order to get similar results. (Selfcontrol of the laboratories)

- The results of the kiln furniture testings (saggers ect.) have to be evaluated concerning the following considerations:

  - Is Meepe able to produce a batch with a similar chemical composition.

  - What kind of raw material should be taken to get the batch for the kiln furniture. (Chemical calculation)





- After sclving both questions positively the following work has to be done:

  - Controlling of the sieve analyses

  - Developping a batch out of available raw materials, try to use domestic raw materials

  - Mixing of about 10 kg of the batch

  - Pressing of the batch in different shapes at Meepe

  - Burning the test material in Meepe as well as in Central Laboratory by different temperatures

  - Making physical and chemical tests of the bodies in both laboratories

  - Controlling and comparing the data with these of the original kiln furniture

  - Discussing the differences and try to get only small differences within the chemical and physical data

  - Trying to test the developped kiln furniture in the ceramic factory

Dr.-Ing.
BIEHLER

- If there is some more time try to develop an insulating brick which has the following data

  - Brick density 0.8 kg/m^3
  - Cold crushing strength 15 - 25 N/mm^2
  - Shrinkage less than 2 mm
    by a temperature of 1'350°C after ASTM

  - Content of

Al_2O_3	about	45 %
Fe_2O_3	less than	4 %
Alkalies	less than	2 %
TiO_2	less than	2 %
Sum/ CaO, MgO	less than	0.5%

Dr.-Ing.
BIEHLER

CONTROL PROGRAM LANKA REFRACTORIES

RAW MATERIAL TESTS

Chemical Analysis

- SiO_2 : .....
- AL_2O_3 : .....
- ZrO_2 : .....
- Fe_2O_3 : .....
- TiO_2 : .....
- CaO : .....
- MgO : .....
- Na_2O : .....
- K_2O : .....
- LOI (Loss of ignition) : .....
- Crystal water : .....
- Moisture content (others if necessary) : .....

Mineralogical Components

Very different depending on raw material

Physical Tests

- Seger cone : .....
- Shrinkage : .....
- After drying % : .....
- After firing % : .....
- Sieve analysis : .....
- Specific weight : .....
- D.T.A.(Differential Thermo Analysis) : .....
- T.G.A.(Thermo Graphimetric Analysis) : .....
- L.D. (Different Expansion) : .....

Name : Date :

Dr.-Ing.
BIEHLER

CONTROL PROGRAM LANKA REFRACTORIES

BODY TESTS DURING PROCESSING

Material : .....

Chemical Analysis (normally not done) : .....

Mineral Components (normally not done) : .....

Physical Tests

- Sieve analysis : .....
- Moisture content before entering the kiln : .....
- Weight after pressing : .....
- Measurement of the shapes (shrinkage or expansion) : .....
- Control of the texture : .....
- Control of the layers : .....
- Control of the surface : .....
- Control of the press : .....

Production Tests

- Pressure of the press : .....
- Speed of the press : .....
- Drying time : .....
- Burning temperature : .....
- Seger cone : .....

Name : Date :

Dr.-Ing.
BIEHLER

CONTROL PROGRAM LANKA REFRACTORIES

3. FIRED ITEMS

Chemical Analysis		Special Analysis	
- SiO_2	:	- ZrO_2	: .....
- Al_2O_3	:	- SrO_2	: .....
- Fe_2O_3	:	- Cr_2O_3	: .....
- TiO_2	:	- SiC	: .....
- CaO	:	-	: .....
- MgO	:	-	: .....
- Na_2O	:	-	: .....
- K_2O	:	-	: .....
- LOI (loss of ignition)	:		

Mineralogical Components

- Mullite : .....
- Pericles : .....
- Dolomite : .....
- Chrystobalite : .....
- Tridymite : .....
- others : .....
- ..... : .....
- ..... : .....

Physical Tests

- Buk density : .....
- Apparent porosity : .....
- Water absorption : .....
- Linear contraction : .....
- Cold crushing strength : .....
- Refractoriness under load : .....
- Expansion or shrinkage on reheating : .....
- Size control according to the order : .....
- Quality control : .....

Name : Date :

Dr.-Ing.
BIEHLER

WORKING PROGRAM:
FOR THE MG OF THE CENTRAL LABORATORY AND
THE DGM OF LANKA REFRACTORIES

3. CONSIDERATIONS TO BUILD UP AN ORGANIZATION SYSTEM BETWEEN LABORATORY OF MEEPE AND CENTRAL LABORATORY

The following points have to be decleared:

- Who gives orders for the accomplishment of the development program.

- Who will be in charge of the development of refractory products.

- Who guesses the cost for a new development. Probably it would be the best to anounce a development group from Lanka Refractories.
  - Define the members of the group

- Divide the tasks to the both laboratories as there are:
  - Chemical analyses
  - Physical data

  Work out the details in fixing every task mentioned in the annex of the study.

- Define how often these researches have to be done.(Daily, weekly, monthly after starting a new production a.s.o)

- Define who and in which way the transport of the test samples has to be organised between Meepe and Piliyandala.

- How often a discussion has to take place between the experts of the both laboratories to fix decision.

- Work out a plan and a time schedule for the duties of each member of the group.

Dr.-Ing.
BIEHLER

WORKING PROGRAM:
FOR THE SALES OFFICER

4. SOME TASKS CONCERNIG THE SALES OFFICER

The sales officer should be paid from the Lanka Refractories but he must be independend so that he can inform the clients in the best way concernig construction even if no refractories of Lanka Refractories can be used. (The question of dealing refractory materials has to be discussed.)

The sales officer should be a man who knows nearly everything about the process of the consumers' productions and can give advice to the people who handle refractories as there are the technical staff, the administration and the buying department.

The sales officer has to do the following tasks:

- To Study the processes of consumer which are used to produce their products

- To think about rationalism of those processes concerning
  - Heat reduction (using insulating bricks)
  - Less wear of refractory by using products with better characteristic features for the processes.(eg magnesite in a basic process)

- To reduce the costs for a construction or a process for the costumer by using new construction systems and better quality, e.g. castables instead of stones.

- To influence the construction of different sort of kilns to reduce the investment costs.

- To develop a visiting program for the costumers, the range of the visits has to conform with the importance of the clients. The importance of such a client depends on:

  - the turnover in refractories
  - the development of the company
  - the need of advice
  - the quality of the management

  The most important costumers have to be visited once a month at least and the most unimportant clients once a year at least.

- To phone regularly to the person who is in charge of the order and also to that person who has to work with refractory delivered by Lanka Refractories.

- To collect all informations which are available about the products of Lanka Refractories concerning:
  - Quality
  - Possibility of use
  - Need for the next period (months, years)
  - To discuss problems and give good advice

- To collect all informations about the products which are used and delivered by other companies. If possible try to analyse and compare them with your own products and find out where the products of Lanka Refractories are used better and where they are used worse.

- To develop three different selling plans (budgets):
  - the first plan for one year (divided into two parts, each part includes half a year program
  - a plan for two years
  - a plan for five years

  Control these plans and correct the data every half year at least.

  The base for these plans is a detailed knowing of the development of the consumers what could be achieved only by regular visits and by receiving the clients' confidence.

- To help Lanka Refractories to develop a good lucrative price system which allows to earn money in the company. The prices of most of the products should be only a little cheaper than the prices of those products bought abroad but the quality must be equal.