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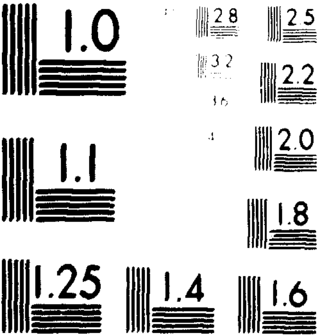
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Contract No 82/61
United Nations Industrial Development Organization
(UNIDO)

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India.

# FEASIBILITY REPORT FOR RECONSTRUCTION STUDY OF ALUMINA CALCINER FOR ENERGY CONSERVATION AT KORBA ALUMINA PLANT. (INDIA)

Project No SI/IND/82/802

Volume I

General explanatory note

VAMI

V O TSVETMETPROMEXPORT

Leningrad
1983

## Composition of Feasibility Study

Volume I - General Explanatory Note

Volume II – Drawings

Volume III – Equipment Specifications

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# I. EXECUTIVE SUMMARY

## 1.1. General Initial Data and Conditions (Section 2)

The Project Initiator of the reconstruction study of the calcination plant at the operating Korba alumina plant (Madhya Pradesh, India) is the Government of India undertaking Bharat Aluminium Company Ltd. (BALCO) with place of business in New Delhi (India, New Delhi, 110019) answerable to the Department of Steel and Mines.

BALCO is an operator of the aluminium integrated plant in Madhya Pradesh consisting of:

- bauxite mine;
- 200,000 tpy alumina plant;
- 100,000 tpy aluminium smelter.

The project is aimed at reduction in fuel oil consumption of the calcination kilns of the alumina plant through a more comprehensive utilisation of heat of calcined alumina and off-gas.

Reconstruction of the calcination plant at Korba alumina plant will ensure:

- reduction in consumption of fuel oil down to 8,000 tpy;
- lower fuel oil imports for production of alumina.

India has a limited fuel resources and is forced to import the bulk of its needs from other countries.

Production capacity of the operating alumina plants in India in 1982 amounted to 640,000 tpy.

All these plants operate rotary kilns at the calcination sections. Reconstruction of the calcination kilns with the view to utilise heat of calcined alumina and flue gas will result in reduction of fuel oil consumption down to 25,000 tpy.

Under the contract between UNIDO and V/O Tsvetmetpromexport (No 82/61) the Feasibility Report for reconstruction study of the calcination section at the Korba alumina plant is prepared by VAMI Institute of the Ministry for Non-ferrous Metals of the USSR.

1.2. Capacity of Korba Alumina Plant (Section 3)

The design capacity of the Korba alumina plant is 200,000tpy. However, because of shortage of electric power and low market demand for alumina the plant has not yet attained the rated capacity.

These reasons attributed to the present capacity of the plant of 85,000 tpy of alumina.

1.3. Materials and other Production Factors (Section 4)

Alumina is obtained at the calcination section out of aluminium hydroxide, as a main raw material.

Auxiliary means include electric power, fuel oil, compressed air, water.

Implementation of the concepts included in the Feasibility Report will ensure the following expected reduction is specific consumption rates of fuel oil and other major utilities.

| S/N | Description | Unit | Change in parameters | | | |
|---|---|---|---|---|---|---|
| | | | before reconstruction | reconstraction, I stage | reconstraction, II stage | reconstradion III stage |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | Capacity of rotary kiln of fluidised bed calciner | t/hour | 12.8 | 14 | 21 | 28 |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| 2 | Fuel consumption | kg/t | 124 | 112 | 98 | 85 |
| 3 | Compressed air rate | $nm^3/t$ | 96 | 142 | 142 | 96.4 |
| 4 | Electric power demand | kWh/t | 33 | 30 | 20 | 16 |

Note: Major process parameters of modified rotary kilns of the plant under stage II include concepts under stage I

1.4. Location and Plant Site (Section 5)

The alumina plant is situated in vicinity of the town of Korba, Belaspur region, Madhya Pradesh. At present the town of Korba is one of the industrial centres of Madhya Pradesh, the region includes a number of thermal power plants totaling 540 MW and fired with local coal, and also the BALCO aluminium integrated plant comprising an alumina plant, aluminium smelter, and casting and rolling mills.

Korba is linked with the national railway Bombey-Celcutta through a rail track and with major regional centres of Madhya Pradesh via motor roads.

Power and heat supply of the region is from the existing thermal power plants, and water supply - from the river of Hasdeo.

The alumina plant site is located 12 km North-East of Korba, with area being abt 26 ha, the aluminium smelter, and casting and rolling mills are situated East of the alumina plant.

1.5. Engineering Design (Section 6)

This Feasibility Report provides for reconstruction of the calcination plant at the existing alumina plant aimed at reduction in specific consumption of fuel.

This reconstruction is proposed for implementation in three stages:

Stage I - modernisation of the hydrate drying zone in the rotary kilns with recycle of dust from the electrostatic precipitators to the cooling zone and improvement in fuel oil burning process (dwg.1354690-TM, sheet 1);

Stage II - installation of fluidised bed coolers to replace the existing planetary coolers of the rotary kilns (dwg.1354691, sheet 1);

Stage III - replacement of the existing rotary kilns by one new stationary fluidised bed calciner at the same site (dwg.1354697, sheet 1).

The last stage should be viewed as a potential solution to be materialised after implementation of stages I & II and consideration of production of special aluminas at the plant.

The Feasibility Report is mainly based on the use of indigenous equipment and inputs totaling abt 99.7%. Supplies of the equipment and materials from the USSR (instrumentation and control systems) assumed in this Feasibility Report for the sake of cost estimation is less than 1%, and can be reviewed, if agreed upon with the Indian Party.

1.6. Production Procedure and Additional Expenses (Chapter 7)

The planned stages of reconstruction of the calcination department do not require additional direct spending of the material, power and labour resources.

The additional production costs include those covering the current repair and maintenance of the newly built facilities, their depreciation and an interest paid for the borrowed funds. These costs are included in the calculations into the fixed (constant) production costs.

1.7. Personnel (Chapter 8)

A reconstruction of the calcination department does not involve any change in the composition and quantity of the workers, engineers and technicians, clerical staff. Repair and maintenance of the newly installed equipment to be carried out by the existing repair facilities of the plant.

1.8. Project Implementation

As it has been agreed upon with the Indian side for reducing the required capital investments it is planned to carry out the reconstruction project in three stages.

The first stage including an installation for a hydrate thermal treatment and an introduction of the dust into a firing end of the kiln requires small capital envestments (Rs.2.9 mln) and can be effected during 6 months.

The second stage involves dismantling the existing plenetary coolers of the calcination kilns and an installation instead of them of the fluid bed coolers. Along with an improvement of a hydrate supply system to be carried out at the first stage, these two successive reconstruction stages are assumed in the calculations to be equal to 1 year.

The third stage is assessed separately. It can be carried out without taking into account the activities planned during the first and second stages, or at the following stages aimed at improving the calcination process and at a higher utilization of the design capacity. This stage will require the most money for its implementation (Rs.25.2 mln) and involves a complete replacement of the calcination kilns by a fluid bed installation for production of the cell-grade alumina. In the calculation a duration of this stage is assumed to be 1-1.5 years.

The periods specified above include only a duration of the construction activities and erection of the equipment and do not include a preparatory period (investigations, engineering etc.).

For determining an optimum reconstruction volume of the calcination department reconstruction as applied to the second stage the Feasibility Report considers an alternative of installing a fluid bed cooler for one calcination kiln only. In this case an amount of the additional capital investments as compared with a modification of the two kilns is reduced by 45.5%. An economic efficiency of the alternative being considered results from an increase (up to 150.000 t/year) of a calcination kiln's capacity when operating with a fluid bed cooler.

The resulting parameters of the variants being considered calculated from a design capacity of the calcination department are given below.

| Description | Unit of measure | Reconstruction volume | |
|---|---|---|---|
| | | basic variant (reconstruction of two kilns) stage II | reconstruction of one kiln |
| 1. Design capacity, alumina | thous.t | 200 | 200 |
| 2. Reduction of annual fuel oil consumption | t | 5200 | 4500 |
| 3. Capital investments, total | Rs.mln | 18.8 | 11.6 |
| including | | | |
| 3.1. Hydrate thermal treatment | -"- | 2.9 | 2.9 |
| 3.2. Additional costs connected with installation of a fluid bed cooler | -"- | 15.9 | 8.7 |
| 4. IRRI | % | 74.1 | 93.7 |
| 5. Break-even point | thous.t | 21.0 | 17.9 |
| 6. Payback period | year | 1.2 | 0.8 |

As one can see from the above figures an implementation of the second stage of the calcination reconstruction involving one kiln is more preferrable than a complete replacement of the existing coolers (planetary) by the fluid bed coolers at the two kilns. An efficiency of the variant being considered as compared with the basic one is higher by approximately 26% (when calculating for the design capacity).

1.9. Financial and Economic Evaluation (Chapter 10)

A financial and economic evaluation of the calcination department reconstruction is made on the basis of a cash flow analysis for the three reconstruction stages and taking into account a production level. The second stage is evaluated as a successive one taking into account the costs involved and savings effected at the first stage.

An evaluation is based on a price level for the beginning of 1983 and does not take into account a price escalation.

As a profit parameter a net additional profit is assumed, resulting from a reduction of the fuel oil costs (occupying in the production costs' structure of the calcination department over 76%) and a reduction in consumption of other services as a result of implementation of the planned measures and an increase of the process equipment efficiency.

A total amount of an additional annual profit for the reconstruction stages is as follows

Rs.thous

| Stages | Current capacity (85 thous. t/year) | | Planne[illegible] t[illegible] [illegible]acity (200 year) | |
|---|---|---|---|---|
| | total annual profit | including that due to fuel oil savings | tota[illegible] annua[illegible] profit | [illegible]ncluding that due to fuel oil savings |
| I | 3.023 | 2.927 | 7.113 | 6.888 |
| II | 6.710 | 6.342 | 15.789 | 14.924 |
| III | 10.177 | 9.514 | 23.946 | 22.386 |

Total capital investment costs by stages of reconstruction and major cost items are as follows:

Rs.000

| S.No | Cost item | Stages | | |
| --- | --- | --- | --- | --- |
| | | I | II | III |
| 1 | Fixed capital investment, total, including | 2060 | 15403 | 21442 |
| 1.1 | Civil engineering works | 986 | 6655 | 10078 |
| 1.2 | Equipment (incl.erection) | 701 | 7937 | 10112 |
| 1.3 | Know-how (incl.tax) | 373 | 811 | 1252 |
| 2 | Preproduction costs | 843 | 3410 | 3807 |
| | Total cost | 2903 | 18813 | 25249 |

In accordance with the initial data it is considered in the Feasibility Report estimates that the capital investment required by stages of reconstruction would be covered by Government funds in form of equities and long-term bank loans in ratio 50:50.

The production costs determined as the annual sum of additional production expenditures include scheduled repair and maintenance of units to be constructed, depreciation of capital investment and interest on loans. The salvage value of the equipment to be dismantled is not included in calculations. The above costs are distributed as follows by stages of reconstruction:

Rs.000/year

| S.No | Cost item | Stages | | |
| --- | --- | --- | --- | --- |
| | | I | II | III |
| 1 | Scheduled repair and maintenance | 23 | 232 | 303 |

| S.No | Cost item | Stages | | |
|---|---|---|---|---|
| | | I | II | III |
| 2 | Depreciation | 189 | 1223 | 1641 |
| 3 | Interest (average for period of operation calculated per one year) | 76 | 538 | 732 |
| | Total | 288 | 1993 | 2676 |

Basing on the calculation of cash-flow the parameters of the internal rate of return, the break-even point and the pay-back period characterising the efficiency of the calciner reconstruction Stages were determined.

The financial analysis is based on the fuel oil price of Rs.2,740 per 1 liter (or Rs.2,870 per tonne).

The efficiency of reconstruction stages is summarized as follows:

| S.No | Parameters | Unit | Stages | | |
|---|---|---|---|---|---|
| | | | I | II | III |
| 1 | Internal rate of return on investment for capacity: | | | | |
| | - existing (85,000 tpy) | % | 103.3 | 31.9 | 31.6 |
| | - designed (200,000 tpy) | % | 244.2 | 74.1 | 66.0 |
| 2 | Internal rate of return on equities for capacity: | | | | |
| | - existing (85,000 tpy) | % | 183.4 | 44.1 | 40.1 |
| | - designed (200,000 tpy) | % | 464.6 | 119.9 | 87.5 |
| 3 | Break-even point | 000tpy | 8.0 | 21.0 | 20.7 |
| 4 | Pay-back period for capacity: | | | | |
| | - existing (85,000 tpy) | year | 1.0 | 2.8 | 2.5 |
| | designed (200,000 tpy) | -"- | 0.4 | 1.2 | 1.1 |

As it can be seen from the data above the most efficient is the Stage I. The parameters under stages II and III are approximately of the same level.

In addition to this the parameters of the annual savings calculated per Rs.1,000 of capital investment, also characterizing the high profitability of the reconstruction are supplimented below:

Rs.000

| Stages | Capacity level existing | Capacity level designed |
|---|---|---|
| I | 1.0 | 2.4 |
| II | 0.3 | 0.8 |
| III | 0.4 | 0.9 |

1.10. Conclusion

The estimates justifying the technical concepts of reconstruction on stages of calcination allow to conclude the following:

1. The high efficiency of measures for the calcination reconstriction proved by the experience of the USSR allow to implement within tight schedule (within limits of one year) with the capital investment relatively low to compare with the profit obtained.

2. The reconstruction of calcination at Korba Alumina Plant in function of its reconstruction stages ensures the saving of

the annual fuel oil consumption in amount of 2,400 to 7,800 t (calculated for the designed capacity).

On the national scale based on total availability of installed capacities for alumina production (640,000-660,000 tpy) the reconstruction of operating calciners of this type ensures the reduction in fuel oil imports for these purposes by more than 20,000 tpy and thus improves the foreign exchange balance of the country.

3. Based on the level of the capacity utilization at Korba Alumina Plant at present (42.5% of design capacity and because BALCO is short of capital for investment the most reasonable solution is the implementation of the first stage of reconstruction of two kilns, including the modernization of the hydrate heat treatment and the dust recycle to the process, at the least capital intensive stage and the construction of the fluidized bed cooler only for one calciner which can be considered as the experimental demonstration unit provided for the mastering of the new process, personnel training and gaining the experience of operation to be used at other Plants of the country.

## 2. GENERAL INITIAL DATA AND CONDITIONS

### 2.1. Project background

#### 2.1.1. Aim and scope of project

The aim of the project

The Project is aimed to reduce the fuel oil consumption at calcination department of the alumina plant at Korba (the state of Madhya Pradesh) due to more complete utilisation of calcined alumina heat and of flue-gases and to optimization of fuel combusion condition.

The reconstruction of the calcination plant at Korba enables to reduce the fuel oil consumption for this unit at the designed capacity of the plant by 2,400-7,800 tonne per year (depending on stages of reconstruction).

## Scope of Project

To reduce the fuel consumption at calcination plant the Feasibility Study considers the problems related to the reconstruction of existing calcination kilns and also replacement of rotary kilns by a fluid bed calciner.

To speed up implementation of the fuel saving programme and to reduce the initial capital cost the Feasibility Study considers three stages of the calcination plant reconstruction:

I stage - Reconstruction of alumina hydrate drying zone, recycle of dust from E.S.P. to the coling zone of the kiln and the improvement of the fuel oil firing process. The above measures will result in reduction of oil rate per tonne of alumina by 9.6% and increase in throughput of the kiln to 14 tonnes per hour of alumina.

II stage - Installation of fluid bed coolers to replace the existing planetary coolers for the rotary kilns. Implementation of this measure will supplement the scope of work under the I stage and will further reduce oil consumption by up to 21% and increase throughput to 21 t/hour.

III stage - Replacement of the existing rotary kilns by a fluid bed calciner. In this case reduction in oil consumption (regardless of the measures under I and II stages) will amount to 31% and throughput of the kiln will increase to 28 t/hour.

2.1.2. Product range and capacity

The proposed reconstruction of the calcination kilns will not affect the type and quality of the product - alumina. It will not affect the designed capacity of the Alumina Plant (200,000 tpy) either.

2.1.3. Project implementation schedule

Based of experience of reconstruction of the calcination plants at the USSR alumina refineries we would recommend the following schedule for the reconstruction of Korba Alumina refinery calcination plant:

I stage - 6 months;

II stage -12 months;

III stage -12 months.

Construction will be implemented by stages. The engineering design will by prepared simultiniously for three stages.

2.1.4. Economic benefits of the Project.

As is known India is rather limited in fuel resources and is forced to import the bulk of fuel requirements from other countries.

The production capacities of the Indian alumina plants in 1981-1982 was 640,000 tpy of alumina, while all the plants use rotary kilns for calcination of rotary kilns. Reconstruction of the existing calcination kilns at the alumina plants in India will allow reduction in oil consumption down to 25,000 tpy, depending on recuperation of flue gases and calcined alumina heat.

## 2.2. Initiator of the project and designer of the Feasibility Report

### 2.2.1. Initiator of the Project

The initiator of the Project for the study of calcination plant reconstruction at its Alumina plant at Korba, is Bharat Aluminium Company Ltd. (BALCO), established in the year 1965, New Delhi 110019, Nehru Place, 18.

BALCO's Aluminium Complex in Korba, Madhya Pradesh State comprises:

- bauxite mine
- alumina plant
- aluminium smelter
- fabrication complex

### 2.2.2. The role played by BALCO in the Project Implementation

BALCO is participating directly to carry out the Feasibility Study on the reconstruction of Alumina calciners for energy conservation at its Korba Alumina Plant on behalf of the government of India.

BALCO has taken an active part and rendered assistance to the group of Soviet experts of VAMI Institite who had been to India in January 1983 for implementation of the Contract between V/O Tsvetmetpromexport and UNIDO to collect the Initial Data required for techno-economic study on the feasibility of reconstruction of the calcination plant.

### 2.2.3. Designer of the Feasibility Report

In accordance with the contract between UNIDO (United Nations Industrial Development Organization) and V/O Tsvetmetpromexport the reconstruction studies (reconstruction) of calcination department of the Alumina Plant in Korba has to be carried out by the All-Union research and design institute of aluminium, magnesium and electrode industry (VAMI) of the Ministry for Non-Ferrous Metallurgy of the USSR, Leningrad, V.O., Sredniy prospect, 86.

### 2.3. General characteristic of the Alumina plant location region

The alumina Plant is located in the vicinity of Korba town, Bilaspur district in the State of Madhya Pradesh, India.

At present Korba is one of the Industrial centers of Madhya Pradesh and the following industrial enterprises are located in the region:

- Western Coalfields Limited's Colliery complex;
- The Thermal power plants of 540 MW based on local coal owned by Madhya Pradesh Electricity Board;
- BALCO Aluminium Complex comprising of:
- Alumina plant of 200,000 tpy capacity;
- Aluminium smelter of 100,000 tpy capacity,
- Fabrication complex of 50,000 tpy capacity.

Besides, two super Thermal Power Plants one belonging to Madhya Pradesh Electricity Board and another to NTPC are under construction.

For transportation purposes Korba is connected by broad gauge railway line of 37 km long with the railway station Champa on Bombay- Calcutta National main line. Korba is also connected with Bilaspur, Raipur and other importent centres of State of Madhya Pradesh by all-weather motor roads.

The major source of water supply of the region is the Hasdeo river. The electric power for the region and its industrial units in general is supplied from MPEB Thermal Power Plant.

## 3. CAPACITY OF THE ALUMINA PLANT IN KORBA

The designed capacity of the plant is 200,000 tonnes of alumina per annum. Because of shortage of power available and the insufficient demand for alumina, the plant has never been run to the designed capacity. Since start-up of the plant (April, 1973), until now a total quantity of about one million tonnes of alumina has been produced by the plant.

At present the productivity rate of the plant is to the order of 85,000 tonnes of alumina per year.

The production programme of the Calcination plant is considered in two variants in the Feasibility Report:

- basing on the designed capacity of the plant of 200,000 tonnes of alumina per year;

- basing on the existing capacity of the plant at present (in amount of 85,000 tonne of alumina per year).

## 4. MATERIALS AND OTHER PRODUCTION FACTORS

### 4.1. Requirements for raw materials and inputs.

Initial product for alumina production is the alumina hydrate. The main factor for the above conversion in calcination kilns is the constant minimum moisture content, since each additional moisture percent increases the specific fuel consumption by 1%.

The optimum permissible moisture content which could be allowed at hydrate filtration section is 7-8% against the moisture content of 10-12% in works hydrate of Korba plant.

Furnace oil is used as the kiln fuel. At Korba Alumina Plant the sulphur content of fuel oil used reaches 4-5%.

In calcination kilns it is reasonable to use fuel oil with low sulphur content so as to reduce the temperature of outlet gases from the kiln and to decrease the fuel consumption, however the availability of fuel oil of lower sulphur is not within the control of BALCO.

With the sulphur content in fuel up to 1% the flue-gases temperature can be reduced down to 140-160°C. The calorific value of liquid fuel used is about 9,400-9,600 kcal/kg.

### 4.2. Selection and characteristic of raw materials and fuel

The following is assumed for the calculations of the Feasibility Report:

- Alumina hydrate

| S.N° | Chemical composition and other specifications | Unit | Mean value |
|---|---|---|---|
| 1 | 2 | 3 | 4 |
| 1 | $Na_2O_{total}$ | % | 0.41 |
| 2 | $K_2O_{total}$ | % | 0.012 |
| 3 | $SiO_2$ | % | 0.027 |
| 4 | $Fe_2O_3$ | % | 0.058 |

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| 5 | L.O.I. | % | 34.57 |
| 6 | Specific density | g/cm$^3$ | 2.43 |
| 7 | Bulk weight | g/cm$^3$ | 1.23 |
| 8 | Angle of repose | degree | 30.0 |
| 9 | Water content | % | 10 to 12 |

- Fuel oil - lowest calorific value is 9400 kcal/kg.
  - sulphur content, % - maximum - 4.5
  - minimum - 2.5

4.2.1. Specific consumption of raw materials, utilities and inputs for alumina production (for Calcination Plant)

| S.N° | Description | Unit | Quantity |
|---|---|---|---|
| 1 | Alumina hydrate | t | 1.72 |
| 2 | Fuel oil, calorific value 9400 kcal/kg | kg | 124 |
| 3 | Compressed air | nm$^3$ | 96.0 |
| 4 | Power | kWh | 33.0 |
| 5 | Water | m$^3$ | 7.0 |
| 6 | Refractories | t | 0.00384 |

## 4.3. Cost Estimate

The proposed reconstruction of the calcination plant requires no additional production expenses for materials and utilities.

Additional expenses related to a higher flowrate of compressed air for the stage I of reconstruction project will be offset by total savings in operating costs as shown in the estimates of additional revenue for this stage.

## 5. LOCATION AND SITE

### 5.1. Plant location

Korba Alumina plant site is located at about 12 kms North-East from Korba town at an approximate latitude of 22°23'N and longitude of 82°44'E.

The Alumina plant area is a rectangular plot 300 m wide and 660 m long with total area of 26 hectares and longitudinal side oriented in North-South direction. The site finished level is fixed at 288.75 to 291.75 m above the Mean See level.

The western boundary of the site is facing the 440 MW Power Station and is located about 300 m from this Power Station . The Aluminium Smelter is located in the eastern side of Alumina Plant Site.

The flood basin of Dhengur Nalls stream is located at the southern boundry of the plant site. In this region the ash disposal pond of MPEB is located. From the northern side of the site a similar flood basin of Belgary-Nalls stream is located, where the Red Mud pond of the Alumina Plant is situated.

In monsoon period the water level of these streams reaches 280-286 m above the sea level. These streams are flowing into the major river of the region i.e. Hasdeo, running from north to south about 2.5 kms west from the Alumina Plant.

The plant site is connected with motor roads and the railway siding with Korba Railway Station.

5.2. Location of Calcination Plant

The existing calcination plant consisting of two rotary kilns and two multi-storey structures by the ends of these kilns is sited on the eastern boundary of the alumina plant site with area of 50x200 m., stretched in north-southern direction.

The feed end of the kiln with the multi-storey structure is in the southern part of the plant site, and the discharge end - in northern part.

This site also contains two fuel oil tanks on the northern boundary and three tanks for soda ash near the southern boundary.

The site is levelled, provided with engineering communications and motor roads along its perimeter.

The alumina storage is located 30 m east of the calcination plant, with a rail track passing between these two units.

5.3. Cost Estimate

Since reconstruction of the calcination plant will be effected on the existing alumina plant, no expenses for purchassing the land site are required.

5.4. Local Conditions

5.4.1. Climate

The region climate is tropical, the region is noted for low seismicity, maximum temperature of the hottest months (May-June) is +47°C, that of the coldest month (January) is +8°C. Average monthly rainfall is about 1000 mm. RH ranges from 11 to 100%. Prevailing wind direction is northern to western,

5.4.2. Soil Conditions

The soils of the site are from sandy loams to clayey loams with bearing capacity of 1.25 kg/cm$^2$ to 1.5 kg/cm$^2$ at a depth of 2.0 m and 2.0-2.5 kg/m$^2$ at a depth of 2.0 m and 2.0-2.5 kg/cm$^2$ at a depth of 4-5 m. Bed rock lies at a depth of 15-20 m from the surface.

Depth of ground water table is 2.0-3.0 m.

5.5. Environmental Impact

One of the major sources of pollution of air at the alumina refinery is calcination kilns, with the following emmissions of contaminents as of 1983:

| S/N | Description | Unit | One kiln | Two kilns |
|---|---|---|---|---|
| 1 | Dust | kg/h | 5-6 | 10-12 |
| | | t/y | 44-45 | 88-90 |
| 2 | $SO_2$ | -"- | 10 | 20 |
| | | | 78-80 | 160 |

The proposed reconstruction of the calcination plant ensures reduction in fuel oil consumption and in rate of exit gases. Amount of dust and $SO_2$ per tonne of finished product emitted into air will drop as compared with the actual level of emissions.

# 6. ENGINEERING DESIGN

## 6.1. Design break-down

### 6.1.1. Initial data

The following is assumed for as the Initial data for elaboration of process calculations and erection drawings of reconstruction of the Calcination plant:

- the capacity of the existing Alumina plant (designed capacity) - 200,000 tonnes of alumina per annum;
- the continuous operation of process sections;
- the Initial data for elaboration of the Feasibility Report of calcination kilns reconstruction at Korba Alumina Plant (New-Delhi, February 1983);
- the local studies of the calcination Plant carried out during collection of the Initial data.

### 6.1.2. Brief Characteristic of the Calcination Plant

The essence ofcalcination technology in Korba Plant is similar to the technology used in the USSR and other countries and consists of the following:

The hydrate of alumina $AL(OH)_3$. with bound moisture of 12% is fed to the rotary calcination kilns. Hydrate after passing through the drying, dehydrating and calcination zones, leaves the kilns in the output form of aluminium oxide ($Al_2O_3$). The cooling of this fine powder materials from calcination temperature of 1150-1200°C down to 100°C is carried out successively in the end zone of rotary kiln, in recuperative cooler and in hydro-air cooler. The separation of refractory lining impurities from alumina is carried out in the vibrating screen installed between the recuperator and hydro-air coolers. The cooled product through pneumatic system is conveyed to the silos.

The flue-gases from the kilns are cleaned out of dust in cyclones and electrostatic precipitator and then through chimney stack and discharged to air. The dust captured in electrostatic precipitators and cyclones is recycled to the kiln.

The list of existing equipment in Calcination Plant

| S.N° | Name of equipment | Specification details | N° installed |
|---|---|---|---|
| 1, | 2 | 3 | 4 |
| 1 | Hydrate long belt conveyor | 500 mm wide, 60 t/hr Capacity, speed:1 mt/sec | 2 |
| 2 | Apron feeder | 2.0 m dia, speed 4-10rpm, N = 11 kW | 2 |
| 3 | Belt conveyor | 650 mm wide, speed 1m/sec N = 3.75 kW | 2 |
| 4 | Screw conveyor | 450 mm, dia, 6.5 m long. Capacity 30 t hydrate/hr, N = 15 kW | 2 |
| 5 | Electro-static precipitator | LURGI type, 550 mA, 440 V | 2 |
| 6 | ESP small screw conveyor | 500 mm dia, 7 m long, N = 5 kW | |
| 7 | ESP long screw conveyor | 500 mm dia, 12.5 m long, N = 11 kW | |
| 8 | DC Dust collector (group cyclones, Istage) | 4 cyclones of 1.370 m dia | 2 |
| 9 | Noric Dust collector (group cyclones, II stage) | 90 number CI cyclones, 225 mm dia | 2 |

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| 10 | Kiln with main drive | 3.6/3.3 m dia, 80 m long, slope 1°45' 42 sec/rev. In kiln I - altern.current drive, N = 95 kW; In kiln II - direct current drive, N = 95 kW | 2 |
| 11 | Vibrating screen | 1.22 m wide, 2.74 m long, 14 mesh screen | 2 |
| 12 | Hydro-air cooler | Area 5.2 $m^2$, cooling surface 76 $m^2$, dia of coil tubes 50 mm | 2 |
| 13 | Pneumatic chamber pumps (Fluxo vessels) | Capacity 5.8 $m^3$ | 4 |
| 14 | Primary air fans | 6650 $m^3$/hr at 255 mm Wg, N = 11 kw | 2 |
| 15 | Oil supply system | Two pumps, 25-30 atm.pressure, N = 7.5 kW, oil flow 3000 1/hr 40 m3/capacity, 9.6 m3/metre tank height | 2 |
| 16 | Oil tanks | | |
| 17 | Bag filter above the kiln | Two compartments with exhaust fan of 170 m3 capacity at 200 mm Wg | 1 |
| 18 | SF (I) Bag filter | 144 bags, exhaust fan 566 m3/min | 1 |
| 19 | I.D. Fan | 103000 $m^3$/hr capacity at 220 mm Wg and 260°C, N = 150 kW | 2 |
| 20 | Air blower | Capacity 1450 $m^3$/hr, pressure 3500 mm Wg, N = 3.75kW | 2 |

## Description of the existing instrumentation and automation systems

The instrumentation scheme includes the following measurements:

- Temperature of flue-gases and alumina at outlet of recuperative coolers, of alumina after fluid bed cooler;
- Fuel oil input including return oil and primary air consumptions;
- Draught in kiln and before gas suction;
- Content of oxygen and carbon dioxide ($CO_2$) in flue gases;
- Hydrate consumption.

The process automation is not available. The following control systems are available: the remote control of gate valve installed at gas suction for oxygen content in flue gases, the remote measurement of hydrate consumption and the automatic maintenance of fuel oil pressure in the return line.

### 6.1.2. Brief description of gas-cleaning plant. Data on emissions

In calcination Plant the following system of gas-cleaning is adopted: gas from the kiln → dust collectors (the stages I & II) → electrostatic precipitator → I.D.Fan → chimney stack.

The specification of gas coming for gas-cleaning (from one kiln) is shown in Table below:

| Gas parameters | From the kiln | After cyclones | From electrostatic precipitator |
|---|---|---|---|
| Volume - $nm^3/hr$ | 48.000 | 53.000 | 56.000 |

| Gas parameters | From the kiln | After cyclones | From electrostatic precipitator |
|---|---|---|---|
| Temperature, °C | 260-280 | 240-250 | 230 |
| Dust content, $g/nm^3$ | 250-260 | 30 | 0.1 |
| $SO_2$ - $g/nm^3$ | 0.2 | - | 0.18 |

The major sources of detrimental emissions at this plant are the calcination kilns.

The specification of kiln emissions is as follows:

| Emission type | Unit | Rrom one kiln | Rrom two kilns |
|---|---|---|---|
| Dust | kg/hr | 5-6 | 10-12 |
| | t/year | 44-45 | 88-90 |
| $SO_2$ | kg/hr | 10 | 20 |
| | t/year | 78-80 | 160 |

6.1.3. Scope of design documentation

Besides the present general Explanatory Note of reconstruction of the Calcination plant, the equipment and process flowsheets, erection and construction drawings, power supply and automation diagrams are worked out for each stage in the Feasibility Report. The above documentation is in Volume II.

The list of equipment and materials is given in Volume III. The Soviet equipment, the Indian equipment and the equipment from third countries is used in the present Feasibility Report.

6.2. Framework of Project

The design lists and break-down determine the framework of the Project and serve as the basis of estimation of investment and production costs.

In this case the framework of the Project is limited only by this section basing on the concepts of reconstruction of calcination kilns approved by BALCO.

The existing service lines are concerned with insignificant modifications.

The proposed concepts are to be implemented in three following stages:

- the reconstruction of existing rotary calcination kilns is to be implemented on stages I and II.

- Stage III provides for replacement of the existing rotary kilns by one new stationary calciner at the same site.

In this connection the reconstruction under stages I and II involves the process, electrical and construction designes, the instrumentation and automation of existing rotary kilns in limits of the Calcination Plant.

The following major works should be included in the scope of works under stage III besides the construction of the fluidised bed furnace from the side of the rotary kiln N° 2:

- the reconstruction of the aluminium hydrate feed line;

- the construction of the pneumatic conveyor rack for the calcined alumina transportation to the storage;

- the moving of small part of water supply and sewerage system and reconstruction of fuel supply.

## 6.3. Technology

### 6.3. 1. Types of technology of alumina calcination

In world practice the alumina calcination is carried out in rotary kilns in moving layer or in stationary fluidized bed furnaces.

The alumina calcined in rotary kilns is cooled in drum or cyclone coolers, in fluid bed coolers or in coolers combining different principles of material movement.

The alumina calcined in fluid bed furnaces is cooled in cyclone coolers or fluid bed coolers.

The elevated fuel consumption is the disadvantage of the alumina calcination in rotary kilns which is connected with the low efficiency of heat exchange between the material and the furnace gases inside the kiln, the high heat losses to the environment related to the difficulty of heat insulation of rotary kiln casings and to cooled water and the high temperature of flue-gases.

While calcining the alumina in fluidized bed furnaces, the fuel consumption can be reduced due to the intensification of drying and dehydration process, to the reduction of unit sizes and of heat losses to the environment related to the reliable heat insulation of stationary furnace casings. The calcination in fluid bed calciners enables the complete automation of the process and the reduction of the operating personnel. Besides the efficient control of the finished product quality (the alpha-alumina content) is ensured.

6.3.2. Selection of calcination process

The calcination process in rotary kilns at Korba Plant is characterised by the elevated fuel consumption amounting to 124 kg/t because of high heat losses of flue-gases (up to 23%), of calcined alumina and to the environment (about 28%). The heat losses of casing of the recuperative cooler installed on the rotary kiln are rather important.

The major ways to increase the intensity of rotary kiln operation for fuel saving are as follows:

- the recuperation of flue-gases heat due to the drying of aluminium hydroxide in fluidized bed inside the furnace;
- the recuperation of the calcined alumina heat to heat the air supplied for fuel burning and the calcination of part of the recycle dust.

The improvement of the process of alumina cooling in order to use more completely the calcined alumina heat can be implemented in the cyclone-type coolers or in fluidized bed coolers. The fluid bed cooler is assumed for the conditions of the Korba plant. This is related to the fact that the utilisation of the cyclone heat exchangers for cooling of alumina calcined in the rotary kiln requires the installation of an additional surge tank to receive the excess material because of the non-uniform discharge of the kiln. But this concept makes the equipment arrangement of the process rather difficult and is not considered.

In the traditional method of calcination in rotary kiln the dust captured in the gas-cleaning plant is recycled to the feed end of the kiln resulting in additional fuel consumption for the temperature of flue-gases.

To reduce the fuel consumption and the quantity of recycle dust between the kiln and the gas cleaning system, it is reasonable to supply the part of the recycle dust directly to the high temperature zone of the kiln. As per the results of the analysis carried out the cristalline water content of the recycled dust is 1.5 to 2.0%. The quantity of the recycled dust fed to the high temperature zone is determined by the temperature conditions of the process.

The possibility to use the fluid bed calciner with utilization of part of the existing equipment is also considered in the Feasibility Report. The fluidised bed unit can be installed at the site adjacent to the existing rotary kiln N° 2 using the system of the alumina hydrate supply and the gas-cleaning plant of the kiln.

This method of calcination process in the fluidised bed unit is practically the alternative to the calcination process in rotary kilns and it can be implemented as the third stage of reconstruction of the Calcination plant or separately without the implementation of stages I and II of the reconstruction.

### 6.4. Equipment

#### 6.4.1. Design Data and Selection of Equipment

The equipment is designed basing on the following:

- capacity of the alumina plant (200000 tpy)
- continuous operation of all process sections (365 days/year)

To select engineering solutions and equipment for reconstruction of the calcination department the following considerations were also taken into account:

- minimum additional equipment;

- maximum possible saving of fuel oil for alumina calcination after reconstruction;

- minimum time for reconstruction and installation of equipment by stages;

- experience gained in the USSR in reconstruction of the existing calcination plants at alumina refineries.

6.4.2. Priority of Calcination Plant Reconstruction

As a relatively large scope of work is required to achieve a considerable reduction in fuel consumption at the calcination plant, as well as a high capital investment, the Feasibility study provides for reconstruction of the calcination kilns at the Korba alumina plant by stages:

- Stage I - reconstruction of the calcination kilns in such scope as to attain the required reduction in fuel consumption by decreasing temperature of kiln exit gases, to improve heat exchange inside the kiln and to recycle part of dust to the hot end of the kiln;

- Stage II - reconstruction of the kilns to ensure reduction in fuel consumption by decreasing heat loss to air by replacing the existing heat recovery coolers by fluidised bed coolers;

- Stage III - further reduction in fuel consumption (as compared with stages I and II by replacing the rotary kilns by a fluidised bed calciner.

Analysis of the above stages of reconstruction of the calcination kilns suggests that the stage III should be considered only as a potential variant.

Decision on implementation of stage III of the calcination department reconstruction should be taken only after attaining the design capacity of the plant (200000 tpy) and establishment of special alumina production at the Korba alumina plant.

6.4.3. Selection of Equipment

To improve calcination process at the Korba alumina plant the feasibility study considers the following proposals:

- drying hydrate in suspended state;
- recycle of dust to the hot zone;
- cooling alumina in a fluidised bed.

6.4.3.1. Drying Aluminium Hydrate in Suspended State

Earlier two alternatives of equipment flowsheets for hydrate drying were considered;

- feeding hydrate to the exit gas duct;
- reconstruction of the kiln drying zone.

Analysis showed that feeding hydrate to the gas duct requires a considerable reconstruction of the feed line with additional installation of equipment (belt and screw conveyors, elevator) or reconstruction of the gas line (U-shaped gas duct with installation of a feeder).

The Feasibility study recommends the alternative with reconstruction of the drying zone of the kiln, which will also ensure no change in the kiln feeding equipment. The kiln dehydration zone will be provided with a special heat exchange lining.

6.4. 3.2. Recycle of Dust to Hot Zone

Recycle of dust to the hot zone of the kiln will be ensured by provision of a jet unit operated by compressed air and a cyclone to separate dust from carrier air.

6.4.3.3. Cooling Alumina in Fluidised Bed

To cool alumina in a fluidised bed provision will be made for a fluidised bed cooler in the form of a horizontal unit with a directional flow of material, including a series-connected chamber for separation of refractory chops (trash) from alumina, air and air-water heat recovery chambers and separate cyclones to clean hot air.

The world practice of the calcination includes the use of principle of aluminium hydroxide heat treatment in a suspended state and fluidised bed: calciners with circulating bed, Lurgi (FRG), flash calciners Mark III, Alcoa (USA), calciners of suspended alumina, Pechiney (France).

Drawbacks of the above calciner designs lie in complexity, separation of stages of treatment (in various units), requirements for significant diversity in types of refractory bricks, relatively high energy demand.

The Feasibility study proposes a VAMI-designed fluidised bed calciner which includes cyclone exchangers for drying hydrate, a shaft heat exchanger for dehydration in a suspended bed, a chamber for calcination in a fluidised bed and a three-stage cyclone cooler with air-water fluidised bed cooler for cooling calcined alumina.

The calciner is lined with standard bricks and features a low hydraulic resistance. The unit is fitted with blowers to supply air, fuel burners, hydrate feeders and pneumatic pumps or air lifts for discharge of alumina.

### 6.5. Brief Description of Stages of Reconstruction of Calcination Plant

#### 6.5.1. Stage I of Reconstruction of Existing Calcination Kilns (dwg 1354690, sheet 1-2)

This stage of reconstruction of the calcination kilns provides for drying aluminium hydrate in a suspended bed with recycle of dust to the discharge end of the kiln.

##### 6.5.1.1. Hydrate Drying In Suspended Bed

Original wet hydrate is fed by the existing screw feeder to the modified drying zone of the kiln fitted with transfer vanes and a separating diaphragm of special design.

Loaded material is dried when moving ahead by heat of gases from the dehydration zone, becomes suspended in gases and is carried out from the kiln to the cyclones (stage I and II) of the gas cleaning system.

Dried product trapped in the cyclones is transferred along the inlined feeding tube behind the diaphragm directly in the kiln dehydration zone. Since the drying zone becomes shorter the non-lined section of the kiln is lined with refractory brick.

Intensification of hydrate drying process ensures that the process is completed over the short section of the kiln and exit gas temperature is lowered from 250-275°C to 180-220°C, and hence reduces fuel consumption.

##### 6.5.1.2. Recycle of Dust to Discharge End of Kiln

To lower fuel consumption after reconstruction of the drying zone of the kiln it would be necessary to reduce air rate through the heat recovery cooler. This results in higher temperature of alumina at exit from the cooler. To lower temperature of cooled alumina and to more efficiently use heat of calcined alumina provision is made for recycle of dust from the ESP to the discharge section of the kiln.

With this purpose in mind modifications will be introduced in the dust collection system, which involve removal of one of the screw conveyors and a dust elevator.

Trapped dust is collected from under the ESP hoppers and fed by the jet conveyor by means of compressed air to the area of the burner platform to the discharge cyclone fitted with a fluidised bed lock, then gravity fed to the discharge end of the kiln. Dust is calcined and passes along with alumina for cooling.

6.5.1.3. Process Parameters of Stage I

| | |
|---|---|
| Capacity, t/h | 14 |
| Fuel consumption, kg/t | 112 |
| Temperature of exit gas, °C | 180-220 |
| Compressed air rate, $Nm^3/t$ | 142 |
| Power demand, kWh/t | 30 |

6.5.1.4. New Equipment for Stage I

Jet conveyor, capacity t t/h,

Discharge cyclone, ø 600 mm, fluidised bed lock.

6.5.2. Stage II of Reconstruction of Existing Calcination Kilns (dwg 1354691, 1354693)

Stage II involves installation of an alumina cooler. This stage will be implemented after introduction of the measures under stage I.

6.5.2.1. Reconstruction Concepts of Rotary Kilns

Stage II involves removal of the existing heat recovery cooler, vibrating screen, fluidised bed cooler, pneumatic chamber pumps and bag filters.

The discharge end of the kiln is shortened by abt 32 m and fitted with a new burner end.

Calcined alumina via the modified discharge end is fed to the trash separator, where in a fluidised bed refractory spallings and lumps are separated from alumina flow, then alumina comes to the heat recovery chambers, is cooled down in a fluidised bed and discharged into the pneumatic chamber pumps. Hot air is cleaned from dust in separate cyclones and is fed to the kiln for combustion of fuel, and trapped dust is recycled to the fluidised bed cooler.

The fluidised bed cooler is located downstream of the rotary kiln.

6.5.2.2. Dust Recycle

Trapped dust from the ESP fed under stage I to the discharge end for calcination and cooling alumina at the exit from the heat recovery cooler, is fed via the discharge cyclone to the trash separator under stage II for calcination and cooling along with the calcined alumina due to reconstruction of the discharge end of the kiln.

Replacement of a rotary heat recovery cooler by a stationary fluidised bed cooler with inside lining to ensure lower temperature outside the body will reduce heat losses to the surrounding air. The cooler will allow passage of such rate of air as required for combustion of fuel, which improves rate of heat supplied to the kiln along with hot air and reduction in fuel consumption of calcination process.

Improvement in the rotary kilns by maximum use of heat of off-gas and calcined alumina ensures reduction in fuel consumption by 20-21%.

6.5.2.3. Process Parameters of Stage II

| | |
|---|---|
| Capacity, t/h | 21 |
| Fuel consumption, kg/t | 98 |
| Air rate in cooler, $Nm^3/h$ | $20\text{-}21 \times 10^3$ |
| Temperature of exit gas, °C | 180-220 |
| Hot air temperature, °C | 500-550 |
| Hydraulic resistance of cooler, Pa: | |
| air heat recovery chamber | 4500-5000 |
| air-water heat recovery chamber | 9000-10000 |
| Power demand, kWh/t | 22 |
| Compressed air rate, $Nm^3/t$ | 142 |

6.5.2.4. New Equipment under Stage II

Fluidised bed cooler with a trash separator, area of 85 $m^2$,
Separate cyclones, 4 pcs, ø 1100 mm,
Fan, Q = 25000 $m^3/h$ , H = 7000 Pa
Air blower, Q = 4000 $m^3/h$, H = 11000 Pa.

6.5.3. Stage III of Reconstruction of Calcination Plant at Korba Alumina Plant (dwg 1354692)

6.5.3.1. Basic Measures

Stage III of reconstruction of the calcination plant provides for calcination of hydrate not in the two existing rotary kilns but in a new stationary fluidised bed calciner installed next to the kiln No 2.

Intensification of calcination process in a fluidised bed considerably reduces size of the unit, allows installation of the lining to ensure a low temperature of the calciner shell and ensures reduction in heat loss to air 3-5 times as compared with a rotary kiln and reduction in fuel consumption by 12-14% as compared with an improved rotary kiln.

In this case hydrate will be fed to the gas duct of the cyclone heat exchanger of the fluidisided bed calciner to be dried, dehydrated, calcined and cooled, the final product will be fed by pneumatic chamber pumps to the existing silo. Exit gas after the cyclone heat exchangers of the calciner will be fed to the gas cleaning system of the existing rotary kiln No 2 with the first stage of the cyclone cleaner (DC dust collector), consisting of four cyclones 1370 mm diameter to be expanded and the second stage of cyclones 225 mm dia (No ic dust collector) to be removed, the ESP to be retained and the fume fan (I.D.fan) to be replaced.

To feed hydrate to the fluidised bed calciner the belt conveyor supplying original hydrate will be extended, and a receiving hopper with a screw conveyor will be installed.

Firing of the kiln with oil is from the existing fuel supply line by elongation of the existing fuel oil line.

Transport of alumina from the fluidised bed calciner to the existing alumina storage silo will require construction of a new pneumatic conveyor rack between the calciner and the storage

30-32 m long fitted with pneumatic pumps.

6.5.3.2. Process Parameters of Stage III

| | |
|---|---|
| Capacity, t/h | 28 |
| Fuel consumption, kg/t | 85 |
| Hydraulic resistance, Pa | 12000 |
| Power consumption, kWh/t | 16 |
| Compressed air rate, $Nm^3/t$ | 96.4 |
| Temperature of exit gas, °C | 180-220 |

6.5.3.3. New Equipment under Stage III

Fluidised bed calciner with cyclone hear exchangers,

Calciner proper and cyclone cooler 28 t/h capacity,

Screw conveyor ø 500 mm,

Fan, Q = 44000 $m^3/h$, H = 2400 Pa,

Air blower, Q = 15000 $m^3/h$, H = 15000 Pa.

Pneumatic pumps, ø 1800 mm.

6.6. Summary Table of Major Process Parameters of Calcination plant

| S/N | Description | Unit | Plant parameters before reconstruction | Parameters under stage I and II of reconstruction | | Parameters under stage III-new calciner |
|---|---|---|---|---|---|---|
| | | | | I | II | |
| 1 | Capacity of one kiln | t/h | 12.8 | 14 | 21 | 28 |
| 2 | Fuel rate | kg/t | 124 | 112 | 98 | 85 |
| 3 | Air rate | $Nm^3/t$ | 96 | 142 | 142 | 96.4 |
| 4 | Power demand | kWh/t | 33 | 30 | 22 | 16 |

Notes: Parameters under stage II of reconstruction include measures under stage I.

Parameters in column 4 (before reconstruction) are based in reported plant data and study conducted January 17-19, 1983

6.7. Concepts of Electrical and Automation Designs

As the Feasibility study provides for reconstruction of the calcination plant in three stages the electrical and automation concepts will be considered by stages.

6.7.1. Power Supply

Reconstruction of the process equipment of the calcination plant requires no change in the existing power supply system. Change in power demand by reconstruction stages is given in Table below.

| S/N | Description | Unit | Change in power demand | | | |
|---|---|---|---|---|---|---|
| | | | stage I | stage II | stage I & II | stage III |
| 1 | New equipment | kW | 0.00 | +204.0 | +204.0 | +203.0 |
| 2 | Cancelled equipment | kW | 0.00 | -110.0 | -110.0 | -670.0 |
| | Total | | 0.00 | +94.0 | +94.0 | -467.0 |

There are no changes in power demand at stage I.

Total power demand at stage II will be somewhat higher due to provision of electrical equipment for the fluidised bed cooler (fans and air blowers).

This involves removal of electric users of the cancelled process equipment with total power rating of abt. 110 kW, including:

- two vibrating screens, total power demand 10 kW;
- two primary air fans, total power demand 22 kW;
- two I.D. fans, total power demand 45 kW;
- one blower, power demand 30 kW.

Under stage III two existing rotary calcination kilns willbe replaced by a stationary fluidised bed calciner, which involves addition of the following electric users:

- screw feeder, power demand 22 kW;
- fan, power demand 56 kW;
- air blower, power demand 125 kW.

This involves removal of the rotary kilns with the electrical equipment totaling 670 kW.

Power supply of the new electric motors will be from the standby circuit breakers of the LV panel of the transformer substation TS-5 (see dwg.1247412).

The supply and distribution lines will be laid in cables with aluminium cores and PVC insulation, and tropicalised sheath. Control and signalling lines will be laid in cables with cooper cores.

6.7.2. Automation

Stage I, in addition to the existing automation system of the calcination kilns, provides for compressed air flow rate and pressure gauges of the jet pumps.

Stage II involves an automation system of the fluidised bed cooler. The major parameters to be monitored are inlet and outlet temperatures of the dust, air, gas flows and alumina; pressure and pressure drops in the cooler chambers, air and gas lines; air rates at the trash collector section and cooler.

The control system provides for maintenance of ratio of fuel rate fed to the kiln and air rate fed to the cooler, as well as distribution of air by the cooler chambers.

To prevent breakdown of the vibrating feeder it is interlocked with a gauge of material temperature at the exit from the trash separator.

Gauges and devices under stages I and II will be mounted on the panels provided in the existing operator room in free space.

Stage III provides for automation of the fluidised bed calciner which replaces two rotary kilns.

To ensure the preset operating conditions of the calciner the following parameters will be monitored:

- alumina temperature in the shaft heat exchanger and upstream of the cyclone cooler stages, before and after the final cooler, fuel and exit gas temperatures;

- air pressure after the fans, at the fluidised bed chamber section and the final cooler, at the cyclone cooler stage, fuel pressure at the burner and exit gas pressure;

- air rate after the fans, at the fluidised bed chamber section and the final cooler, the cyclone cooler stage, fuel rate fed to the fluidised bed chamber, water rate fed to the final cooler;

- analysis of exit gas for content of oxygen and carbon dioxide after the shaft heat exchanger.

The system for automatic control of the calciner provides the following:

- maintenance of ratio of fuel and air rates fed to the fluidised bed chamber;

- distribution of air rates by sections of the fluidised bed chamber and final cooler;

- feed rate of the calciner according to temperature of exit gas.

Stage III involves provision of the operator station of the fluidised bed calciner.

6.8. Civil Enfineering concepts and Units

6.8.1. Existing vertical elevation and civil engineering concepts of calcination plant

6.8.1.1. Vertical Elevation Concepts

The calcination plant with two rotary kilns 3.6/3.3 m dia by 80.0 m long consists of three parts:

feed end (cold end of the kiln)

kilnpart

discharge part (hot end of the kiln).

Centre distance between the kilns is about 12.5 m.

The feed part of the calcination plant is an open three-bay, fivestorey structure 30.60 m high with platforms at el.9.100 m, 13.800 m, 18.000 m, 22.000 m and 30.600 m.

Plan dimension of the structure is 19.70 by 27.50 m, with larger dimension along the kiln. Two outer bays of the structure 7.20 m each are designed to accommodate the process equipment and ESP's. The centre bay (5.30 m in size) houses two hydrate receiving hoppers at el.18.000 m and a stack 2.75 m dia, 45.0 m high installed on a separate foundation at el.0.00 m.

The kiln part 70.3 m long is open. The major structures of the kiln part are four supports for each kiln, with top at el. 6.9 to 8.0 m.

Each kiln is provided with catwalks along its side from the cold to hot end for maintenance purposes mounted on separate steel supports.

The discharge part (hot of the kiln) is also a three-bay open structure 21.0 m high and plan dimensions 22.5 by 25.0 m. This structure is provided with two platforms at el.6.65 m for instrumentation and fuel supply equipment, and at el.12.000 m for location of bag filters.

A shed with bay of 22.5 m is provided above the ends of the both kilns.

Pneumatic transport of alumina from the calcination plant to the alumina storage is by Fluxo vessels mounted in a pit at the hot end of the kiln measuring 5.0 by 20.0 m in plan and floor elevation of -5.50. Length of the alumina pneumatic conveying line laid on steel supports from the Fluxo vessels to the alumina silo is 50 m.

The cable trench at el.±0.00 m passes along the whole calcination plant, with coverings of precast R.C.C. slabs.

6.8.1.2. Existing Design Concepts

Both structures of the cold and hot ends of the kiln are three-bay multi-storey steel frameworks supporting cast-in-place R.C.C. floors on secondary steel beams. All vertical supports of the frames are two-branch steel lattice columns.

The column foundations are cast-in-place R.C.C. raft foundations on R.C.C. piles 550 mm dia, 15-20 m long with bearing capacity of 100 t each. The chimney stack foundation in the feed structure is also a cast-inplace R. C.C. raft foundation supported by 10 R.C.C. piles 550 mm dia each. Floors at el. 0.00 mm are of concrete. Hoppers, chutes, guards and stairs are in steel.

The shed above the hot end of the kiln is of corrugated asbestoscement sheets laid on steel purlins carried by two triangle steel girders with span of 22.50 m.

Walls of the instrumentation and substation rooms in the structures are of brick, roofs of cast-in-place R.C.C. slabs.

Supports of the kilns are of cast-in-place R.C.C. on cast-in-place R.C.C. piles 550 mm dia, 15-18 m long.

Guard structures of the pit for the Fluxo vessels in the discharge structure (bottom, walls, slab floor) are of cast-in-place concrete.

Characteristics of Main Structural Elements Materials

All basic load-bearing steel structural elements are made of steel grade 440 to IS-226 with design load of 1550-1650 $kg/cm^2$, secondary steel members of steel grade 440 to IS-226 with design load of 1550-1650 $kg/cm^2$. For kiln supports use was made of concrete grade M-200 to IS-456, for piles - concrete grade M-200, cover slabs - concrete grade M-250, foundations and mat foundation - concrete grade M-200, floor - concrete grade M-150.

Reinforcement of the R.C.C. structures is re-bar with design tensile strength of 2100 kg/cm$^2$.

6.8.2. Proposed Major Civil-engineering Concepts

According to the proposal for reconstruction of the calcination plant by stages the civil concepts will be considered separately for each stage.

6.8.2.1. Stage I

Stage I of reconstruction of the existing rotary kilns involves an insignificant scope of civil works and is limited by:

- installation of two steel hoppers and chutes with a capacity of 1.8 m$^3$ each on the platform at el. 9.100 m in the existing structure of the cold end of the kiln and dismantling a few sections of R.C.C. floor slabs;
- installation of special supports for two cyclone dischargers 600 mm diameter each on the platform at el.120 m in the existing structure of the hot end of the kiln;
- installation of two pipe lines 100 mm diameter each for recycling dust from the cold end of the kiln to the hot end, the above lines will be fixed to the existing structural members of the cold and hot end structures of the kilns and the catwalks running along the kilns.

6.8.2.2. Stage II
(dwg.1332928-AC, sheet 1-2)

Stage II of reconstruction of the two existing rotary kilns provides for replacement of the recuperative coolers of the kilns by two stationary fluidised bed coolers. The fluidised bed coolers will be mounted at el. ±0.000 in front of the existing structure of the hot end of the kilns.

Siting the fluidised bed coolers in this area requires that two fuel oil tanks along with the fencing will be moved 5.0 m north.

Scope of civil works for construction of two fluidised bed coolers includes the following works:

- construction of two cast-in-place R.C.C. pits under the ends of the kiln for a trash separator measuring 6.0 by 6.5 m and 2.2 m deep;

- construction of cast-in-place R.C.C. foundations for each cooler;

- construction of a common (for two coolers) cast-in-place R.C.C. pit 5.4 m wide, 22.5 m long and 5.60 m deep for Cera pumps, provision is made for sheet piling of 30.0 m long and 6.0 m high from el. -2.5 m;

- construction of a shed on steel supports with corrugated asbestos-cement roofing above the new pit;

- installation of steel supports for new cyclones on the platform at el.12.0 m in the existing structure of the hot and of the kilns with dismantling small sections of R.C.C. cover slabs at el.6.650 and 12.000 m;

- moving two fuel tanks and their fencing;

- reinforcement of the existing pit near the hot and of the kilns to enable it to carry loads from the fluidised bed cooler and closing separate openings on the pit coverings with steel plates.

6.8.2.3. Stage III

(dwg.1332929-AC, sheet 1-2)

Stage III involves construction of the fluidised bed calciner next to the rotary kiln No 2 from the side of the cold end structure and installation of the alumina pneumatic conveyor rack 32 m long.

According to the process concepts the fluidised bed calciner will be mojnted on a separate open multi-storey structure with platforms at el.6.0, 12.0 and 18 m, with platforms at el.6.0 and 18.0 m coinciding with the platforms of the existing structure at the cold end of the rotary kilns, which is attributed to technological links.

The new structure's width between centres of columns is 9.4 m and length 60.0 m, while all process equipment is located on the first (lower) platform.

To align the foundations for the columns of the new structure of cold end the centre distance between the outer columns is assumed equal to 3.0 m.

The framework of the proposed structure will be of steel with cast-in-place R.C.C. on steel purlins.

Foundations for columns of the structure are as follows:

- supports bearing direct load of the calciner are in form of cast-in-place mat foundations on piles (bore and driven piles) 550 mm dia, 18 m long;

- other supports in form of cast-in-place R. C.C. foundation on natural bed;

- foundations for equipment located at ground level are of cast-in-place R.C.C. and C.C. type.

As fencing structures (walls and roof) of the extended hydrate conveyor the use is made of asbestos-cement sheets on steel structures, and bricks for walls of a built-in instrumentation room.

The alumina pneumatic conveyor rack from the calciner to the storage is of open type, on steel supports 5.0 m high and pitch measuring 6.0 m; the upper part of the rack is also in steel.

Foundations for supports of the rack are on natural bed, made of cast-in-place R.C.C.

6.9. Estimate cost

Estimate cost of the reconstruction of calcination kilns is determined on the basis of the financial estimation carried out in accordance with the Initial data for elaboration of the Feasibility Report, which has been collected by the group of experts of VAMI Institute of Ministry for Non-ferrous metals of the USSR in collaboration with BALCO who renders assistance under this project.

6.9.1. Technology cost

The cost of know-how was determined by the Soviet side similar to world practice in calculation of analog costs taking into consideration the tax on know-how in amount of 25,0 % of its total cost. The Total sum of capital costs for technology acquisition makes:

I stage - Rs. 339,600

II stage - Rs. 398,200

III stage - Rs. 1,138,200

(ref.to Shedule 6-1)

6.9.2. Equipment cost

Capital costs for acquisition and erection of equipment include the following cost items: equipment and materials, erection works, primary stock of spare parts, port charges, bank charges, cost of transportation from port to construction site and insurance charges for imported equipment.

The production equipment includes the major process equipment, handling equipment, electrical equipment, instrumentation and automation equipment for main process operations.

For calculations of capital costs the costs of equipment, materials and erection are adopted as follows:

- for equipment and materials supplied from the USSR (instruments and automation equipment, cables) - in accordance with V/O Tsvetmetpromexport data based on 1983 price level;

- for equipment and materials supplied by Indian side, as well as for the cost of initial stock of spare parts (5%of equipment cost), bank charges (5%) - in accordance with BALCO data given in the Initial data for the preparation of the Feasibility Report of reconstruction study of Alumina Calciner for energy conservation at Korba Alumina Plant in India and also with the initial data for the preparation of the Feasibility Report of the setting-up of Gallium production at the same plant.

The investment costs were calculated for 1983 price level without taking into account the escalation.

On the basis of the costs mentioned above the total cost of equipment and materials makes:

I stage - Rs. 637,100

II stage - Rs. 6,578,600

III stage - Rs. 9,192,800

(Ref.to Schedules 6-2, 6-3).

### 6.9.3. Cost of buildings, structures and other civil works

The estimated cost of buildings and structures includes the construction works for reconstruction of the Calcination Plant - dismantling of RCC and steel structures, construction of new foundations for equipment, pits, steel framework structures, racks, platforms, lining and heat insulation.

The estimated cost of construction works is determined basing on the overall quantities of civil works and on unit rates in accordance with BALCO data given in Annexures to the Initial data.

The price level is adopted for the beginning of 1983 without taking into account the escalation.

The estimated cost of construction works by stages of reconstruction makes:

I stage - Rs. 896,400

II stage - Rs. 5,153,600

III stage - Rs. 9,162,200

(Ref.to Schedules 6-4, 6-5).

**Estimate of technology costs:**

**Lump-sum payments.**

Schedule 6-1 .

| S-No | Cost item | Foreign | Local | Total Rs.000 |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
| | <u>Stage I</u> | | | |
| 1 | Cost of technology know-how | 271.7 | | 271.7 |
| 2 | Tax on know-how | - | 67.9 | 67.9 |
| | Total of Stage I | 271.7 | 67.9 | 339.6 |
| | <u>Stage II</u> | | | |
| 1 | Cost of technology know-how | 318.6 | - | 318.6 |
| 2 | Tax on know-how | - | 79.6 | 79.6 |
| | Total of Stage II | 318.6 | 79.6 | 398.2 |
| | <u>Stage III</u> | | | |
| 1 | Cost of technology know-how | 910.6 | - | 910.6 |
| 2 | Tax on know-how | - | 227.6 | 227.6 |
| | Total of Stage III | 910.6 | 227.6 | 1138.2 |

Estimate of Investment cost

Schedules 6-2, 6-3

Estimate of investment cost

Equipment

Project component - Calcination plant

| S. No | Quan-tity | Unit | Item description | Lo-cal | Fore-ign | Unit price, Rs.000 | Cost, Rs. 000 fo-reign | lo-cal | total |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | | | Stage I | | | | | | |
| | | | Production equip-ment | | | | | | |
| 1 | 37.8 | t | Process equipment | + | - | 12.42 | - | 469.5 | 469.5 |
| | | | Spare parts | | | | - | 0.5 | 0.5 |
| | | | Erection | | | | - | 38.0 | 38.0 |
| | | | Total | | | | - | 508.0 | 508.0 |
| 2 | 0.52 | t | Instrumentation and controls | -<br>+ | +<br>- | 162.3<br>50.3 | 84.4 | 15.6 | 100.0 |
| | 0.31 | | Spare parts | | + | | 4.0 | - | 4.0 |
| | | | Erection | | | | - | 18.5 | 18.5 |
| | | | Total | | | | 88.4 | 34.1 | 122.5 |
| | | | TOTAL of 1 | | | | 88.4 | 542.1 | 630.5 |
| 3 | 1.5 | % | Port charges and levies | + | - | 88.4 | - | 1.3 | 1.3 |
| 4 | 1 | % | Bank charges | + | - | 88.4 | - | 0.9 | 0.9 |
| 5 | 5 | % | Transportation from port of deli-very to construc-tion site including loading-unloading | | | | | | |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|
| | | | operations and insurance | + | - | 88.4 | - | 4.4 | 4.4 |
| | | | TOTAL of Stage I | | | 88.4 | | 548.7 | 637.1 |
| | | | **Stage II** | | | | | | |
| | | | Production equipment | | | | | | |
| 1 | 322.2 | t | Process equipment | + | - | 13.98 | - | 4506.4 | 4506.4 |
| | | | Spare parts | | | | | 33.6 | 33.6 |
| | | | Erection | + | | | - | 504.2 | 504.2 |
| | | | Total | | | | | 5044.2 | 5044.2 |
| 2 | 2.96 | t | Electrical equipment | + | - | 47.7 | - | 141.2 | 141.2 |
| | | | Spare parts | + | - | | - | 1.8 | 1.8 |
| | | | Erection | | | | - | 28.2 | 28.2 |
| | | | Total | | | | | 171.2 | 171.2 |
| 3 | 2.79 | t | Instrumentation and controls | -<br>+ | +<br>- | 344.59<br>185.0 | 961.4 | 77.7 | 1039.1 |
| | | | Spare parts | - | + | | 47.7 | - | 47.7 |
| | | | Erection | + | - | | - | 200.8 | 200.8 |
| | | | Total | | | | 1009.1 | 278.5 | 1287.6 |
| | | | TOTAL of 1 | + | + | | 1009.1 | 5493.9 | 6503.0 |
| 4 | 1.5 | % | Port charges | + | - | | - | 15.1 | 15.1 |
| 5 | 1 | % | Bank charges | + | - | | - | 10.1 | 10.1 |
| 6 | 5 | % | Transportation from port of delivery to construction site including loading-unloading operations and insurance | + | - | | - | 50.4 | 50.4 |
| | | | TOTAL of Stage II | | | | 1009.1 | 5569.5 | 6578,6 |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|
| | | | **Stage III**<br>Production equipment | | | | | | |
| 1 | 261.1 | t | Process equipment | + | - | 20.1 | - | 7256.7 | 7256.7 |
| | | | Spare parts | + | - | | - | 15.0 | 15.0 |
| | | | Erection | + | - | | - | 682.4 | 682.4 |
| | | | Total | | | | | 7954.1 | 7954.1 |
| 2 | 2.13 | t | Electrical equipment | + | - | 44.13 | - | 94.0 | 94.0 |
| | | | Spare parts | + | - | | - | 13.2 | 13.2 |
| | | | Erection | + | - | | - | 21.2 | 21.2 |
| | | | Total | | | | | 128.4 | 128.4 |
| 3 | 3.1<br>0.36 | t<br>t | Instrumentation and controls | -<br>+ | +<br>- | 259.42<br>105.55 | 804.2 | 38.0 | 842.2 |
| | | | Spare parts | | + | | 39.8 | - | 39.8 |
| | | | Erection | + | - | | - | 165.0 | 165.0 |
| | | | Total | | | | 844.0 | 203.0 | 1047.0 |
| | | | TOTAL of 1 | | | | 844.0 | 8285.5 | 9129.5 |
| 4 | 1.5 | % | Port charges | + | - | | - | 12.7 | 12.7 |
| 5 | 1 | % | Bank charges | + | - | | - | 8.4 | 8.4 |
| 6 | 5 | % | Transportation from port of delivery to construction site including loading- unloading operations and insurance | + | - | | - | 42.2 | 42.2 |
| | | | TOTAL of Stage III | | | | 844.0 | 8348.8 | 9192.8 |

Estimate of investment cost

Schedules 6-4
6-5

Estimate of investment cost

Civil engineering works

Project component - Calcination Plant

| S. No | Quan-tity | Unit | Item description | Lo-cal | Fore-ign | Unit cost, Rs.000 | Cost, Rs.000 foreign | local | total |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | | | **Stage I** | | | | | | |
| | | | Buildings and special engineering works | | | | | | |
| 1 | - | - | General and special engineering works | + | - | | - | 72.7 | 72.7 |
| 2 | 80 | $m^3$ | Lining works | + | - | 10.3 | - | 823.7 | 823.7 |
| | | | TOTAL of Stage I | + | - | | | 896.4 | 896.4 |
| | | | **Stage II** | | | | | | |
| | | | Buildings and special engineering works | | | | | | |
| 1 | | - | General and special engineering works | + | - | | - | 1181.6 | 1181.6 |
| 2 | 450 | $m^3$ | Lining and heat insulation works | + | - | 8.8 | - | 3972.0 | 3972.0 |
| | | | TOTAL of Stage II | | | | | 5153.6 | 5153.6 |
| | | | **Stage III** | | | | | | |
| | | | Buildings and special engineering works | | | | | | |
| 1 | - | - | General and special civil engineering works | + | - | | - | 5448.1 | 5448.1 |
| 2 | 375 | $m^2$ | Lining works | + | - | 9.9 | - | 3714.1 | 3714.1 |
| | | | TOTAL of Stage III | + | - | | - | 9162.2 | 9162.2 |

## 7. PRODUCTION PROCEDURE AND ADDITIONAL COSTS

As it has been noted above, the calcination department is one of the main units of the alumina production. A modification project at Korba alumina plant does not envisage any change in the production scheme established at the plant.

The modification is aimed at improving and modernizing the calcination process to increase an efficiency of the fuel use and to reduce its specific consumption.

As it has been noted (section 4.4) the modification will not require additional direct costs connected with services or labour for this department.

The additional expenditures provided for in the Feasibility Report include the routine repair and maintenance of the facilities to be established, their depriciation and financial charges. These expenses form the overheads and are included into the fixed production costs.

According to the basic data for preparation of the Feasibility Report the current repair and maintenance costs to be at 0.5% of the buildings and structures costs and 2.5% of the equipment costs, and depreciation - at 6.5% of the total investments (without an interest paid during the reconstruction period), as is a current practice of the plent activity.

An interest is calculated from the conditions of the loan for reconstruction activities, their repayment and an annual amount to be paid, according to the initial data.

An Income tax and dividents to the shareholders were not included into the calculations because at the present time the plant as a whole is not quite profitable.

## 8. PERSONNEL

A reconstruction of the calcination department will not involve any change in the structure and quantity of the main production staff of the department. Repair andmaintenance of the newly installed equipment to be carried out by the existing facilities of the plant.

## 9. PROJECT IMPLEMENTATION

### 9.1. Programme and time table of the project

According to the request of the Indian side for reducing the required capital investmets it is planned to carry out the reconstruction project in three stages.

The first stage co-vering a hydrate thermal treatment and requiring small capital investments (Rs. 2.9 mln) can be carried out during 6 months without time required for the engineering work. To simplify the calculations the reconstruction costs will be included into the finished product costs starting from the next year after commencement of the reconstruction taking into account a design capacity of the calcination department.

The second stage involves an installation of the fluid bed coolers. The carrying out of this stage does not exclude the costs involved in the hydrate thermal treatment of the first stage, they can be effected simultaneously.

Taking into account that the project will be implemented in stages, a timetable for carrying out these two stages was taken as a basis when calculating the performance figures for the second stage. First the thermal hydrate treatment is carried out (stage I) and then an installation of the fluid bed coolers for the both calcination kilns. For these two stages it is planned to carry out construction work and installation of the equipment during one year without taking into account the time required for engineering work.

A design capacity of the rebuilt facilities will be reached starting from the year following a completion of the reconstruction project (in calculations the third year after a commencement of the reconstruction is taken as a reference). Starting from this year the costs incurred will be written off and a total effect of reduction of the fuel consumption will be taken into account.

The third stage is considered separately from the first two stages, because it involves a complete replacement of the calcination kilns (complete with coolers, fuel supply systems and hydrate charging facilities) by a fluid bed calcination unit. So, a total amount of savings for this stage from reduction in a fuel and power consumption does not result from the previous measures aimed at their reducing.

On the basis of an utilization factor for the plant's equipment (an utilization factor for the main process equipment is below 37%), this stage is considered as a promising alternative. Its realization is expedient for a higher production level because an operation of this unit requires stable process conditions for a specific utilization level of the production capacity. Besides, this stage during a replacement of the equipment will bring some losses due to a reduction of the production output.

The 3-d stage is the most capital intensive one (Rs.25.2mln). A design capacity for this stage is assumed equal to that for the 1-st and 2-nd stages. It is planned to reach this capacity in a year following completion of the reconstruction (or in the third year from the beginning of reconstruction works).

9.2. Project Implementation Variants

As for as the second reconstruction stage is concerned, an additional alternative is considered of installing a fluid bed cooler for one calcination kiln only keeping in mind that an installation of the fluid bed cooler ensures a considerable (by 64% as compared with the design figure) increase of a calcination kiln capacity. This alternative, as compared with an installation of the coolers for the both kilns, will require less capital investments - by Rs. 7.2 mln of 45.5%. Taking into account that the measures are fully introduced for a hydrate thermal treatment (stage I), a total amount of the capital costs for this alternative is Rs.11.56 mln against Rs.18.81 mln of the basic variant (stage II).

On the basis of a design capacity of the kiln under modification (150 thos.t/year) its normal reachable capacity is assumed in the calculations equal to 150 thous.t/year) its normal reachable capacity is assumed in the calculations equal to 150 thous.t/year. The remaining 50 thous.t/year required for reaching a design capacity of the calcination department will be produced by the operating kiln where the first stage works only were carried out.

In the calculations for an existing production level the fuel savings are taken into account which are ensured, as a whole, through an operation of the kiln with a fluid bed cooler.

For calculation of the cash flows, IRRI and a break-even point of the variants under consideration see Appendix

Below, in the Schedule 9-1 summary of the techno-economic parameters is given of the variant considered in comparison with the basic stage No 2

Schedule 9-1

Comparison of Parameters of the
Reconstruction Variants

| Description | Unit of measure | Current capacity variants | | Design variants | |
|---|---|---|---|---|---|
| | | basic-reconstruction of two kilns (stageII) | reconstruction of one kiln | basic-reconstruction of two kilns (stageII) | recontsruction of one kiln |
| 1. Annual output | thous.t | 85 | 85 | 200 | 200 |
| 2. Reduction in annual consumption of fuel oil | | | | | |
| 3. Capital investments, total | Rs.mln | 18.8 | 11.6 | 18.8 | 11.6 |
| including | | | | | |
| 3.1. Hydrate thermal treatment | -"- | 2.9 | 2.9 | 2.9 | 2.9 |
| 3.2. Installation of fluid bed cooler | -"- | 15.9 | 8.7 | 15.9 | 8.7 |
| 4. IRRI | % | 31.9 | 49.5 | 74.1 | 93.7 |
| 5. Break-even point | thous.t | 21.0 | 17.9 | 21.0 | 17.9 |
| 6. Payback period | year | 2.8 | 1.5 | 1.2 | 0.8 |

As one can see from the data above, the most preferrable variant in a level of costs and their efficiency is a reconstruction of the calcination department involving an installation of the fluid bed cooler for one kiln only. Besides, in this case in the long run there is a possibility without reducing a total output of the department, through some extra capacity available, of using an existing calcination kiln for production, for example, of special grade aluminas.

Estimate of investment cost

Schedule 9-2

Estimate of investment cost

Project implementation

Project component - Calcination Plant

| S. No | Quantity | Unit | Item description | Local | Foreing | Unit cost, Rs.000 | Cost, Rs.000 | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | foreign | local | total |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 1 | | | **Stage I** | | | | | | |
| | | | Control, co-ordination start-up and commissioning | + | - | | | 5.7 | 5.7 |
| 2 | | | Units insurance | + | - | | | 7.6 | 7.6 |
| 3 | | | Accomodation of Soviet experts deputied to India for rendering technical assistance | + | + | | 297.5 | 69.0 | 366.5 |
| 4 | | | Income taxes for services of Soviet experts | + | | | - | 198.3 | 198.3 |
| 5 | | | Design works | - | + | | 187.0 | - | 187.0 |
| 6 | | | Administration charges | + | - | | - | 1.0 | 1.0 |
| 7 | | | Contingencies | + | + | | 84.4 | 179.4 | 263.8 |
| | | | TOTAL of Stage I | | | | 568.9 | 461,0 | 1029.9 |
| | | | **Stage II** | | | | | | |
| 1 | | | Control, co-ordination, start-up and commissioning | + | - | | - | 57.7 | 57.7 |
| 2 | | | Units insurance | + | - | | - | 58.3 | 58.3 |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|
| 3 | | | Accomodation of Soviet experts deputied to India for rendering technical assistance | + | + | | 400.0 | 117.0 | 517.0 |
| 4 | | | Income taxes for services of Soviet experts | + | - | | - | 266.7 | 266.7 |
| 5 | | | Design works | - | + | | 1427.6 | - | 1427.6 |
| 6 | | | Administration charges | + | - | | | 6.0 | 6.0 |
| 7 | | | Contingencies | + | + | | 315.7 | 1130.6 | 1446.3 |
| | | | TOTAL of stage II | | | | 2143.3 | 1636,3 | 3779.6 |
| | | | Stage III | | | | | | |
| 1 | | | Control, co-ordination, start-up and commissioning | + | - | | - | 82.6 | 82.6 |
| 2 | | | Units insurance | + | - | | - | 91.5 | 91.5 |
| 3 | | | Accomodation of Soviet experts deputied to India for rendering technical assistance | + | + | | 517.5 | 174.0 | 691.5 |
| 4 | | | Income taxes for services of Soviet experts | + | - | | - | 345.0 | 345.0 |
| 5 | | | Design works | - | + | | - | 10.0 | 10.0 |
| 6 | | | Contingencies | + | + | | 451.2 | 2546.9 | 5755.8 |
| | | | TOTAL of Stage III | | | | 3208.9 | 2546.9 | 5755.8 |

## 10. FINANCIAL AND ECONOMIC EVALUATION

The financial and economic evaluation of the calcination plant reconstruction study was prepared by stages in order to show their effectiveness with respect to two levels of capacity of the plant: existing (85.000 tpy) and design (200.000 tpy).

Installation of the hydrate drier (stage I) and the fluidised bed cooler (stage II) is considered as successive stages of reconstruction. Replacement of the rotary kilns by the fluidised bed calciner (stage III) is assessed separately from stage I & II, since, this stage is a complex of separate engineering concepts technologically not related to two first stages and can be implemented without a preliminary modernisation of the equipment, or at later stages of reconstruction.

Production expenses for the calcination plant at Korbaalumina plant include a major cost item - fuel (75-78%), which is oil. Reconstruction of the calcination plant with the view to conserve oil (at high prevailing price of Rs 2870/t of oil) ensures a significant economic saving.

This saving is shown in calculations as an additional revenue of the calcination department accrued from lower fuel costs and other utilities costs (electric power, compressed air, industrial water).

Table 10-0 below shows calculations of the additional revenue by the reconstruction stages and capacity levels of the calcination department.

Assessment of costs is made basing on the actual price level as of beginning of 1983 excluding price escalation in accordance with the Initial data and capital investment costs.

To estimate foreign exchange component it was assumed that Rs 10 is equivalent to R 1 in conformity with the intergovernmental agreement for construction of industrial plant in India.

The financial analysis includes:

- estimate of cash flow from the beginning of reconstruction over the whole operating life (15 years);

- estimate and determination of IRR on total capital investment, including IRR on equity, payback period and breakeven point of the reconstruction project;

- sensitivity analysis showing effect of fuel oil price on IRR, payback period and breakeven point items.

Economic evaluation involves determination in estimated form of requirements for additional capital investment for implementation of the measures by stages of reconstruction, additional production costs related to scheduled repair and maintenante of the fixed assets, and finances. Evaluation is based on estimates of capital investment by cost items (general civil works, equipment, know-how, preparatory costs), the Initial data on magnitude of operating costs, depreciation, financing sources, and amount and terms.

Schedule 10-0

Estimate of additional revenue from fuel and utilities saving

| Stages and cost categories | Unit of measure, x/000 | Unit cost, Rs | Consumption per 1 tonne of alumina | | Capacity | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | existing, 85,000 tpy | | designed, 200,000 tpy | |
| | | | before reconstruction | after reconstruction | reduction(-), increase (+) of annual consumption | annual profit, Rs.000 | reduction (-), increase (+) of annual consumption | annual profit, Rs.000 |
| **Stage I** | | | | | | | | |
| 1. Fuel oil | kg | 2870 | 0.124 | 0,112 | -1020 | 2927 | -2400 | 6888 |
| 2. Power | kWh | 400 | 0.033 | 0.03 | -255 | 102 | -600 | 240 |
| 3. Compressed air | $nm^3$ | 1.6 | 0.096 | 0.142 | +3910 | -6 | +9200 | -15 |
| Total of I | - | - | - | - | - | 3023 | - | 7113 |
| Same, per 1 tonne of alumina, Rs | - | - | - | - | - | 35.6 | - | 35.6 |
| **Stage II** | | | | | | | | |
| 1. Fuel oil | kg | 2870 | 0.112 | 0.098 | -1190 | 3415 | -280 | 8036 |
| 2. Power | kWh | 400 | 0.03 | 0.022 | -680 | 272 | -1600 | 640 |
| TOTAL of II | | - | - | - | - | 3687 | - | 8676 |
| TOTAL of stages I + II | | | | | | | | |
| Same, per 1 tonne of alumina, Rs | - | - | - | - | - | 78.9 | | 78.9 |
| **Stage III** | | | | | | | | |
| 1. Fuel oil | kg | 2870 | 0.124 | 0.085 | -3315 | 9514 | -7800 | 22386 |
| 2. Power | kWh | 400 | 0.033 | 0.016 | -1445 | 578 | -3400 | 1360 |
| 3. Industrial water | $m^3$ | 250 | 0.007 | 0.003 | -340 | 85 | -800 | 200 |
| TOTAL of III | - | - | - | - | - | 10177 | - | 23946 |
| Same, per 1 tonne alumina, Rs | - | - | - | - | - | 119.7 | | 119.7 |

### 10.1. Total Investment Costs

Total investment cost by reconstruction stages is determined as sum of basic (civil works, equipment, incl. installation and know-how costs) and preliminary (to be used at the preparatory stage) capital costs amounting to (Rs thousand):

| | Stages | | | |
|---|---|---|---|---|
| | I | II | I & II | III |
| 1. Fixed investment cost, total | 2060 | 133343 | 15403 | 21442 |
| 1.1. Civil works | 986 | 5669 | 6655 | 10078.5 |
| 1.2. Equipment | 700.5 | 7236 | 7936.5 | 10111.5 |
| 1.3. Know-how | 373.5 | 438 | 811.5 | 1252 |
| 2. Preliminary expenses | 843 | 2567 | 3410 | 3807 |
| TOTAL | 2903 | 15910 | 18813 | 25249 |

Amount of fixed assets (Rs 2060, 13343 and 21442 thousand, by stages respectively) is estimated on the basis of estimates (Section 6, Schedules 6-1, 6-2, 6-3).

Scheduel 10-1 shows breakdown of the fixed capital costs by cost items.

For the purpose of calculations the Feasibility report assumes that part of the equipment (instrumentation and automation) will be imported and so the equipment cost includes bank and installation costs.

The cost of process know-how includes a know-how tax.

Fixed assets include also a contingency of 10% of total cost.

Breakdown of preparatory costs estimated by reconstruction stages as Rs 843, 2567 and 3807 thousand, respectively (indluding a contingency) is shown in Schedule 10-2.

Summary of capital requirements is shown in Schedule 10-3.

Breakdown of total investment costs by years of reconstruction under stage I & II is shown in Schedule 10-4, and under stage III - in Schedule 10-5.

Estimates of total capital requirements do not include the working capital, as it is expected that implementation of the reconstruction project will require no additional expenses for the working capital for the calcination section.

Schedule 10-1

# Fixed investment cost

Rs.000

| Stages / costs / investment category | I fore-ign | I local | I total | II fore-ign | II local | II total | I + II fore-ign | I + II local | I + II total | III fore-ign | III local | III total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| 1. Buildings and structures | - | 72.7 | 72.7 | - | 1181.6 | 1181.6 | - | 1254.3 | 1254.3 | - | 5448.1 | 5448.1 |
| 1.1. General construction works | | | | | | | | | | | | |
| 1.2. Lining and heat insulation works | - | 823.7 | 823.7 | - | 3972.0 | 3972.0 | - | 4795.7 | 4795.7 | - | 3714.1 | 3714.1 |
| 1.3. Contingencies | - | 89.6 | 89.6 | | 515.4 | 515.4 | - | 605.0 | 605.0 | - | 916.3 | 916.3 |
| Total of I | - | 986.0 | 986.0 | - | 5669.0 | 5669.0 | - | 6655.0 | 6655.0 | - | 10078.5 | 10078.5 |
| 2. Technology | | | | | | | | | | | | |
| 2.1. Know-how | 271.7 | - | 271.7 | 318.6 | - | 318.6 | 590.3 | - | 590.3 | 910.6 | - | 910.6 |
| 2.2. Tax on know-how | - | 67.9 | 67.9 | - | 79.6 | 79.6 | - | 147.5 | 147.- | - | 227.6 | 227.6 |
| 2.3. Contingencies | 27.2 | 6.7 | 33.9 | 31.9 | 7.9 | 39.8 | 59.1 | 14.6 | 73.7 | 91.0 | 22.8 | 113.8 |
| Total of 2 | 289.9 | 74.6 | 373.5 | 350.5 | 87.5 | 438.0 | 649.4 | 162.1 | 811.5 | 1001.6 | 250.4 | 1252.0 |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3. Equipment | | | | | | | | | | | | |
| 3.1. Process | - | 470.0 | 470.0 | - | 4540.0 | 4540.0 | - | 5010.0 | 5010.0 | - | 7271.7 | 7271.7 |
| 3.2. Electrical | - | - | - | - | 143.0 | 143.0 | - | 143.0 | 143.0 | - | 107.2 | 107.2 |
| 3.3. Instrumentation & automation | 88.4 | 15.6 | 104.0 | 1009.1 | 77.7 | 1086.8 | 1097.5 | 93.3 | 1190.8 | 844.0 | 38.0 | 882.0 |
| 3.4. Port charges & levies | - | 1.3 | 1.3 | - | 15.1 | 15.1 | - | 16.4 | 16.4 | - | 12.7 | 12.7 |
| 3.5. Bank charges | - | 0.9 | 0.9 | - | 10.1 | 10.1 | - | 11.0 | 11.0 | - | 8.4 | 8.4 |
| 3.6. Transportation from port to site | - | 4.4 | 4.4 | - | 50.4 | 50.4 | - | 54.8 | 54.8 | - | 42.2 | 42.2 |
| 3.7. Equipment erection | - | 56.5 | 56.5 | - | 733.2 | 733.2 | - | 789.7 | 789.7 | - | 868.6 | 868.6 |
| 3.8. Contingencies | 8.8 | 54.6 | 63.4 | 100.9 | 556.5 | 657.4 | 109.7 | 611.1 | 720.8 | 84.4 | 834.3 | 918.7 |
| TOTAL of 3 | 97.2 | 603.3 | 700.5 | 1110.0 | 6126.0 | 7236.0 | 1207.2 | 6729.3 | 7936.5 | 928.4 | 9183.1 | 10111.5 |
| TOTAL fixed investment costs | 396.1 | 1663.9 | 2060.0 | 1460.5 | 11882.5 | 13343.0 | 1856.6 | 13546.4 | 15403.0 | 1930.0 | 19512.0 | 21442.0 |

Schedule 10-2

Preproduction capital expenditures

Rs.000

| S.No | Stages / costs / cost category | I foreign | I local | I total | II foreign | II local | II total | I + II foreign | I + II local | I + II total | III foreign | III local | III total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Control, co-ordination, start-up and commissioning | - | 5.7 | 5.7 | - | 57.7 | 57.7 | - | 63.4 | 63.4 | - | 82.6 | 82.6 |
| 2 | Unit insurance | - | 7.6 | 7.6 | - | 58.3 | 58.3 | - | 65.9 | 65.9 | - | 91.5 | 91.5 |
| 3 | Accomodations of Soviet experts dispatched to India for rendering technical assistance | 297.5 | 69.0 | 366.5 | 400.0 | 117.0 | 517.0 | 697.5 | 186.0 | 833.5 | 517.5 | 174.0 | 692.5 |
| 4 | Tax on services of Soviet experts | - | 198.3 | 198.3 | - | 266.7 | 266.7 | - | 465.0 | 465.0 | - | 345.0 | 345.0 |
| 5 | Design works | 187.0 | - | 187.0 | 1427.6 | - | 1427.6 | 1614.6 | - | 1614.6 | 2240.2 | - | 2240.2 |
| 6 | Administration charges | - | 1.0 | 1.0 | - | 6.0 | 6.0 | - | 7.0 | 7.0 | - | 10.0 | 10.0 |
| 7 | Contingencies | 48.4 | 28.5 | 76.9 | 182.9 | 50.8 | 233.7 | 231.3 | 79.3 | 310.6 | 275.8 | 70.4 | 346.2 |
| | TOTAL preproduction | 532.9 | 310.1 | 843. | 2010.5 | 556.5 | 2567.0 | 2543.4 | 866.6 | 3410.0 | 3033.5 | 773.5 | 3807.8 |

Schedule 10-3

Summary Table of capital costs

| Stages / cost category | I | | | II | | | I + II | | | III | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| cost | foreign | local | total | foreign | local | total | foreign | local | total | foreign | local | total |
| 1. Fixed investment costs | 396.1 | 1663.9 | 2060. | 1460.5 | 11882.5 | 13343.0 | 1856.6 | 13546.4 | 15403 | 1930 | 19512 | 21442 |
| 2. Preproduction capital costs | 532.9 | 310.1 | 843 | 2010.5 | 556.5 | 2567 | 2543.4 | 866.6 | 3410 | 3033.5 | 773.5 | 3807 |
| TOTAL cost | 929 | 1974 | 2903 | 3471 | 12439 | 15910 | 4400 | 14413 | 18813 | 4963.5 | 20285.5 | 25249 |

Schedule 10-4

Break-down of total capital investment by years
Stages I and II

Rs.000

| Period years costs / cost category | Reconstruction I | | | Reconstruction II | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | fore-ign | local | total | fore-ign | local | total | fore-ign | local | total |
| **I stage** | | | | | | | | | |
| 1. Fixed capital investment | 396.1 | 1663.9 | 2060 | - | - | - | 396.1 | 1663.9 | 2060 |
| 2. Preproduction capital costs | 532.9 | 310.1 | 843 | - | - | - | 532.9 | 310.1 | 843 |
| Total of stage I | 929 | 1974 | 2930 | - | - | - | 929 | 1974 | 2903 |
| **II stage** | | | | | | | | | |
| 1. Fixed capital investment | - | - | - | 1460.5 | 11882.5 | 13343 | 1460.5 | 11882.5 | 13343 |
| 2. Preproduction capital costs | - | - | - | 2010.5 | 556.5 | 2567 | 2010.5 | 556.5 | 2567 |
| Total of stage II | - | - | - | 3471 | 12439 | 15910 | 3471 | 12439 | 15910 |
| TOTAL of stages I + II | 929 | 1974 | 2903 | 3471 | 12439 | 15910 | 4400 | 14413 | 18813 |

Schedule 10-5

Break-down of total capital investment by years
Stage III

Rs.000

| Period / years / costs / cost category | Reconstruction | | | | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | I | | | II | | | | | |
| | foreign | local | total | foreign | local | total | foreign | local | total |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 1. Fixed capital investment | | | | | | | | | |
| 1.1. Buildings and structures | - | 6720.0 | 6720.0 | - | 3358.5 | 3358.5 | - | 10078.5 | 10078.5 |
| 1.2. Technology | 1001.6 | 250.4 | 1252.0 | - | - | - | 1001.6 | 250.4 | 1252.0 |
| 1.3. Equipment | - | 4578.9 | 4578.5 | 928.4 | 4604.6 | 5533 | 928.4 | 9183.1 | 10112.5 |
| Total of I | 1001.6 | 11548.9 | 12550.5 | 928.4 | 7963.1 | 8891.5 | 1930.0 | 1951 | 21442 |
| 2. Preproduction capital costs | | | | | | | | | |
| 2.1. Insurance of units, design works | 2240.2 | 91.5 | 2331.7 | - | - | - | 2240.2 | 91.5 | 2331.7 |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|
| 2.2. Control and co-ordination of Soviet experts (including tax) and administration charges | 344.0 | 402.0 | 746.0 | 173.5 | 209.6 | 383.1 | 517.5 | 611.6 | 1129.1 |
| 2.3. Contingencies | 258.4 | 49.4 | 307.8 | 17.4 | 21.0 | 38.4 | 275.8 | 70.4 | 346.2 |
| Total of III | 2842.6 | 542.9 | 3385.5 | 190.9 | 230.6 | 421.5 | 3033.5 | 773.5 | 3807. |
| GRAND TOTAL | 3844.2 | 12091.8 | 15936 | 1119.3 | 8193.7 | 9313 | 4963.5 | 20285.5 | 25249.0 |

## 10.2. Project Financing

According to the initial data the estimates assume shares (50%) and long-term bank loans (50%) as the main sources of financing for reconstruction stages of the calcination plant.

Based on the above ratio amounts of money by financing sources and reconstruction stages are estimated as follows (RS thousand):

| | Stages | | | |
|---|---|---|---|---|
| | I | II | I & II | III |
| 1. Governmental shares | 1452 | 7955 | 9407 | 12625 |
| 2. Long-term loans (12.5% interest) | 1452 | 7955 | 9406 | 12624 |
| Total | 2903 | 15910 | 18813 | 25249 |

Schedules 10-6, 10-7 show breakdown of financing sources by years of reconstruction.

The estimates assume the following conditions for granting long-term loans:

- interest rate - 12.5%;
- debt payment is by equal installments for 10 years starting with commissioning the reconstructed units;
- loan interest accumulated on semi-annual basis during reconstruction period will be paid along with the original amounts under the same conditions;
- debt payments are effected at the end of each year.

Schedule 10-6

Break-down of financing sources by years

Stages I and II

Rs.000

| Period | Reconstruction | | Total |
|---|---|---|---|
| years | 1 | 2 | |
| costs / cost category | local | | |
| I Stage | | | |
| 1. Government equities | 1452 | - | 1452 |
| 2. Long-term loan | 1451 | - | 1451 |
| Total of Stage I | 2903 | - | 2903 |
| II Stage | | | |
| 1. Government equities | - | 7955 | 7955 |
| 2. Long-term loan | - | 7955 | 7955 |
| Total of Stage II | - | 15910 | 15910 |
| TOTAL of Stages I + II | | | |

Schedule 10-7

Break-down of financing sources by years

Stage III

Rs.000

| Period / years / costs / cost category | Reconstruction 1 local | 2 | Total |
|---|---|---|---|
| 1. Government equities | 12625 | - | 12625 |
| 2. Long-term loan | 3311 | 9313 | 12624 |
| TOTAL | 15936 | 9313 | |

## 10.3. Production Costs

Production costs resulting from reconstruction of the calcination plant include additional operating costs by reconstruction stages related to routine repairs, maintenance of newly installed equipment, depreciation of capital investment and loan interest.

The estimate of additional opere'ing costs is based on capital investment by cost items and financing sources by reconstruction stages, and also the initial data used for calculations of repair and maintenance costs of buildings, structures and equipment, depreciation as shown in Section 7. Loan interest in calculated over the loan payment time on the basis of annual interest rate (12.5%).

Schedule 10-8 shows estimate of annual production costs.

Production costs under stage II were estimated including additional expenses of stage I of reconstruction.

Schedule 10-8

Estimate of additional production costs

| Stages and cost categories | Capital invest-ment, Rs.000 | Rate, % | Annual costs, Rs.000 |
|---|---|---|---|
| 1 | 2 | 3 | 4 |
| Stage I | | | |
| 1. Scheduled repair and maintenance | | | |
| 1.1. Buildings and structures | 986 | 0.5 | 5 |

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| 1.2. Equipment | 700.5 | 2.5 | 18 |
| Total of 1 | 1686.5 | 1.4 | 23 |
| 2. Depreciation | 2903 | 6.5 | 189 |
| 3. Interest (average of estimated operation period) | - | - | 76 |
| Total of Stage I | - | - | 288 |
| Same calculated per 1 tonne of alumina, Rs | | | |
| - for existing capacity | - | - | 3.4 |
| - for design capacity | - | - | 1.4 |
| <u>Stage II</u> | | | |
| 1. Scheduled repair & maintenance | | | |
| 1.1. Buildings and structures | 6655 | 0.5 | 33 |
| 1.2. Equipment | 7936.5 | 2.5 | 199 |
| Total of 1 | 14591.5 | 1.6 | 232 |
| 2. Depreciation | 18813 | 6.5 | 1223 |
| 3. Interest (average of estimated operation period) | - | - | 538 |
| TOTAL of Stage II | - | - | 1993 |
| - Same, calculated per 1 tonne | | | |
| - for existing capacity | - | - | 23.4 |
| - for design capacity | - | - | 10.0 |
| <u>Stage III</u> | | | |
| 1. Scheduled repair & maintenance | | | |
| 1.1. Buildings and structures | 10078.5 | 0.5 | 50 |

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| 1.2. Equipment | 10111.5 | 2.5 | 253 |
| Total of 1 | 20190 | 1.5 | 303 |
| 2. Depreciation | 25249 | 6.5 | 1641 |
| 3. Interest (average of estimated operation period) | - | - | 732 |
| TOTAL of Stage III | - | - | 2676 |
| Same, calculated per 1 tonne of alumina, Rs | | | |
| - for existing capacity | - | - | 31.5 |
| - for design capacity | - | - | 13.4 |

## 10.4. Financial Analysis

Estimate of cash flow and calculation of the parameters is based on a design operating period of 15 years including a reconstruction period (1 year for stage I, 2 years for stage II including measures for hydrate heat treatment under stage I, and 2 years for stage III)

At the end of this period estimate will be made of the salvage value (undeterred value of total investment cost).

Financial analysis is based on the price level as of beginning of 1983 excluding subsequent price escalation.

Analysis has been prepared for two levels of capacity of the calcination plant based on the following conditions:

- estimated net revenue (additional revenue less additional production costs) is taken as a net estimated profit;

- normal capacity of the calcination section attained after reconstruction is 200.000 tpy of alumina;

- base price of fuel oil equals its actual price as of beginning of 1983 of Rs 2740/1000 l (or Rs 2870/t);

- design capacity is assumed to be attained the next year after completion of reconstruction (on 2nd year under stage I, on 3d year under stage II and III from the beginning of reconstruction);

- sensitivity analysis investigates effect of variation in fuel oil price within ±20% of the base price, according to UNIDO recommendations, on IRR, breakeven point and payback period.

Calculations of IRR and sensitivity analysis have been carried out by the computer using a set of computer programmes developed in VAMI.

The estimates are based on parameters of the current values shown in Schedules 10-9, 10-10, 10-11 of cash flow by reconstruction stages. Estimated cash inflow includes money received for capital construction from goverment funds and bank loans, and also money resulting from additional revenue as savings of fuel and utilities by stages of reconstruction.

The IRR is determined by discounting different time net values to current value with the use of discounting factors.

Breakeven point is calculated as derived physical quantities and sets a minimum level of capacity at which additional revenue from reduction in consumption of fuel oil and utilities equals reconstruction expenses. Constant production costs for estimate of the breakeven point include costs related to maintenance of fixed assets, interest and depreciation per average year for the design operating period.

The results of computer calculations of IRR and breakeven point are shown in Schedules 10-12, 10-13, 10-14.

Payback period is calculated from the start of operation after completion of reconstruction and sets the time for which total investment costs (fixed and preliminary) are repaid by net additional revenue. The estimate of total investment capitel includes net profit with interest and depreciation.

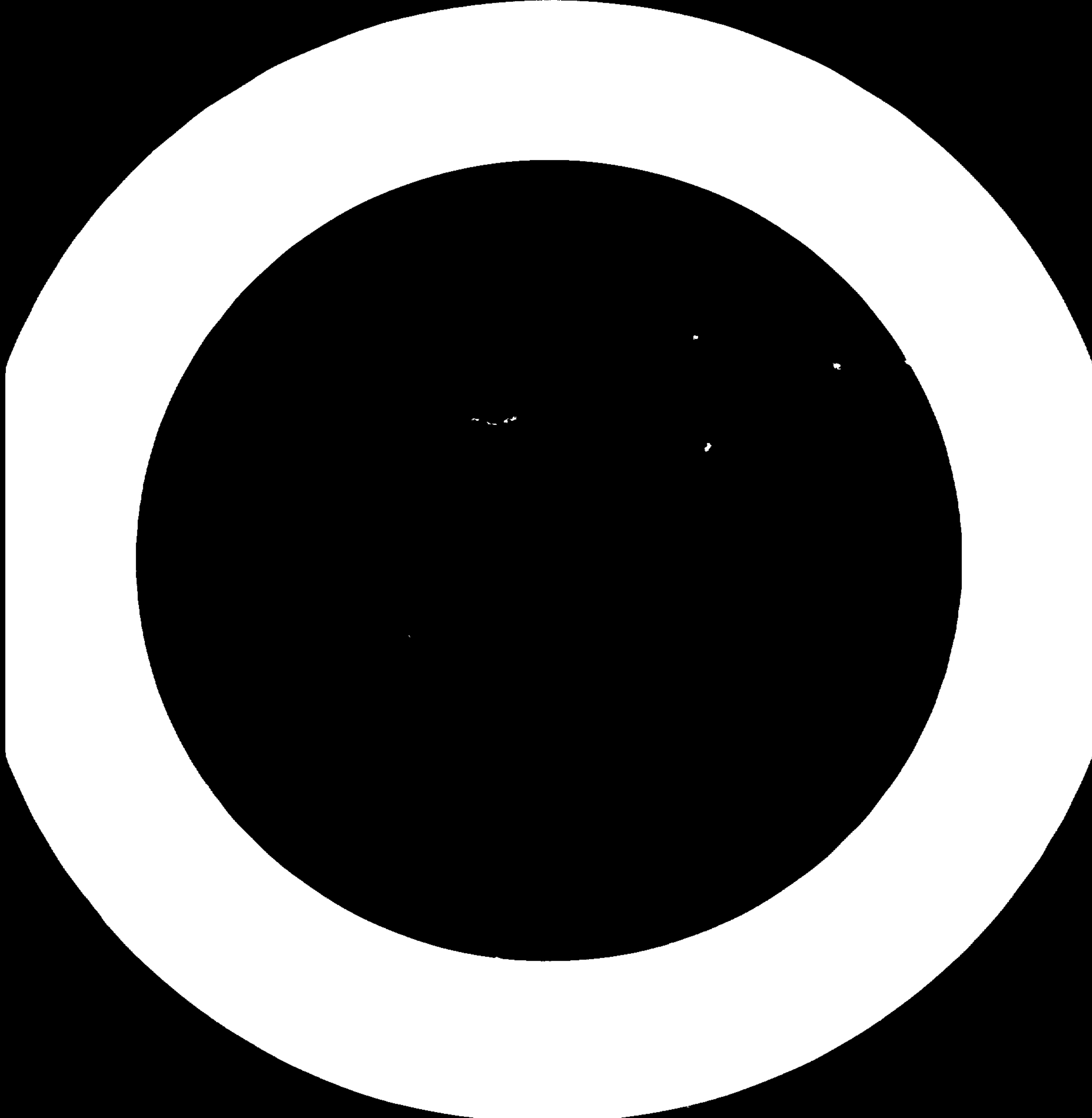
Table below shows summary of savings resulting from reconstruction stages as estimated on the base price of fuel oil:

| S.N. | Parameters | Unit | Stages I | II | III |
|---|---|---|---|---|---|
| 1. | Internal rate of return | | | | |
| | 1.1. on investment | | | | |
| | - existing capacity | % | 103.3 | 31.9 | 44.2 |
| | - design capacity | % | 244.2 | 74.1 | 117.7 |
| | 1.2. on equities | | | | |
| | - existing capacity | % | 183.4 | 44.1 | 65.4 |
| | - design capacity | % | 464.6 | 119.9 | 180.2 |
| 2. | Break-even point | 000t | 8.0 | 21.0 | 20.7 |
| 3. | Pay-back period | | | | |
| | - existing capacity | year | 1.0 | 2.8 | 2.5 |
| | - design capacity | -"- | 0.4 | 1.2 | 1.1 |

As seen from results the most savings come from stage I of reconstruction of the calcination plant as the most capital-intensive variant ensuring the biggest annual savings from lower costs of fuel per Rs of capital investment (1 and 2.4, respectively with the existing and design capacity levels). The corresponding index for stage II and III is Rs 0.3-0.4 (with existing capacity) and Rs 0.8-0.9 (with design capacity).

Installation of fluidised bed coolers (stage II) is also a profitable project. Combined with improvement in hydrate heat treatment this stage will ensure as a whole IRR by 12% higher than stage III.

In the event of installation of a fluidised bed cooler for one kiln only (for details on this variant under stage II refer to Section 9) savings under stage II will be increased to 37% as compared with stage III.



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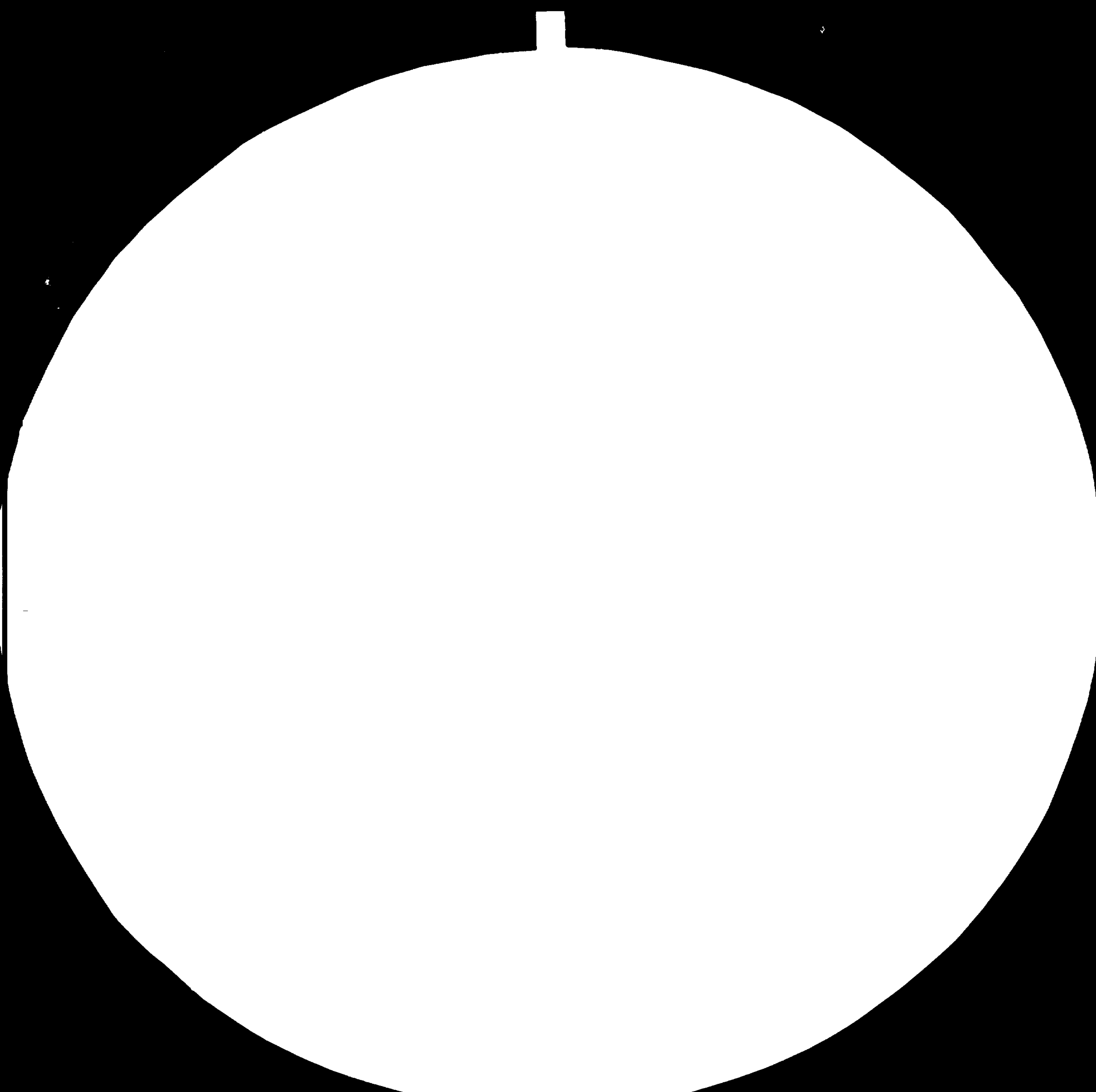
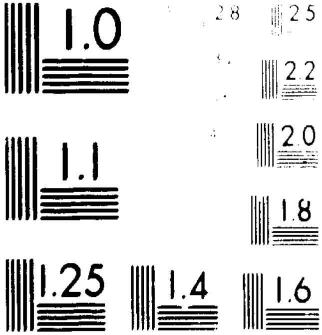



1.0
2.8
2.5
2.2
2.0
1.1
1.8
1.25
1.4
1.6

Cash flow table

Stage I

| Cost category | Years 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| 1. Total cash inflow for capacity: | | | | | | | | |
| - existing | 2903 | 3023 | 3023 | 3023 | 3023 | 3023 | 3023 | 3023 |
| - design | 2903 | 7113 | 7113 | 7113 | 7113 | 7113 | 7113 | 7113 |
| 2. Cash outflow | | | | | | | | |
| 2.1. Capital investment | 2903 | - | - | - | - | - | - | - |
| 2.2. Operating costs | - | 23 | 23 | 23 | 23 | 23 | 23 | 23 |
| 2.3. Interest | - | 193 | 173 | 154 | 135 | 116 | 96 | 77 |
| 2.4. Debt repayment | - | 154 | 154 | 154 | 154 | 154 | 154 | 154 |
| TOTAL of 2 | 2903 | 370 | 350 | 331 | 312 | 293 | 273 | 254 |
| 3. Net cash for existing capacity: | | | | | | | | |
| - current | 0 | 2653 | 2673 | 2692 | 2711 | 2730 | 2750 | 2769 |
| - cumulative | 0 | 2653 | 5326 | 8018 | 10729 | 13459 | 16209 | 18978 |
| 4. Net cash for design capacity: | | | | | | | | |
| - current | 0 | 6743 | 6763 | 6782 | 6801 | 6820 | 6840 | 6859 |
| - cumulative | 0 | 6743 | 13506 | 20288 | 27089 | 33909 | 40749 | 47608 |

SECTION 1

Schedule 10-9

ble

Rs.000

| Years 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | Salvage value | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3023 | 3023 | 3023 | 3023 | 3023 | 3023 | 3023 | 3023 | 3023 | 3023 | - | 45225 |
| 7113 | 7113 | 7113 | 7113 | 7113 | 7113 | 7113 | 7113 | 7113 | 7113 | - | 102485 |
| - | - | - | - | - | - | - | - | - | - | -257 | 2646 |
| 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | - | 322 |
| 116 | 96 | 77 | 58 | 39 | 19 | - | - | - | - | - | 1060 |
| 154 | 154 | 154 | 154 | 154 | 154 | - | - | - | - | - | 1540 |
| 293 | 273 | 254 | 235 | 216 | 196 | 23 | 23 | 23 | 23 | -257 | 5568 |
| 2730 | 2750 | 2769 | 2788 | 2807 | 2827 | 3000 | 3000 | 3000 | 3000 | 257 | 39657 |
| 13459 | 16209 | 18978 | 21766 | 24573 | 27400 | 30400 | 33400 | 36400 | 39400 | - | 39657 |
| 6820 | 6840 | 6859 | 6878 | 6897 | 6917 | 7090 | 7090 | 7090 | 7090 | 257 | 96917 |
| 33909 | 40749 | 47608 | 54486 | 61383 | 68300 | 75390 | 82480 | 89570 | 96660 | - | 96917 |

SECTION 2

Cash-flow table

Stage II

| Cost category | Years 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| 1. Total cash inflow for capacity: | | | | | | | | | |
| - existing | 2903 | 15910 | 6710 | 6710 | 6710 | 6710 | 6710 | 6710 | 6710 |
| - design | 2903 | 15910 | 15789 | 15789 | 15789 | 15789 | 15789 | 15789 | 1578 |
| 2. Cash outflow | | | | | | | | | |
| 2.1. Capital investment | 2903 | 15910 | - | - | - | - | - | - | - |
| 2.2. Operating costs | 0 | 0 | 232 | 232 | 232 | 232 | 232 | 232 | 232 |
| 2.3. Interest | 0 | 0 | 1273 | 1145 | 1018 | 891 | 764 | 636 | 509 |
| 2.4. Debt repayment | 0 | 0 | 1018 | 1018 | 1018 | 1018 | 1018 | 1018 | 1018 |
| Total of 2 | 2903 | 15910 | 2523 | 2395 | 2268 | 2141 | 2014 | 1886 | 1759 |
| 3. Net cash for existing capacity: | | | | | | | | | |
| - current | 0 | 0 | 4187 | 4315 | 4442 | 4569 | 4696 | 4824 | 495 |
| - cumulative | 0 | 0 | 4187 | 8502 | 12944 | 17513 | 22209 | 27033 | 3198 |
| 4. Net cash for design capacity: | | | | | | | | | |
| - current | 0 | 0 | 13266 | 13394 | 13521 | 13648 | 13775 | 13903 | 140 |
| - cumulative | 0 | 0 | 13266 | 26660 | 40181 | 53829 | 67604 | 81507 | 955 |

SECTION 1

Schedule 10-10

Cash-flow table

Stage II

| Years 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | Salvage value | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 6710 | 6710 | 6710 | 6710 | 6710 | 6710 | 6710 | 6710 | 6710 | 6710 | - | 106043 |
| 15789 | 15789 | 15789 | 15789 | 15789 | 15789 | 15789 | 15789 | 15789 | 15789 | - | 224070 |
| - | - | - | - | - | - | - | - | - | - | -2914 | 15899 |
| 232 | 232 | 232 | 232 | 232 | 232 | 232 | 232 | 232 | 232 | - | 3016 |
| 891 | 764 | 636 | 509 | 382 | 255 | 127 | - | - | - | - | 7000 |
| 1018 | 1018 | 1018 | 1018 | 1018 | 1018 | 1018 | - | - | - | - | 10180 |
| 2141 | 2014 | 1886 | 1759 | 1632 | 1505 | 1377 | 232 | 232 | 232 | -2914 | 36095 |
| 4569 | 4696 | 4824 | 4951 | 5078 | 5205 | 5333 | 6478 | 6478 | 6478 | 2914 | 69948 |
| 17513 | 22209 | 27033 | 31984 | 37062 | 42267 | 47600 | 54073 | 60556 | 67034 | - | 69948 |
| 13648 | 13775 | 13903 | 14030 | 14157 | 14284 | 14412 | 15557 | 15557 | 15557 | 2914 | 187975 |
| 53829 | 67604 | 81507 | 95537 | 109694 | 123978 | 138390 | 153947 | 169504 | 185061 | - | 187975 |

## SECTION 2

Cash-flow table
Stage III

| Cost category | Years | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1. Total cash inflow for capacity: | | | | | | | | |
| - existing | 15935 | 9314 | 10177 | 10177 | 10177 | 10177 | 10177 | 10177 |
| - design | 15935 | 9314 | 23946 | 23946 | 23946 | 23946 | 23946 | 23946 |
| 2. Cash outflow | | | | | | | | |
| 2.1. Capital investment | 15935 | 9314 | - | - | - | - | - | - |
| 2.2. Operating costs | 0 | 0 | 303 | 303 | 303 | 303 | 303 | 303 |
| 2.3. Interest | 0 | 0 | 1730 | 1557 | 1384 | 1211 | 1038 | 865 |
| 2.4. Debt repayment | 0 | 0 | 1384 | 1384 | 1384 | 1384 | 1384 | 1384 |
| TOTAL of 2 | 15935 | 9314 | 3417 | 3244 | 3071 | 2898 | 2725 | 2552 |
| 3. Net cash for existing capacity: | | | | | | | | |
| - current | 0 | 0 | 6760 | 6933 | 7106 | 7279 | 7452 | 7625 |
| - cumulative | 0 | 0 | 6760 | 13693 | 20799 | 28078 | 35530 | 43155 |
| 4. Net cash for design capacity | | | | | | | | |
| - current | 0 | 0 | 20529 | 20702 | 20875 | 21048 | 21221 | 21394 |
| - cumulative | 0 | 0 | 20529 | 41231 | 62106 | 83154 | 104375 | 125769 |

SECTION 1

Schedule 10-11

Cash-flow table

Stage III

| Years 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | Sal-vage value | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0177 | 10177 | 10177 | 10177 | 10177 | 10177 | 10177 | 10177 | 10177 | 10177 | - | 157550 |
| 3946 | 23946 | 23946 | 23946 | 23946 | 23946 | 23946 | 23946 | 23946 | 23946 | - | 336547 |
| | - | - | - | - | - | - | - | - | - | -3916 | 21333 |
| 03 | 303 | 303 | 303 | 303 | 303 | 303 | 303 | 303 | 303 | - | 3939 |
| 211 | 1038 | 865 | 692 | 519 | 346 | 173 | - | - | - | - | 9515 |
| 384 | 1384 | 1384 | 1384 | 1384 | 1384 | 1384 | - | - | - | - | 13840 |
| 898 | 2725 | 2552 | 2379 | 2206 | 2033 | 1860 | 303 | 303 | 303 | -3916 | 48627 |
| 279 | 7452 | 7625 | 7798 | 7971 | 8144 | 8317 | 9874 | 9874 | 9874 | 3916 | 108923 |
| 3078 | 35530 | 43155 | 50953 | 58924 | 67068 | 75385 | 85259 | 95133 | 10577 | - | 108923 |
| 1048 | 21221 | 21394 | 21567 | 21740 | 21913 | 22086 | 23643 | 23643 | 23643 | 3916 | 287920 |
| 3154 | 104375 | 125769 | 147336 | 169076 | 190981 | 213075 | 236718 | 260361 | 2[illegible]4004 | - | 287920 |

SECTION 2

## INTERNAL RATE OF RETURN CALCULATION

### STAGE I

| PERIOD | RECONSTRUCTION | | OPERATION | | |
|---|---|---|---|---|---|
| YEARS | 1 | 2 | 3 | 4 | 5 |
| 1.ADDITIONAL RETURN: | | | | | |
| 1.1.EXISTING CAPACITY | - | 3023 | 3023 | 3023 | 30 |
| 1.2.PROPOSED CAPACITY | - | 7112 | 7112 | 7112 | 71 |
| 2.OUTFLOW | | | | | |
| 2.1.INVESTMENT COSTS | -2903 | - | - | - | |
| - INCLUDING EQUITY | -1452 | - | - | - | |
| 2.2.ADDITIONAL OPERATING COSTS | - | -23 | -23 | -23 | - |
| 2.3.INTERESTS | - | -193 | -173 | -154 | -1 |
| 2.4.REPAYMENTS | - | -154 | -154 | -154 | -1 |
| 3.NET RETURN ON INVESTMENT: | | | | | |
| 3.1.EXISTING CAPACITY | -2903 | 3000 | 3000 | 3000 | 3 |
| 3.2.PROPOSED CAPACITY | -2903 | 7089 | 7089 | 7089 | 7 |
| 4.NET RETURN ON EQUITY: | | | | | |
| 4.1.EXISTING CAPACITY | -1452 | 2653 | 2673 | 2692 | 27 |
| 4.2.PROPOSED CAPACITY | -1452 | 6742 | 6762 | 6781 | 6 |

| PERIOD | OPERATION | | | | |
|---|---|---|---|---|---|
| YEARS | 9 | 10 | 11 | 12 | 13 |
| 1.ADDITIONAL RETURN: | | | | | |
| 1.1.EXISTING CAPACITY | 3023 | 3023 | 3023 | 3023 | 3 |
| 1.2.PROPOSED CAPACITY | 7112 | 7112 | 7112 | 7112 | 7 |
| 2.OUTFLOW | | | | | |
| 2.1.INVESTMENT COSTS | - | - | - | - | |
| - INCLUDING EQUITY | - | - | - | - | |
| 2.2.ADDITIONAL OPERATING COSTS | -23 | -23 | -23 | -23 | - |
| 2.3.INTERESTS | -58 | -39 | -19 | - | |
| 2.4.REPAYMENTS | -154 | -154 | -154 | - | |
| 3.NET RETURN ON INVESTMENT: | | | | | |
| 3.1.EXISTING CAPACITY | 3000 | 3000 | 3000 | 3000 | 3 |
| 3.2.PROPOSED CAPACITY | 7089 | 7089 | 7089 | 7089 | 7 |
| 4.NET RETURN ON EQUITY: | | | | | |
| 4.1.EXISTING CAPACITY | 2788 | 2807 | 2827 | 3000 | 3 |
| 4.2.PROPOSED CAPACITY | 6877 | 6896 | 6916 | 7089 | 7 |

**SECTION 1**

INTERNAL RATE OF RETURN ON INVESTMENT:
- EXISTING CAPACITY 103.3 P.C.
- PROPOSED CAPACITY 244.2 P.C.

INTERNAL RATE OF RETURN ON EQUITY:
- EXISTING CAPACITY 183.4 P.C.
- PROPOSED CAPACITY 464.6 P.C.

BREAK-EVEN POINT [illegible]

SCHEDULE 10-12

...E OF RETURN CALCULATION

STAGE I

RS THOU

| ...STRUCTION | | OPERATION | | | | | |
|---|---|---|---|---|---|---|---|
| | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| - | 3023 | 3023 | 3023 | 3023 | 3023 | 3023 | 3023 |
| - | 7112 | 7112 | 7112 | 7112 | 7112 | 7112 | 7112 |
| ...3 | - | - | - | - | - | - | - |
| ...2 | - | - | - | - | - | - | - |
| - | -23 | -23 | -23 | -23 | -23 | -23 | -23 |
| - | -193 | -173 | -154 | -135 | -116 | -96 | -77 |
| - | -154 | -154 | -154 | -154 | -154 | -154 | -154 |
| ...3 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 |
| ...3 | 7089 | 7089 | 7089 | 7089 | 7089 | 7089 | 7089 |
| ...2 | 2653 | 2673 | 2692 | 2711 | 2730 | 2750 | 2769 |
| 2 | 6742 | 6762 | 6781 | 6800 | 6819 | 6839 | 6858 |

RS THOU

| | OPERATION | | | | | | TOTAL |
|---|---|---|---|---|---|---|---|
| | 10 | 11 | 12 | 13 | 14 | 15 | |
| 3 | 3023 | 3023 | 3023 | 3023 | 3023 | 3023 | 42327 |
| 2 | 7112 | 7112 | 7112 | 7112 | 7112 | 7112 | 99581 |
| - | - | - | - | - | - | - | -2903 |
| - | - | - | - | - | - | - | -1452 |
| 3 | -23 | -23 | -23 | -23 | -23 | -23 | -322 |
| 8 | -39 | -19 | - | - | - | - | -1060 |
| ...4 | -154 | -154 | - | - | - | - | -1540 |
| ...0 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 39102 |
| ...9 | 7089 | 7089 | 7089 | 7089 | 7089 | 7089 | 96356 |
| ...8 | 2807 | 2827 | 3000 | 3000 | 3000 | 3000 | 37953 |
| ...7 | 6896 | 6916 | 7089 | 7089 | 7089 | 7089 | 95207 |

...ENT:

103.3 P.C.
244.2 P.C.

183.4 P.C.
464.6 P.C.
P.C THOU...

SECTION 2

## INTERNAL RATE OF RETURN CALCULATION

### STAGE II

| PERIOD | RECONSTRUCTION | | OPERATION | |
|---|---|---|---|---|
| YEARS | 1 | 2 | 3 | 4 |
| 1.ADDITIONAL RETURN: | | | | |
| 1.1.EXISTING CAPACITY | - | - | 6710 | 6710 |
| 1.2.PROPOSED CAPACITY | - | - | 15788 | 15788 |
| 2.OUTFLOW | | | | |
| 2.1.INVESTMENT COSTS | -2903 | -15910 | - | - |
| - INCLUDING EQUITY | -1452 | -7955 | - | - |
| 2.2.ADDITIONAL OPERATING COSTS | - | - | -232 | -232 |
| 2.3.INTERESTS | - | - | -1273 | -1145 |
| 2.4.REPAYMENTS | - | - | -1018 | -1018 |
| 3.NET RETURN ON INVESTMENT: | | | | |
| 3.1.EXISTING CAPACITY | -2903 | -15910 | 6478 | 6478 |
| 3.2.PROPOSED CAPACITY | -2903 | -15910 | 15556 | 15556 |
| 4.NET RETURN ON EQUITY: | | | | |
| 4.1.EXISTING CAPACITY | -1452 | -7955 | 4187 | 4315 |
| 4.2.PROPOSED CAPACITY | -1452 | -7955 | 13265 | 13393 |

| PERIOD | OPERATION | | | |
|---|---|---|---|---|
| YEARS | 9 | 10 | 11 | 12 |
| 1.ADDITIONAL RETURN: | | | | |
| 1.1.EXISTING CAPACITY | 6710 | 6710 | 6710 | 6710 |
| 1.2.PROPOSED CAPACITY | 15788 | 15788 | 15788 | 15788 |
| 2.OUTFLOW | | | | |
| 2.1.INVESTMENT COSTS | - | - | - | - |
| - INCLUDING EQUITY | - | - | - | - |
| 2.2.ADDITIONAL OPERATING COSTS | -232 | -232 | -232 | -232 |
| 2.3.INTERESTS | -509 | -382 | -255 | -127 |
| 2.4.REPAYMENTS | -1018 | -1018 | -1018 | -1018 |
| 3.NET RETURN ON INVESTMENT: | | | | |
| 3.1.EXISTING CAPACITY | 6478 | 6478 | 6478 | 6478 |
| 3.2.PROPOSED CAPACITY | 15556 | 15556 | 15556 | 15556 |
| 4.NET RETURN ON EQUITY: | | | | |
| 4.1.EXISTING CAPACITY | 4951 | 5078 | 5205 | 5333 |
| 4.2.PROPOSED CAPACITY | 14029 | 14156 | 14283 | 14411 |

INTERNAL RATE OF RETURN ON INVESTMENT:
- EXISTING CAPACITY 31.9 P.C.
- PROPOSED CAPACITY 74.1 P.C.

INTERNAL RATE OF RETURN ON EQUITY:
- EXISTING CAPACITY 44.1 P.C.
- PROPOSED CAPACITY 119.9 P.C.

BREAK-EVEN POINT 21.0 THOU T

SECTION 1

SCHEDULE 10-13

ERNAL RATE OF RETURN CALCULATION

STAGE II

RS THOU

| RECONSTRUCTION | | OPERATION | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| - | - | 6710 | 6710 | 6710 | 6710 | 6710 | 6710 |
| - | - | 15788 | 15788 | 15788 | 15788 | 15788 | 15788 |
| -2903 | -15910 | - | - | - | - | - | - |
| -1452 | -7955 | - | - | - | - | - | - |
| - | - | -232 | -232 | -232 | -232 | -232 | -232 |
| - | - | -1273 | -1145 | -1018 | -891 | -764 | -636 |
| - | - | -1018 | -1018 | -1018 | -1018 | -1018 | -1018 |
| -2903 | -15910 | 6478 | 6478 | 6478 | 6478 | 6478 | 6478 |
| -2903 | -15910 | 15556 | 15556 | 15556 | 15556 | 15556 | 15556 |
| -1452 | -7955 | 4187 | 4315 | 4442 | 4569 | 4696 | 4824 |
| -1452 | -7955 | 13265 | 13393 | 13520 | 13647 | 13774 | 13902 |

RS THOU

| OPERATION | | | | | | | TOTAL |
|---|---|---|---|---|---|---|---|
| 9 | 10 | 11 | 12 | 13 | 14 | 15 | |
| 6710 | 6710 | 6710 | 6710 | 6710 | 6710 | 6710 | 87239 |
| 15788 | 15788 | 15788 | 15788 | 15788 | 15788 | 15788 | 205256 |
| - | - | - | - | - | - | - | -18813 |
| - | - | - | - | - | - | - | -9407 |
| -232 | -232 | -232 | -232 | -232 | -232 | -232 | -3016 |
| -509 | -382 | -255 | -127 | - | - | - | -7000 |
| -1018 | -1018 | -1018 | -1018 | - | - | - | -10180 |
| 6478 | 6478 | 6478 | 6478 | 6478 | 6478 | 6478 | 65410 |
| 15556 | 15556 | 15556 | 15556 | 15556 | 15556 | 15556 | 183427 |
| 4951 | 5078 | 5205 | 5333 | 6478 | 6478 | 6478 | 57636 |
| 14029 | 14156 | 14283 | 14411 | 15556 | 15556 | 15556 | 175653 |

ON INVESTMENT:

31.9 P.C.
74.1 P.C.

ON EQUITY:

44.1 P.C.
119.9 P.C.
21.0 THOU T

SECTION 2

# INTERNAL RATE OF RETURN CALCULATION

## STAGE III

| PERIOD | RECONSTRUCTION | | OPERATION | | |
|---|---|---|---|---|---|
| YEARS | 1 | 2 | 3 | 4 | 5 |
| 1.ADDITIONAL RETURN: | | | | | |
| 1.1.EXISTING CAPACITY | - | - | 10177 | 10177 | 10177 |
| 1.2.PROPOSED CAPACITY | - | - | 23945 | 23945 | 23945 |
| 2.OUTFLOW | | | | | |
| 2.1.INVESTMENT COSTS | -15935 | -9314 | - | - | - |
| - INCLUDING EQUITY | -12625 | - | - | - | - |
| 2.2.ADDITIONAL OPERATING COSTS | - | - | -303 | -303 | -303 |
| 2.3.INTERESTS | - | - | -1730 | -1557 | -1384 |
| 2.4.REPAYMENTS | - | - | -1384 | -1384 | -1384 |
| 3.NET RETURN ON INVESTMENT: | | | | | |
| 3.1.EXISTING CAPACITY | -15935 | -9314 | 9874 | 9874 | 9874 |
| 3.2.PROPOSED CAPACITY | -15935 | -9314 | 23642 | 23642 | 23642 |
| 4.NET RETURN ON EQUITY: | | | | | |
| 4.1.EXISTING CAPACITY | -12625 | | 6760 | 6933 | 7106 |
| 4.2.PROPOSED CAPACITY | -12625 | | 20528 | 20701 | 20874 |

| PERIOD | | | OPERATION | | |
|---|---|---|---|---|---|
| YEARS | 9 | 10 | 11 | 12 | 13 |
| 1.ADDITIONAL RETURN: | | | | | |
| 1.1.EXISTING CAPACITY | 10177 | 10177 | 10177 | 10177 | 10177 |
| 1.2.PROPOSED CAPACITY | 23945 | 23945 | 23945 | 23945 | 23945 |
| 2.OUTFLOW | | | | | |
| 2.1.INVESTMENT COSTS | - | - | - | - | - |
| - INCLUDING EQUITY | - | - | - | - | - |
| 2.2.ADDITIONAL OPERATING COSTS | -303 | -303 | -303 | -303 | -303 |
| 2.3.INTERESTS | -692 | -519 | -346 | -173 | - |
| 2.4.REPAYMENTS | -1384 | -1384 | -1384 | -1384 | - |
| 3.NET RETURN ON INVESTMENT: | | | | | |
| 3.1.EXISTING CAPACITY | 9874 | 9874 | 9874 | 9874 | 9874 |
| 3.2.PROPOSED CAPACITY | 23642 | 23642 | 23642 | 23642 | 23642 |
| 4.NET RETURN ON EQUITY: | | | | | |
| 4.1.EXISTING CAPACITY | 7798 | 7971 | 8144 | 8317 | 9874 |
| 4.2.PROPOSED CAPACITY | 21566 | 21739 | 21912 | 22085 | 23642 |

INTERNAL RATE OF RETURN ON INVESTMENT:
- EXISTING CAPACITY 31.6 P.C.
- PROPOSED CAPACITY 66.0 P.C.

INTERNAL RATE OF RETURN ON EQUITY:
- EXISTING CAPACITY 40.1 P.C.
- PROPOSED CAPACITY 87.5 P.C.

BREAK-EVEN POINT 20.7 THOU T

SECTION 1

SCHEDULE 10-14

# INTERNAL RATE OF RETURN CALCULATION

## STAGE III

RS THOU

| | RECONSTRUCTION | | OPERATION | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| | - | - | 10177 | 10177 | 10177 | 10177 | 10177 | 10177 |
| | - | - | 23945 | 23945 | 23945 | 23945 | 23945 | 23945 |
| | -15935 | -9314 | - | - | - | - | - | - |
| | -12625 | - | - | - | - | - | - | - |
| | - | - | -303 | -303 | -303 | -303 | -303 | -303 |
| | - | - | -1730 | -1557 | -1384 | -1211 | -1038 | -865 |
| | - | - | -1384 | -1384 | -1384 | -1384 | -1384 | -1384 |
| | -15935 | -9314 | 9874 | 9874 | 9874 | 9874 | 9874 | 9874 |
| | -15935 | -9314 | 23642 | 23642 | 23642 | 23642 | 23642 | 23642 |
| | -12625 | | 6760 | 6933 | 7106 | 7279 | 7452 | 7625 |
| | -12625 | | 20528 | 20701 | 20874 | 21047 | 21220 | 21393 |

RS THOU

| | OPERATION | | | | | | | TOTAL |
|---|---|---|---|---|---|---|---|---|
| | 9 | 10 | 11 | 12 | 13 | 14 | 15 | |
| | 10177 | 10177 | 10177 | 10177 | 10177 | 10177 | 10177 | 132301 |
| | 23945 | 23945 | 23945 | 23945 | 23945 | 23945 | 23945 | 311297 |
| | - | - | - | - | - | - | - | -25249 |
| | - | - | - | - | - | - | - | -12625 |
| | -303 | -303 | -303 | -303 | -303 | -303 | -303 | -3939 |
| | -692 | -519 | -346 | -173 | - | - | - | -9515 |
| | -1384 | -1384 | -1384 | -1384 | - | - | - | -13840 |
| | 9874 | 9874 | 9874 | 9874 | 9874 | 9874 | 9874 | 103113 |
| | 23642 | 23642 | 23642 | 23642 | 23642 | 23642 | 23642 | 282109 |
| | 7798 | 7971 | 8144 | 8317 | 9874 | 9874 | 9874 | 92382 |
| | 21566 | 21739 | 21912 | 22085 | 23642 | 23642 | 23642 | 271378 |

RN ON INVESTMENT:

31.6 P.C.
66.0 P.C.

RN ON EQUITY:

40.1 P.C.
87.5 P.C.
20.7 THOU T

SECTION 2

## 10.5. Sensitivity analysis

The sensitivity analysis of the project studies the effect of the fuel oil price changes on the internal rate of return, break-even level and pay-back period by reconstruction stages and in function of the production level.

The fuel oil price varies within ±20% of the basic price (Rs. 2,870 per 1 tonne) with the interval of 5%.

The calculation results are given in Schedules 10-15, 10-16, 10-17 and 10-18 and are demonstrated also on diagrams 1 to 4.

The variation of the fuel oil price within the range above determines the proportional influence of the internal rate of return deviation by stages in average within the range of ±27% from the level determined for the basic fuel oil price with significant changes of the absolute values.

For the stage I the IRR on investment varies in function of capacity utilization from 84% (for existing production level and minimum fuel oil price) to 224% (respectively with the design capacity and maximum fuel oil price).

For stages II and III this parameter varies within the range of 25-36%.

In calculations of the IRR on equities its values for all stages increase 1.7 to 1.9 times.

The variation of the break-even point, determined by the variation of the fuel oil price, makes ±15% for all stages with its minimum value of 6,800 tonnes (for maximum fuel oil price of Stage I) and maximum value of 25,500 t (for minimum fuel oil price of Stage II).

The pay-back period doesn't exceed 3.5 years (with the existing capacity of Stage II). In calculation for the design capacity for Stage I regardless the variation of the fuel oil price the costs are to be repaid in less than 0.5 year.

Thus the financial and economic evaluation has shown the high profitability of the Stage I of reconstruction which is conserving on the rather high level with the variations of the fuel oil price, as it was shown be the sensitivity analysis.

The parameters of the efficiency of Stages II and III are inferior to the parameters of the Stage I and they are about at the same level.

SCHEDULE 10-15

## SENSITIVITY ANALYSIS

### EFFECT ON "IRR" OF FURNACE OIL PRICE

### STAGE I

BASIC PRICE : RS 1670/T

| DEVIATION OF FURNACE OIL PRICE FROM BASE CASE, P.C | INTERNAL RATE OF RETURN, P.C | | | | BREAK-EVEN POINT, THOU.T |
|---|---|---|---|---|---|
| | EXISTING CAPACITY | | PROPOSED CAPACITY | | |
| | ON INVEST-MENT | ON EQUITY | ON INVEST-MENT | ON EQUITY | |
| -20 | 84 | 145 | 199 | 375 | 9.8 |
| -15 | 89 | 155 | 210 | 398 | 9.3 |
| -10 | 93 | 164 | 221 | 420 | 8.8 |
| -5 | 98 | 174 | 233 | 442 | 8.4 |
| 0 | 103 | 183 | 244 | 464 | 8.0 |
| 5 | 108 | 192 | 255 | 486 | 7.7 |
| 10 | 112 | 202 | 266 | 509 | 7.4 |
| 15 | 117 | 211 | 277 | 531 | 7.1 |
| 20 | 122 | 221 | 288 | 553 | 6.8 |

SCHEDULE 10-16

## SENSITIVITY ANALYSIS

### EFFECT ON 'IRR' OF FURNACE OIL PRICE

### STAGE II

BASIC PRICE : RS 2870/T

| DEVIATION OF FURNACE OIL PRICE FROM BASE CASE, P.C | INTERNAL RATE OF RETURN, P.C — EXISTING CAPACITY: ON INVESTMENT | EXISTING CAPACITY: ON EQUITY | PROPOSED CAPACITY: ON INVESTMENT | PROPOSED CAPACITY: ON EQUITY | BREAK-EVEN POINT, THOU. T |
|---|---|---|---|---|---|
| -20 | 25 | 33 | 61 | 97 | 25.5 |
| -15 | 27 | 30 | 64 | 103 | 24.2 |
| -10 | [illegible] | 38 | 68 | 109 | [illegible] |
| -5 | [illegible] | 41 | 71 | 114 | [illegible] |
| 0 | 31 | 44 | 74 | 119 | [illegible] |
| 5 | 33 | 46 | 77 | 125 | 20.1 |
| 10 | 34 | 49 | 80 | 130 | 19.3 |
| 15 | 36 | 52 | 83 | 135 | 18.5 |
| 20 | 37 | 54 | 86 | 141 | 17.8 |

SCHEDULE 10-17

# SENSITIVITY ANALYSIS

## EFFECT ON "IRR" OF FURNACE OIL PRICE

## STAGE III

### BASIC PRICE : RS 2870/T

| DEVIATION OF FURNACE OIL PRICE FROM BASE CASE, P.C | INTERNAL RATE OF RETURN, P.C | | | | BREAK-EVEN POINT, PROD.T |
|---|---|---|---|---|---|
| | EXISTING CAPACITY | | PROPOSED CAPACITY | | |
| | ON IN-VEST-MENT | ON EQUITY | ON IN-VEST-MENT | ON EQUITY | |
| -20 | 26 | 32 | 56 | 74 | 25.1 |
| -15 | 27 | 34 | 59 | 78 | 23.8 |
| -10 | 28 | 36 | 61 | 81 | 22.7 |
| -5 | 30 | 38 | 63 | 84 | 21.7 |
| 0 | 31 | 40 | 66 | 87 | 20.7 |
| 5 | 32 | 42 | 68 | 90 | 19.8 |
| 10 | 34 | 43 | 70 | 93 | 19.0 |
| 15 | 35 | 45 | 72 | 96 | 18.3 |
| 20 | 36 | 47 | 74 | 99 | 17.6 |

Schedule 10-18

Sensitivity analysis

Effect of fuel oil price on pay-back period

Basic price: Rs. 2,870 per 1 tonne

| Deviation of fuel oil price from basic price, % | Pay-back period, years | | | | | |
|---|---|---|---|---|---|---|
| | Stage I | | Stage II | | Stage III | |
| | existing capacity | design capacity | existing capacity | design capacity | existing capacity | design capacity |
| -20 | 1.2 | 0.5 | 3.5 | 1.5 | 3.1 | 1.3 |
| -10 | 1.0 | 0.5 | 3.1 | 1.3 | 2.7 | 1.2 |
| 0 | 1.0 | 0.4 | 2.8 | 1.2 | 2.5 | 1.1 |
| +10 | 0.9 | 0.4 | 2.6 | 1.1 | 2.3 | 1.0 |
| +20 | 0.8 | 0.3 | 2.4 | 1.0 | 2.1 | 0.9 |

ГРАФИК 1. ЗАВИСИМОСТЬ ВНУТРЕННЕЙ НОРМЫ ПРИБЫЛИ НА КАПИТАЛ(ВНПК), ОТ ЦЕНЫ НА МАЗУТ И УРОВНЯ ПРОИЗВОДИТЕЛЬНОСТИ.

DIAGRAM 1. EFFECT OF FUEL OIL PRICE AND PRODUCTION LEVEL ON INTERNAL RATE OF RETURN ON INVESTMENT (IRRI).

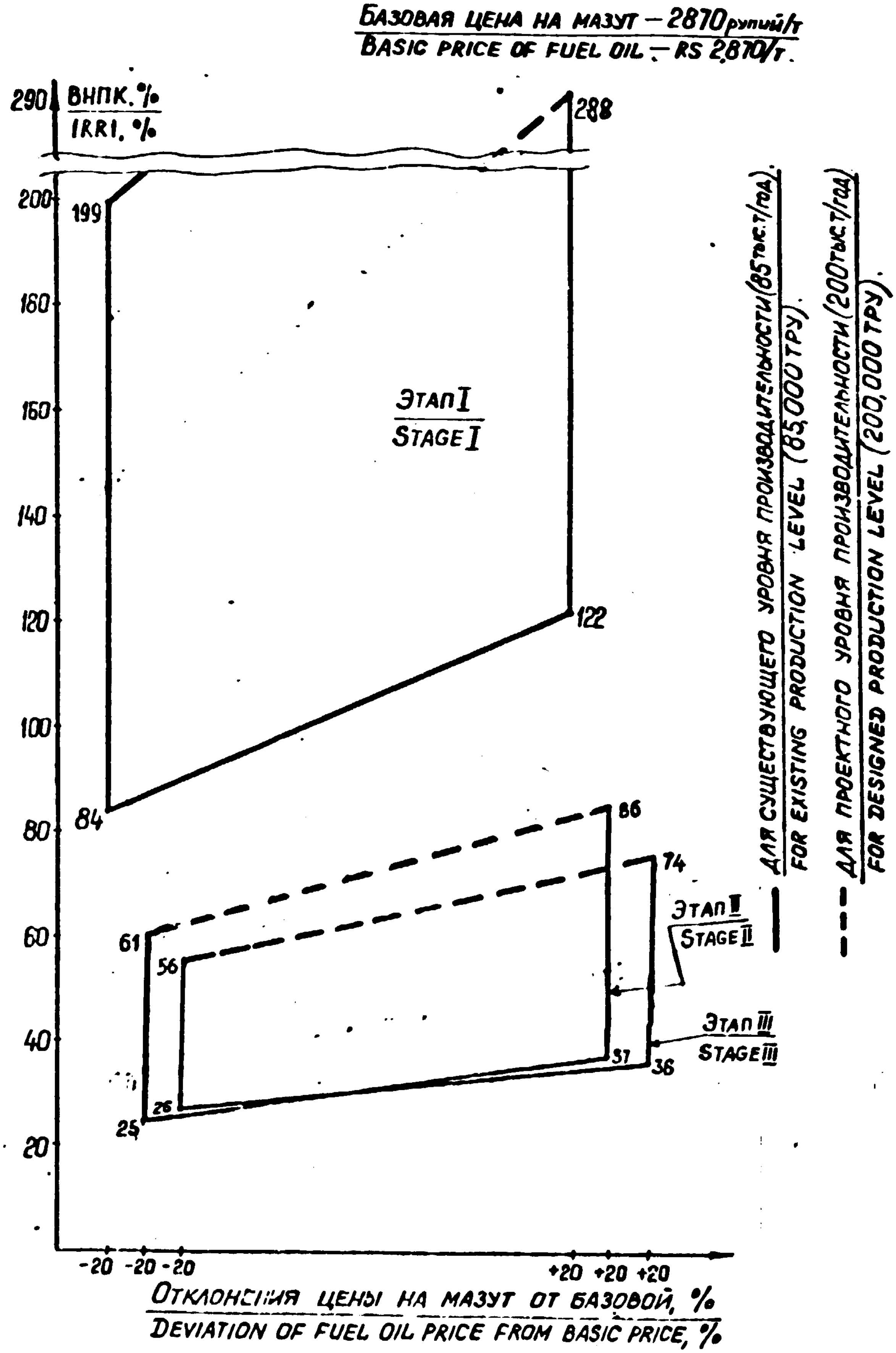


График 2. Зависимость внутренней нормы прибыли на акции (ВНПА) от цены на мазут и уровня производительности.

DIAGRAM 2. EFFECT OF FUEL OIL PRICE AND PRODUCTION LEVEL ON INTERNAL RATE OF RETURN ON EQUITIES (IRRE).

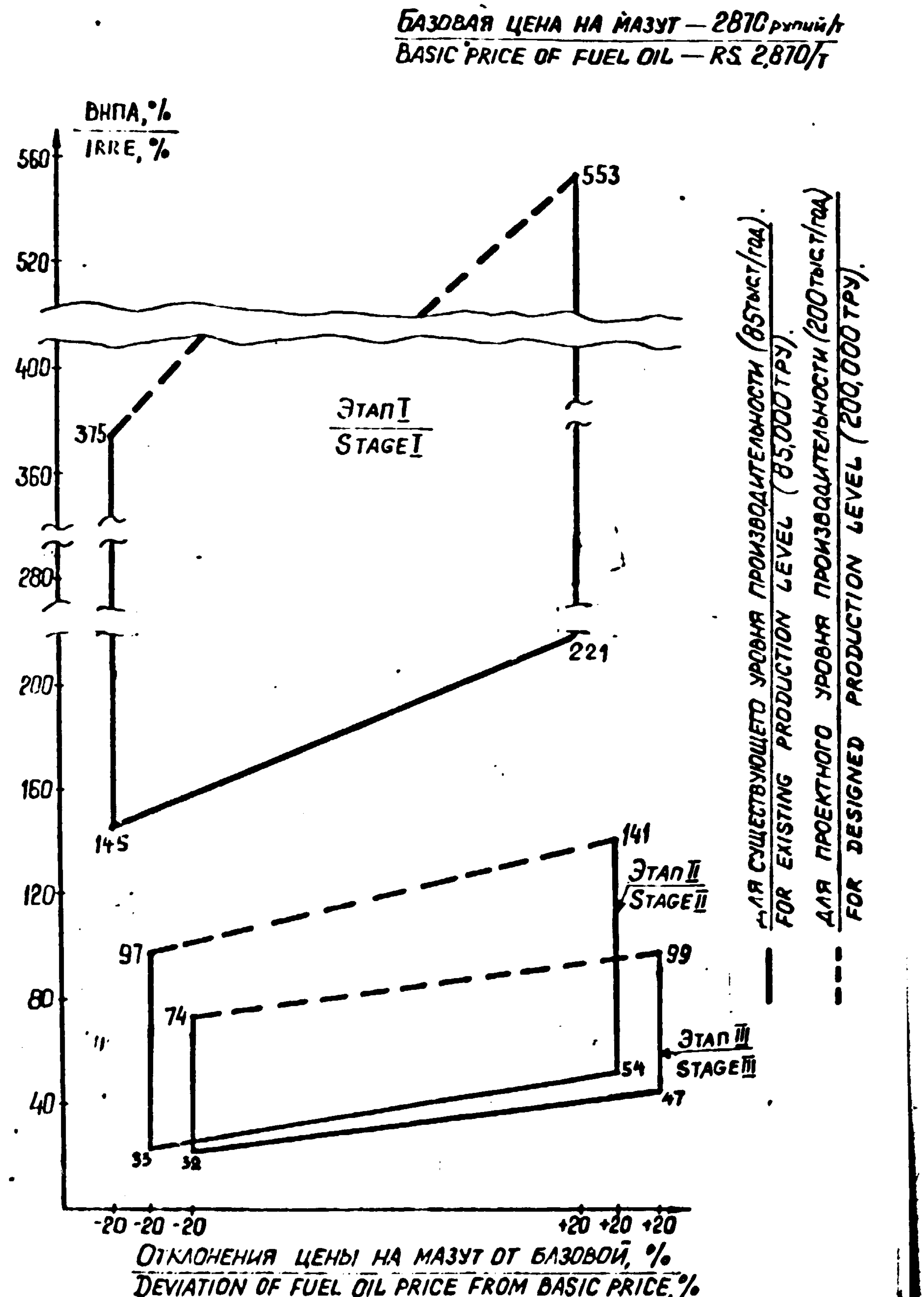


График 3. З[illegible] точки [illegible] от [illegible] на [illegible]зут.

Diagram 3. Effect of fuel oil [illegible] on [illegible]s.

Б[illegible] цена на [illegible]зут - [illegible] [illegible]

Basic [illegible] of fuel oil Rs. [illegible]

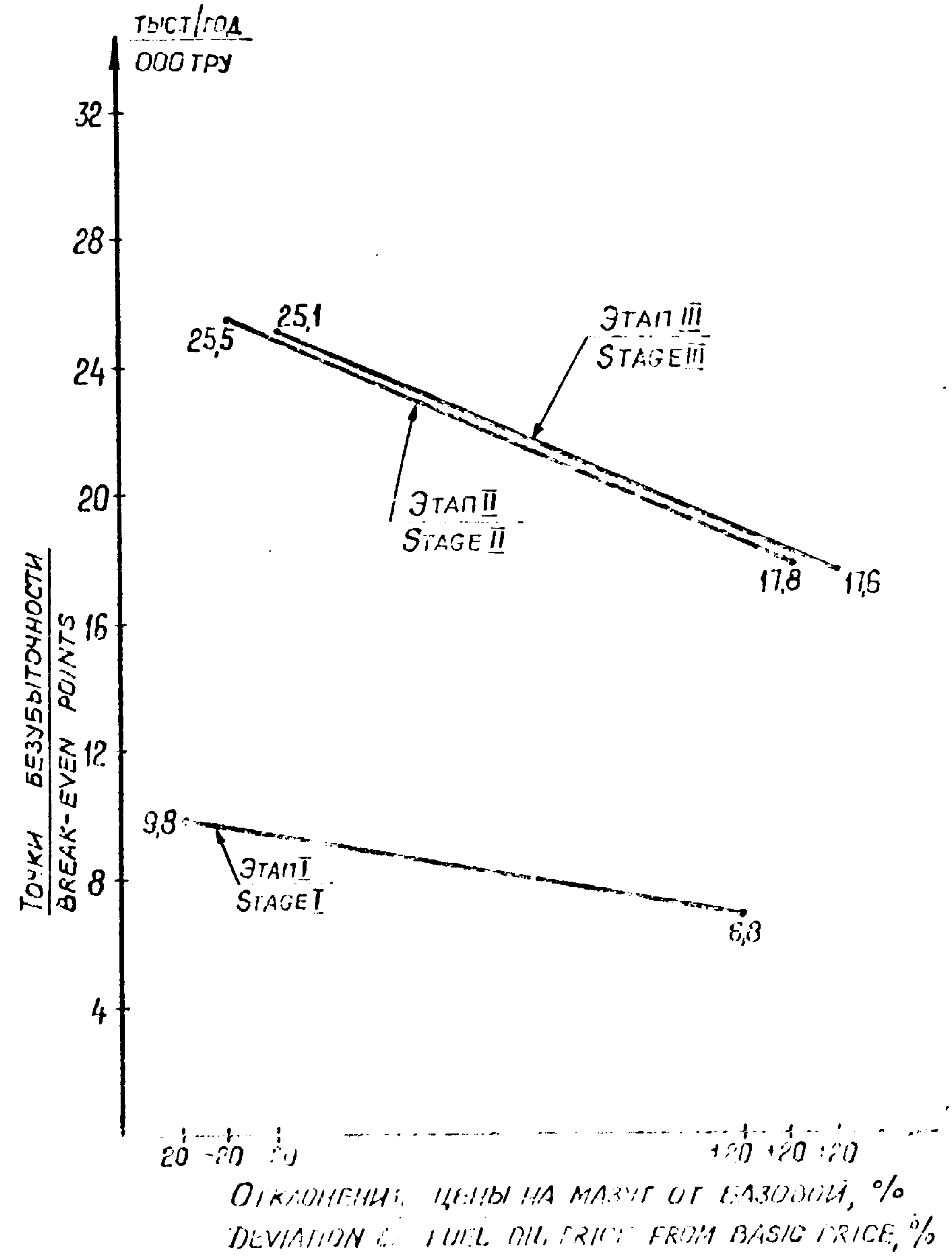
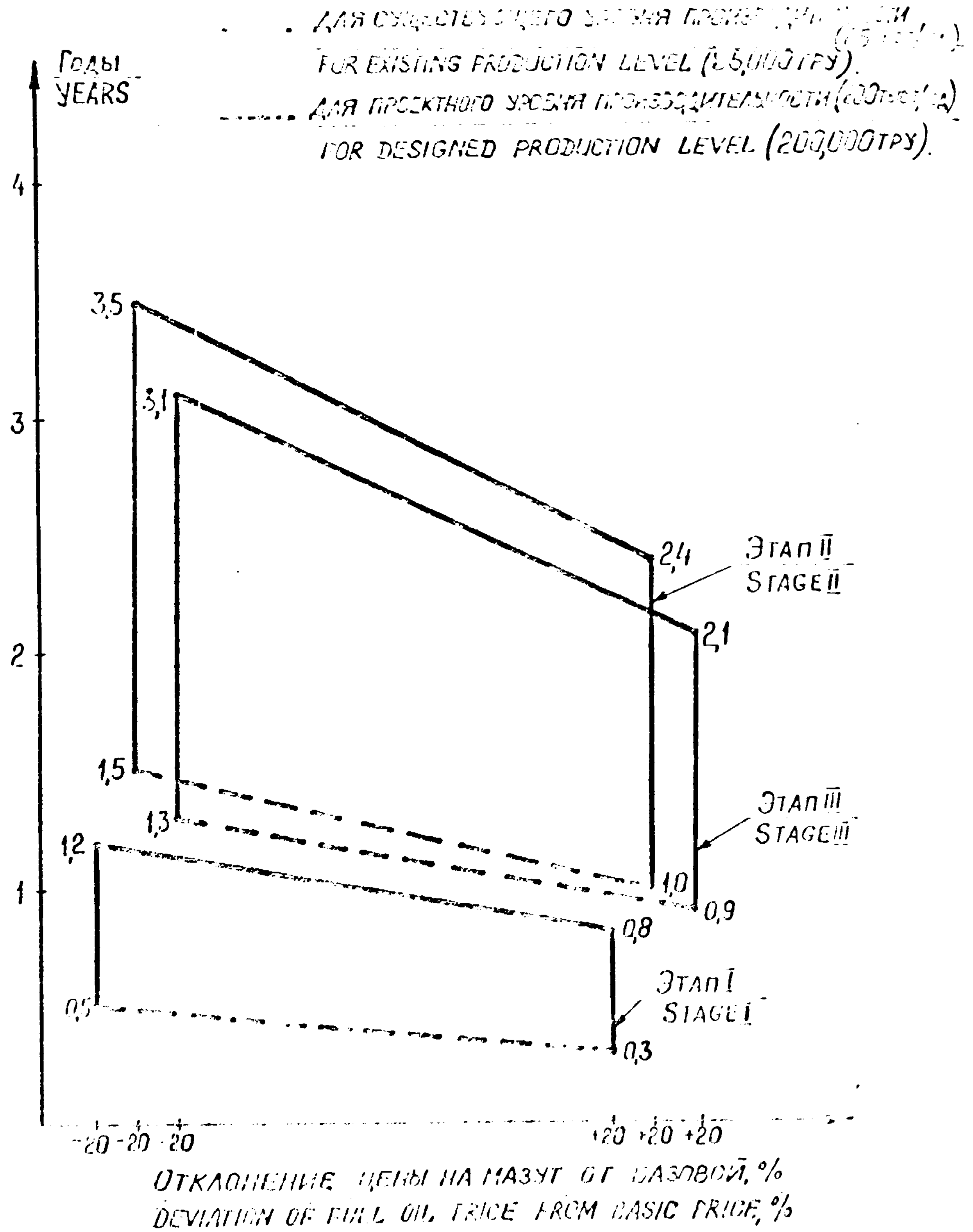


График 4. [illegible] от [illegible] на мазут и уровня производительности

DIAGRAM 4. EFFECT OF FUEL OIL PRICE AND PRODUCTION LEVEL ON PAY-BACK PERIOD

[illegible] цена мазута - 2870 [illegible]
BASIC PRICE OF FUEL OIL - RS 2,310/T



ANNEXURES

Cash-flow table

Variant of installation of cooler for one kiln

| Cost category | years | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 1. Total cash inflow | 2903 | 8661 | 13620 | 13620 | 13620 | 13620 | 13620 | 13620 | 13620 |
| 2. Cash outflow | | | | | | | | | |
| 2.1. Capital investment | 2903 | 8661 | - | - | - | - | - | - | - |
| 2.2. Operating costs | 0 | 0 | 227 | 227 | 227 | 227 | 227 | 227 | 227 |
| 2.3. Interest | 0 | 0 | 791 | 712 | 633 | 554 | 475 | 396 | 317 |
| 2.4. Debt repayment | 0 | 0 | 633 | 633 | 633 | 633 | 633 | 633 | 633 |
| Total of 2 | 2903 | 8661 | 1651 | 1572 | 1493 | 1414 | 1335 | 1256 | 1177 |
| 3. Net cash: | | | | | | | | | |
| - current cash flow | 0 | 0 | 11969 | 12048 | 12127 | 12206 | 12285 | 12364 | 12443 |
| - cumilative cash | 0 | 0 | 11969 | 24017 | 36144 | 48350 | 60635 | 72999 | 85442 |

SECTION 1

Annexure 1

er for one kiln

Rs.000

| years | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | Sal-vage value | Total |
| 13620 | 13620 | 13620 | 13620 | 13620 | 13620 | 13620 | 13620 | 13620 | - | 188624 |
| - | - | - | - | - | - | - | - | - | -1788 | 9776 |
| 227 | 227 | 227 | 227 | 227 | 227 | 227 | 227 | 227 | - | 2951 |
| 475 | 396 | 317 | 237 | 158 | 79 | - | - | - | - | 4352 |
| 633 | 633 | 633 | 633 | 633 | 633 | - | - | - | - | 6330 |
| 1335 | 1256 | 1177 | 1097 | 1018 | 939 | 227 | 227 | 227 | -1788 | 23409 |
| 12285 | 12364 | 12443 | 12523 | 12602 | 12681 | 13393 | 13393 | 13393 | 1788 | 165215 |
| 60635 | 72999 | 85442 | 96965 | 110567 | 123248 | 136641 | 150034 | 163427 | - | 165215 |

# SECTION 2

## INTERNAL RATE OF RETURN CALCULATION

## VARIANT OF THE COOLER FOR ONE KILN

| PERIOD | RECONSTRUCTION | | OPERATION | |
|---|---|---|---|---|
| YEARS | 1 | 2 | 3 | 4 |
| 1.ADDITIONAL RETURN: | | | | |
| 1.1.EXISTING CAPACITY | - | - | 6710 | 6710 |
| 1.2.PROPOSED CAPACITY | - | - | 13619 | 13619 |
| 2.OUTFLOW | | | | |
| 2.1.INVESTMENT COSTS | -2903 | -8661 | - | - |
| - INCLUDING EQUITY | -1452 | -4321 | - | - |
| 2.2.ADDITIONAL OPERATING COSTS | - | - | -227 | -227 |
| 2.3.INTERESTS | - | - | -791 | -712 |
| 2.4.REPAYMENTS | - | - | -633 | -633 |
| 3.NET RETURN ON INVESTMENT: | | | | |
| 3.1.EXISTING CAPACITY | -2903 | -8661 | 6483 | 6483 |
| 3.2.PROPOSED CAPACITY | -2903 | -8661 | 13392 | 13392 |
| 4.NET RETURN ON EQUITY: | | | | |
| 4.1.EXISTING CAPACITY | -1452 | -4321 | 5059 | 5138 |
| 4.2.PROPOSED CAPACITY | -1452 | -4321 | 11968 | 12047 |

| PERIOD | OPERATION | | | |
|---|---|---|---|---|
| YEARS | 9 | 10 | 11 | 12 |
| 1.ADDITIONAL RETURN: | | | | |
| 1.1.EXISTING CAPACITY | 6710 | 6710 | 6710 | 6710 |
| 1.2.PROPOSED CAPACITY | 13619 | 13619 | 13619 | 13619 |
| 2.OUTFLOW | | | | |
| 2.1.INVESTMENT COSTS | - | - | - | - |
| - INCLUDING EQUITY | - | - | - | - |
| 2.2.ADDITIONAL OPERATING COSTS | -227 | -227 | -227 | -227 |
| 2.3.INTERESTS | -317 | -237 | -158 | -79 |
| 2.4.REPAYMENTS | -633 | -633 | -633 | -633 |
| 3.NET RETURN ON INVESTMENT: | | | | |
| 3.1.EXISTING CAPACITY | 6483 | 6483 | 6483 | 6483 |
| 3.2.PROPOSED CAPACITY | 13392 | 13392 | 13392 | 13392 |
| 4.NET RETURN ON EQUITY: | | | | |
| 4.1.EXISTING CAPACITY | 5533 | 5613 | 5692 | 5771 |
| 4.2.PROPOSED CAPACITY | 12442 | 12522 | 12601 | 12680 |

| | |
|---|---|
| INTERNAL RATE OF RETURN ON INVESTMENT: | |
| - EXISTING CAPACITY | 49.5 P.C. |
| - PROPOSED CAPACITY | 93.7 P.C. |
| INTERNAL RATE OF RETURN ON EQUITY: | |
| - EXISTING CAPACITY | 75.1 P.C. |
| - PROPOSED CAPACITY | 150.9 P.C. |
| BREAK-EVEN POINT | 17.9 THOU T |

SECTION 1

ANNEXURE 2

TERNAL RATE OF RETURN CALCULATION

ARIANT OF THE COOLER FOR ONE KILN

RS THOU

| RECONSTRUCTION | | OPERATION | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| - | - | 6710 | 6710 | 6710 | 6710 | 6710 | 6710 |
| - | - | 13619 | 13619 | 13619 | 13619 | 13619 | 13619 |
| -2903 | -8661 | - | - | - | - | - | - |
| -1452 | -4321 | - | - | - | - | - | - |
| - | - | -227 | -227 | -227 | -227 | -227 | -227 |
| - | - | -791 | -712 | -633 | -554 | -475 | -396 |
| - | - | -633 | -633 | -633 | -633 | -633 | -633 |
| -2903 | -8661 | 6483 | 6483 | 6483 | 6483 | 6483 | 6483 |
| -2903 | -8661 | 13392 | 13392 | 13392 | 13392 | 13392 | 13392 |
| -1452 | -4321 | 5059 | 5138 | 5217 | 5296 | 5375 | 5454 |
| -1452 | -4321 | 11968 | 12047 | 12126 | 12205 | 12284 | 12363 |

RS THOU

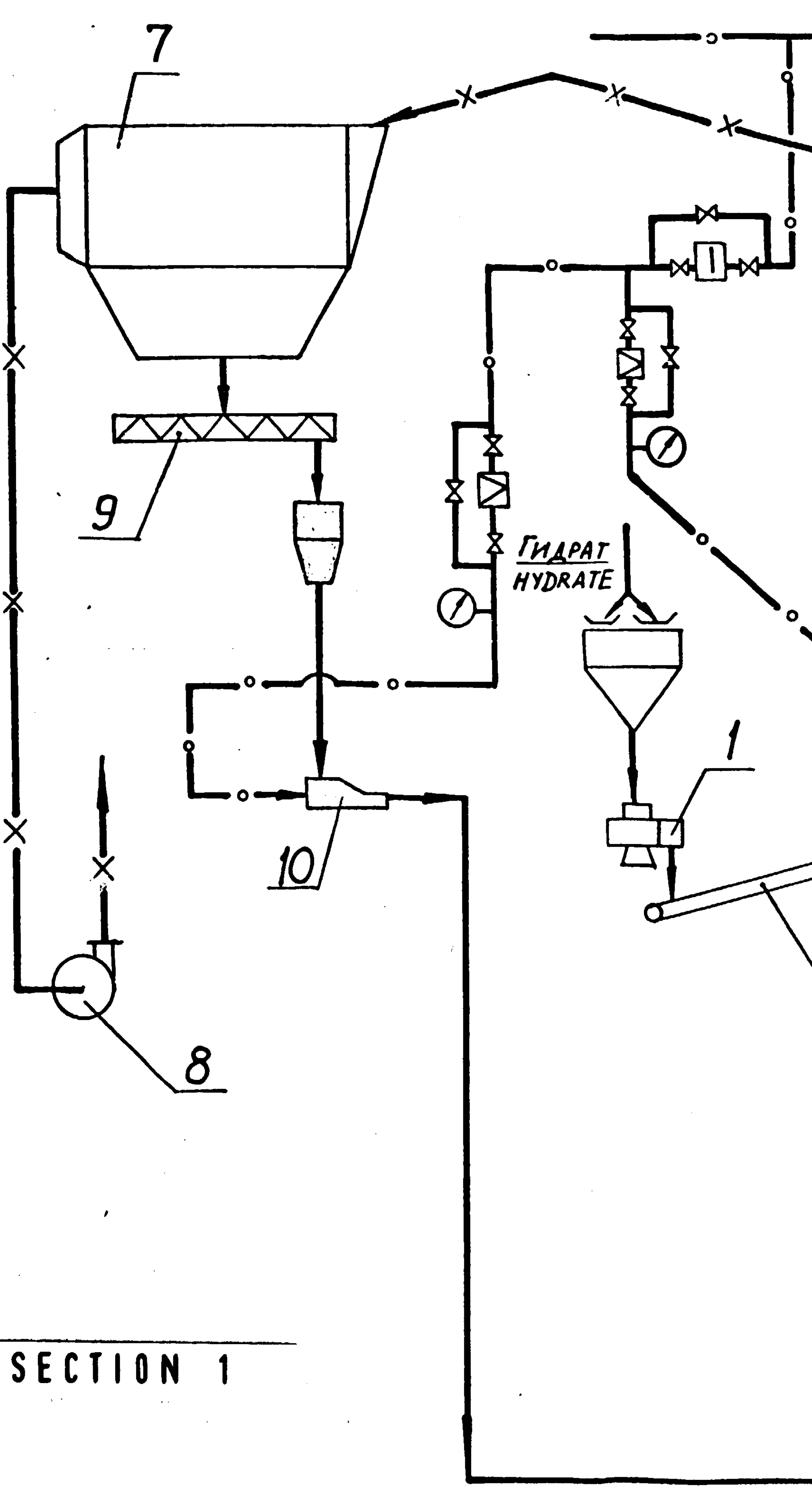
| OPERATION | | | | | | | TOTAL |
|---|---|---|---|---|---|---|---|
| 9 | 10 | 11 | 12 | 13 | 14 | 15 | |
| 6710 | 6710 | 6710 | 6710 | 6710 | 6710 | 6710 | 87239 |
| 13619 | 13619 | 13619 | 13619 | 13619 | 13619 | 13619 | 177059 |
| - | - | - | - | - | - | - | -11564 |
| - | - | - | - | - | - | - | -5773 |
| -227 | -227 | -227 | -227 | -227 | -227 | -227 | -2951 |
| -317 | -237 | -158 | -79 | - | - | - | -4352 |
| -633 | -633 | -633 | -633 | - | - | - | -6330 |
| 6483 | 6483 | 6483 | 6483 | 6483 | 6483 | 6483 | 72724 |
| 13392 | 13392 | 13392 | 13392 | 13392 | 13392 | 13392 | 162544 |
| 5533 | 5613 | 5692 | 5771 | 6483 | 6483 | 6483 | 67833 |
| 12442 | 12522 | 12601 | 12680 | 13392 | 13392 | 13392 | 157653 |

ON INVESTMENT: 49.5 P.C.
93.7 P.C.

ON EQUITY: 75.1 P.C.
150.9 P.C.
17.9 THOU T

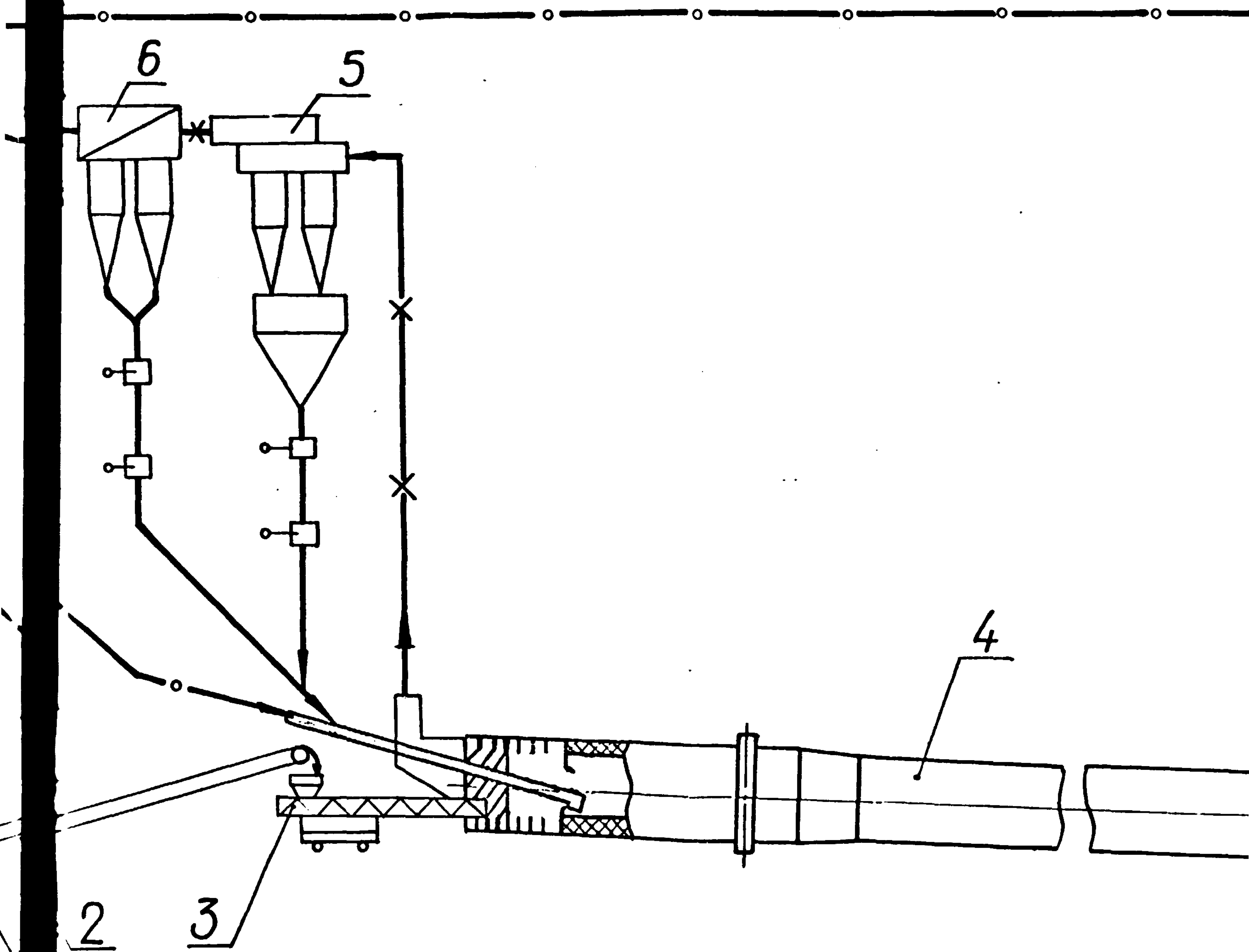
SECTION 2

DRAWINGS

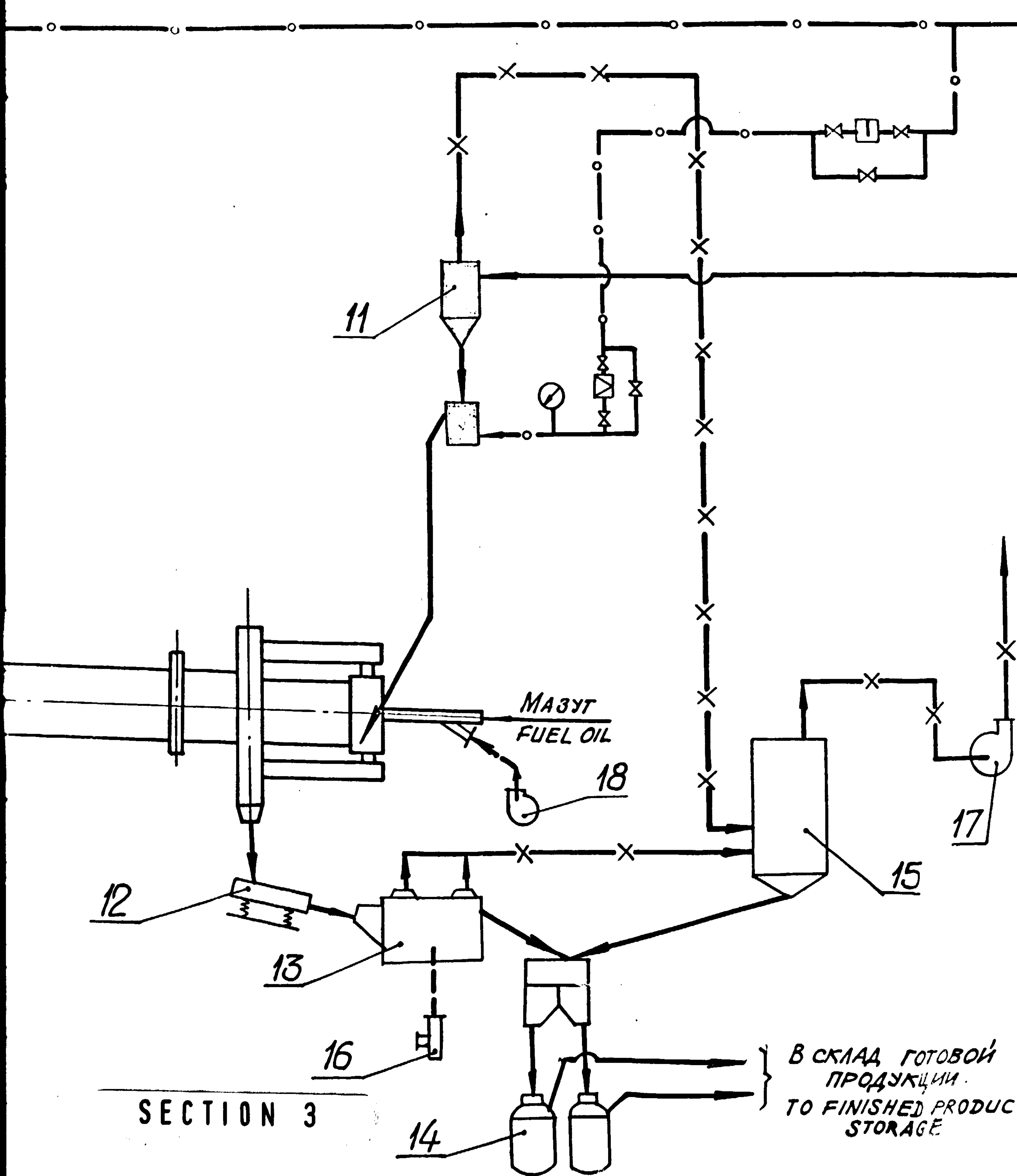



SECTION 1

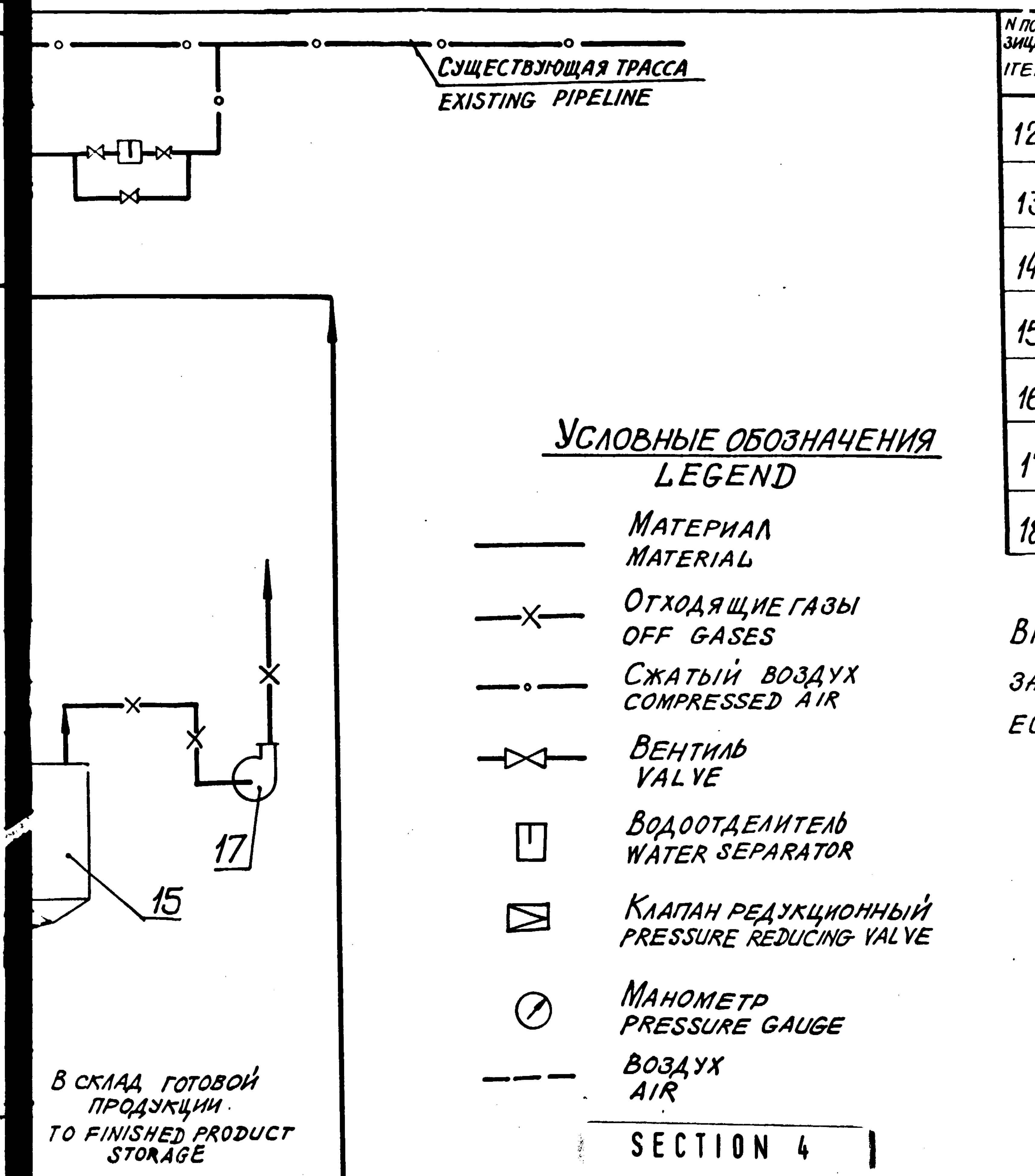
Инв.№подл. | Подп. и дата | Взам.инв.




SECTION 2


11
Мазут
FUEL OIL
18
17
12
15
13
16
В склад готовой продукции
TO FINISHED PRODUC
STORAGE
14

SECTION 3


СУЩЕСТВУЮЩАЯ ТРАССА
EXISTING PIPELINE
17
15
В СКЛАД ГОТОВОЙ ПРОДУКЦИИ.
TO FINISHED PRODUCT STORAGE
УСЛОВНЫЕ ОБОЗНАЧЕНИЯ
LEGEND
МАТЕРИАЛ
MATERIAL
ОТХОДЯЩИЕ ГАЗЫ
OFF GASES
СЖАТЫЙ ВОЗДУХ
COMPRESSED AIR
ВЕНТИЛЬ
VALVE
ВОДООТДЕЛИТЕЛЬ
WATER SEPARATOR
КЛАПАН РЕДУКЦИОННЫЙ
PRESSURE REDUCING VALVE
МАНОМЕТР
PRESSURE GAUGE
ВОЗДУХ
AIR

SECTION 4

| N позиции ITEM | Наименование DESCRIPTION | Техническая характеристика SPECIFICATIONS | Количество QTY | Примечание REMARKS |
|---|---|---|---|---|
| 12 | Грохот SCREEN | 1,22 × 2,74 м | 2 | Существующий EXISTING |
| 13 | Водо-воздушный доохладитель КС HYDRO-AIR COOLER | F аппарата UNIT = 5,2 м² m²<br>F теплообменников HEAT EXCHANGERS = 76 м² m² | 2 | — " — |
| 14 | Пневмокамерный насос PNEUMATIC CHAMBER PUMP | V = 5,8 м³ m³ | 4 | — " — |
| 15 | Фильтр рукавный BAG FILTER | V = 20000 м³/ч m³/h | 2 | — " — |
| 16 | Воздуходувка AIR BLOWER | Q = 1450 м³/ч m³/h<br>H = 28000 Па Pa | 2 | — " — |
| 17 | Вентилятор FAN | Q = 20000 м³/ч m³/h<br>H = 2500 Па Pa<br>Nдв. = 29,8 кВт kW | 2 | — " — |
| 18 | Вентилятор FAN | Q = 6650 м³/ч m³/h<br>H = 2550 Па Pa. | 2 | — " — |

| N по-зиции ITEM | |
|---|---|
| 1 | Г… RE… |
| 2 | К… Е… |
| 3 | П… S… |
| 4 | П… R… |
| 5 | Б… CY… |
| 6 | Б… CY… |
| 7 | Э… EL… |
| 8 | Д… I… |
| 9 | Ш… S… |
| 10 | С… |
| 11 | Щ… D… |

Вновь устанавливаемое оборудование на схеме затушевано.

EQUIPMENT TO BE INSTALLED IS DARKENED ON DIAGRAM.

SECTION 5

Масшт… SCALE

| КОЛИЧЕСТВО QTY | ПРИМЕЧАНИЕ REMARKS | N ПОЗИЦИИ ITEM | НАИМЕНОВАНИЕ DESCRIPTION | ТЕХНИЧЕСКАЯ ХАРАКТЕРИСТИКА SPECIFICATIONS | КОЛИЧЕСТВО QTY | ПРИМЕЧАНИЕ REMARKS |
|---|---|---|---|---|---|---|
| 2 | СУЩЕСТВУЮЩИЙ EXISTING | 1 | ПИТАТЕЛЬ ТАРЕЛЬЧАТЫЙ RECIPROCATING PLATE FEEDER | φ 2 м/m | 2 | СУЩЕСТВУЮЩИЙ EXISTING |
| 2 | —"— | 2 | КОНВЕЙЕР ЛЕНТОЧНЫЙ BELT CONVEYOR | B=500 | 2 | —"— |
| 4 | —"— | 3 | ПИТАТЕЛЬ ШНЕКОВЫЙ SCREW CONVEYOR | φ450; L=6,5 м/m Q=30 т/ч t/h | 2 | —"— |
| 2 | —"— | 4 | ПЕЧЬ ВРАЩАЮЩАЯСЯ ROTARY KILN | φ3,6/φ3,3 м/m L=80 м/m | 2 | —"— |
| 2 | —"— | 5 | БАТАРЕЯ ЦИКЛОНОВ. I СТУПЕНЬ. CYCLONE BANK. STAGE I | 4 ЦИКЛОНА CYCLONES φ1370 мм/mm | 2 | —"— |
| 2 | —"— | 6 | БАТАРЕЯ ЦИКЛОНОВ. II СТУПЕНЬ CYCLONE BANK. STAGE II | 90 ЦИКЛОНОВ CYCLONES φ225 мм/mm. | 2 | —"— |
| 2 | —"— | 7 | ЭЛЕКТРОФИЛЬТР ELECTROSTATIC PRECIPITATOR | F=30,5 м²/m² | 2 | —"— |
| | | 8 | ДЫМОСОС I. D. FAN | Q=103000 м3/ч m3/h H=2800 Па/Pa | 2 | —"— |
| | | 9 | ШНЕК SCREW | φ 500 L=7 м/m | 2 | СУЩЕСТВУЮЩИЙ EXISTING |
| | | 10 | СТРУЙНЫЙ НАСОС JET PUMP | Q=7 т/ч t/h | 2 | ВНОВЬ УСТАНАВЛИВАЕМЫЕ TO BE INSTALLED. |
| | | 11 | ЦИКЛОН РАЗГРУЗИТЕЛЬ DISCHARGING CYCLONE | φ 600 | 2 | |

...EME

...DIAGRAM.

# SECTION 6

ВАМИ Ленинград
VAMI LENINGRAD

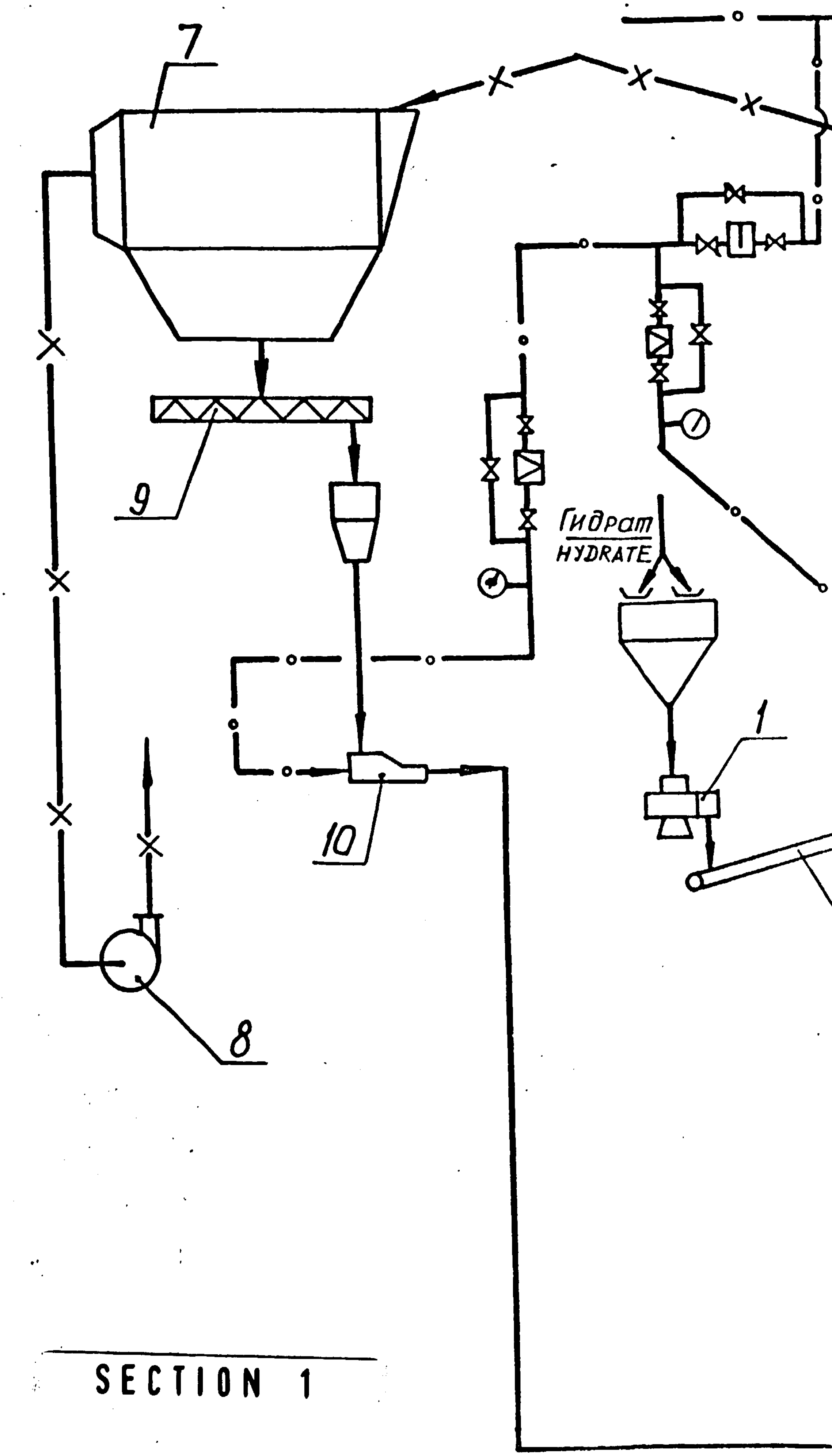
Масштаб
SCALE

ДЛЯ ИНДИЙСКОЙ ФИРМЫ БХАРАТ АЛЮМИНИУМ КОМПАНИ.
FOR BHARAT ALUMINIUM COMPANY; LTD. INDIA



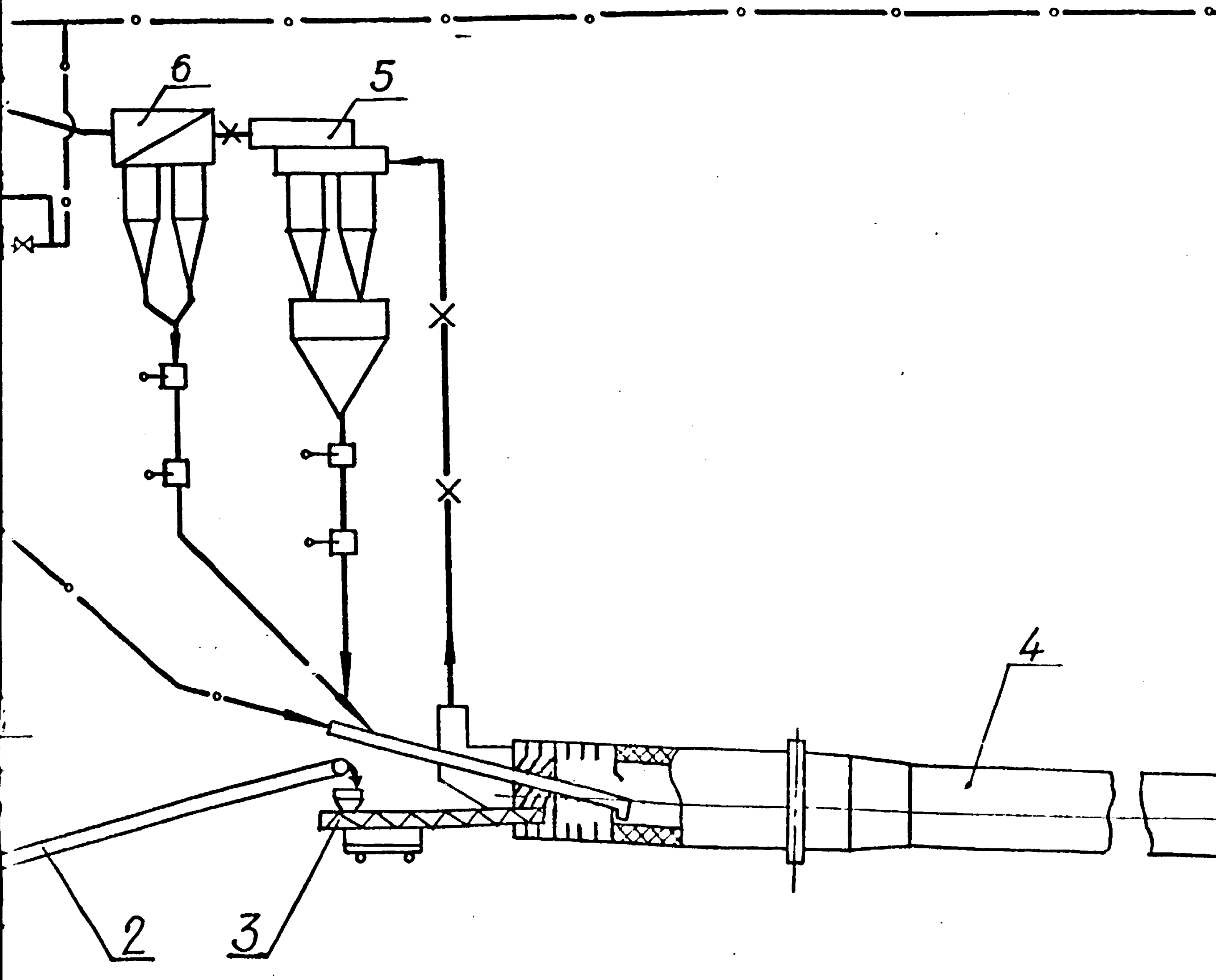
ГЛИНОЗЕМНЫЙ ЗАВОД В КОРБЕ. РЕКОНСТРУКЦИЯ ЦЕХА КАЛЬЦИНАЦИИ. I ЭТАП. СХЕМА АППАРАТУРНО-ТЕХНОЛОГИЧЕСКАЯ.
KORBA ALUMINA PLANT. RECONSTRUCTION OF CALCINATION. I STAGE. PROCESS & EQUIPMENT FLOWSHEET

| 1354690-TM | ЛИСТ SHEET 1 | ЛИСТОВ SHEETS 3 |
|---|---|---|

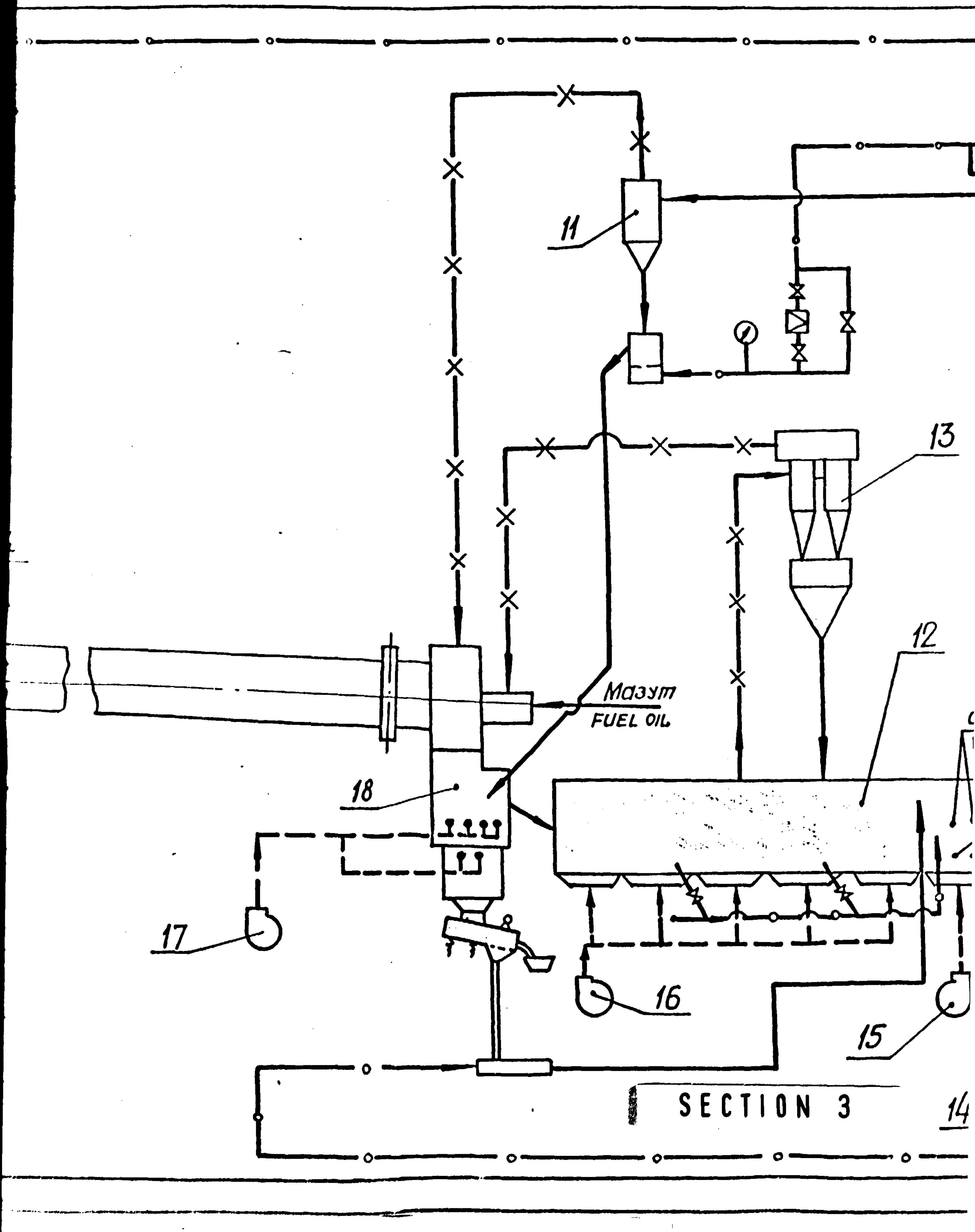


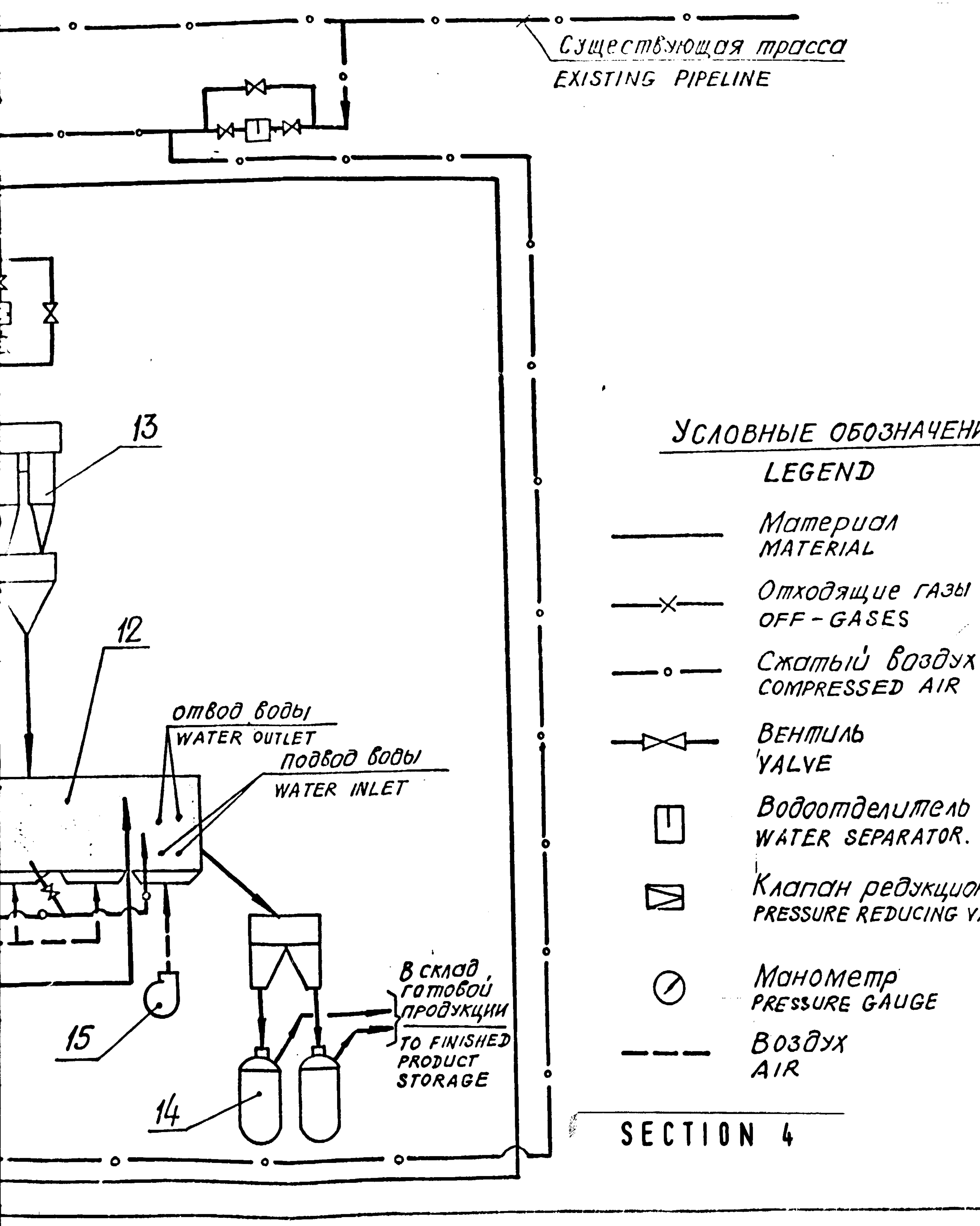

SECTION 1

Инв.N подл | Подп. и дата | Взам. инв.N




SECTION 2


11
13
12
Мазут
FUEL OIL
18
17
16
15
14
SECTION 3


Существующая трасса
EXISTING PIPELINE
13
12
15
14
отвод воды
WATER OUTLET
подвод воды
WATER INLET
В склад готовой продукции
TO FINISHED PRODUCT STORAGE
УСЛОВНЫЕ ОБОЗНАЧЕНИ
LEGEND
Материал
MATERIAL
Отходящие газы
OFF-GASES
Сжатый воздух
COMPRESSED AIR
Вентиль
VALVE
Водоотделитель
WATER SEPARATOR.
Клапан редукцио
PRESSURE REDUCING V
Манометр
PRESSURE GAUGE
Воздух
AIR

SECTION 4

| N позиции ITEM | Наименование DESCRIPTION | Техническая характеристика SPECIFICATION |
|---|---|---|
| 12 | Холодильник кипящего слоя FLUIDBED COOLER | F $\frac{\text{Внутренняя}}{\text{INTERNAL}}$ =75 м2 / m2 |
| 13 | Батарея циклонов CYCLONE BANK | 4 $\frac{\text{циклона}}{\text{CYCLONE}}$ ф 1100 |
| 14 | Пневмокамерный насос PNEUMATIC CHAMBER PUMP | V = 5,8 м3 / m3 |
| 15 | Вентилятор FAN | Q=25000 м3/ч / m3/h H=7000 Па / Pa |
| 16 | Воздуходувка AIR BLOWER | Q = 4000 м3/ч / m3/h H=11000 Па / Pa |
| 17 | Воздуходувка AIR BLOWER | Q=1450 м3/ч / m3/h H=30000 Па / Pa |
| 18 | Шамотоотделитель с виброжолобом. FIRECLAY SEPARATOR WITH VIBRATING CHUTE. | F $\frac{\text{Внутренняя}}{\text{INTERNAL}}$ 3 м2 / m2 |

…расса

…ные обозначения
…EGEND

…атериал
…ATERIAL

…тходящие газы
…FF-GASES

Сжатый воздух
…OMPRESSED AIR

…ентиль
…ALVE

…одоотделитель
…ATER SEPARATOR.

…лапан редукционный
…RESSURE REDUCING VALVE

…анометр
…RESSURE GAUGE

…оздух
…IR

Вновь устанавливаемое оборудование на схеме зачерн…

EQUIPMENT TO BE INSTALLED IS DARKENED ON DIAGRAM

SECTION 5

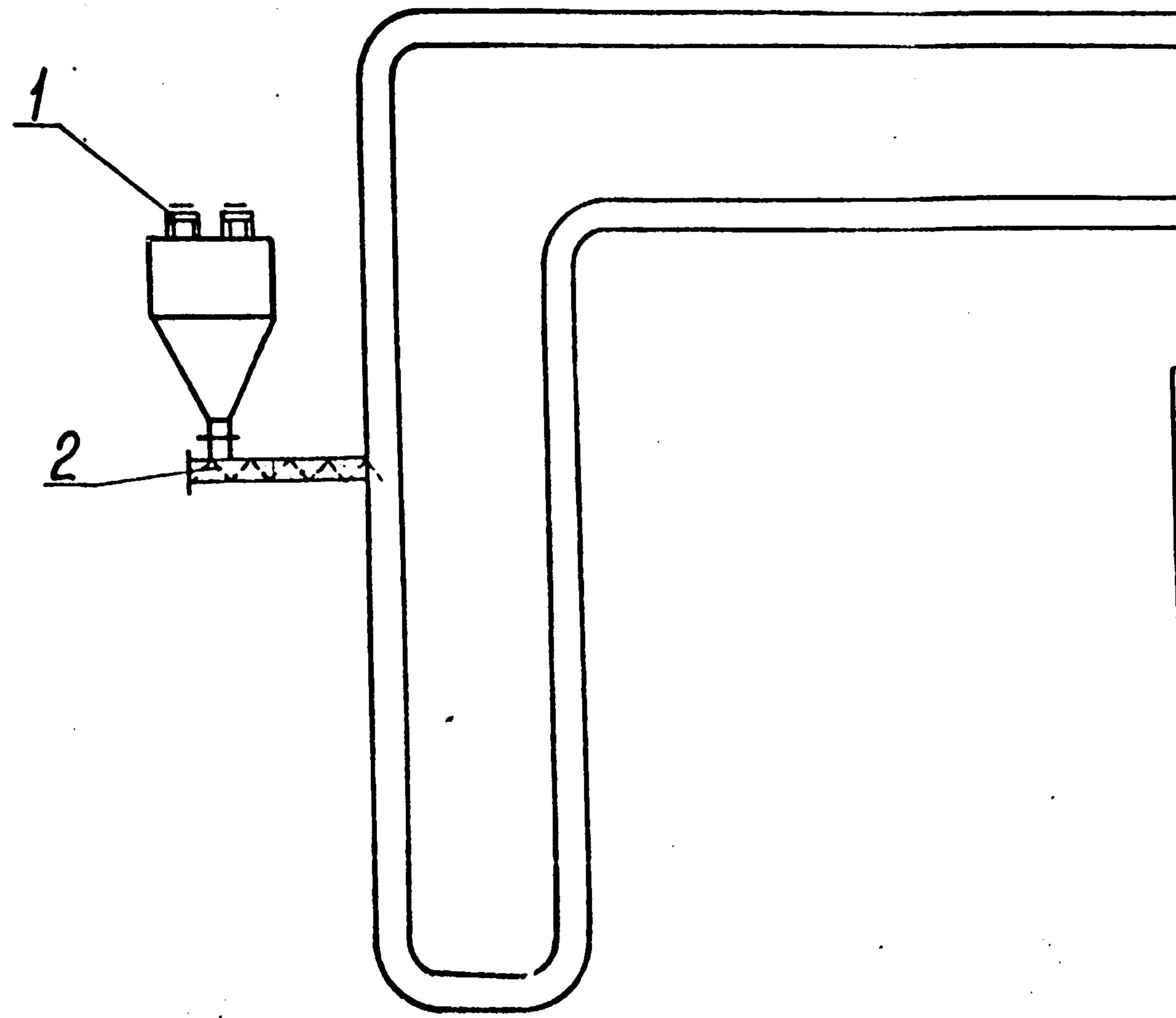
| Количество Q-TY | Примечание REMARK | № позиции ITEM | Наименование DESCRIPTION | Техническая характеристика SPECIFICATION | Количество Q-TY | Примечание REMARK |
|---|---|---|---|---|---|---|
| 2 | Вновь устанавливаемые | 1 | Питатель тарельчатый RECIPROCATING PLATE FEEDER | $\phi 2 \frac{м}{m}$ | 2 | Существующий. EXISTING |
| 2 | TO BE INSTALLED | 2 | Конвейер ленточный BELT CONVEYOR | B=500 | 2 | —"— |
| 4 | Существующий EXISTING | 3 | Питатель шнековый SCREW CONVEYOR | $\phi 450$; $L=6,5 \frac{м}{m}$ $Q=30 \frac{т/ч}{T/H}$ | 2 | —"— |
| 2 | Вновь устанавливаемые | 4 | Печь вращающаяся ROTARY KILN | $\phi 3,6/\phi 3,3 \frac{м}{m}$ $L=80 \frac{м}{m}$ | 2 | —"— |
| 2 | TO BE INSTALLED | 5 | Батарея циклонов. I ступень CYCLONE BANK STAGE I | 4 $\frac{циклона}{CYCLONES}$ $\phi 1370 \frac{мм}{mm}$ | 2 | —"— |
| 2 | Существующая EXISTING | 6 | Батарея циклонов II ступень CYCLONE BANK STAGE II | 90 $\frac{циклонов}{CYCLONES}$ $\phi 225 \frac{мм}{mm}$ | 2 | —"— |
| 2 | Вновь устанавливаемый TO BE INSTALLED | 7 | Электрофильтр ELECTROSTATIC PRECIPITATOR | $F=30,5 \frac{м^2}{m^2}$ | 2 | —"— |
| | | 8 | Дымосос I.D. FAN. | $Q=103000 \frac{м^3/ч}{m^3/H}$ $H=2800 \frac{Па}{Pa}$ | 2 | —"— |
| | | 9 | Шнек SCREW | $\phi 500$ $L=7 \frac{м}{m}$ | 2 | Существующий EXISTING |
| | | 10 | Струйный насос JET PUMP | $Q=7 \frac{т/ч}{T/H}$ | 2 | Установлен на I этапе |
| | | 11 | Циклон-разгрузитель DISCHARGING CYCLONE | $\phi 600$ | 2 | INSTALLED AT STAGE I |

…рушевано;

…м.

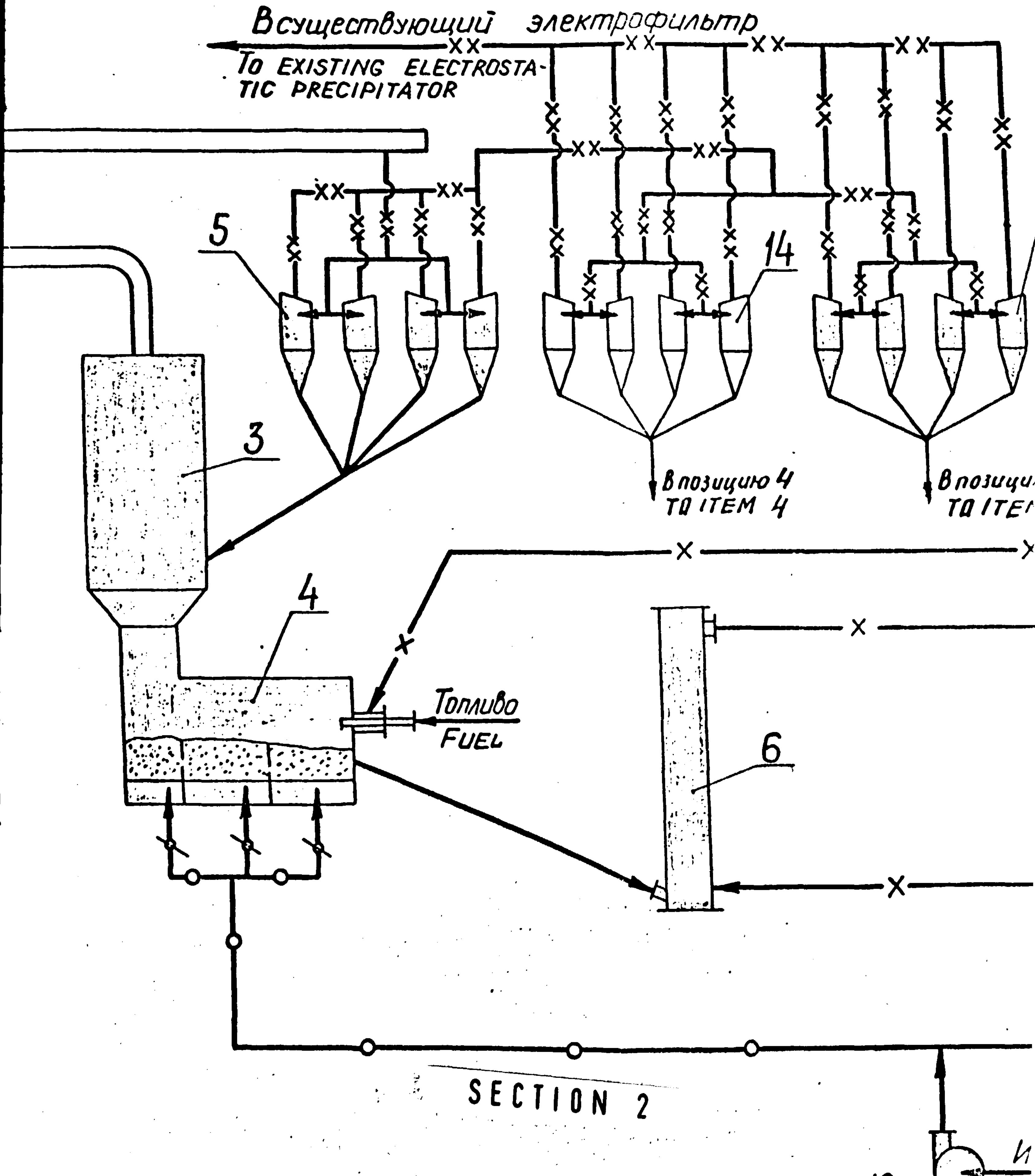
# SECTION 6

| | |
|---|---|
| ВАМИ Ленинград VAMI LENINGRAD | |
| Масштаб SCALE — | Для индийской фирмы Бхарат Алюминиум Компани. FOR BHARAT ALUMINIUM COMPANY. LTD. INDIA |
| Данный чертеж является собственностью института ВАМИ и не может быть скопирован и использован без его разрешения. THIS DRAWING IS THE PROPERTY OF VAMI AND NOT TO BE COPIED OR USED WITHOUT OUR PERMISSION | Глиноземный завод в Корбе. Реконструкция цеха кальцинации. II этап. Схема аппаратурно-технологическая. КОРВА ALLUMINA PLANT. RECONSTRUCTION OF CALCINATION. II STAGE. PROCESS EQUIPMENT FLOWSHEET. |
| | 1354691-TM Лист SHEET 1 Листов SHEETS 3 |

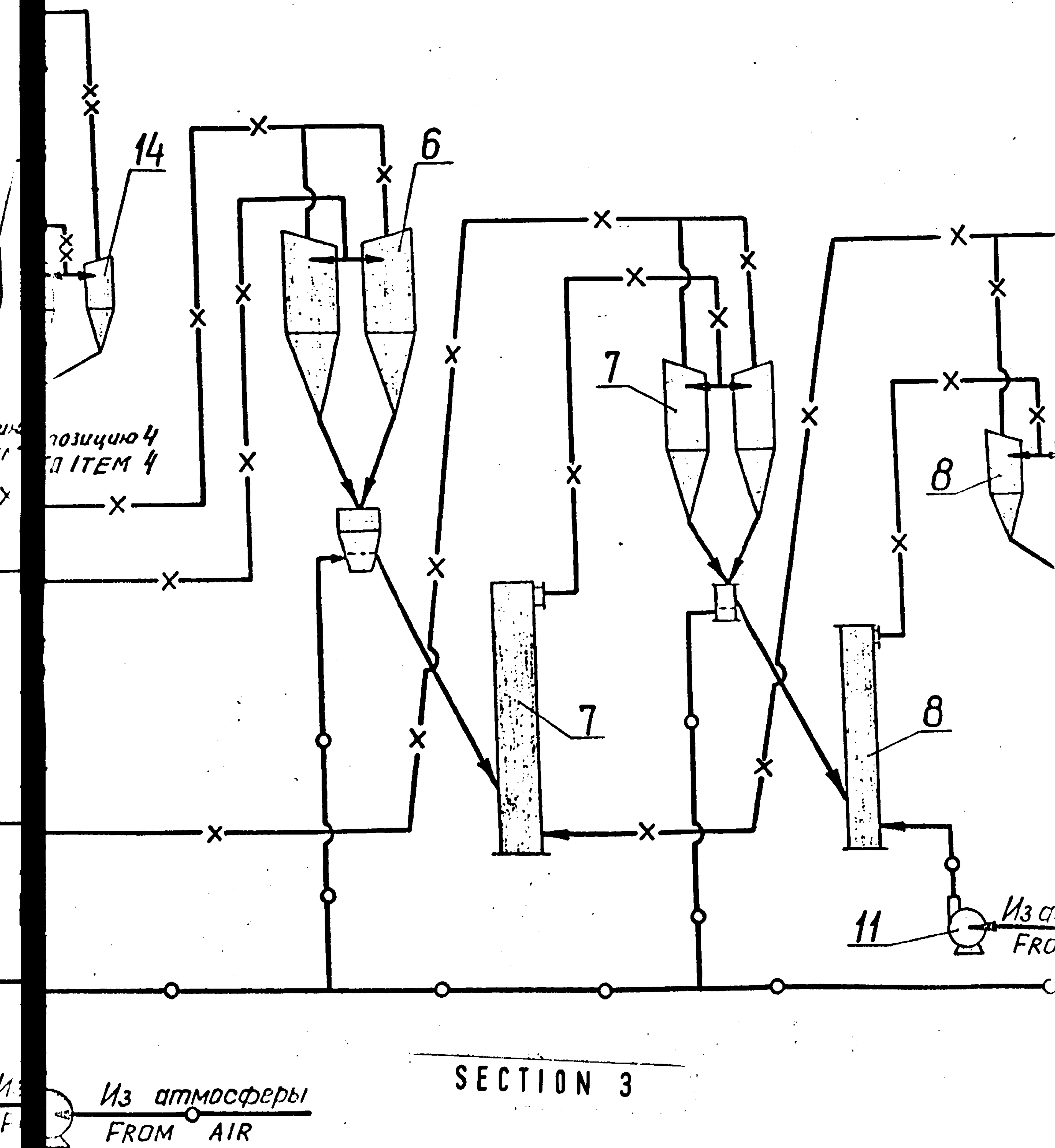



SECTION 1

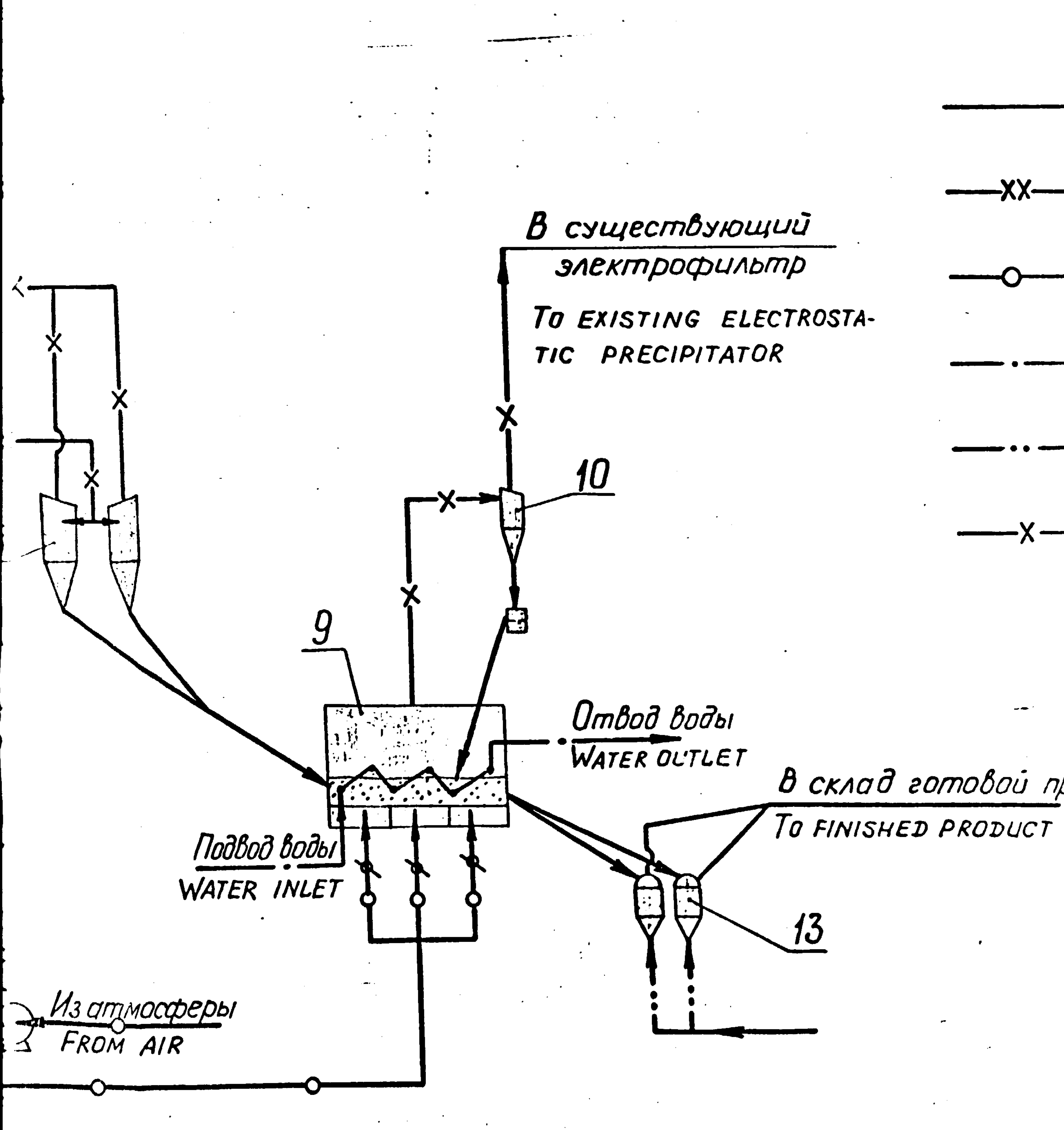
Взам. инв. N°
Подп. и дата
Инв. N° подл.


В существующий электрофильтр
To EXISTING ELECTROSTATIC PRECIPITATOR
5
14
3
В позицию 4
TO ITEM 4
4
Топливо
FUEL
6
12

SECTION 2




SECTION 3



В существующий электрофильтр
To EXISTING ELECTROSTATIC PRECIPITATOR
10
9
Отвод воды
WATER OUTLET
В склад готовой п
To FINISHED PRODUCT
Подвод воды
WATER INLET
13
Из атмосферы
FROM AIR


SECTION 4

## Условные обозначения
## LEGEND

——— Материал
MATERIAL

——xx—— Отходящие газы
FLUE GASES

——o—— Воздух
AIR

A-

——·—— Вода
WATER

——··—— Сжатый воздух
COMPRESSED AIR

——x—— Нагретый воздух
HEATED AIR

ад готовой продукции
ISHED PRODUCT STORAGE

SECTION 5

| № позиции SN | Наименование DESCRIPTION | Техническая характеристика SPECIFICATION | Количество QTY |
|---|---|---|---|
| 9 | Доохладитель „КС" FLUID BED COOLER | $S=15\ м^2$ | 1 |
| 10 | Циклон CYCLONE | Ф 900 мм mm | 1 |
| 11 | Вентилятор FAN | $Q=44000\ м^3/ч$ $m^3/h$ <br> H=240 мм вод. ст. mm WATER GAUGE | 1 |
| 12 | Воздуходувка AIR BLOWER | $Q=15000\ м^3/ч$ $m^3/h$ <br> H=1500 мм вод. ст. mm WATER GAUGE | 1 |
| 13 | Насос камерный CHAMBER PUMP | Ф 1800 мм mm | 2 |
| 14 | I ступень циклонов I STAGE OF CYCLONES | 4 циклона 4 CYCLONS ф1370 мм mm | 2 |

Вновь устанавливаемое оборудование на схеме затушевано.

THE EQUIPMENT TO BE INSTALLED IS DARKENED ON THE DIAGRAM.

SECTION 6

| Количество QTY | Примечание REMARK | N позиции SN | Наименование DESCRIPTION | Техническая характеристика SPECIFICATION | Количество QTY | Примечание REMARK |
|---|---|---|---|---|---|---|
| 1 | | 1 | Конвейер ленточный BELT CONVEYOR | B=650 мм mm | 2 | Реконструкция RECONSTRUCTION |
| 1 | | 2 | Питатель шнековый SCREW FEEDER | Ф500 мм mm | 1 | |
| 1 | | 3 | Теплообменник шахтный SHAFT TYPE EXCHANGER | Ф5400 | 1 | |
| 1 | | 4 | Камера кипящего слоя FLUID BED CHAMBER | S=20 м² m² | 1 | |
| 2 | | 5 | Теплообменник циклонный CYCLONE HEAT EXCHANGER | 4 циклона CYCLONES Ф1400 мм mm | 1 | |
| 2 | 1 существующ. 1 EXISTING | 6 | I ступень холодильника циклонного I STAGE OF CYCLONE COOLER | 2 циклона - Ф2,04м Ф колонки - 1,4м 2 CYCLONES DIA - 2,04m COLUMN, DIA - 1,4m | 1 | |
| | | 7 | II ступень холодильника циклонного II STAGE OF CYCLONE COOLER | 2 циклона - Ф1,8м Ф колонки - 1,2м 2 CYCLONE DIA - 1,8m COLUMN DIA - 1,2m | 1 | |
| | | 8 | III ступень холодильника циклонного III STAGE OF CYCLONE COOLER | 2 циклона - Ф1,52м Ф колонки - 1м 2 CYCLONE DIA - 1,52m COLUMN DIA - 1m | 1 | |

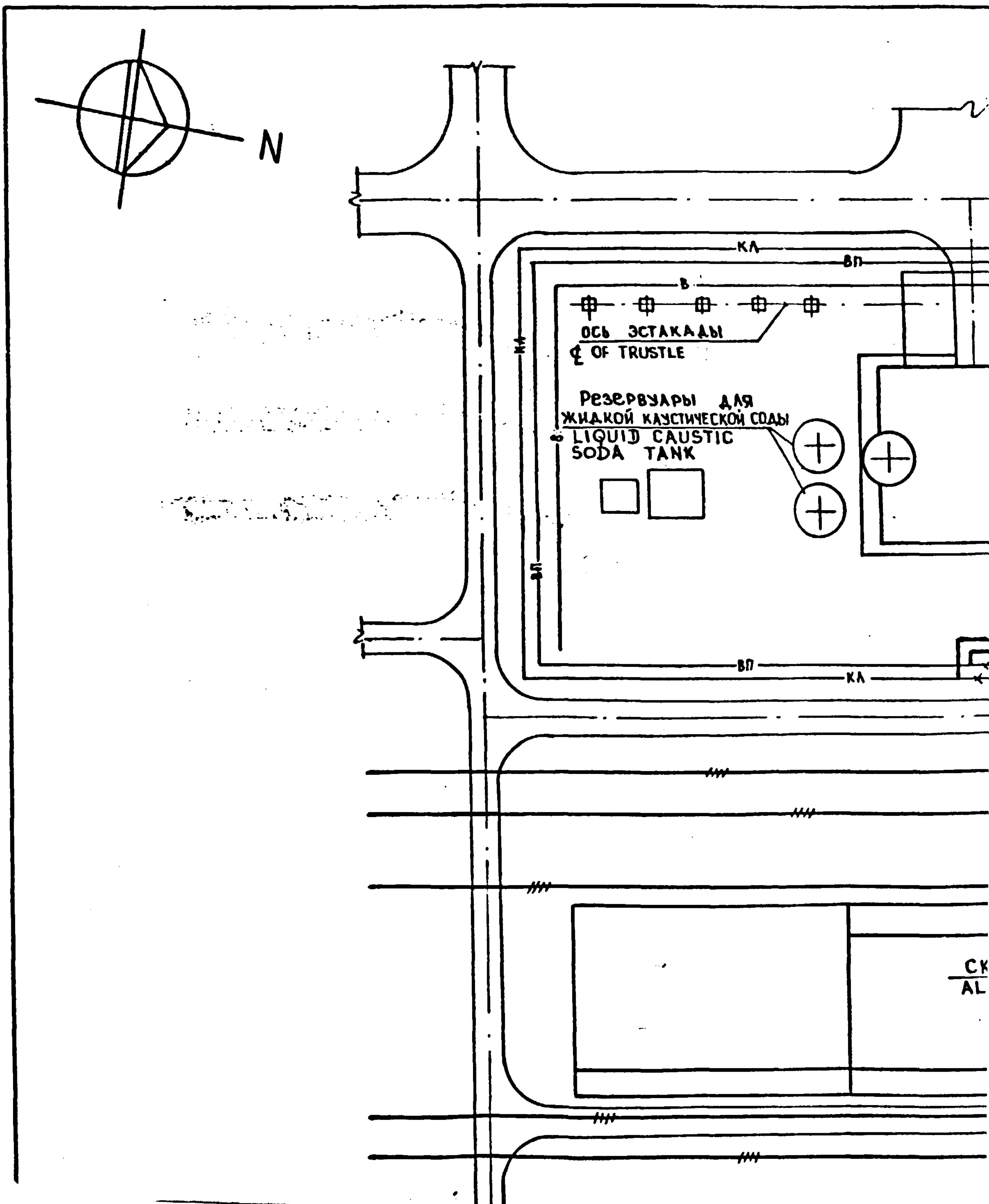
e

SECTION 7

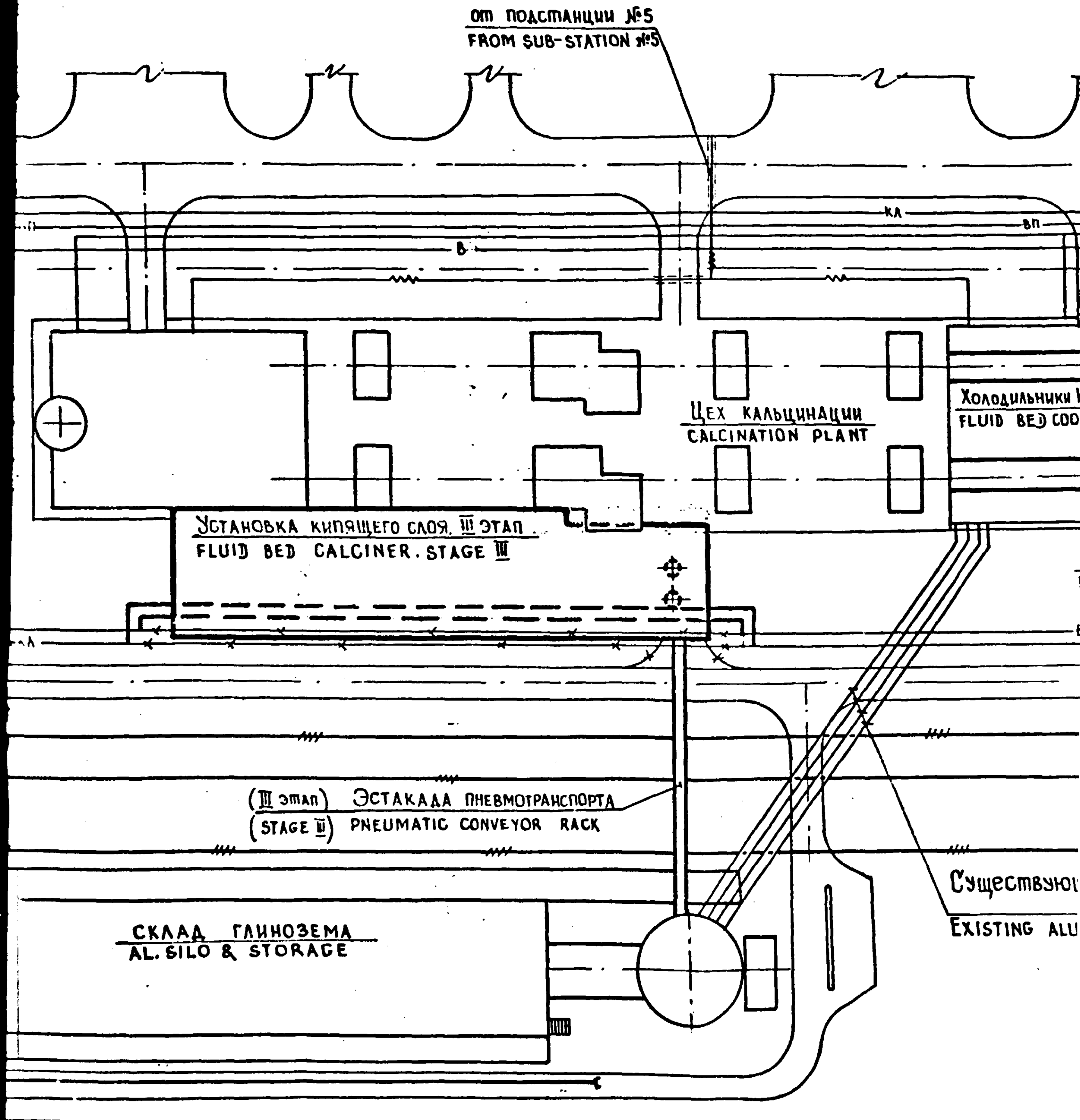
D KENED

| | |
|---|---|
| ВАМИ ЛЕНИНГРАД VAMI LENINGRAD | |
| Масштаб SCALE — | Для Индийской фирмы Бхарат Алюминиум Компани. FOR BHARAT ALUMINIUM COMPANY LTD, INDIA |
| Данный чертеж является собственностью института ВАМИ и не может быть скопирован и использован без его разрешения. THIS DRAWING IS THE PROPERTY OF VAMI AND NOT TO BE COPIED OR USED WITHOUT OUR PERMISSION | Глиноземный завод в Корбе. Реконструкция цеха кальцинации. III этап. Схема аппаратурно-технологическая. KORBA ALUMINA PLANT. RECONSTRUCTION OF CALCINATION. STAGE III. EQUIPMENT AND PROCESS FLOWSHEET. |
| | 1354697-TM Лист SHEET 1 Листов SHEETS 3 |

Формат А4х3 SIZE A4x3

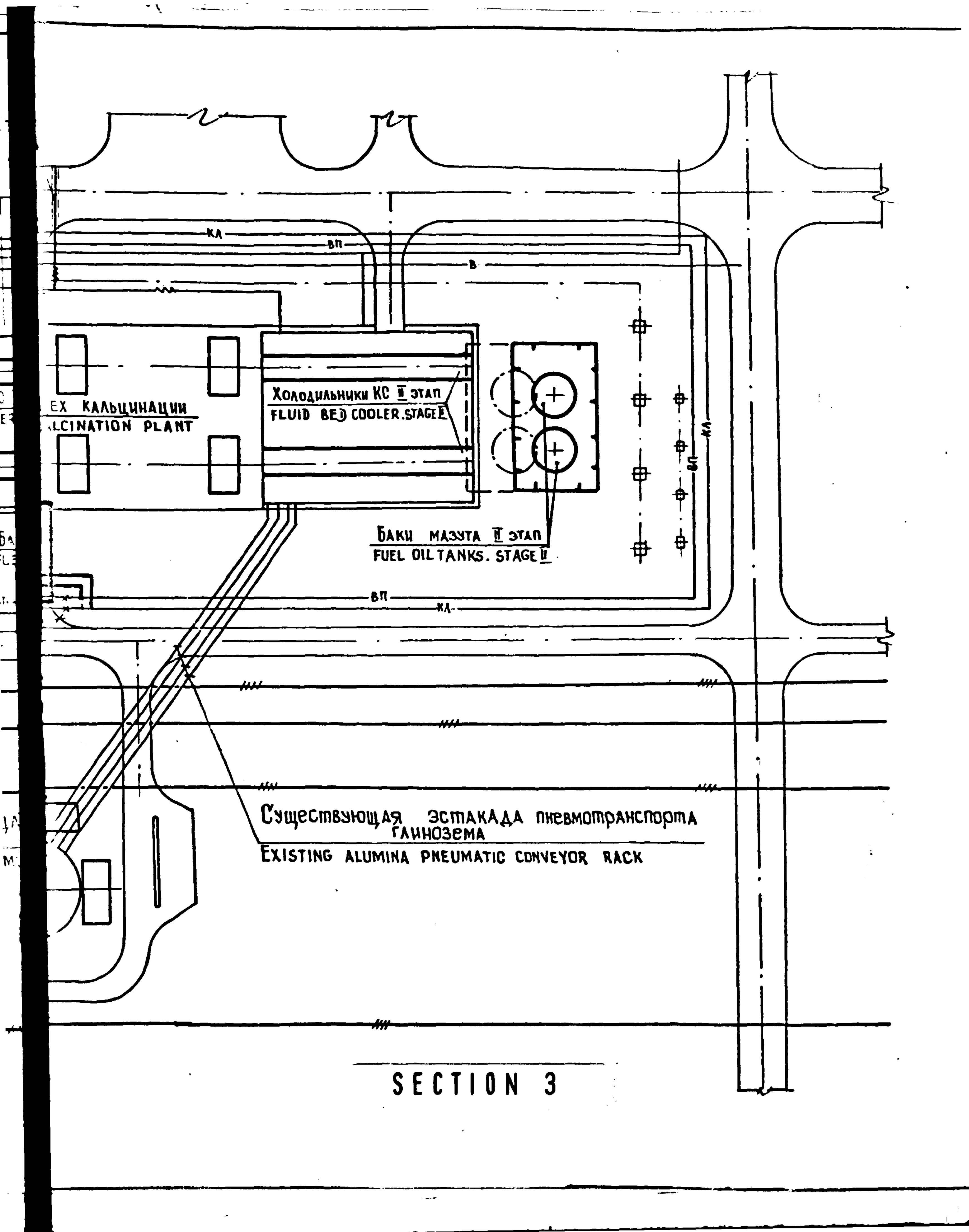

N
КЛ
ВП
В
ОСЬ ЭСТАКАДЫ
℄ OF TRUSTLE
Резервуары для
жидкой каустической соды
LIQUID CAUSTIC
SODA TANK

SECTION 1

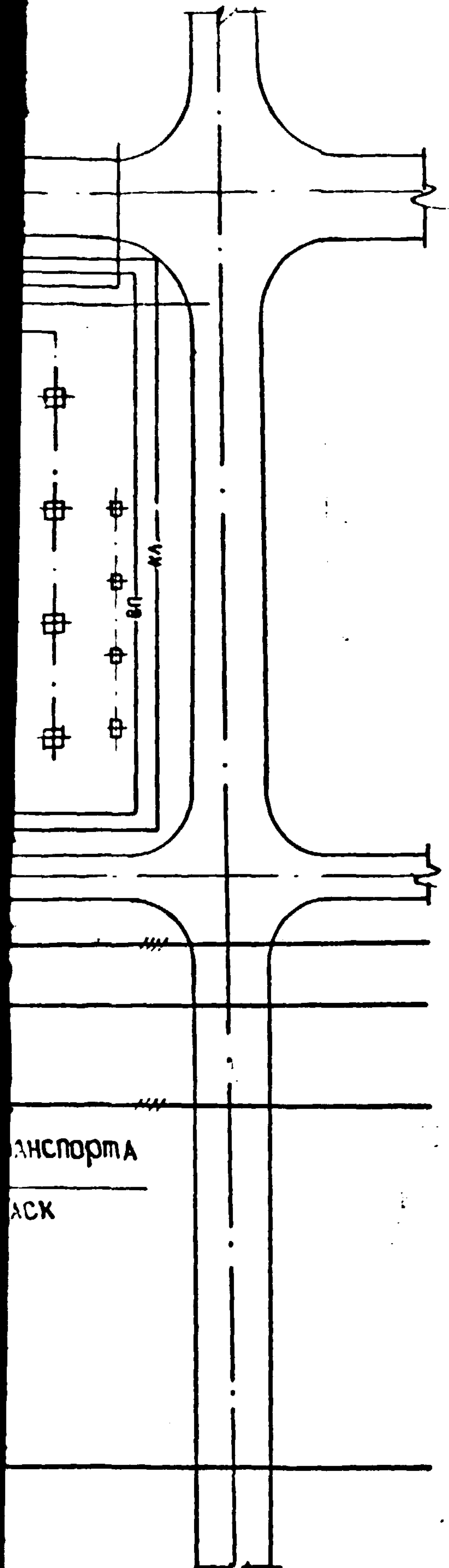


от ПОДСТАНЦИИ №5
FROM SUB-STATION №5
В
КЛ
ВП
ЦЕХ КАЛЬЦИНАЦИИ
CALCINATION PLANT
Холодильники
FLUID BED COO
УСТАНОВКА КИПЯЩЕГО СЛОЯ. III ЭТАП
FLUID BED CALCINER. STAGE III
(III этап) ЭСТАКАДА ПНЕВМОТРАНСПОРТА
(STAGE III) PNEUMATIC CONVEYOR RACK
Существую
EXISTING ALU
СКЛАД ГЛИНОЗЕМА
AL. SILO & STORAGE


SECTION 2


КЛ
ВП
В
EX КАЛЬЦИНАЦИИ
LCINATION PLANT
Холодильники КС II этап
FLUID BED COOLER. STAGE II
Баки мазута II этап
FUEL OIL TANKS. STAGE II
ВП
КЛ
Существующая эстакада пневмотранспорта глинозема
EXISTING ALUMINA PNEUMATIC CONVEYOR RACK

SECTION 3




УСЛОВНЫЕ ОБОЗН
LEGEND

| | |
|---|---|
| | Сооружения проек<br>PROPOSED STRUCTURES |
| | Сооружения сущес<br>EXISTING STRUCTURES |
| | Автомобильные дор<br>EXISTING MOTOR ROAD |
| | Железнодорожные<br>EXISTING RAILWAYS |
| — В — | Водопровод питьевой<br>DRINKING WATER PIP |
| — ВП — | Водопровод произв<br>INDUSTRIAL WATER P |
| — КЛ — | Канализация ливне<br>STORM WATER SEWE |
| | Электрокабель<br>POWER CABLE |
| | Сети разбираемы<br>SYSTEMS TO BE REMO |
| | Сети перекладь<br>SYSTEMS TO BE MOVI |

SECTION 4

# Условные обозначения
# LEGEND

| | |
|---|---|
| | Сооружения проектируемые<br>PROPOSED STRUCTURES |
| | Сооружения существующие<br>EXISTING STRUCTURES |
| | Автомобильные дороги существующие<br>EXISTING MOTOR ROADS |
| | Железнодорожные пути существующие<br>EXISTING RAILWAYS |
| В | Водопровод питьевой<br>DRINKING WATER PIPELINE |
| ВП | Водопровод производственный<br>INDUSTRIAL WATER PIPELINE |
| КА | Канализация ливневая<br>STORM WATER SEWERAGE |
| | Электрокабель<br>POWER CABLE |
| | Сети разбираемые<br>SYSTEMS TO BE REMOVED |
| | Сети перекладываемые<br>SYSTEMS TO BE MOVED |

1. НА ДАН
осущес
цеха
НА I э
ДАННОМ

1. THIS I
STAGES
WORK
ON THIS

SECTION 5

МАСШТАБ
SCALE

ДАННЫЙ ЧЕРТ
СОБСТВЕННОСТ
ВАМИ И НЕ М
СКОПИРОВАН И
БЕЗ ЕГО РАЗР

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# Примечания

## NOTES

1. На данном чертеже показаны сооружения, осуществляемые на II и III этапах реконструкции цеха кальцинации. Мероприятия, осуществляемые на I этапе, ввиду их незначительного объема, на данном чертеже не показаны.

1. This drawing shows units to be installed at stages II and III of calcination plant reconstruction. Work to be carried out at stage I is not shown on this drawing, because of insignificant quantity.

SECTION 6

| | |
|---|---|
| ВАМИ Ленинград<br>VAMI Leningrad | |
| Масштаб / Scale 1:500 | Для Индийской фирмы Бхарат Алюминиум компани.<br>For Bharat Aluminium Company Ltd, India. |
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| | 1219643-ГП \| Лист / Sheet \| Листов / Sheets |

Формат А4х5 Size A4x5

Contract No 82 | 61
United Nations Industrial Development Organization
(UNIDO)

12912
(2 of 2)

# FEASIBILITY REPORT FOR RECONSTRUCTION STUDY OF ALUMINA CALCINER FOR ENERGY CONSERVATION AT KORBA ALUMINA PLANT (INDIA)

Project No SI IND 82 802

Volume II

Drawings

VAMI

V/O TSVETMETPROMEXPORT

Leningrad
1983

## Composition of Feasibility Study

Volume I - General Explanatory Note

Volume II - Drawings

Volume III - Equipment Specifications

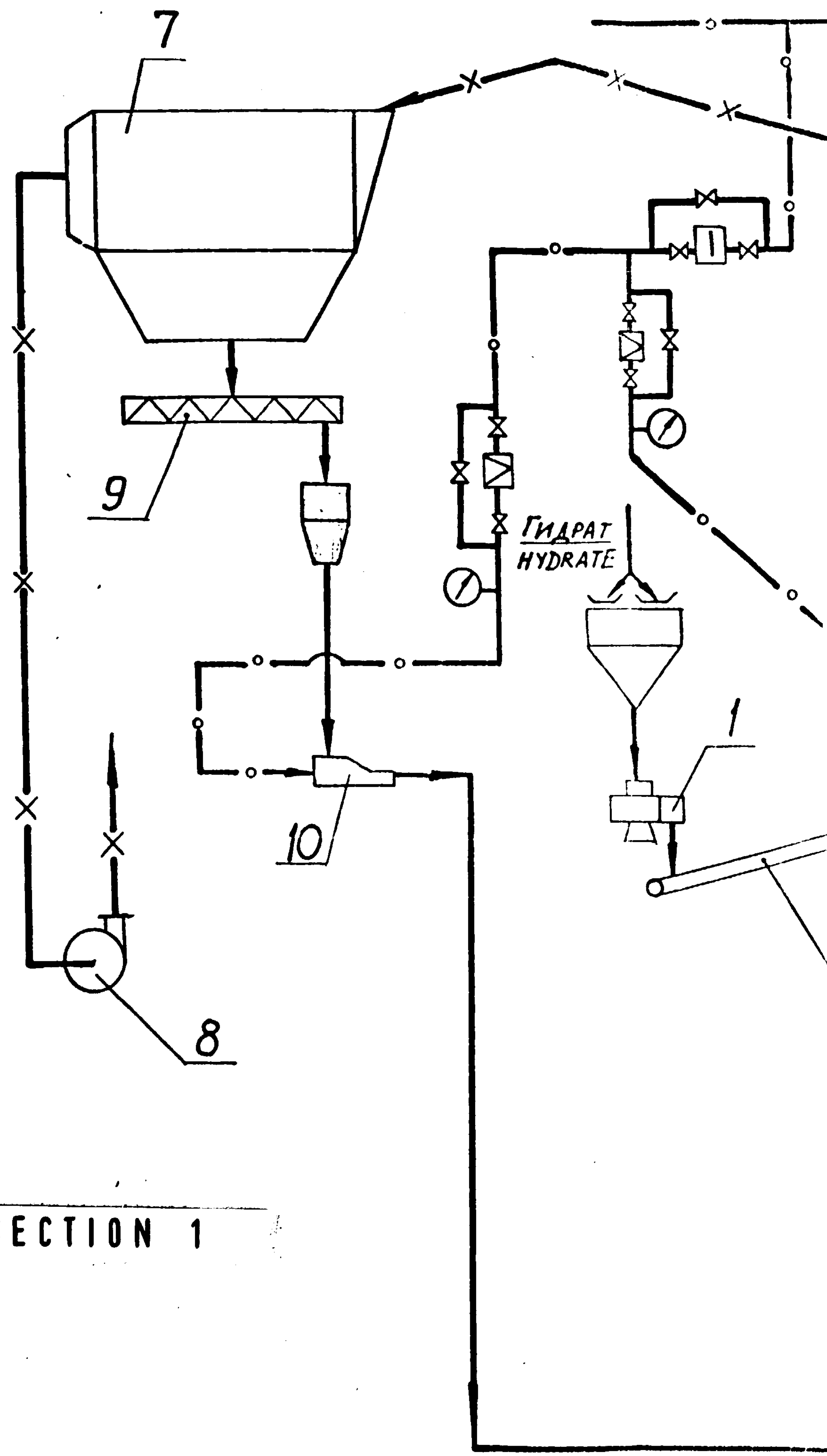
List of drawings

| SNo | Drawing designation | Drawing No |
|---|---|---|
| 1 | 2 | 3 |
| | **Stage I** | |
| 1 | Equipment and process flowsheet | 1354690-TM Sheet 1 |
| 2 | Plan | 1354690-TM Sheet 2 |
| 3 | Section 1-1 | 1354690-TM Sheet 3 |
| 4 | Symbols (I, II and III stages) | 1355573-KA |
| 5 | Equipment and process flowsheet with control points | 1355574-KA |
| | **Stage II** | |
| 1 | Equipment and process flowsheet | 1354691-TM Sheet 1 |
| 2 | Kiln arrangement at el. 0.000 | 1354691-TM Sheet 2 |
| 3 | Section 1-1 | 1354691-TM Sheet 3 |
| 4 | Fluidized bed cooler with fireclay separator. Plan. | 1354693-BO Sheet 1 |
| 5 | Fluidized bed cooler with fireclay separator. Section | 1354693-BO Sheet 2 |
| 6 | Symbols (I, II and III stages) | 1355573-KA |
| 7 | Equipment and process flowsheet with control points | 1355575-KA |
| 8 | Transformer substation No 5 (TS-5) Additional equipment. Low tension board scheme (Stages II and III) | 1247412- ЭС |
| 9 | Plan at el. 0.000; 6.650; 12.000 | 1332928-AC Sheet 1 |
| 10 | Sections 1-1; 2-2; 3-3 | 1332928-AC Sheet 2 |
| 11 | General lay-out (Stages II and III) | 1219643-ГП |

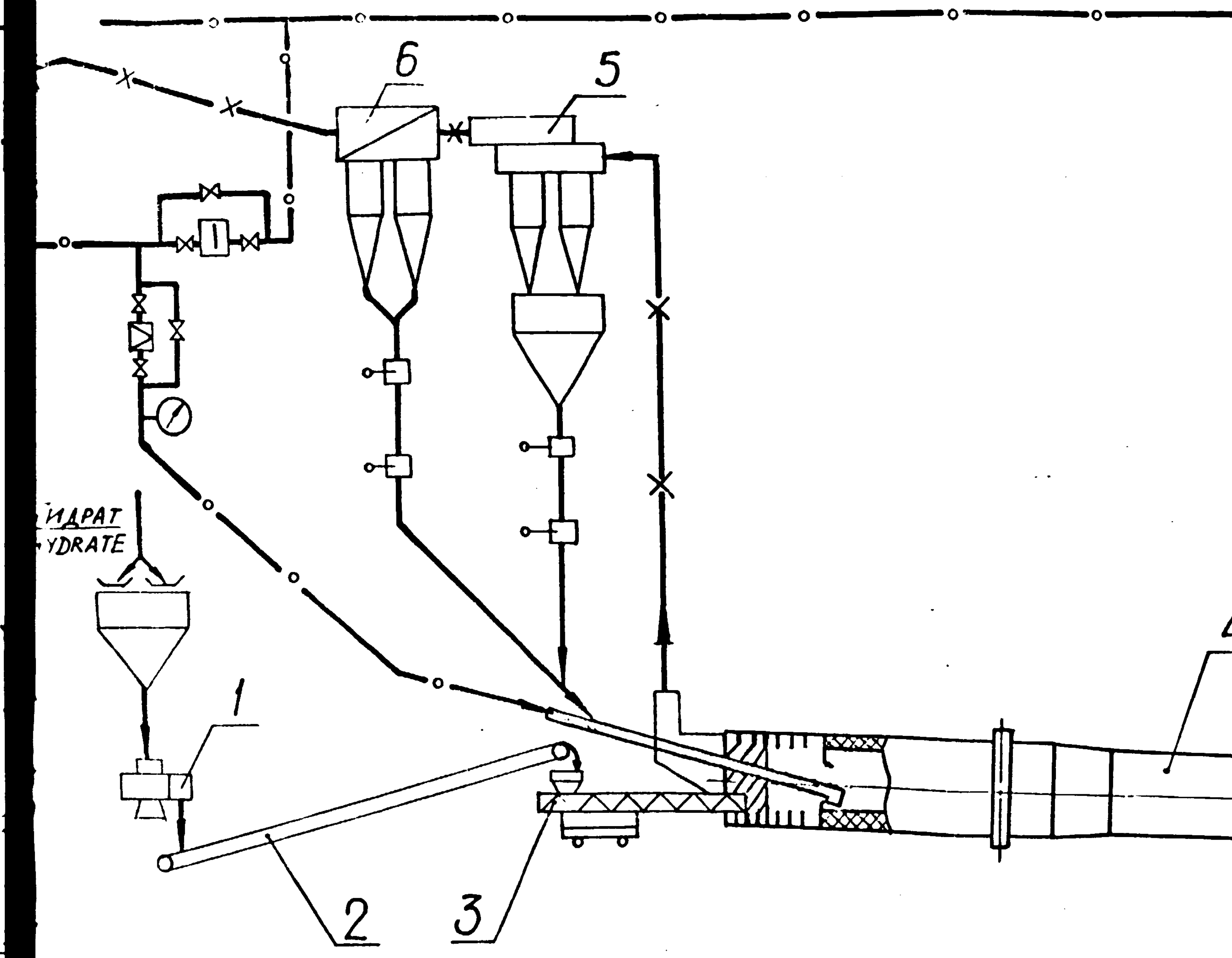
| 1 | 2 | 3 |
|---|---|---|
| | <u>Stage III</u> | |
| 1 | Equipment and process flowsheet | 1354697-TM Sheet 1 |
| 2 | Fluid bed unit. Plans at el. 0.000; 6.000; 12.000; 18.000 | 1354697-TM Sheet 2 |
| 3 | Fluid bed unit. Sections 1-1; 2-2 | 1354697-TM Sheet 3 |
| 4 | Fluid bed furnace | 1354696-BO |
| 5 | Fluid bed cooler | 1354695-BO |
| 6 | Cyclone heat-exchanger | 1354694-BO |
| 7 | Symbols (stages I, II and III) | 1355573-KA |
| 8 | Equipment and process flowsheet with control points | 1355576-KA |
| 9 | Transformer sub-station No 5 (TS-5). Low tension board scheme. | 1247412- ЭС |
| 10 | Plans at el. 0.000; 6.000; 12.000; 18.000 | 1332929-AC Sheet 1 |
| 11 | Sections 1-1; 2-2 | 1332929-AC Sheet 2 |
| 12 | General lay-out | 1219643-ГП |

Note: The following designations are assumed for the different parts of the Feasibility Report:

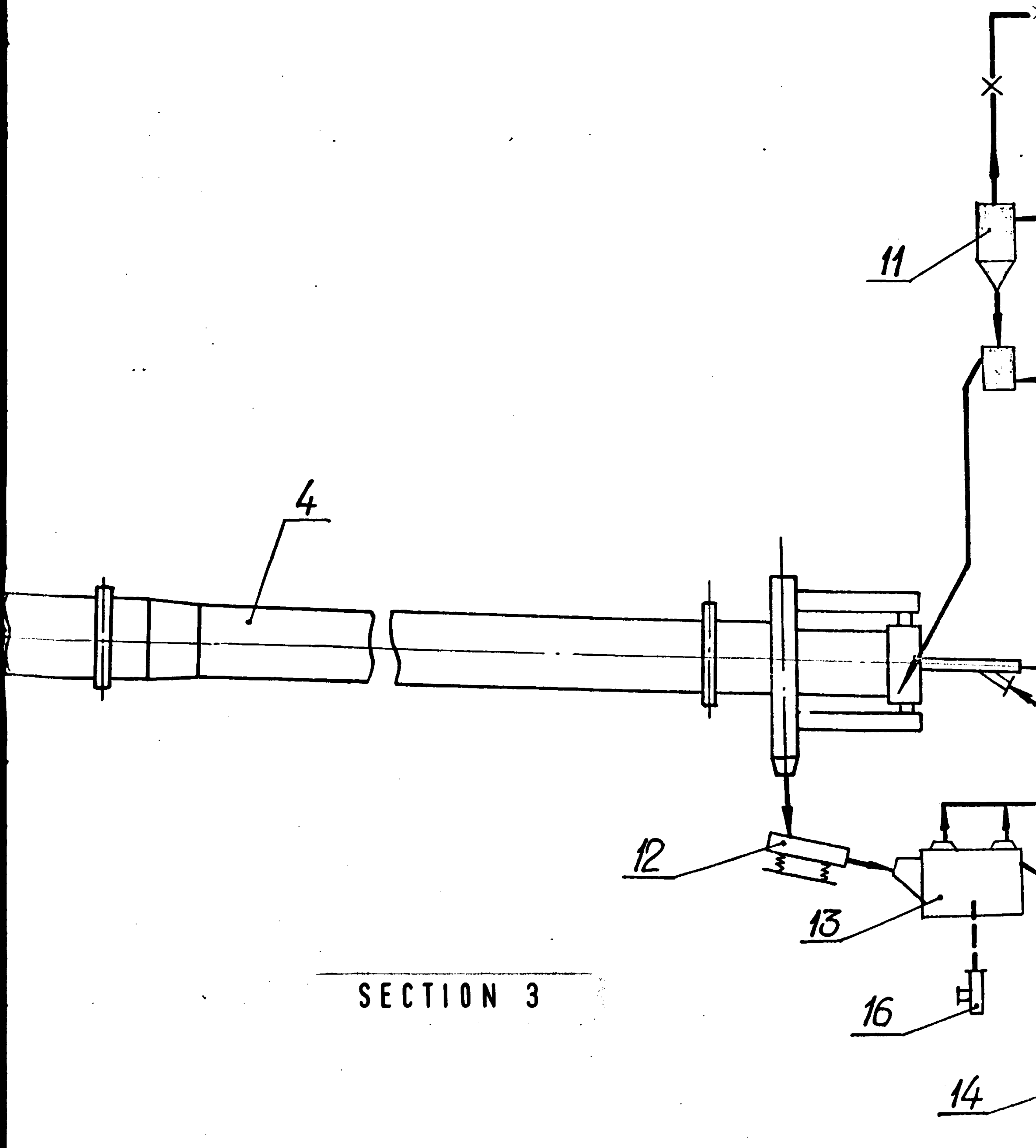
- process drawings - TM and BO
- instrumentation and automation drawings - KA
- electrical drawings - ЭС
- general lay-out - ГП
- civil-engineering drawings - AC



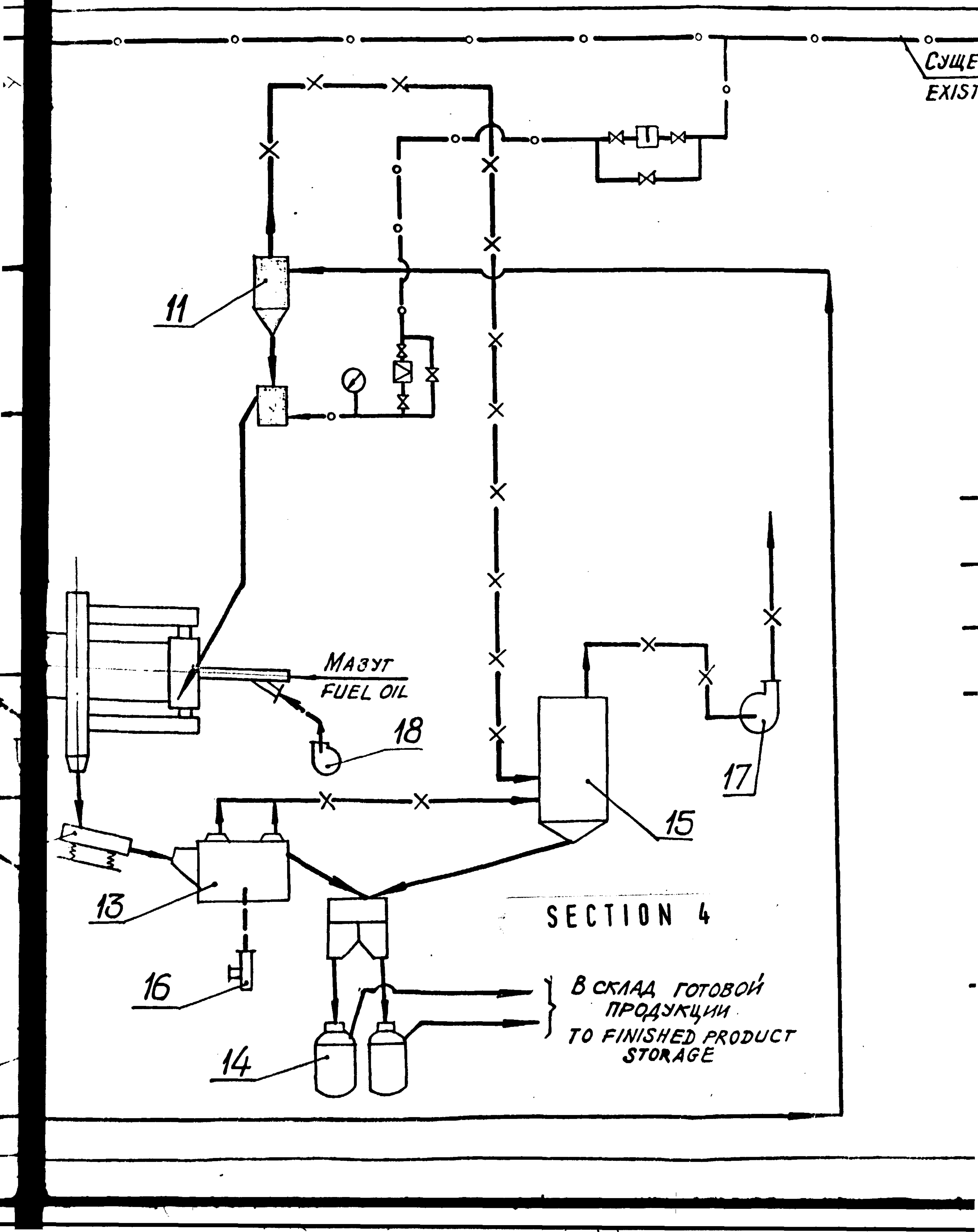

SECTION 1




SECTION 2




SECTION 3



СУЩЕ
EXIST
11
МАЗУТ
FUEL OIL
18
17
15
13
SECTION 4
16
14
В СКЛАД ГОТОВОЙ ПРОДУКЦИИ
TO FINISHED PRODUCT STORAGE

СУЩЕСТВУЮЩАЯ ТРАССА
EXISTING PIPELINE

| N позиции ITEM | НАИМЕНОВАНИЕ DESCRIPTION |
|---|---|
| 12 | Грохот SCREEN |
| 13 | Водо-воздушный доох HYDRO-AIR COOLER |
| 14 | Пневмокамерный насо PNEUMATIC CHAMBER |
| 15 | Фильтр рукавны BAG FILTER |
| 16 | Воздуходувка AIR BLOWER |
| 17 | ВЕНТИЛЯТОР FAN |
| 18 | ВЕНТИЛЯТОР FAN |

## УСЛОВНЫЕ ОБОЗНАЧЕНИЯ
## LEGEND

МАТЕРИАЛ
MATERIAL

ОТХОДЯЩИЕ ГАЗЫ
OFF GASES

СЖАТЫЙ ВОЗДУХ
COMPRESSED AIR

ВЕНТИЛЬ
VALVE

ВОДООТДЕЛИТЕЛЬ
WATER SEPARATOR

КЛАПАН РЕДУКЦИОННЫЙ
PRESSURE REDUCING VALVE

МАНОМЕТР
PRESSURE GAUGE

ВОЗДУХ
AIR

ВНОВЬ УСТАНАВЛИВА
ЗАТУШЕВАНО.
EQUIPMENT TO BE IN

CT

SECTION 5

| НАИМЕНОВАНИЕ DESCRIPTION | ТЕХНИЧЕСКАЯ ХАРАКТЕРИСТИКА SPECIFICATIONS | КОЛИЧЕСТВО QTY | ПРИМЕЧАНИЕ REMARKS |
|---|---|---|---|
| Грохот SCREEN | 1,22 x 2,74 M | 2 | Существующий EXISTING |
| Водо-воздушный доохладитель HYDRO-AIR COOLER | F аппарата UNIT = 5,2 м²/m²; F теплообменников HEAT EXCHANGERS = 76 м²/m² | 2 | —"— |
| Пневмокамерный насос PNEUMATIC CHAMBER PUMP | V= 5,8 м³/m³ | 4 | —"— |
| Фильтр рукавный BAG FILTER | V=20000 м³/ч / m³/h | 2 | —"— |
| Воздуходувка AIR BLOWER | Q= 1450 м³/ч / m³/h; H=28000 Па / PA | 2 | —"— |
| Вентилятор FAN | Q=20000 м³/ч / m³/h; H=2500 Па / PA; Nдв. = 29,8 кВт / KW | 2 | —"— |
| Вентилятор FAN | Q= 6650 м³/ч / m³/h; H=2550 Па / PA. | 2 | —"— |

| N позиции ITEM | НАИМЕНОВАНИЕ DESCRIPTION |
|---|---|
| 1 | Питатель тарельчат... RECIPROCATING PLATE FEED... |
| 2 | Конвейер ленточны... BELT CONVEYOR |
| 3 | Питатель шнековы... SCREW CONVEYOR |
| 4 | Печь вращающаяся ROTARY KILN |
| 5 | Батарея циклонов. I с... CYCLONE BANK. STAG... |
| 6 | Батарея циклонов. II с... CYCLONE BANK. STA... |
| 7 | Электрофильтр ELECTROSTATIC PRECIPI... |
| 8 | Дымосос I. D. FAN |
| 9 | Шнек SCREW |
| 10 | Струйный насос JET PUMP |
| 11 | Циклон разгрузит... DISCHARGING CYCLO... |

...ОВЬ УСТАНАВЛИВАЕМОЕ ОБОРУДОВАНИЕ НА СХЕМЕ ...ТУШЕВАНО.

...UIPMENT TO BE INSTALLED IS DARKENED ON DIAGRAM.

# SECTION 6

E
V

Масштаб
SCALE

ДЛ...
FOR...
ГЛ...
КА...
КО...
I S...

| ... | КОЛИЧЕСТВО QTY | ПРИМЕЧАНИЕ REMARKS |
|---|---|---|
| TE... D3... | 2 | Существующий EXISTING |
| I/... 2 ... $M^2/m^2$ | 2 | —"— |
| U... | 4 | —"— |
| | 2 | —"— |
| TC... G5... | 2 | —"— |
| TC... 4E... | 2 | —"— |
| YT... | 2 | —"— |

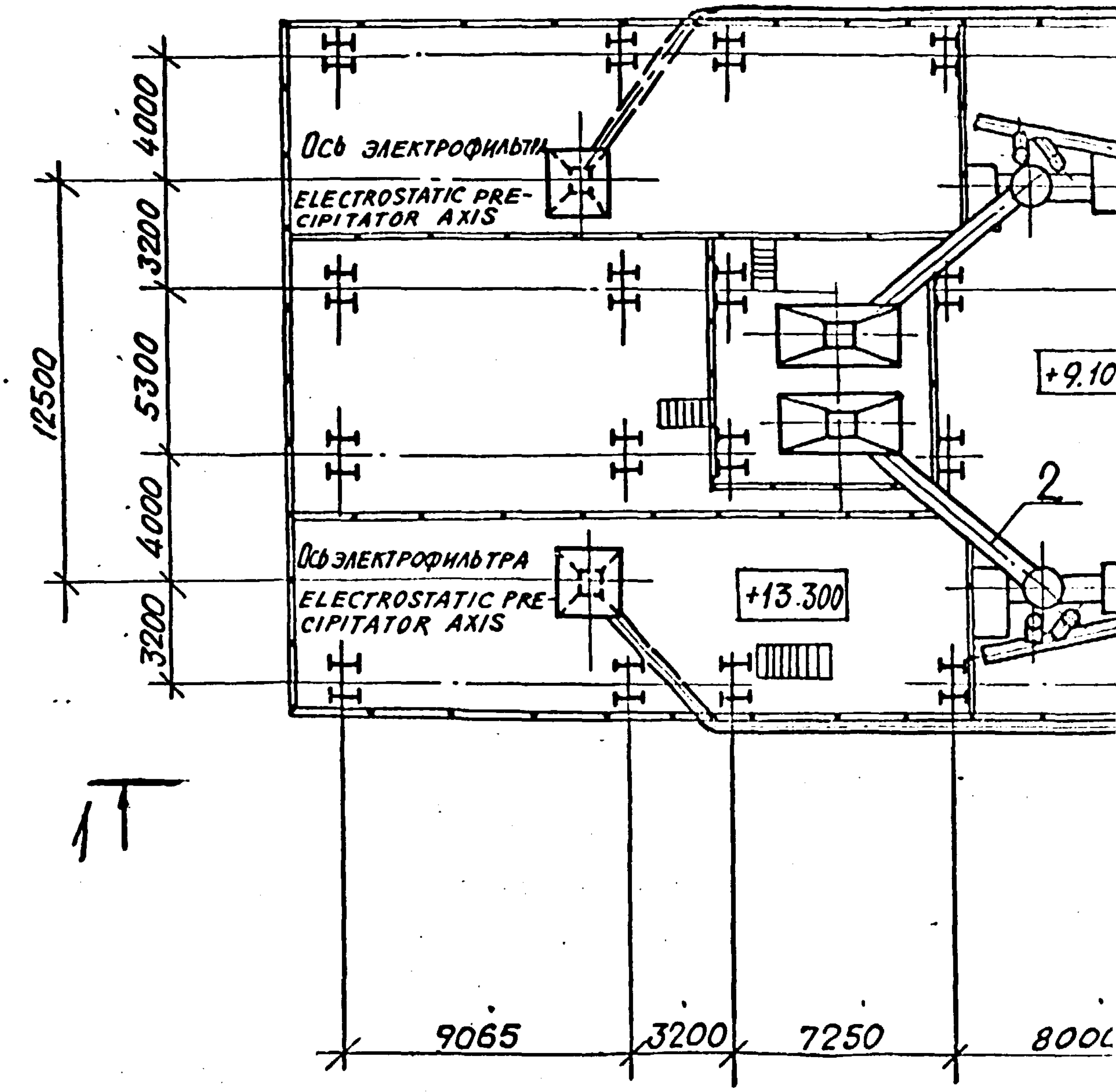
...XEME

... DIAGRAM.

| N ПОЗИЦИИ ITEM | НАИМЕНОВАНИЕ DESCRIPTION | ТЕХНИЧЕСКАЯ ХАРАКТЕРИСТИКА SPECIFICATIONS | КОЛИЧЕСТВО QTY | ПРИМЕЧАНИЕ REMARKS |
|---|---|---|---|---|
| 1 | ПИТАТЕЛЬ ТАРЕЛЬЧАТЫЙ RECIPROCATING PLATE FEEDER | $\phi$ 2 м/m | 2 | СУЩЕСТВУЮЩИЙ EXISTING |
| 2 | КОНВЕЙЕР ЛЕНТОЧНЫЙ BELT CONVEYOR | B=500 | 2 | —"— |
| 3 | ПИТАТЕЛЬ ШНЕКОВЫЙ SCREW CONVEYOR | $\phi$450; L=6,5 м/m; Q=30 т/ч t/h | 2 | —"— |
| 4 | ПЕЧЬ ВРАЩАЮЩАЯСЯ ROTARY KILN | $\phi$3,6/$\phi$3,3 м/m; L = 80 м/m | 2 | —"— |
| 5 | БАТАРЕЯ ЦИКЛОНОВ. I СТУПЕНЬ. CYCLONE BANK. STAGE I | 4 ЦИКЛОНА CYCLONES $\phi$1370 мм/mm | 2 | —"— |
| 6 | БАТАРЕЯ ЦИКЛОНОВ. II СТУПЕНЬ CYCLONE BANK. STAGE II | 90 ЦИКЛОНОВ CYCLONES $\phi$225 мм/mm. | 2 | —"— |
| 7 | ЭЛЕКТРОФИЛЬТР ELECTROSTATIC PRECIPITATOR | F=30,5 м²/m² | 2 | —"— |
| 8 | ДЫМОСОС I. D. FAN | Q=103000 м³/ч m³/h; H=2800 Па/PA | 2 | —"— |
| 9 | ШНЕК SCREW | $\phi$ 500; L=7 м/m | 2 | СУЩЕСТВУЮЩИЙ EXISTING |
| 10 | СТРУЙНЫЙ НАСОС JET PUMP | Q=7 т/ч t/h | 2 | ВНОВЬ УСТАНАВЛИВАЕМЫЕ TO BE INSTALLED. |
| 11 | ЦИКЛОН РАЗГРУЗИТЕЛЬ DISCHARGING CYCLONE | $\phi$ 600 | 2 | |

SECTION 7

| | |
|---|---|
| ВАМИ Ленинград<br>VAMI LENINGRAD | |
| Масштаб<br>SCALE | ДЛЯ ИНДИЙСКОЙ ФИРМЫ БХАРАТ АЛЮМИНИУМ КОМПАНИ.<br>FOR BHARAT ALUMINIUM COMPANY; LTD. INDIA |
| ДАННЫЙ ЧЕРТЕЖ ЯВЛЯЕТСЯ СОБСТВЕННОСТЬЮ ИНСТИТУТА ВАМИ И НЕ МОЖЕТ БЫТЬ СКОПИРОВАН И ИСПОЛЬЗОВАН БЕЗ ЕГО РАЗРЕШЕНИЯ<br>THIS DRAWING IS THE PROPERTY OF VAMI AND NOT TO BE COPIED OR USED WITHOUT OUR PERMISSION. | ГЛИНОЗЕМНЫЙ ЗАВОД В КОРБЕ. РЕКОНСТРУКЦИЯ ЦЕХА КАЛЬЦИНАЦИИ. I ЭТАП. СХЕМА АППАРАТУРНО-ТЕХНОЛОГИЧЕСКАЯ.<br>KORBA ALUMINA PLANT. RECONSTRUCTION OF CALCINATION. I STAGE. PROCESS & EQUIPMENT FLOWSHEET |
| | 1354690-TM — ЛИСТ SHEET 1 — ЛИСТОВ SHEETS 3 |




SECTION 1

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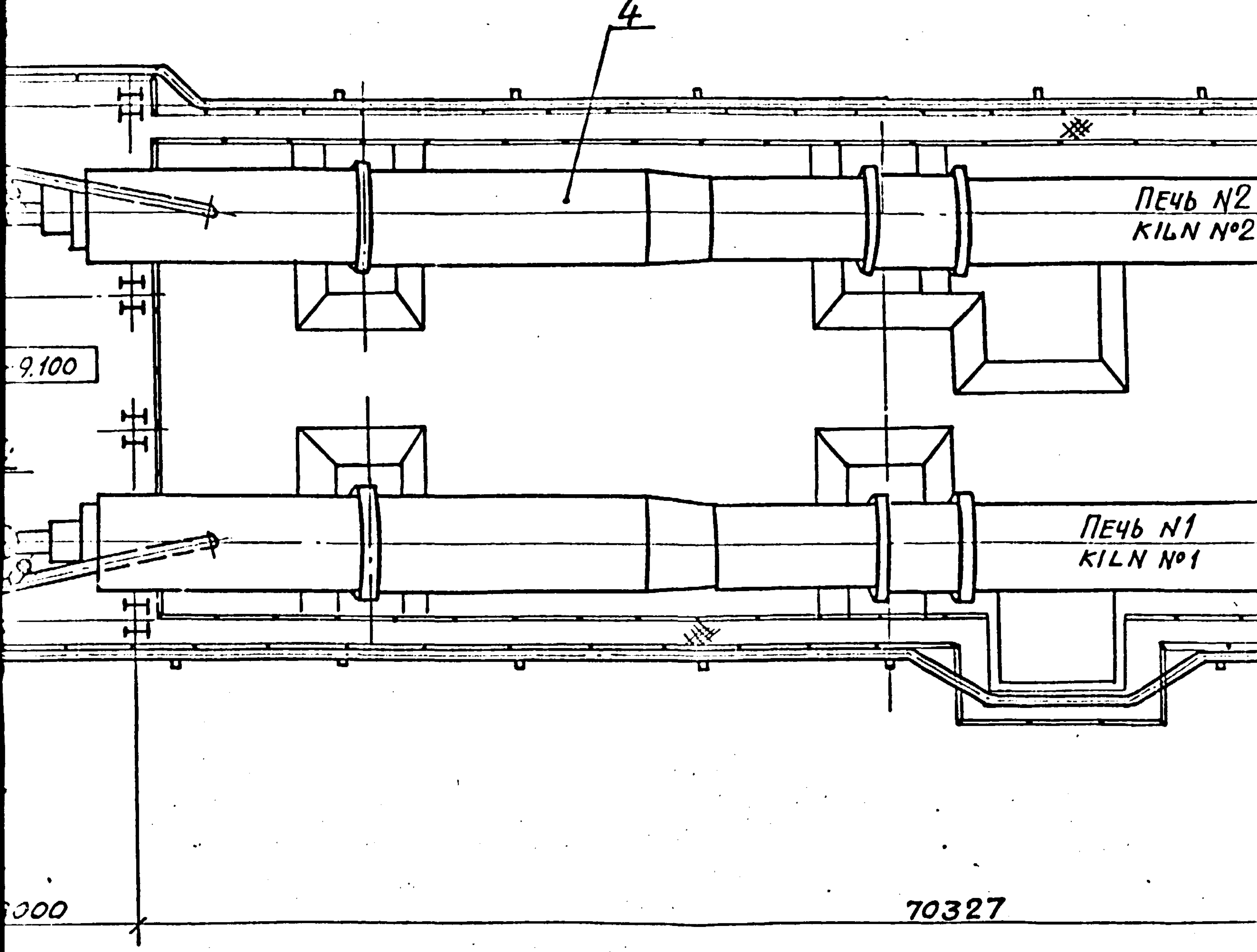
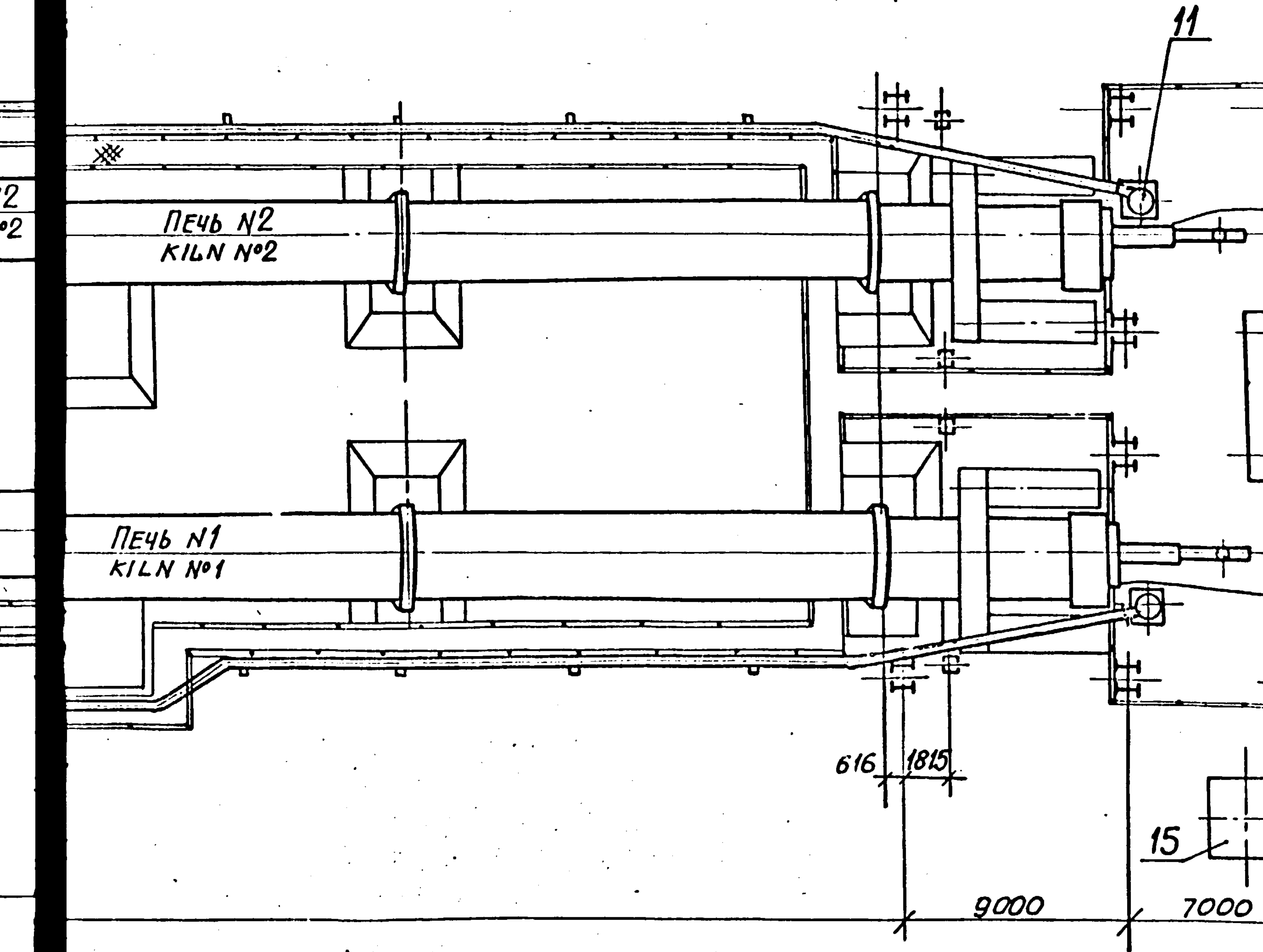
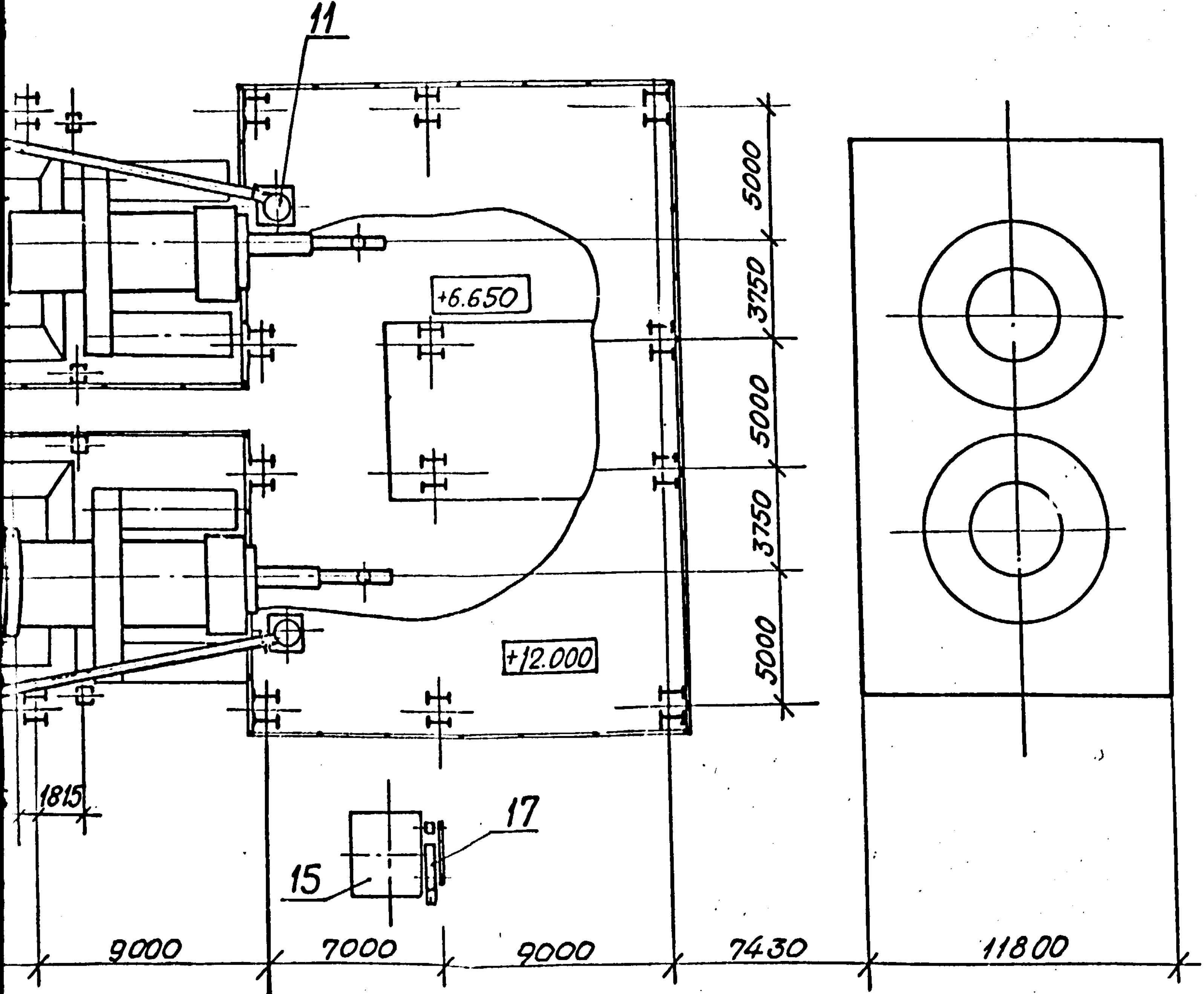



SECTION 2




SECTION 3

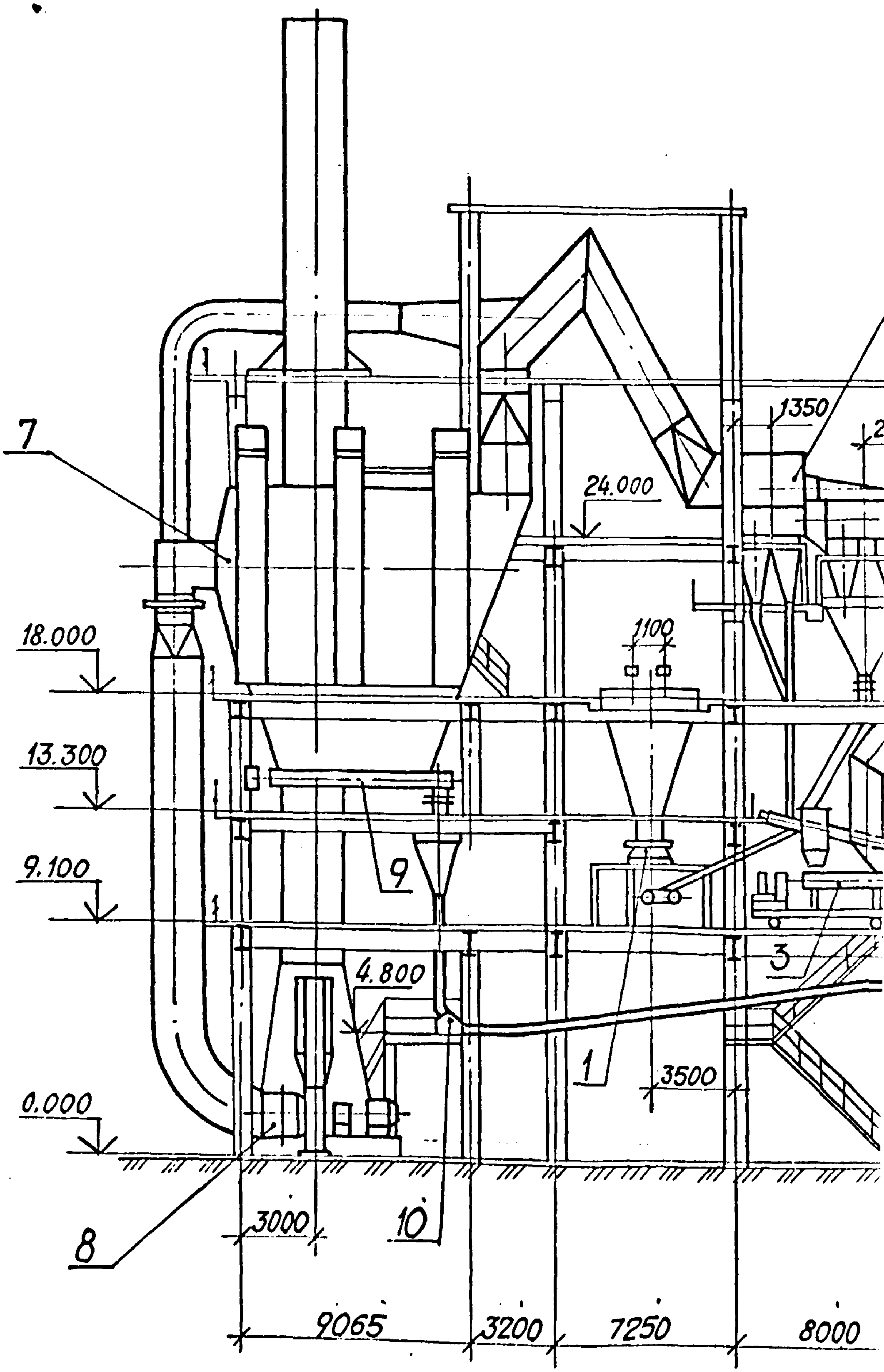

11
+6.650
+12.000
5000
3750
5000
3750
5000
1815
15
17
9000
7000
9000
7430
11800

SECTION 4

SECTION 5

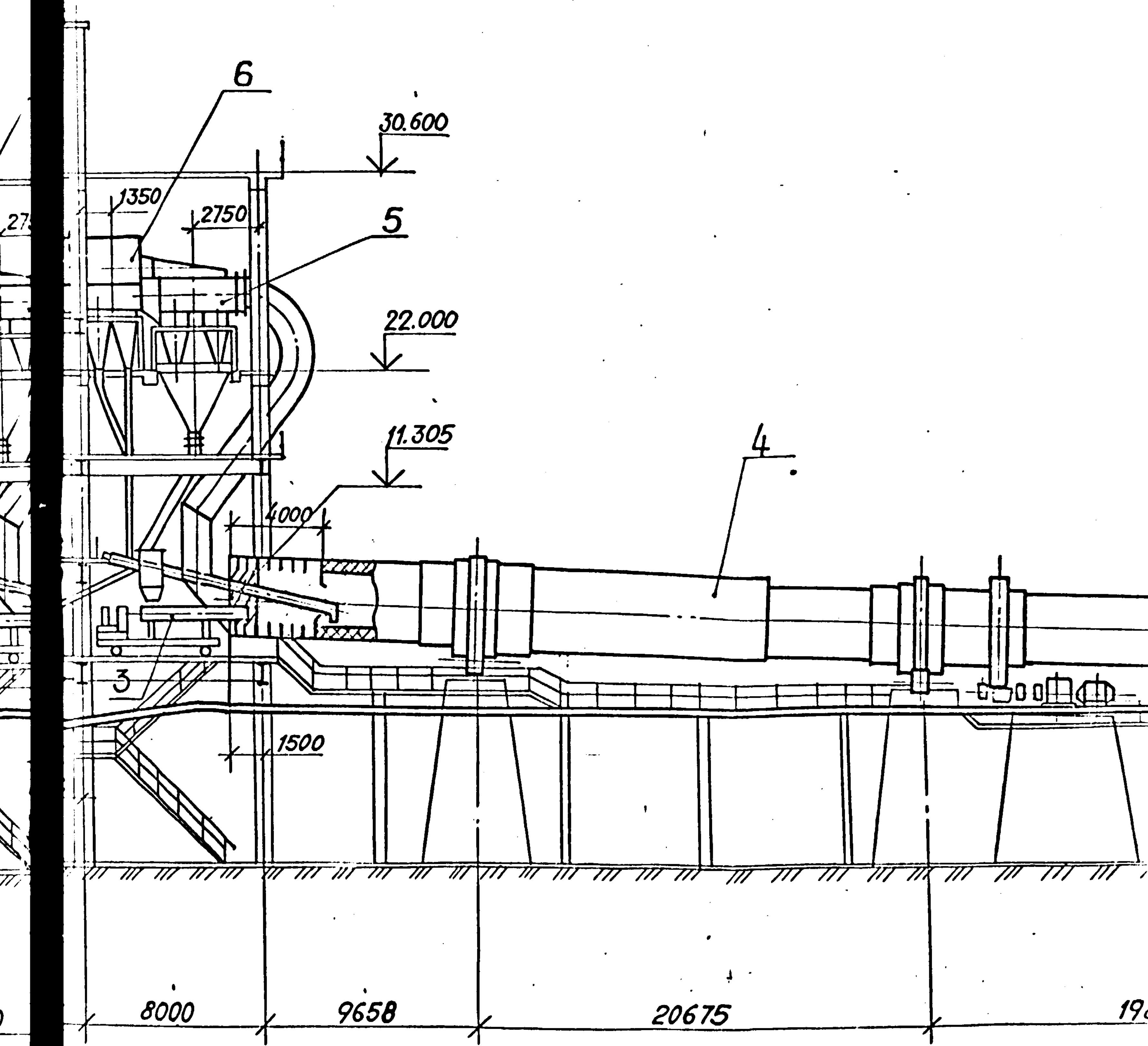
| | |
|---|---|
| ВАМИ Ленинград<br>VAMI LENINGRAD | |
| Масштаб<br>SCALE 1:200 | ДЛЯ ИНДИЙСКОЙ ФИРМЫ БХАРАТ АЛЮМИНИУМ КОМПАНИ<br>FOR BHARAT ALUMINIUM COMPANY LTD, INDIA |
| ДАННЫЙ ЧЕРТЕЖ ЯВЛЯЕТСЯ СОБСТВЕННОСТЬЮ ИНСТИТУТА ВАМИ И НЕ МОЖЕТ БЫТЬ СКОПИРОВАН И ИСПОЛЬЗОВАН БЕЗ ЕГО РАЗРЕШЕНИЯ<br>THIS DRAWING IS THE PROPERTY OF VAMI AND NOT TO BE COPIED OR USED WITHOUT OUR PERMISSION | ГЛИНОЗЕМНЫЙ ЗАВОД В КОРБЕ РЕКОНСТРУКЦИЯ ЦЕХА КАЛЬЦИНАЦИИ I ЭТАП. ПЛАН.<br>KORBA ALUMINA PLANT. RECONSTRUCTION OF CALCINATION. I STAGE. PLAN |
| | 1354690-TM. \| Лист SHEET 2 \| Листов SHEETS 3 |

Формат А4х5 SIZE A4x5



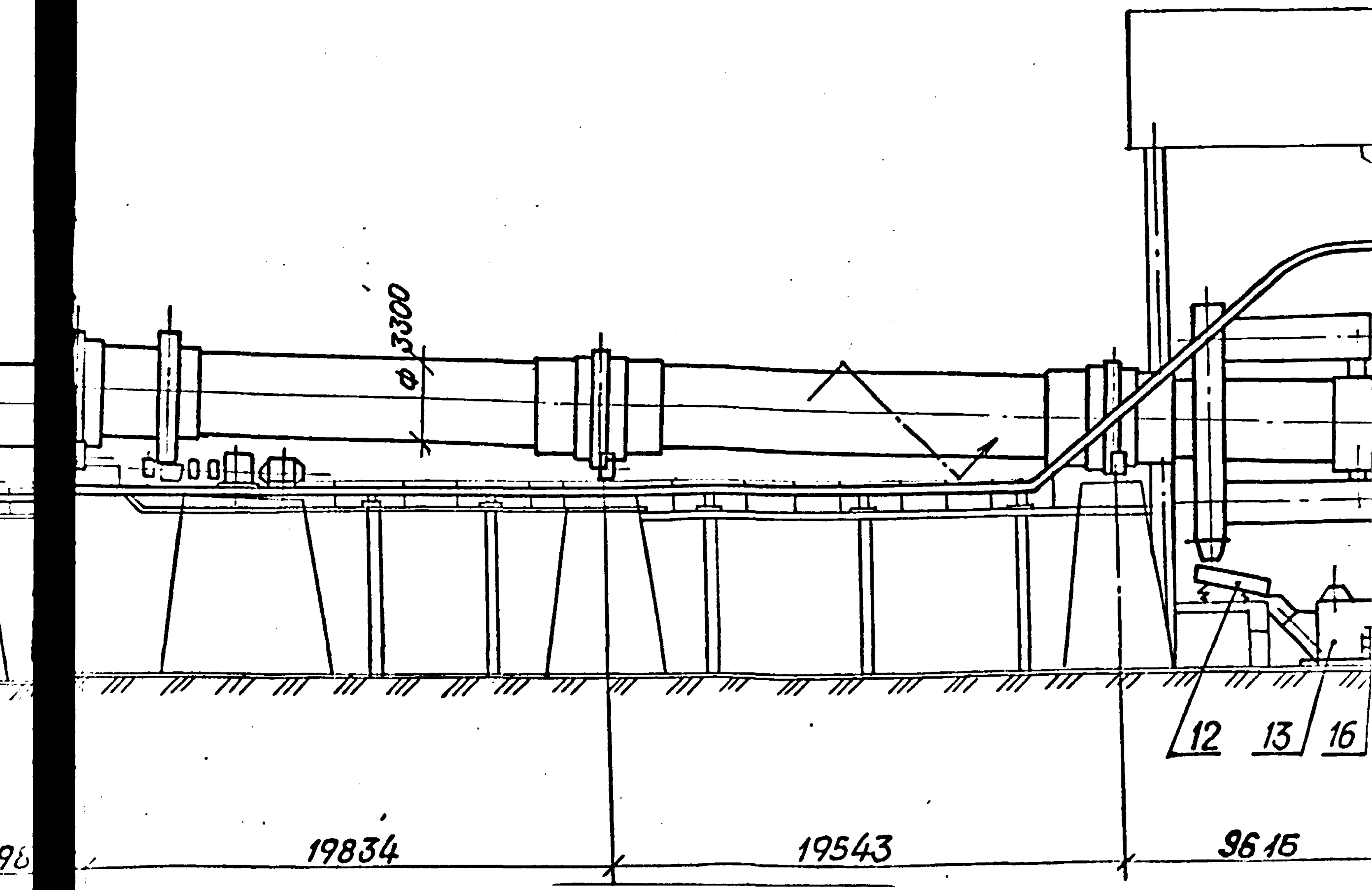

SECTION 1

Инв.N подл. | Подп. и дата | Взам.инв.N.

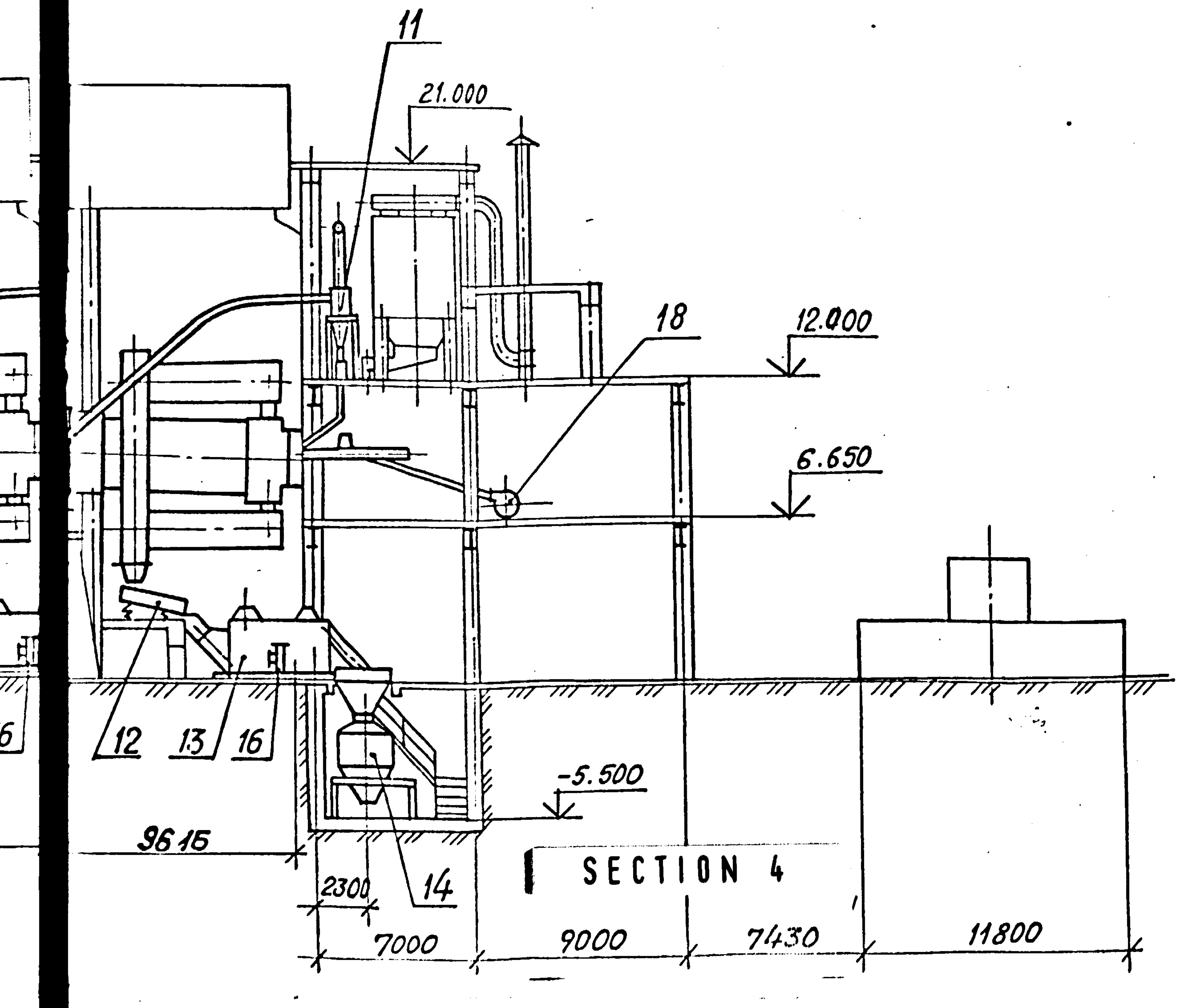


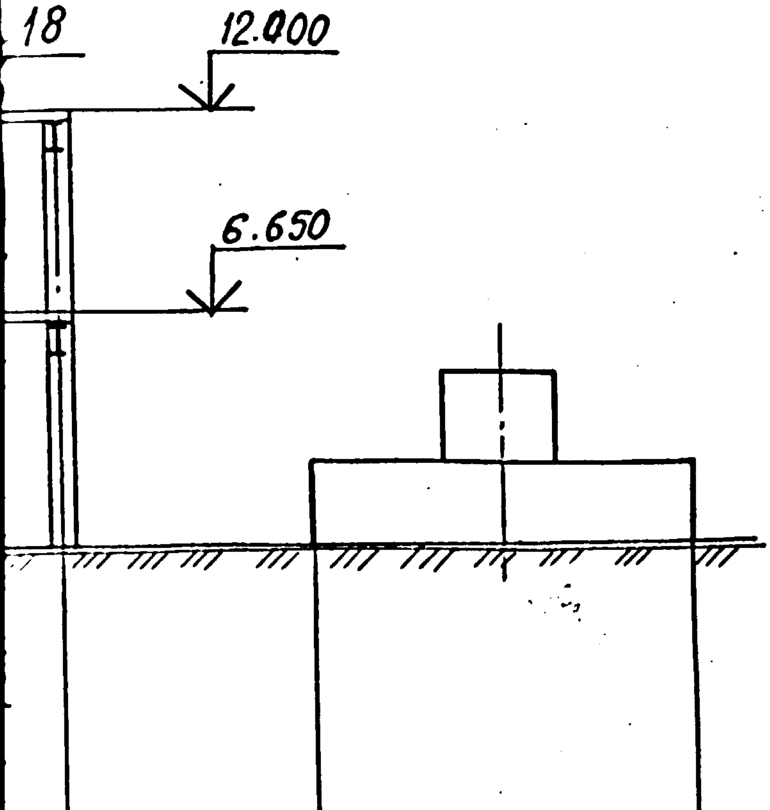

SECTION 2

Разрез 1-1
SECTION




SECTION 3


11
21.000
18
12.000
6.650
-5.500
12
13
16
6
14
9615
2300
7000
9000
7430
11800
SECTION 4




SECTION 5

ВАМИ ЛЕНИ
VAMI LENI

| | |
|---|---|
| Масштаб SCALE 1:200 | ДЛЯ ИНДИЙСКОЙ КО |
| | FOR BHARAT ALUM |
|  | ГЛИНОЗЕМНЫЙ ЗАВО КАЛЬЦИНАЦИИ. I |
|  | KORBA ALUMINA I STAGE. |
| | 135/ |

SECTION 6

| | |
|---|---|
| БАМИ ЛЕНИНГРАД<br>VAMI LENINGRAD | |
| Масштаб<br>SCALE 1:200 | ДЛЯ ИНДИЙСКОЙ ФИРМЫ БХАРАТ АЛЮМИНИУМ КОМПАНИ.<br>FOR BHARAT ALUMINIUM COMPANY LTD, INDIA |
| ДАННЫЙ ЧЕРТЕЖ ЯВЛЯЕТСЯ СОБСТВЕННОСТЬЮ ИНСТИТУТА ВАМИ И НЕ МОЖЕТ БЫТЬ СКОПИРОВАН И ИСПОЛЬЗОВАН БЕЗ ЕГО РАЗРЕШЕНИЯ<br>THIS DRAWING IS THE PROPERTY OF VAMI AND NOT TO BE COPIED OR USED WITHOUT | ГЛИНОЗЕМНЫЙ ЗАВОД В КОРБЕ. РЕКОНСТРУКЦИЯ ЦЕХА КАЛЬЦИНАЦИИ. I ЭТАП. РАЗРЕЗ 1-1<br>KORBA ALUMINA PLANT. RECONSTRUCTION OF CALCINATION I STAGE. SECTION. 1:1 |
| | 1354690-ТМ \| Лист 3 \| Листов 3 |

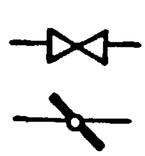
| | |
|---|---|
| TI | Прибор для измерения температуры показывающий, установленный по месту<br>LOCALLY MOUNTED INDICATING INSTRUMENT FOR MEASURING TEMPERATURE |
| TI | Прибор для измерения температуры показывающий установленный на щите<br>BOARD MOUNTED INDICATING INSTRUMENT FOR MEASURING TEMPERATURE |
| TIR | Прибор для измерения температуры показывающий и регистрирующий, установленный на щите<br>BOARD-MOUNTED INDICATING AND RECORDING INSTRUMENT FOR MEASURING TEMPERATURE |
| TIRA | Прибор для измерения температуры показывающий, регистрирующий и сигнализирующий, установленный на щите<br>BOARD-MOUNTED INDICATING, RECORDING AND ALARMING INSTRUMENT FOR MEASURING TEMPERATURE |
| TRC | Аппаратура для измерения температуры регулирующая и регистрируемая, установленная на щите.<br>BOARD-MOUNTED TEMPERATURE MEASURING, CONTROLLING AND RECORDING INSTRUMENTS |
| PI | Прибор для измерения давления (разрежения) показывающий, установленный по месту<br>LOCALLY MOUNTED INDICATING INSTRUMENT FOR MEASURING PRESSURE (RAREFACTION) |
| PI | Прибор для измерения давления (разрежения), показывающий, установленный на щите<br>BOARD-MOUNTED INDICATING INSTRUMENT FOR MEASURING PRESSURE (RAREFACTION) |

SECTION 1

| Инв. № подл. | Подп. и дата | Взам. инв. № |
|---|---|---|
| | | |

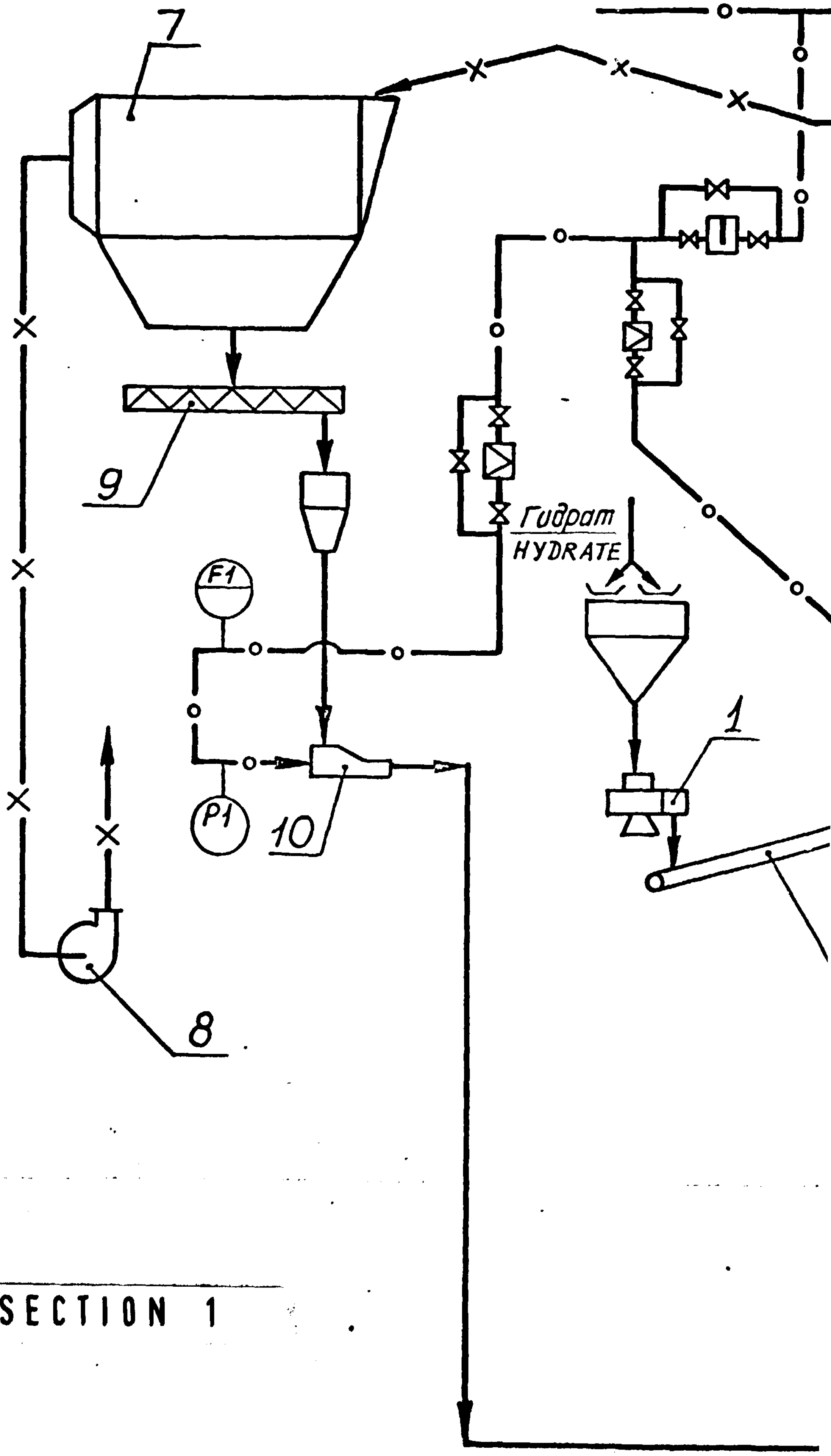
SECTION 2

| | |
|---|---|
| PIR | Прибор для измерения давления (разрежения) показывающий, регистрирующий установленный на щите<br>BOARD-MOUNTED INDICATING AND RECORDING INSTRUMENT FOR MEASURING PRESSURE (RAREFACTION) |
| PDR | Прибор для измерения перепада давления, показывающий, самопишущий, установленный на щите<br>BOARD-MOUNTED INDICATING, RECORDING AND SIGNALLING INSTRUMENT FOR MEASURING PRESSURE DROP |
| FI | Прибор для измерения расхода, показывающий, установленный по месту<br>LOCALLY MOUNTED INDICATING INSTRUMENT FOR FLOW-RATE MEASURING |
| FI | Прибор для измерения расхода показывающий, установленный на щите<br>BOARD-MOUNTED INDICATING INSTRUMENT FOR FLOW-RATE MEASURING |
| FIC | Аппаратура для измерения расхода показывающая и регулирующая, установленная на щите<br>BOARD-MOUNTED INDICATING AND CONTROLLING INSTRUMENTS FOR FLOW-RATE MEASURING |
| FIRC | Аппаратура для измерения соотношения расходов, регистрирующая и регулирующая, установленная на щите<br>BOARD-MOUNTED RECORDING AND CONTROLLING INSTRUMENTS FOR FLOW-RATE RATIO MEASURING |
| QIR $O_2$ | Прибор для измерения содержания кислорода, установленный на щите<br>BOARD-MOUNTED INSTRUMENT FOR MEASURING OXYGEN CONTENT |

| | |
|---|---|
|  | Прибор для измерения содержания двуокиси углерода, установленный на щите<br>BOARD-MOUNTED INSTRUMENT FOR MEASURING CARBON DIOXIDE CONTENT |
|  | Исполнительный механизм<br>ACTUATOR |
|  | Регулирующий орган<br>FLUID CONTROL ELEMENT |
|  | Прибор с сигнальным устройством. Буквы "H" и "L" означают сигнализацию верхнего и нижнего значения измеряемой величины<br>INSTRUMENT WITH WARNING DEVICE. LETTERS "H" AND "L". STAND FOR HIGH AND LOW VALUES OF QUANTITY BEING MEASURED |

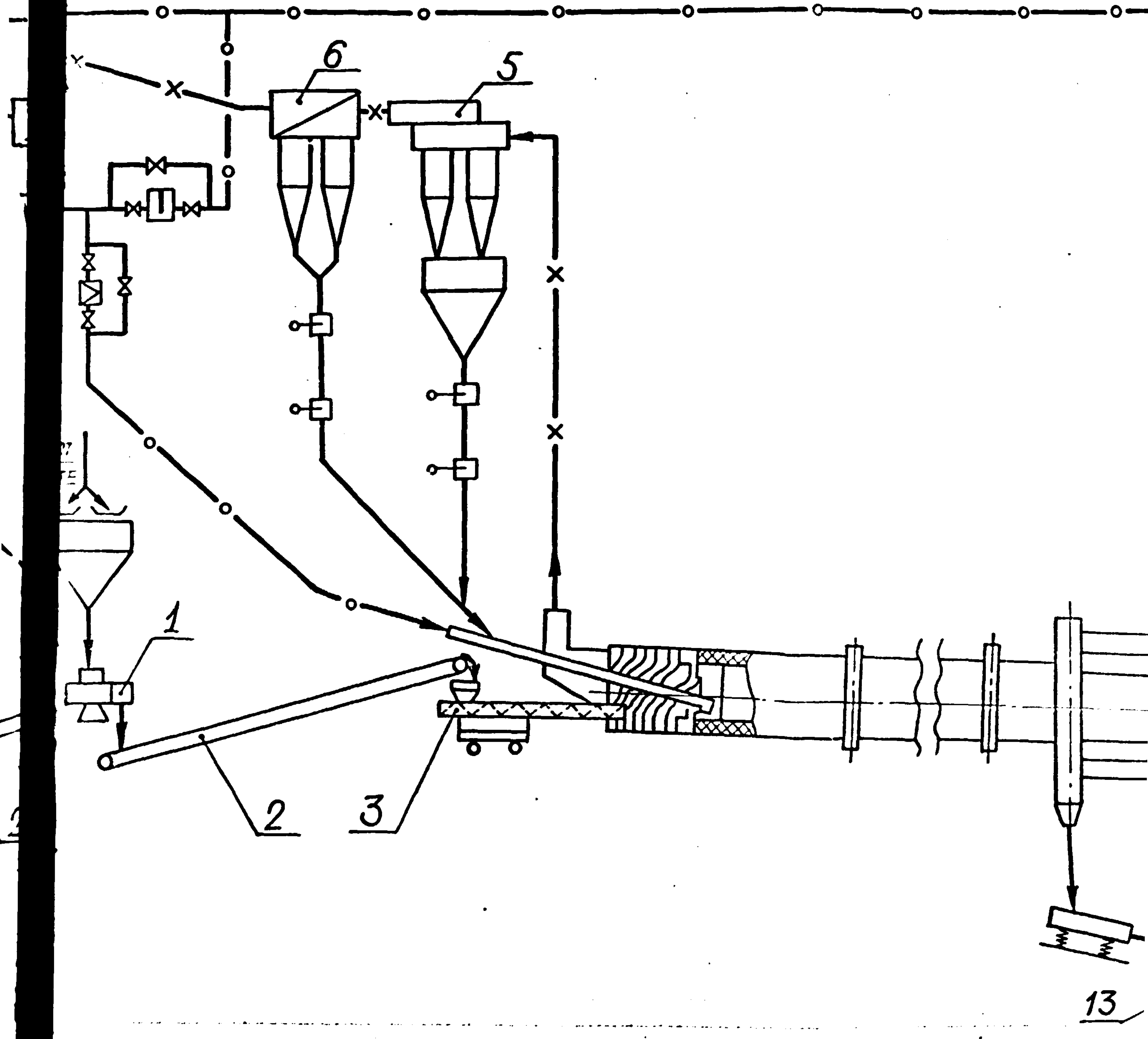
# SECTION 3

| | | | |
|---|---|---|---|
| ВАМИ Ленинград<br>VAMI LENINGRAD | | | |
| Масштаб<br>SCALE — | ДЛЯ ИНДИЙСКОЙ ФИРМЫ БХАРАТ АЛЮМИНИУМ КОМПАНИ.<br>FOR BHARAT ALUMINIUM COMPANY LTD, INDIA | | |
| Данный чертеж является собственностью института ВАМИ не может быть скопирован и использован без его разрешения<br>THIS DRAVING IS THE PROPERTY OF VAMI AND NOT TO BE COPIED OR USED WITHOUT OUR PERMISSION | ГЛИНОЗЕМНЫЙ ЗАВОД В КОРБЕ. РЕКОНСТРУКЦИЯ ЦЕХА КАЛЬЦИНАЦИИ. УСЛОВНЫЕ ОБОЗНАЧЕНИЯ.<br>KORBA ALUMINA PLANT RECONSTRUCTION OF CALCINATION.<br>SYMBOLS | | |
| | 1355573-KA | Лист<br>SHEET | Листов<br>SHEETS 1 |

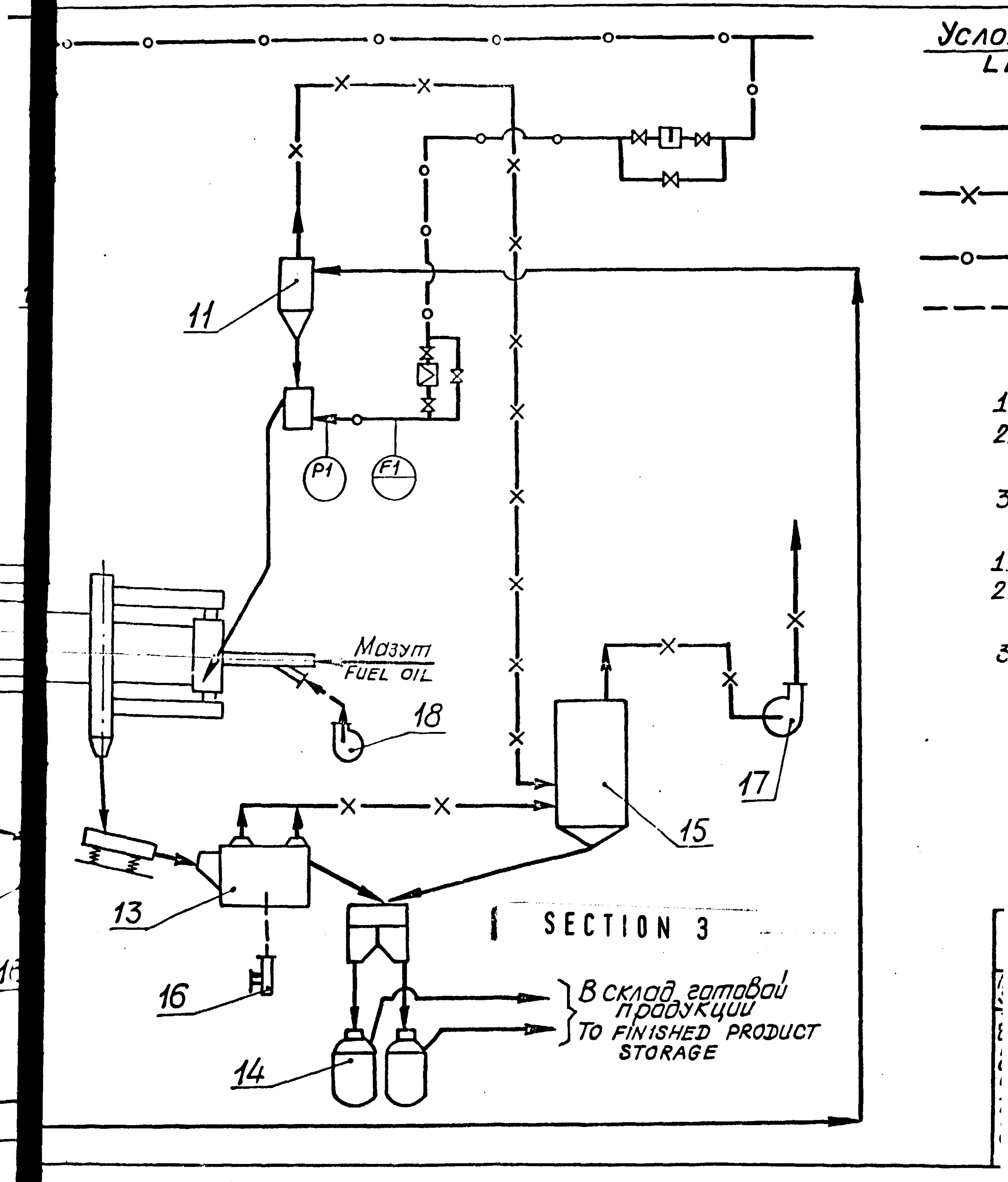



SECTION 1

Инв.№ подл | Подп. и дата | Взам.инв.№




SECTION 2



Услов
L
11
P1
F1
Мазут
FUEL OIL
18
17
15
13
16
14
В склад готовой продукции
TO FINISHED PRODUCT STORAGE
SECTION 3

## Условные обозначения
## LEGEND

| | |
|---|---|
| —— | Материал / MATERIAL |
| —×— | Отходящие газы / FLUE GASES |
| —o— | Сжатый воздух / COMPRESSED AIR |
| — — — | Воздух / AIR |

| | |
|---|---|
| Контуры контроля / MONITORING CIRCUITS | 4 |
| Контуры регулирования / CONTROL CIRCUITS | — |

1. Схема выполнена на основании чертежа 1354690-ТМ.СХ
2. Количество точек контроля и регулирования дано на одну установку.
3. Условные обозначения приборов и средств автоматизации даны на чертеже 1355573-КА

1. THE FLOWSHEET IS BASED ON DWG 1354690-TM.CX
2. THE NUMBER OF MONITORING AND CONTROL POINTS IS GIVEN PER ONE UNIT.
3. THE SYMBOLS OF INSTRUMENTS AND AUTOMATION DEVICES ARE GIVEN ON DWG. 1355573-KA.

# SECTION 4

ЦСТ

<table>
<tr><td colspan="3">ВАМИ Ленинград<br>VAMI LENINGRAD</td></tr>
<tr><td>Масштаб / SCALE —</td><td colspan="2">Для Индийской фирмы Бхарат Алюминиум Компани<br>FOR BHARAT ALUMINIUM COMPANY LTD, INDIA</td></tr>
<tr><td rowspan="2"></td><td colspan="2">ГЛИНОЗЕМНЫЙ ЗАВОД В КОРБЕ. РЕКОНСТРУКЦИЯ ЦЕХА КАЛЬЦИНАЦИИ. I ЭТАП. СХЕМА АППАРАТУРНО-ТЕХНОЛОГИЧЕСКАЯ С ТОЧКАМИ КОНТРОЛЯ И РЕГУЛИРОВАНИЯ.<br>KORBA ALUMINA PLANT. RECONSTRUCTION OF CALCINATION. I STAGE. EQUIPMENT AND PROCESS FLOWSHEET WITH MONITORING AND CONTROL POINTS</td></tr>
<tr><td>1355574-КА</td><td>Лист / SHEET | Листов / SHEETS 1</td></tr>
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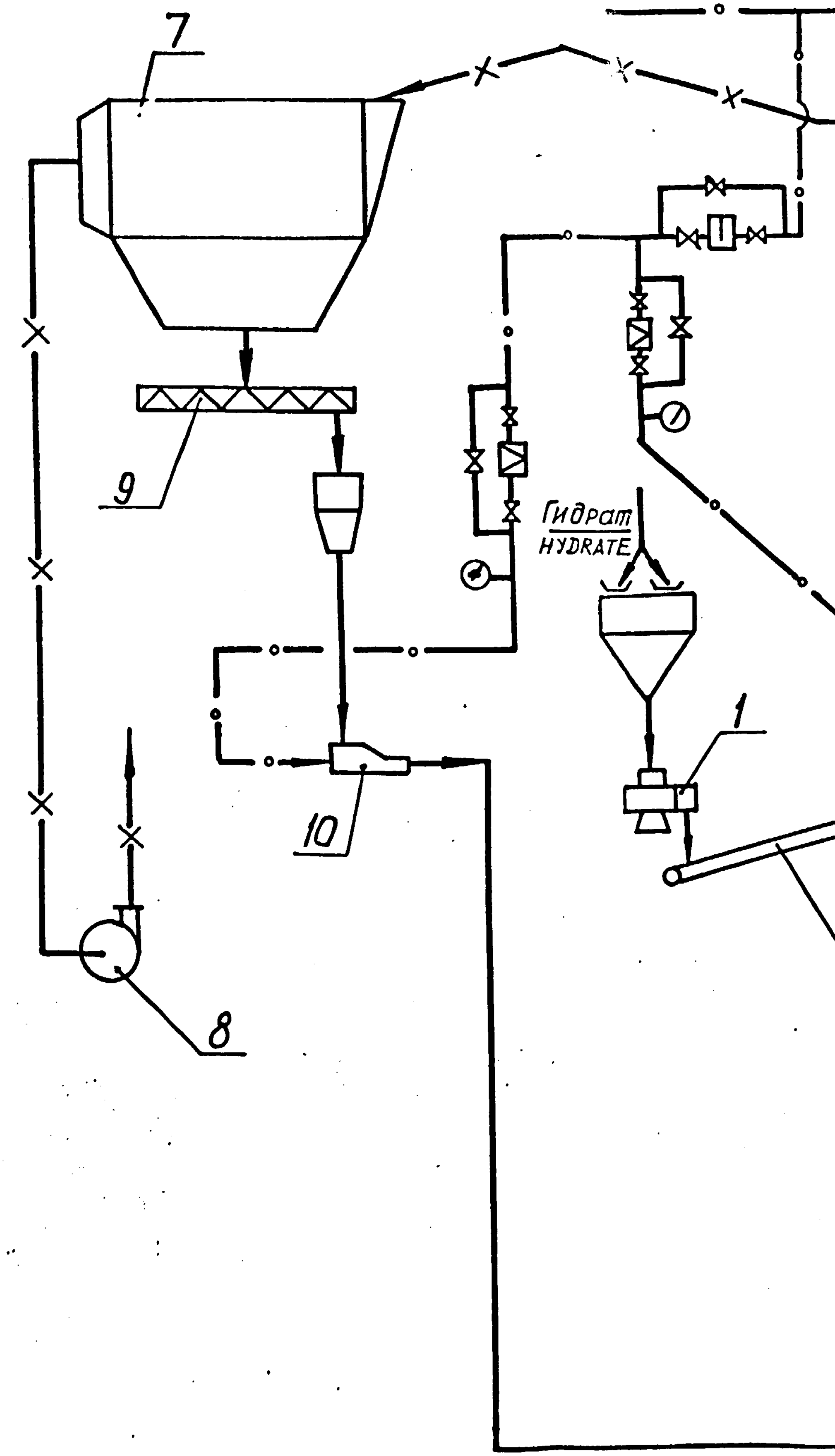
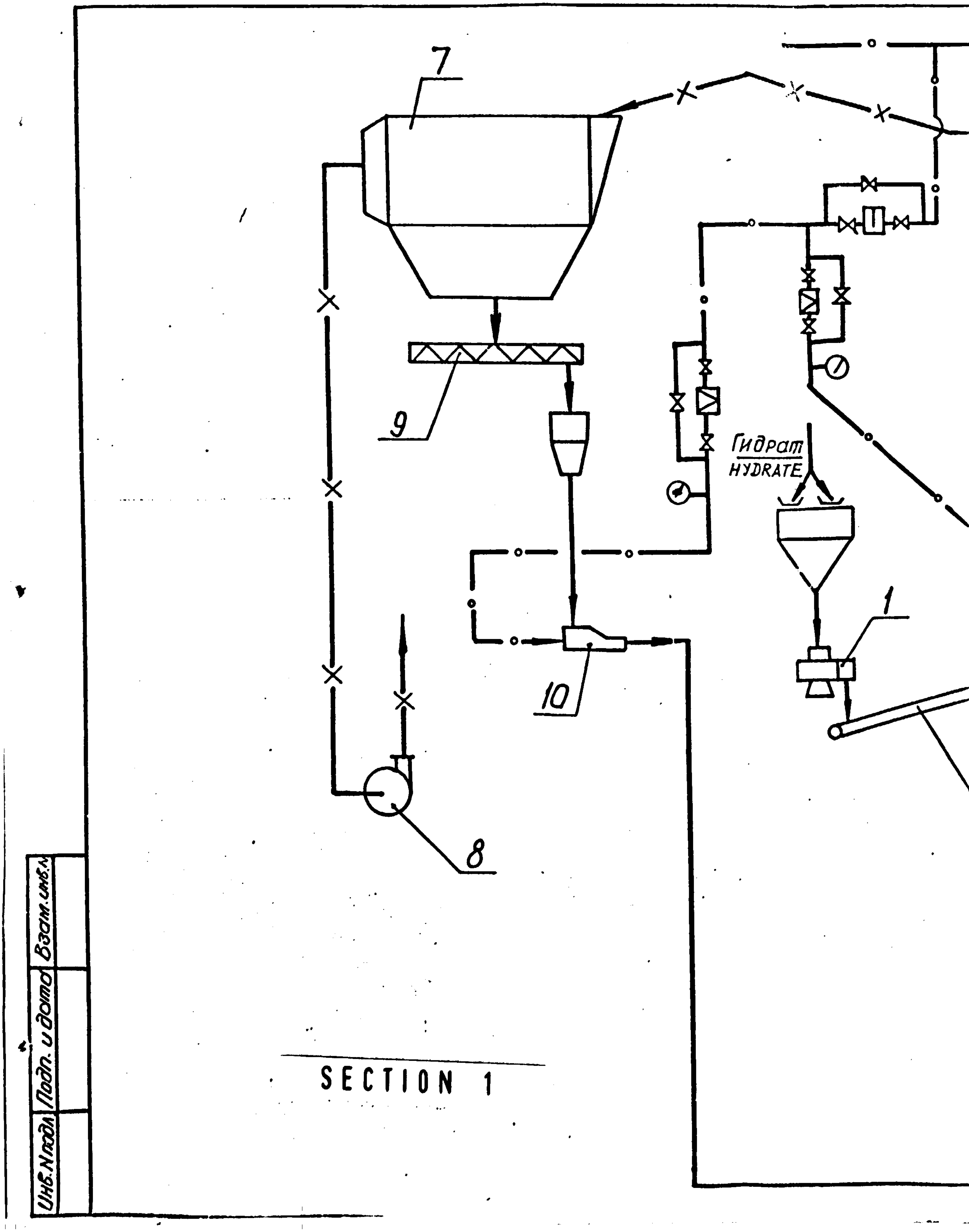
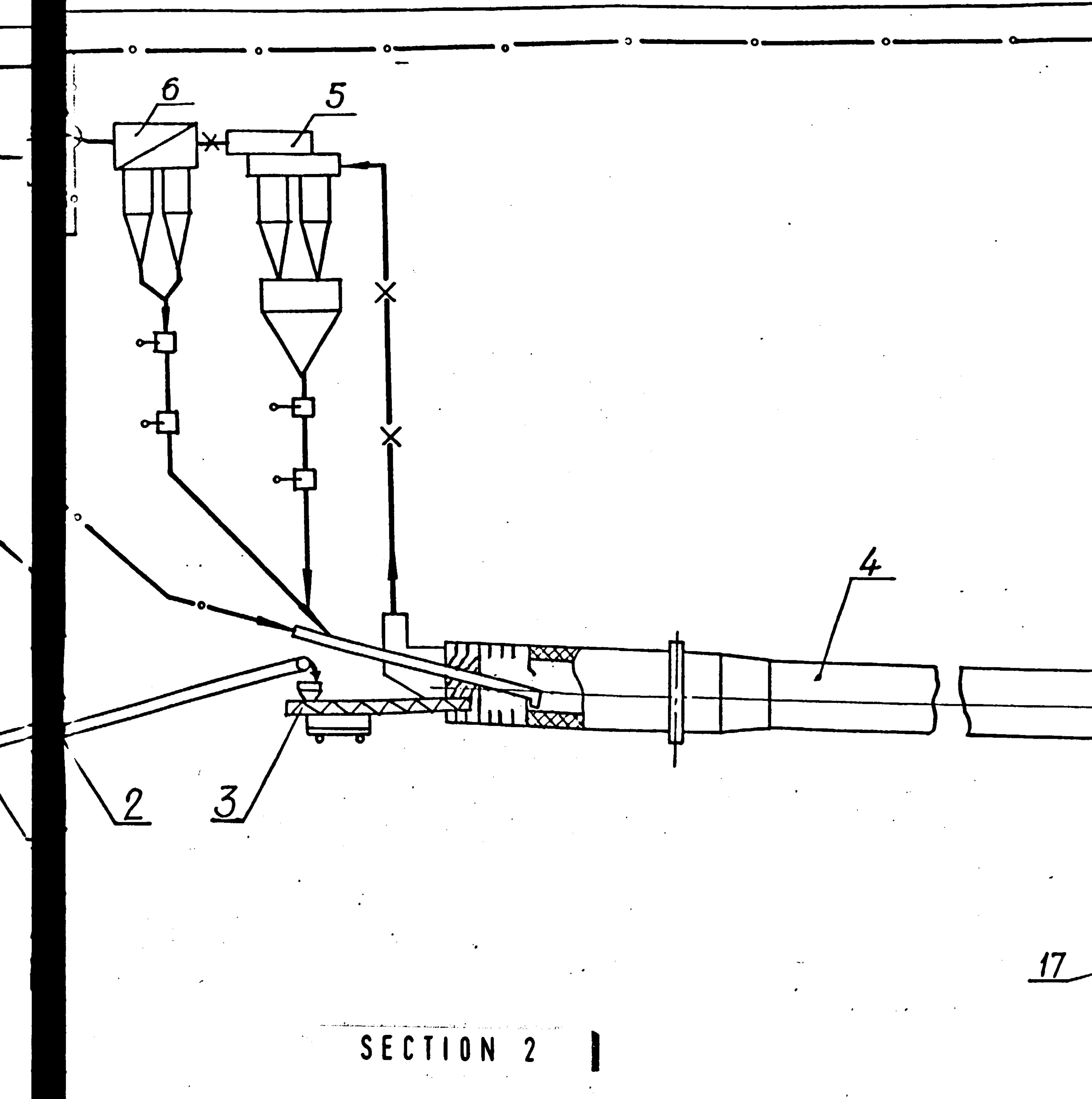


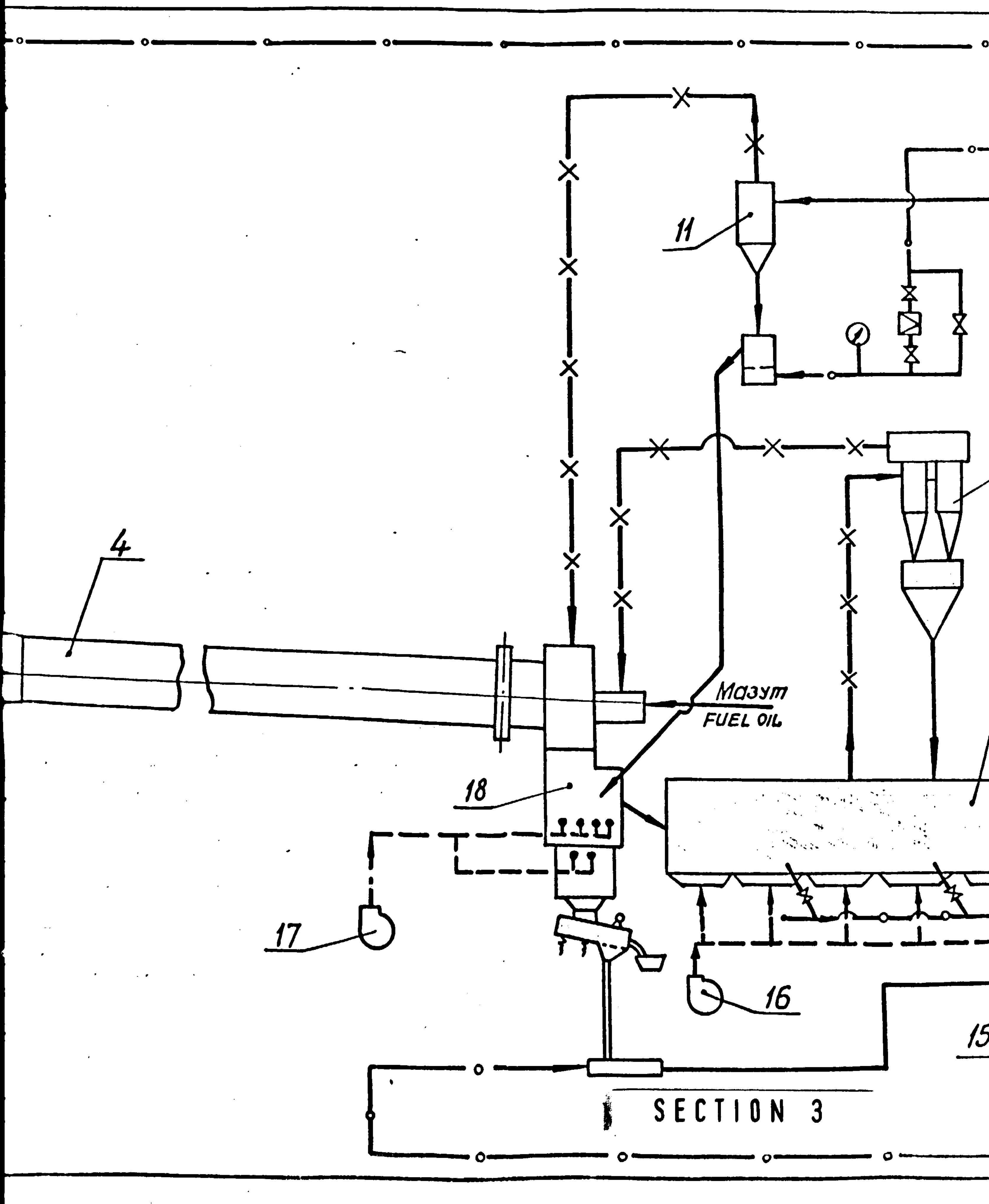

Инв.N подл | Подп. и дата | Взам. инв.N



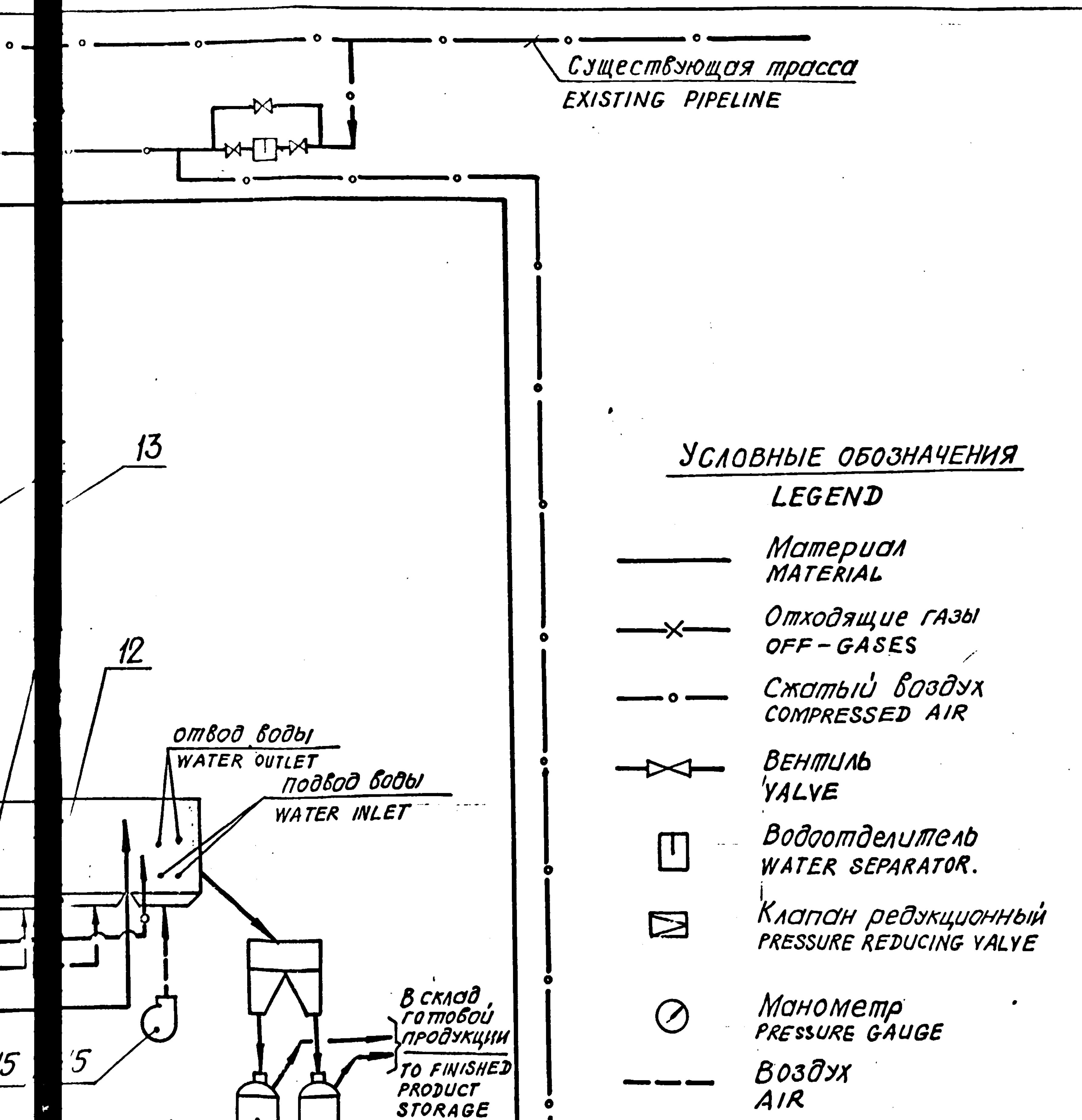

SECTION 1




SECTION 2



11
4
Мазут
FUEL OIL
18
17
16
15
SECTION 3


Существующая трасса
EXISTING PIPELINE
13
12
отвод воды
WATER OUTLET
подвод воды
WATER INLET
В склад готовой продукции
TO FINISHED PRODUCT STORAGE
15
5
14
УСЛОВНЫЕ ОБОЗНАЧЕНИЯ
LEGEND
Материал
MATERIAL
Отходящие газы
OFF-GASES
Сжатый воздух
COMPRESSED AIR
Вентиль
VALVE
Водоотделитель
WATER SEPARATOR.
Клапан редукционный
PRESSURE REDUCING VALVE
Манометр
PRESSURE GAUGE
Воздух
AIR

SECTION 4

| N позиции ITEM | Наименование DESCRIPTION | Техническая характеристика SPECIFICATION | Количество Q-TY | При... ЧА... RE... |
|---|---|---|---|---|
| 12 | Холодильник кипящего слоя FLUIDBED COOLER | F $\frac{\text{Внутренняя}}{\text{INTERNAL}}$ =75 $\frac{м^2}{m^2}$ | 2 | Вн... Ус... ли... М... |
| 13 | Батарея циклонов CYCLONE BANK | 4 $\frac{\text{циклона}}{\text{CYCLONE}}$ φ 1100 | 2 | То... IN... L... |
| 14 | Пневмокамерный насос PNEUMATIC CHAMBER PUMP | $V = 5,8\ \frac{м^3}{m^3}$ | 4 | Сущ... ю... EX... |
| 15 | Вентилятор FAN | $Q=25000\frac{м^3/ч}{m^3/h}$ $H=7000\frac{Па}{Pa}$ | 2 | Вн... Ус... ли... E... |
| 16 | Воздуходувка AIR BLOWER | $Q=4000\frac{м^3/ч}{m^3/h}$ $H=11000\frac{Па}{Pa}$ | 2 | То... IN... L... |
| 17 | Воздуходувка AIR BLOWER | $Q=1450\frac{м^3/ч}{m^3/h}$ $H=30000\frac{Па}{Pa}$ | 2 | Сущ... ю... EX... |
| 18 | Шамотоотделитель с виброжолобом. FIRECLAY SEPARATOR WITH VIBRATING CHUTE. | F $\frac{\text{Внутренняя}}{\text{INTERNAL}}$ 3 $\frac{м^2}{m^2}$ | 2 | Вн... Ус... ли... то... ST... |

...са

...Е ОБОЗНАЧЕНИЯ
...END

...териал
...ERIAL

...одящие газы
...-GASES

...тый воздух
...RESSED AIR

...тиль
...E

...отделитель
...R SEPARATOR.

...пан редукционный
...URE REDUCING VALVE

...ометр
...URE GAUGE

...дух

Вновь устанавливаемое оборудование на схеме затушевано

EQUIPMENT TO BE INSTALLED IS DARKENED ON DIAGRAM.

SECTION 5

| …ние / …N | Техническая характеристика SPECIFICATION | Коли-чество Q-TY | Приме-чание REMARK |
|---|---|---|---|
| …его слоя …ER | $F \frac{\text{Внутренняя}}{\text{INTERNAL}} = 75 \frac{м^2}{m^2}$ | 2 | Вновь устанавливаемые |
| …ионов …NK | $4 \frac{\text{циклона}}{\text{CYCLONE}}$ ф 1100 | 2 | TO BE INSTALLED |
| …ый насос …ER PUMP | $V = 5{,}8 \frac{м^3}{m^3}$ | 4 | Существующий EXISTING |
| | $Q = 25000 \frac{м^3/ч}{m^3/h}$ $H = 7000 \frac{Па}{Pa}$ | 2 | Вновь устанавливаемые |
| …а | $Q = 4000 \frac{м^3/ч}{m^3/h}$ $H = 11000 \frac{Па}{Pa}$ | 2 | TO BE INSTALLED |
| …ка | $Q = 1450 \frac{м^3/ч}{m^3/h}$ $H = 30000 \frac{Па}{Pa}$ | 2 | Существующая EXISTING |
| …итель с …1. …TOR WITH VIBRATING | $F \frac{\text{Внутренняя}}{\text{INTERNAL}}\ 3 \frac{м^2}{m^2}$ | 2 | Вновь устанавливаемый TO BE INSTALLED |

| № позиции ITEM | Наименование DESCRIPTION | Техн… характ… SPEC… |
|---|---|---|
| 1 | Питатель тарельчатый RECIPROCATING PLATE FEEDER | ф2… |
| 2 | Конвейер ленточный BELT CONVEYOR | B=5… |
| 3 | Питатель шнековый SCREW CONVEYOR | ф450, Q=30… |
| 4 | Печь вращающаяся ROTARY KILN | ф3,6/… L=80… |
| 5 | Батарея циклонов. I ступень CYCLONE BANK STAGE I | $4 \frac{\text{цикл…}}{\text{CYCLO…}}$ |
| 6 | Батарея циклонов II ступень CYCLONE BANK STAGE II | $90 \frac{\text{цик…}}{\text{CYCL…}}$ |
| 7 | Электрофильтр ELECTROSTATIC PRECIPITATOR | F=30… |
| 8 | Дымосос I.D. FAN. | Q=103… H=28… |
| 9 | Шнек SCREW | ф 500… L=7… |
| 10 | Струйный насос JET PUMP | Q=7… |
| 11 | Циклон-разгрузитель DISCHARGING CYCLONE | ф 60… |

…ваемое оборудование на схеме затушевано;

…STALLED IS DARKENED ON DIAGRAM.

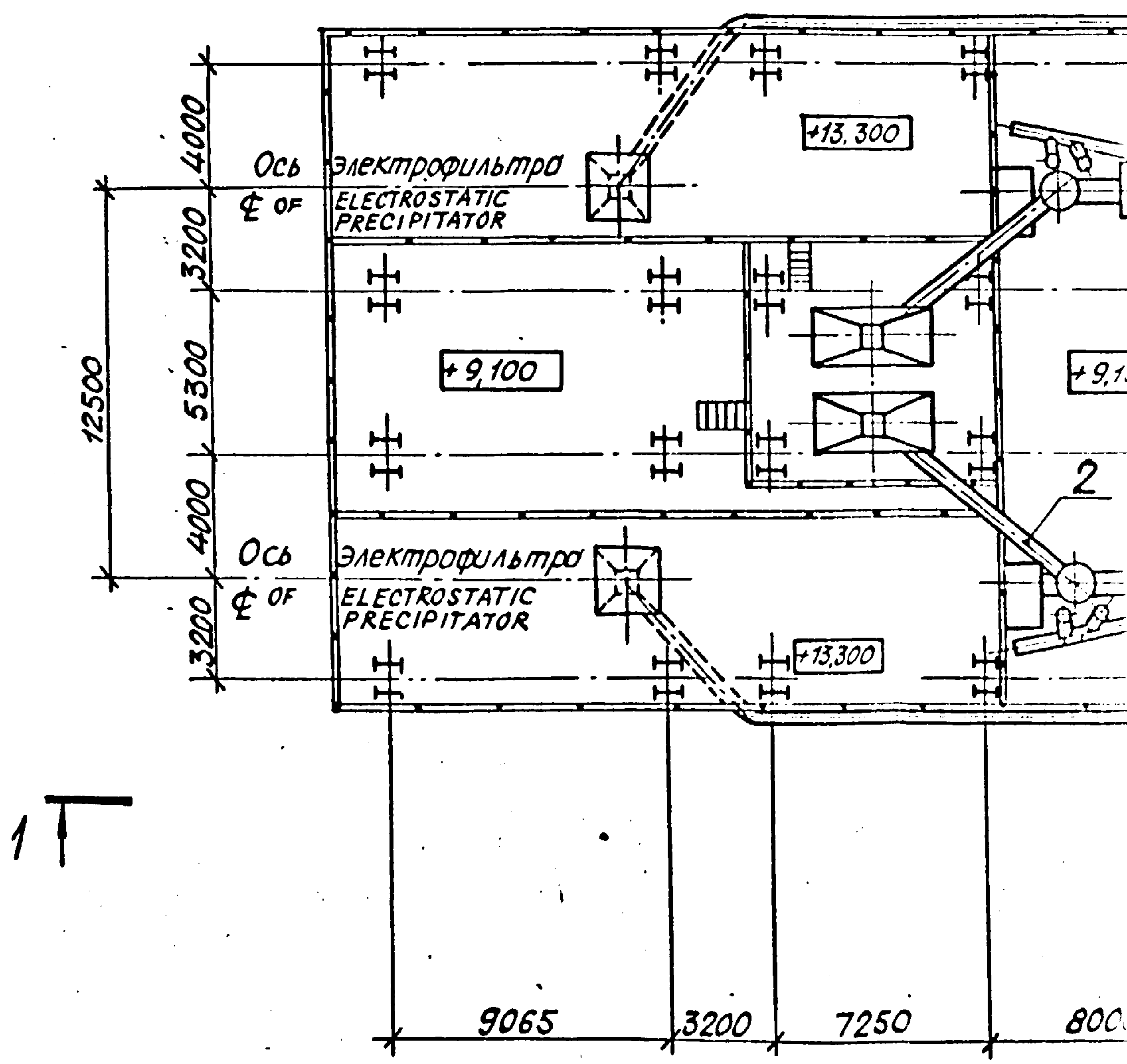
SECTION 6

| | |
|---|---|
| | ВАМИ Ленингр… VAMI LENINGRA… |
| Масштаб SCALE — | Для Индийской фир… комп… FOR BHARAT ALUMINIUM… |
| Данный чертеж является собственностью института ВАМИ и не может быть скопирован и использован без его разрешения | Глиноземный завод в … кальцинации. II этап… |
| THIS DRAWING IS THE PROPERTY OF VAMI AND NOT TO BE COPIED OR USED WITHOUT OUR PERMISSION | КОРБА ALLUMINA PLAN… II STAGE. PROCESS E… |
| | 1354691… |

| Количество Q-TY | Примечание REMARK | № позиции ITEM | Наименование DESCRIPTION | Техническая характеристика SPECIFICATION | Количество Q-TY | Примечание REMARK |
|---|---|---|---|---|---|---|
| 2 | Вновь устанавливаемые TO BE INSTALLED | 1 | Питатель тарельчатый RECIPROCATING PLATE FEEDER | $\phi 2 \frac{м}{m}$ | 2 | Существующий. EXISTING |
| 2 | TO BE INSTALLED | 2 | Конвейер ленточный BELT CONVEYOR | B=500 | 2 | —"— |
| 4 | Существующий EXISTING | 3 | Питатель шнековый SCREW CONVEYOR | $\phi 450$; $L=6{,}5 \frac{м}{m}$ $Q=30 \frac{т/ч}{T/H}$ | 2 | —"— |
| 2 | Вновь устанавливаемые | 4 | Печь вращающаяся ROTARY KILN | $\phi 3{,}6/\phi 3{,}3 \frac{м}{m}$ $L=80 \frac{м}{m}$ | 2 | —"— |
| 2 | TO BE INSTALLED | 5 | Батарея циклонов. I ступень CYCLONE BANK STAGE I | 4 $\frac{\text{циклона}}{\text{CYCLONES}}$ $\phi 1370 \frac{мм}{mm}$ | 2 | —"— |
| 2 | Существующая EXISTING | 6 | Батарея циклонов II ступень CYCLONE BANK STAGE II | 90 $\frac{\text{циклонов}}{\text{CYCLONES}}$ $\phi 225 \frac{мм}{mm}$ | 2 | —"— |
| 2 | Вновь устанавливаемый TO BE INSTALLED | 7 | Электрофильтр ELECTROSTATIC PRECIPITATOR | $F=30{,}5 \frac{м^2}{m^2}$ | 2 | —"— |
| | | 8 | Дымосос I.D. FAN. | $Q=103000 \frac{м^3/ч}{m^3/h}$ $H=2800 \frac{Па}{Pa}$ | 2 | —"— |
| | | 9 | Шнек SCREW | $\phi 500$ $L=7 \frac{м}{m}$ | 2 | Существующий EXISTING |
| | | 10 | Струйный насос JET PUMP | $Q=7 \frac{т/ч}{T/H}$ | 2 | Установлен на I этапе |
| | | 11 | Циклон-разгрузитель DISCHARGING CYCLONE | $\phi 600$ | 2 | INSTALLED AT STAGE I |

SECTION 7

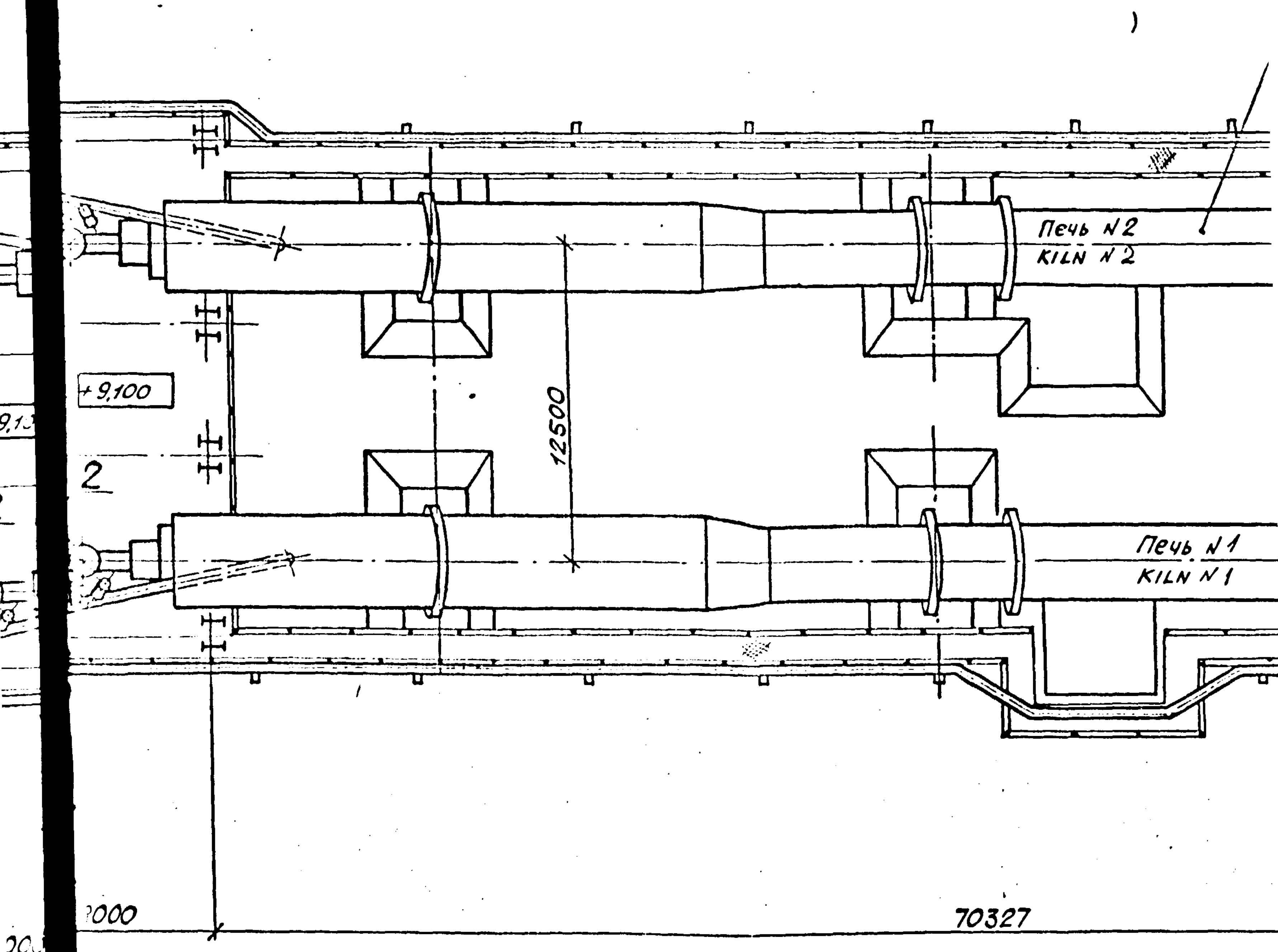
| | |
|---|---|
| ВАМИ Ленинград<br>VAMI Leningrad | |
| Масштаб SCALE — | Для Индийской фирмы Бхарат Алюминиум Компани<br>For Bharat Aluminium Company. LTD. India |
| Данный чертеж является собственностью института ВАМИ и не может быть скопирован и использован без его разрешения<br>THIS DRAWING IS THE PROPERTY OF VAMI AND NOT TO BE COPIED OR USED WITHOUT OUR PERMISSION | Глиноземный завод в Корбе. Реконструкция цеха кальцинации. II этап. Схема аппаратурно-технологическая<br>Корва Alumina plant. Reconstruction of calcination. II stage. Process equipment flowsheet. |
| | 1354691-TM — Лист 1 SHEET 1 — Листов 3 SHEETS 3 |



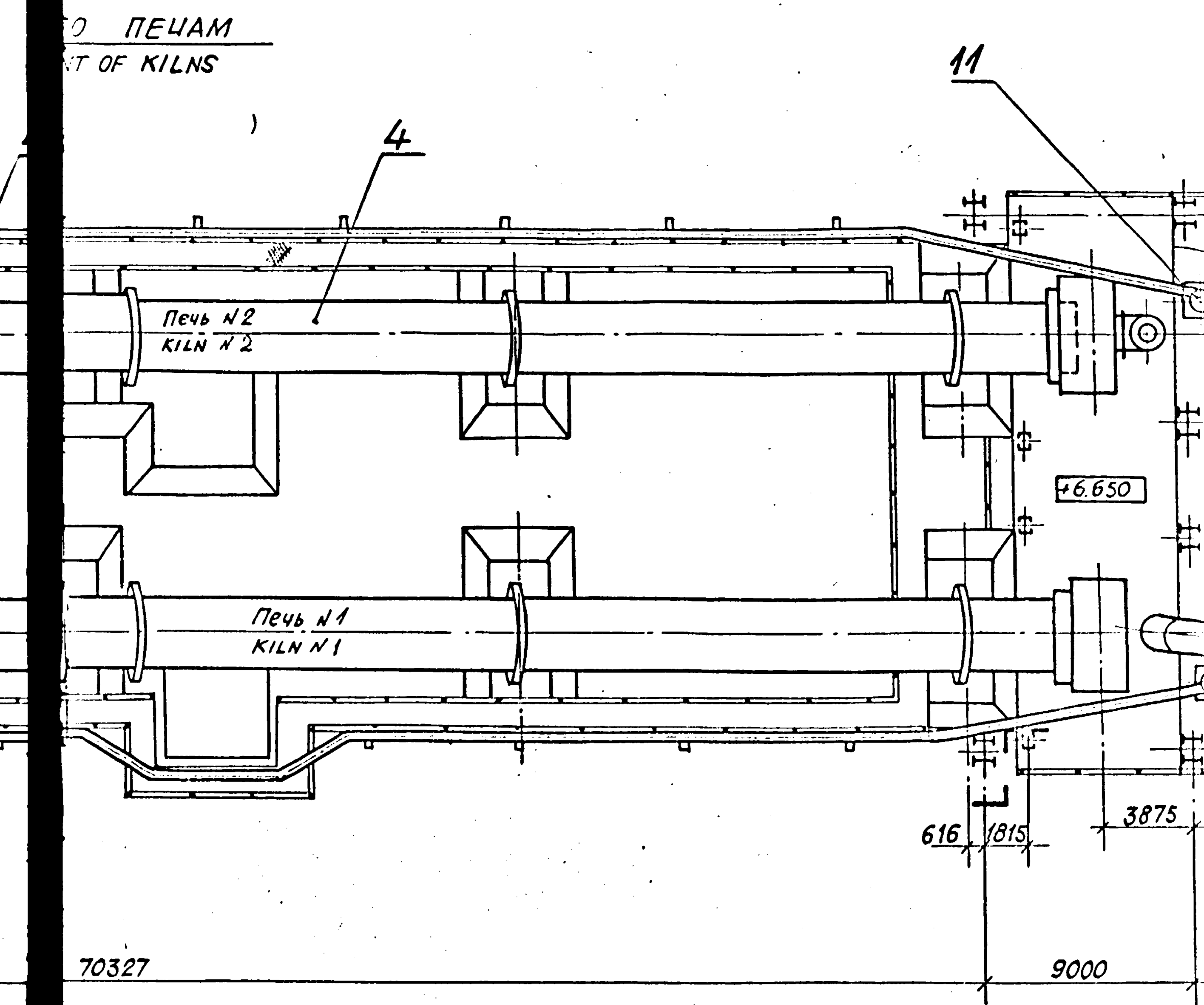

SECTION 1

| Взам.инв.№ | Подп. и дата | Инв.№подл. |
|---|---|---|
| | | |

## ПЛАН ПО ПЕЧАМ
## ARRANGEMENT OF KILNS

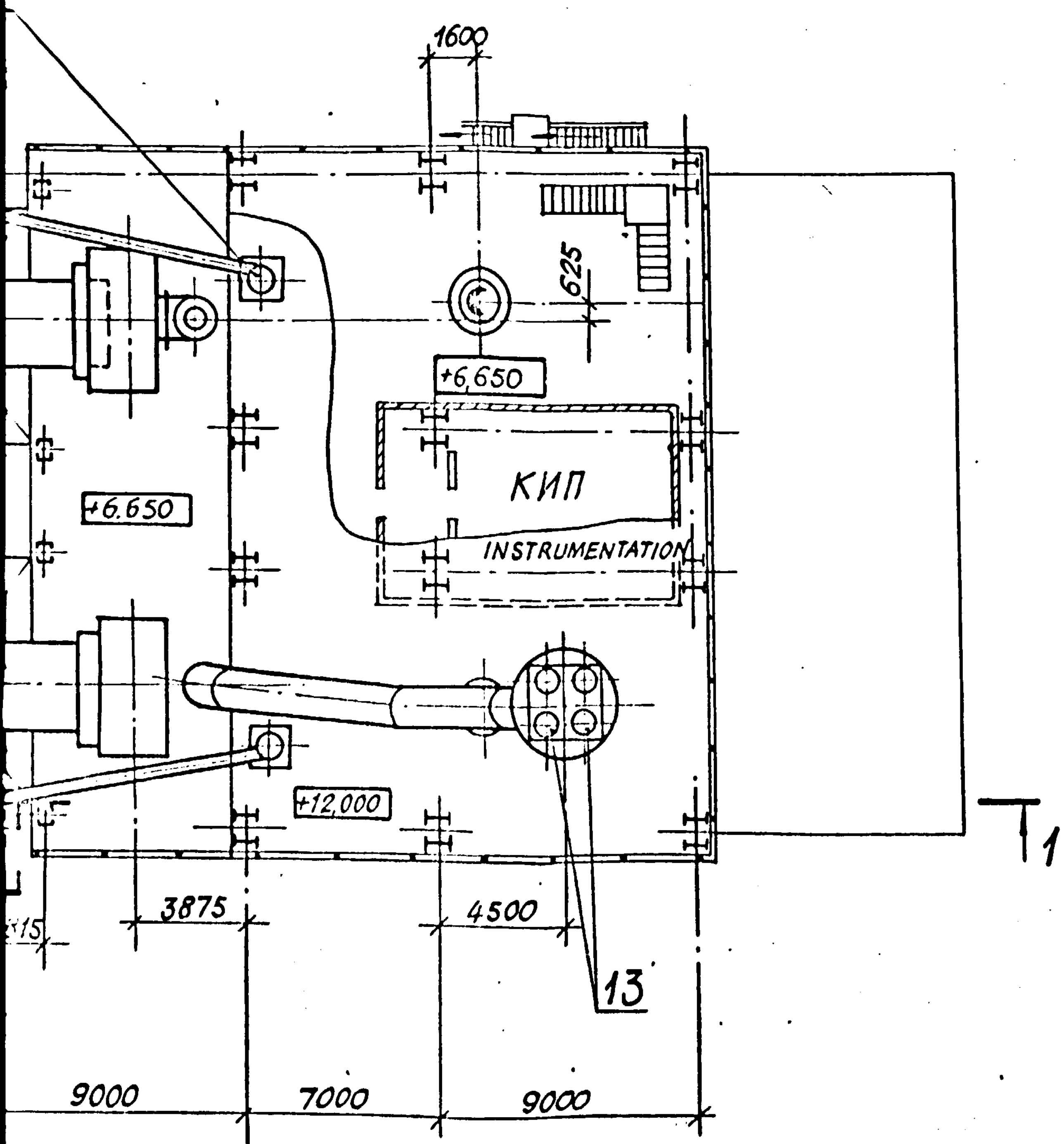



## SECTION 2

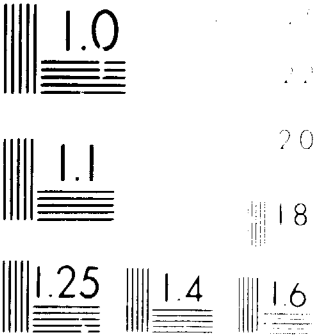


О ПЕЧАМ
T OF KILNS
4
11
Печь N 2
KILN N 2
Печь N 1
KILN N 1
+6.650
616
1815
3875
70327
9000


SECTION 3

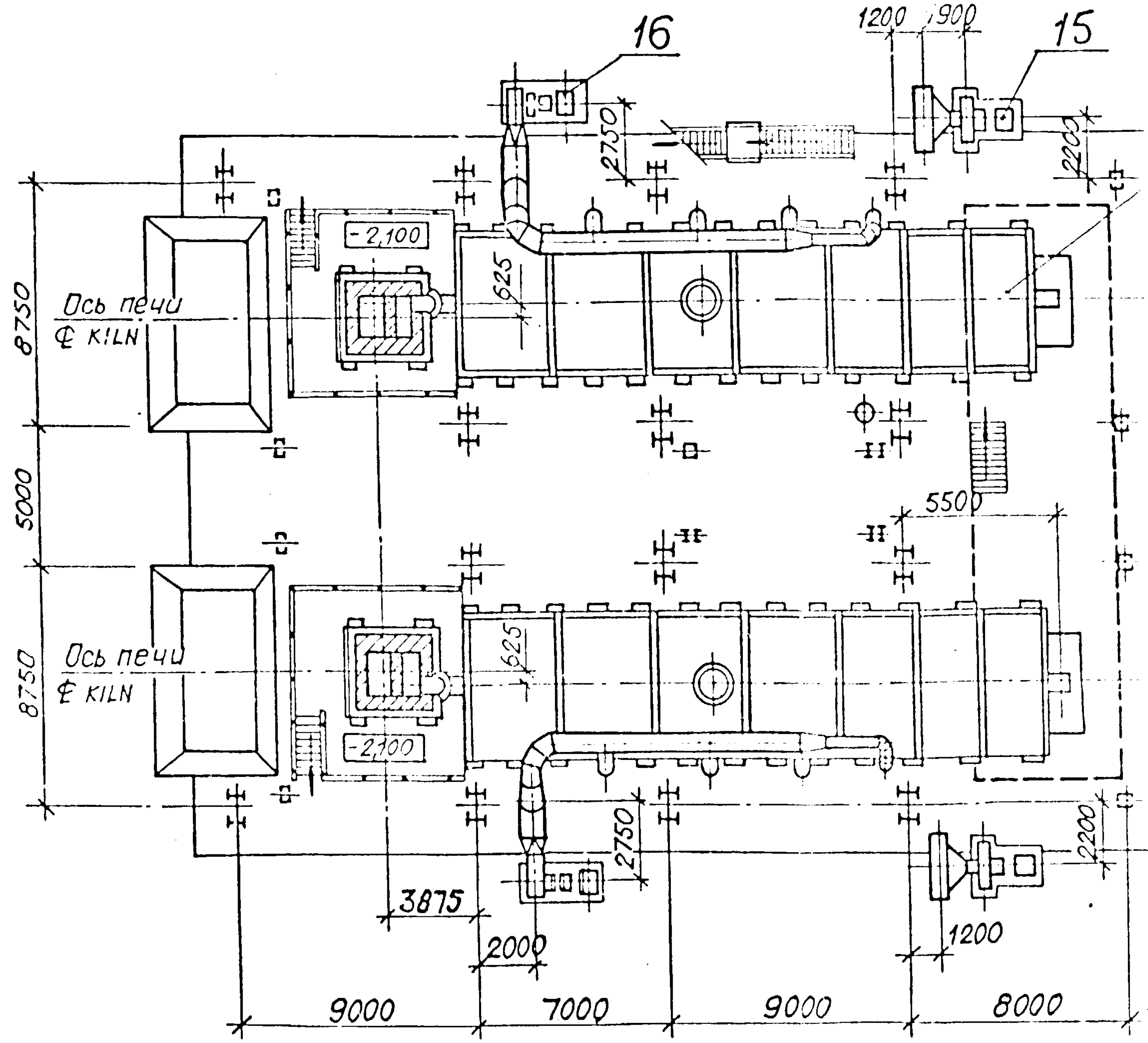

1600
625
+6,650
КИП
INSTRUMENTATION
+6.650
+12,000
3875
4500
13
9000
7000
9000
1

SECTION 4


1.0
1.1
1.25
1.4
1.6
1.8
2.0

ПЛАН НА ОТМ. 0,000

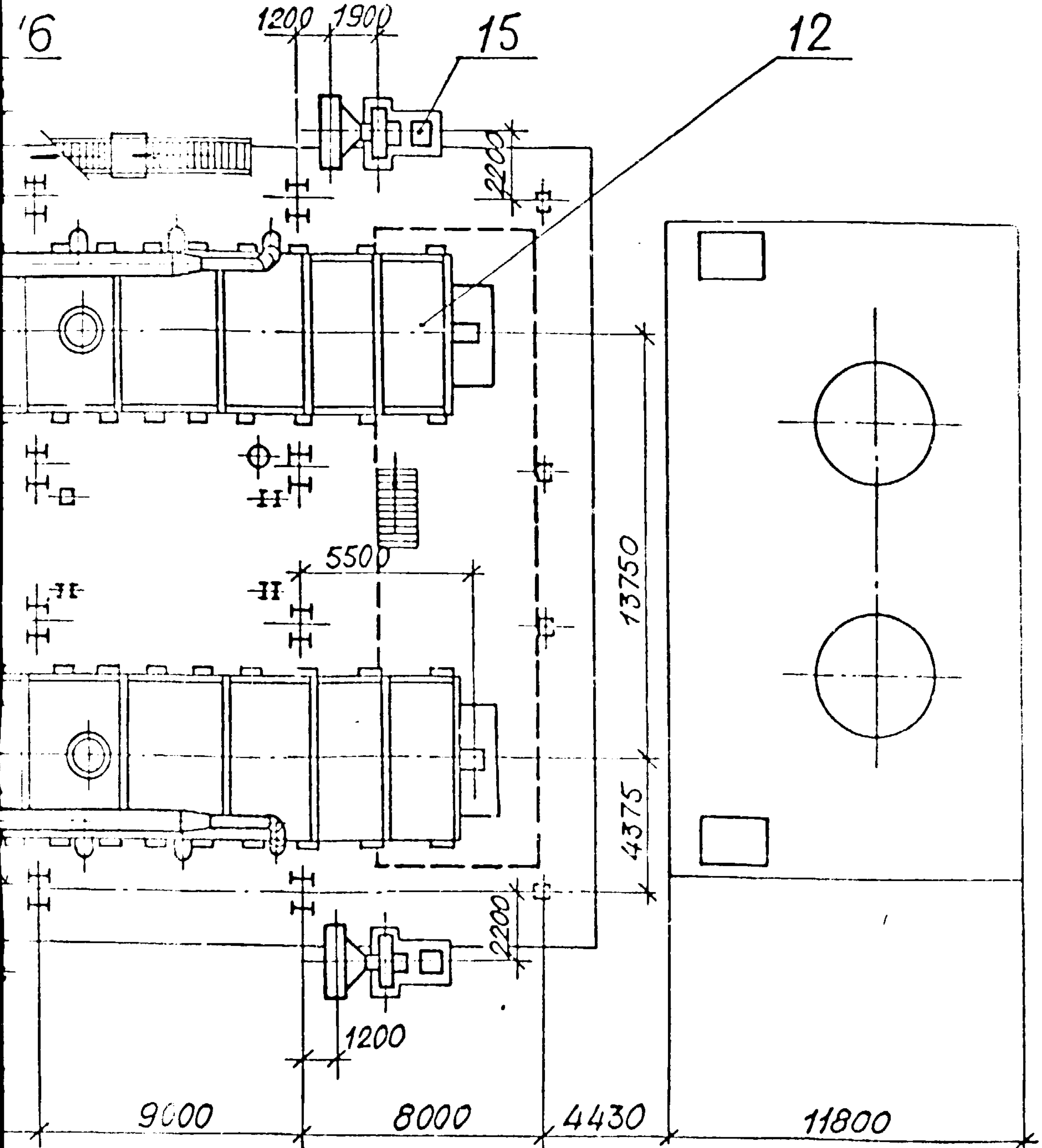
PLAN AT EL. 0,000




SECTION 5

Н НА ОТМ. 0,000

N AT EL 0,000

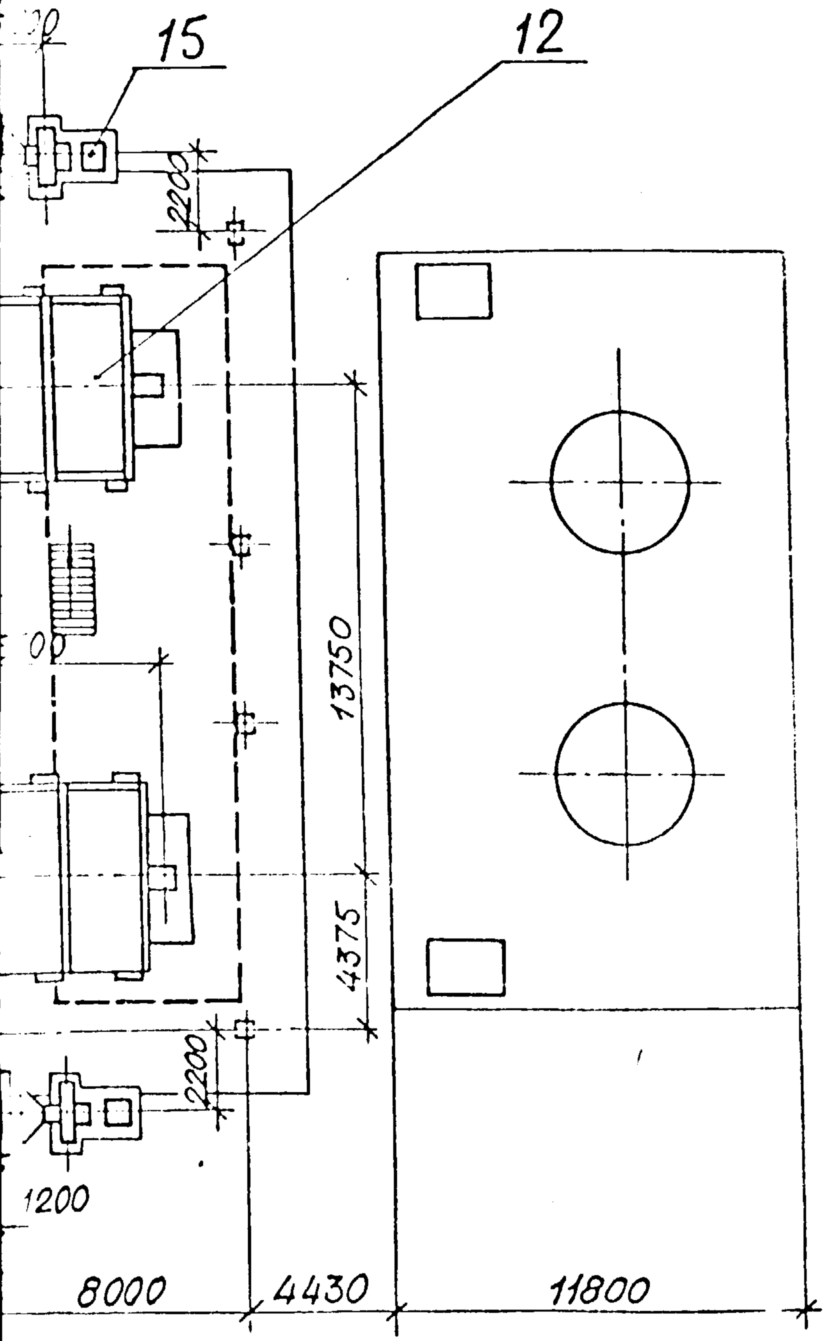



SECTION 6

ВАМИ Ленинград

VAMI LENINGRAD

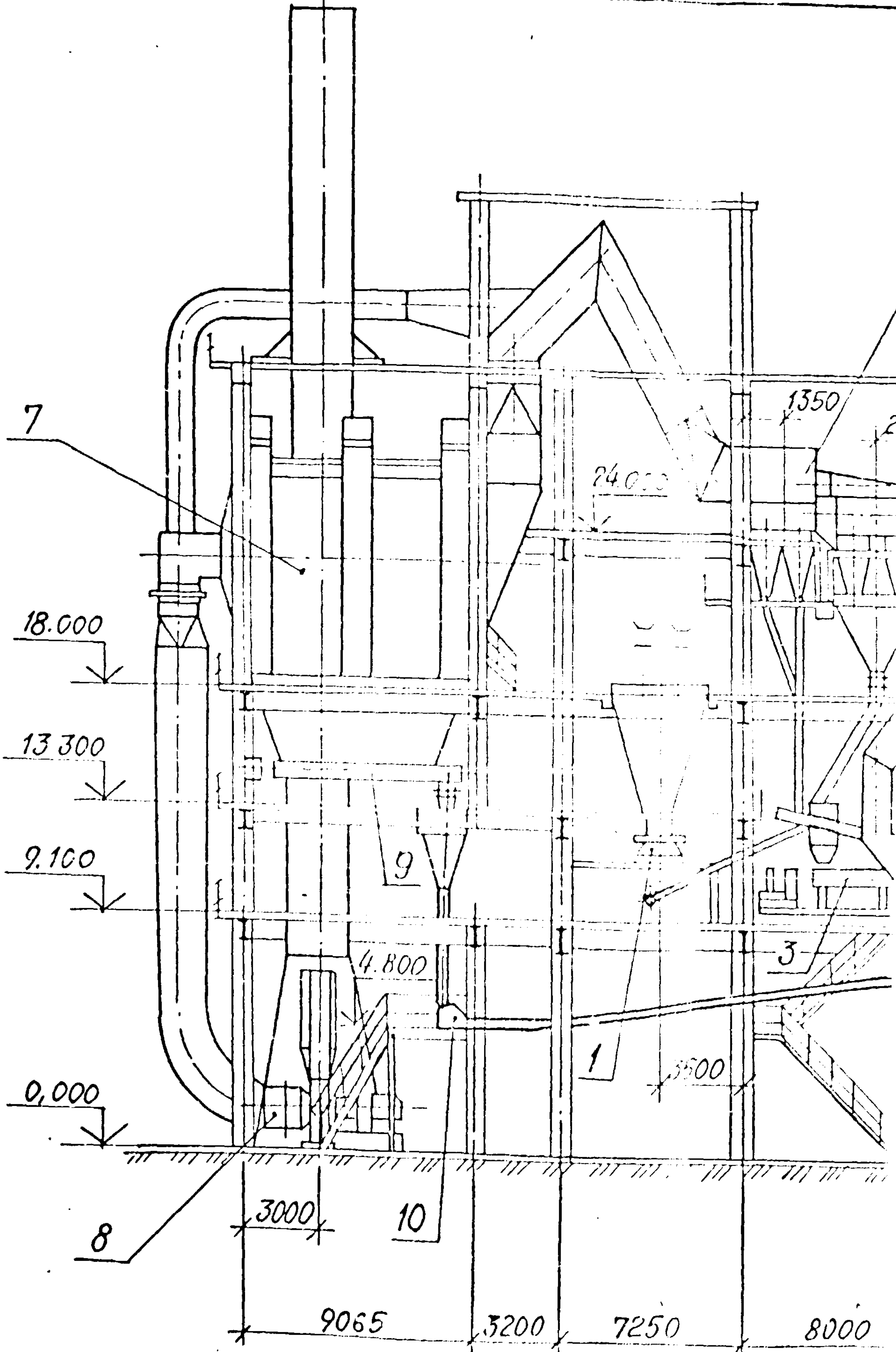
| | |
|---|---|
| Масштаб SCALE 1:200 | Для Индийской фирмы Бхарат Ал... Компани<br>For BHARAT ALUMINIUM COMPANY LT... |
| Данный чертеж является собственностью института ВАМИ и не может быть скопирован и использован без его разрешения<br>THIS DRAWING IS THE PROPERTY OF VAMI AND NOT TO BE COPIED OR USED WITHOUT OUR PERMISSION | Глиноземный завод в Корбе. Реконст... кальцинации. II этап. План по п... на отметке 0,000<br>KORBA ALUMINA PLANT. RECONSTRUCTION... II STAGE. PLAN OF KILNS ... AT EL 0,000<br>1354691-ТМ |




SECTION 7

| | |
|---|---|
| ВАМИ Ленинград<br>VAMI LENINGRAD | |
| Масштаб<br>SCALE 1:200 | Для Индийской фирмы Бхарат Алюминиум Компани<br>FOR BHARAT ALUMINIUM COMPANY LTD, INDIA |
| Данный чертеж является собственностью института ВАМИ и не может быть скопирован и использован без его разрешения<br>THIS DRAWING IS THE PROPERTY OF VAMI AND NOT TO BE COPIED OR USED WITHOUT OUR PERMISSION | Глиноземный завод в Корбе. Реконструкция цеха кальцинации. II этап. План по печам и на отметке 0,000<br>KORBA ALUMINA PLANT. RECONSTRUCTION OF CALCINATION. II STAGE. PLAN OF KILNS AND AT EL. 0,000 |
| | 1354691-TM \| Лист SHEET 2 \| Листов SHEETS 3 |

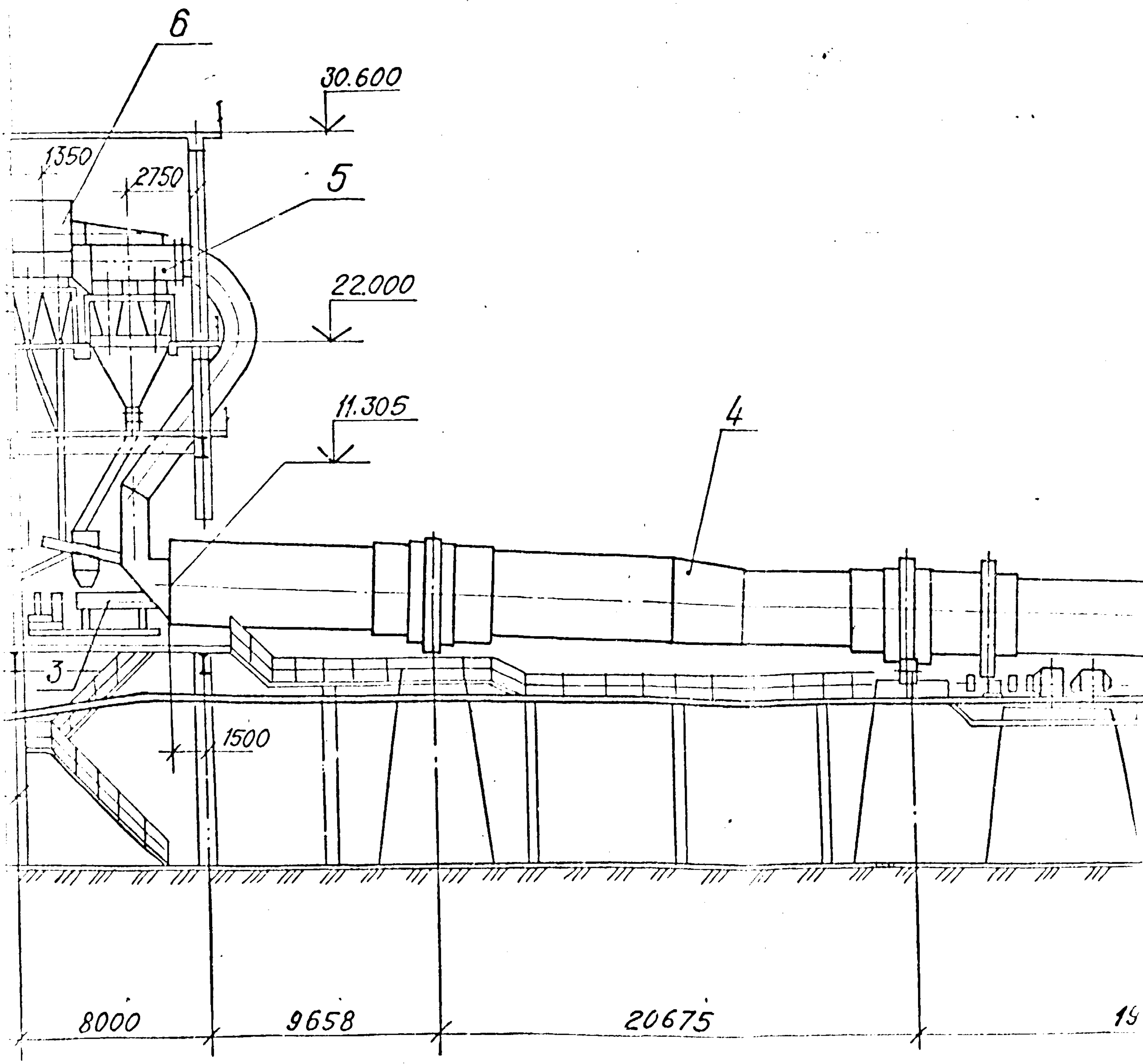
Формат А4×5 SIZE




SECTION 1

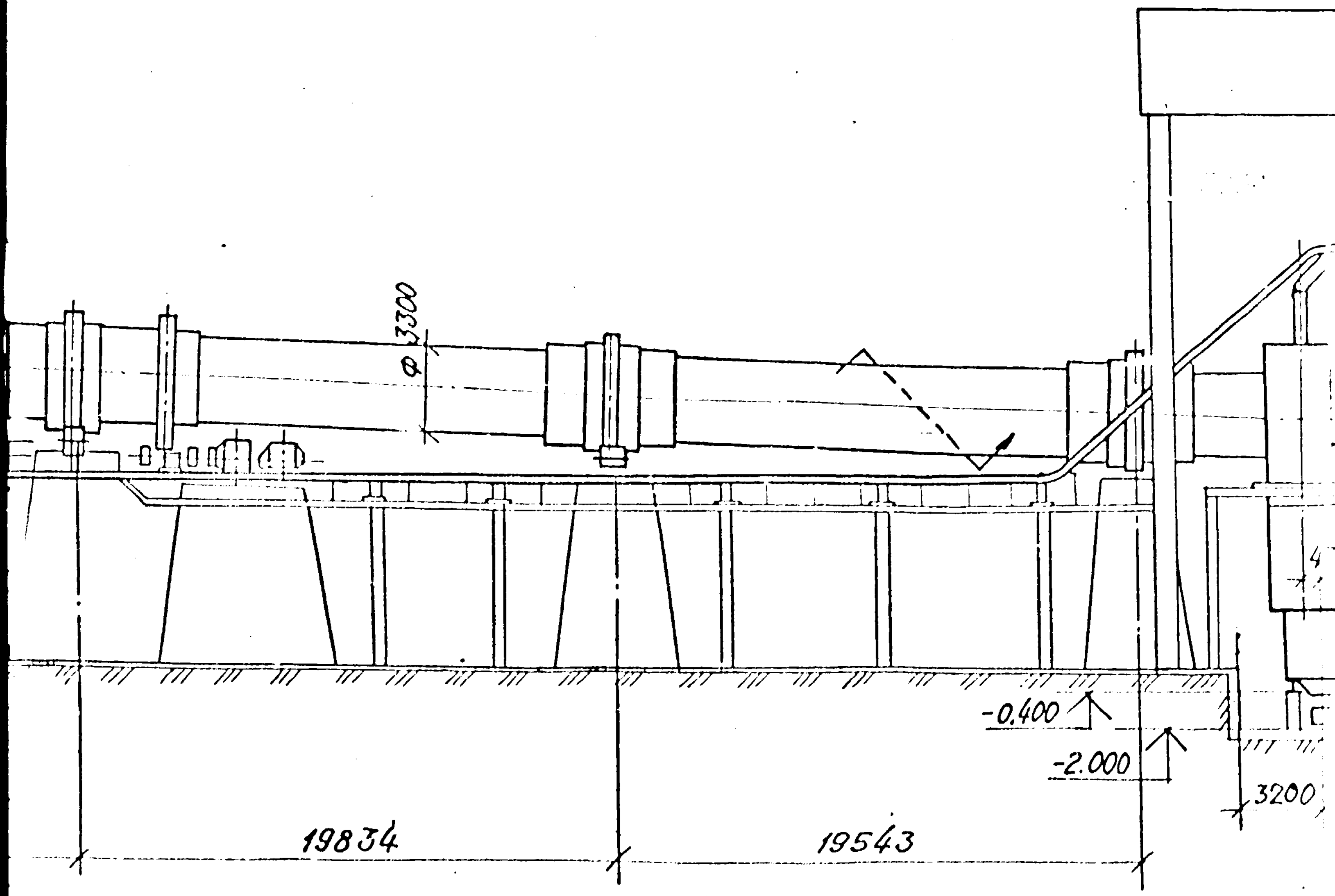
Инв.N подл. | Подп. и дата | Взам.инв.N

## Разрез
## SECTION

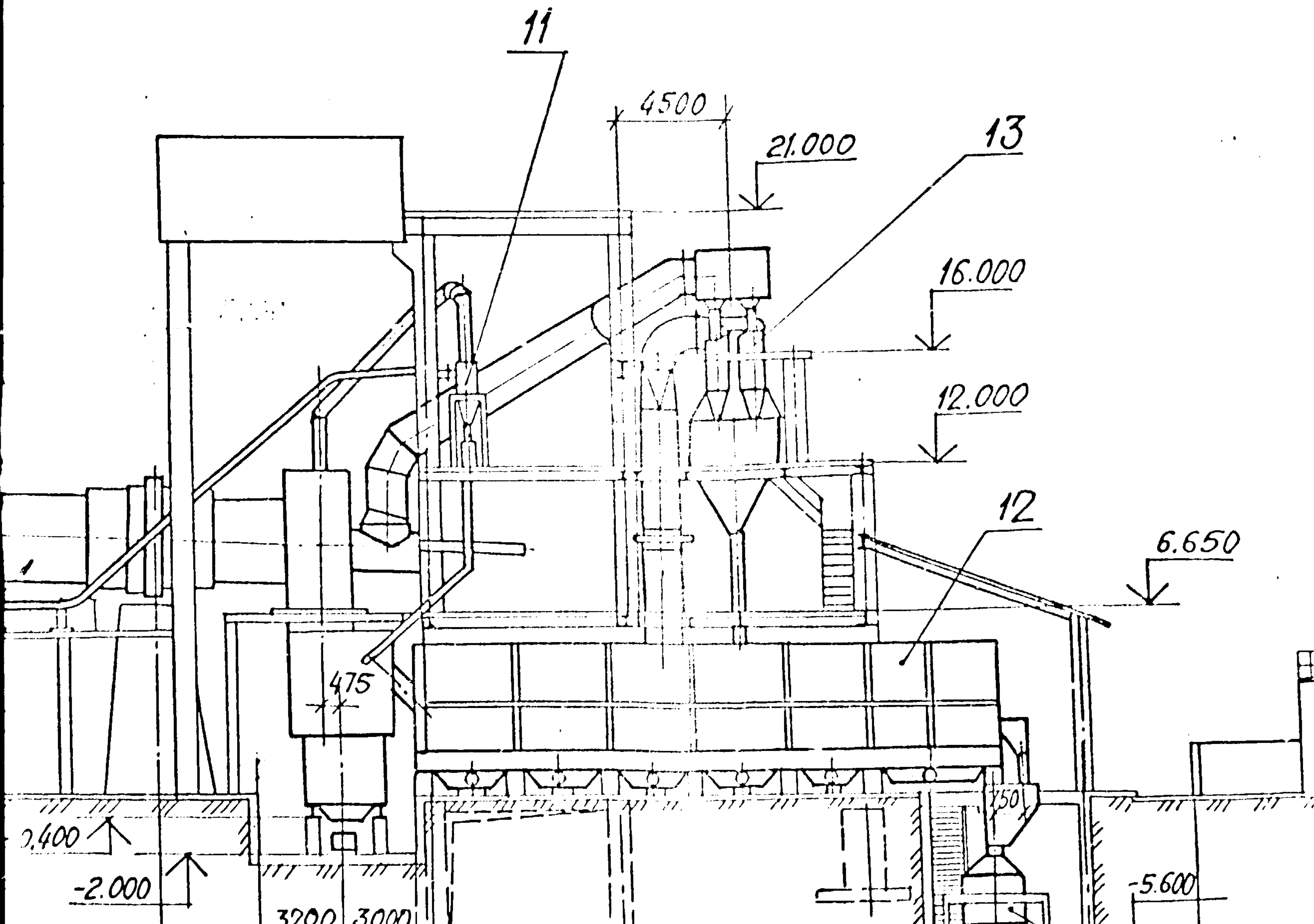



SECTION 2

Разрез / SECTION 1-1

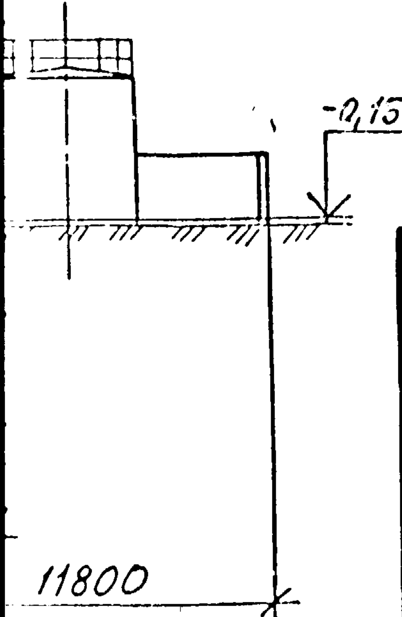



SECTION 3


11
13
12
14
4500
21.000
16.000
12.000
6.650
475
750
0.400
-2.000
-5.600
3200
3000
2150
3200
4750
16000
8000
4430

SECTION 4

# SECTION 5




ВАМИ Ленинград
VAMI LENINGRAD

Масштаб
SCALE 1:200

ДЛЯ ИНДИЙСКОЙ ФИРМЫ БХАРАТ АЛЮМИНИУМ КОМПАНИ.
FOR BHARAT ALUMINIUM COMPANY LTD, INDIA.

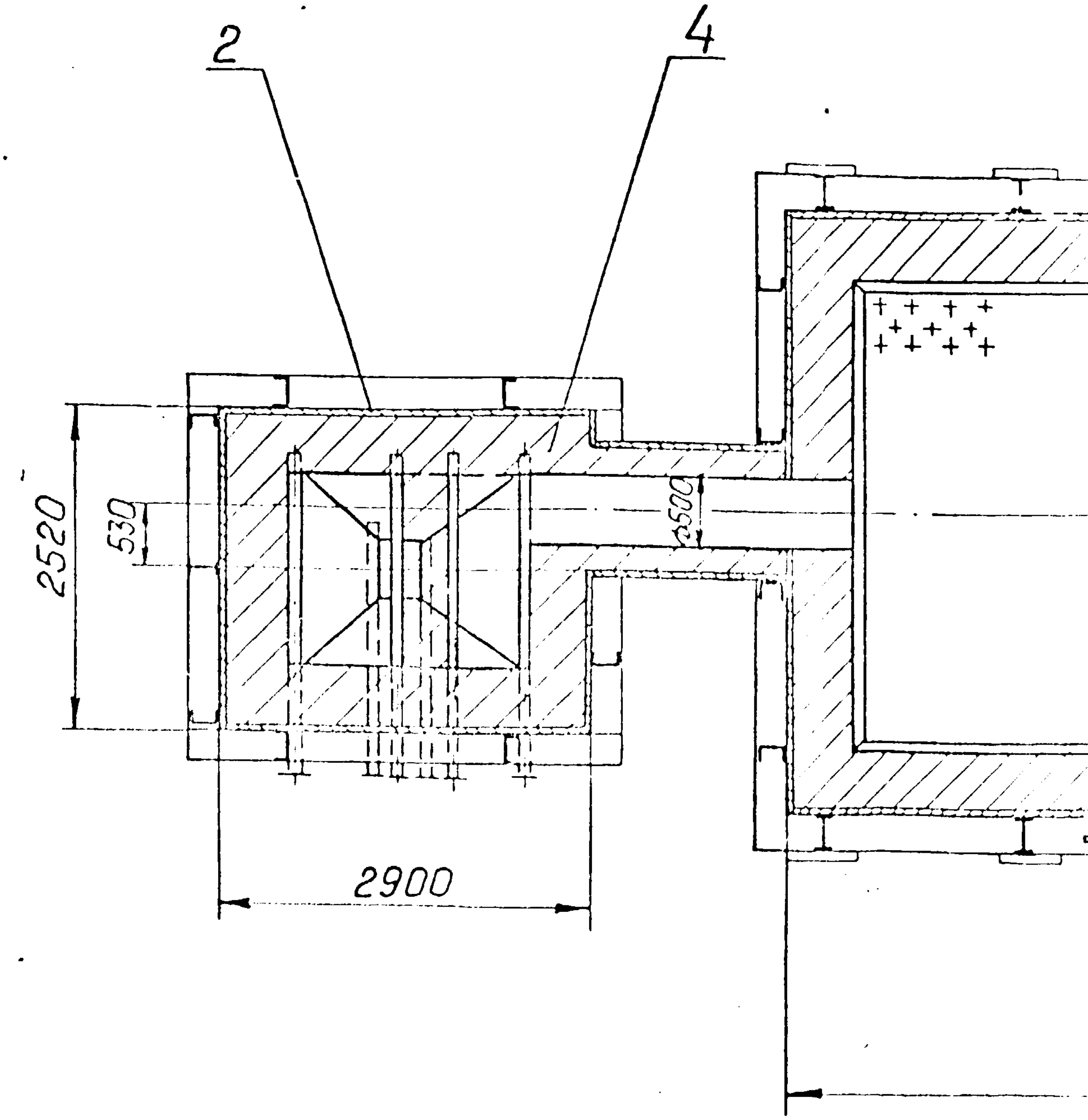


ГЛИНОЗЕМНЫЙ ЗАВОД В КОРБЕ. РЕКОНСТРУКЦИЯ ЦЕХА КАЛЬЦИНАЦИИ. II ЭТАП. РАЗРЕЗ 1-1
KORBA ALUMINA PLANT. RECONSTRUCTION OF CALCINATION. II STAGE. SECTION 1-1

1354691-TM

ЛИСТ SHEET 3 | ЛИСТОВ SHEETS 3

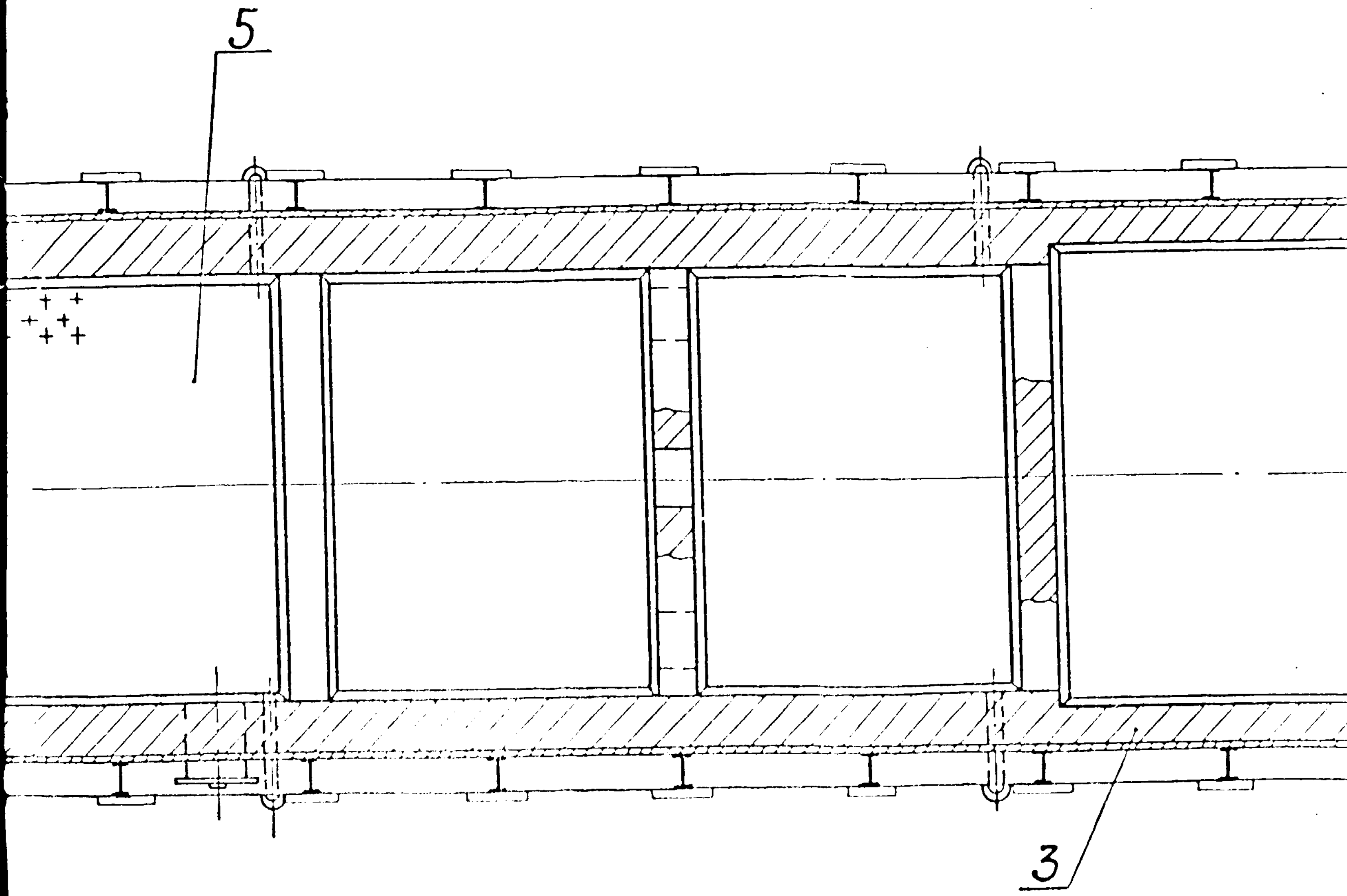
1354693




SECTION 1

Инв. № подл. | Подп. и дата | Взам. инв. №

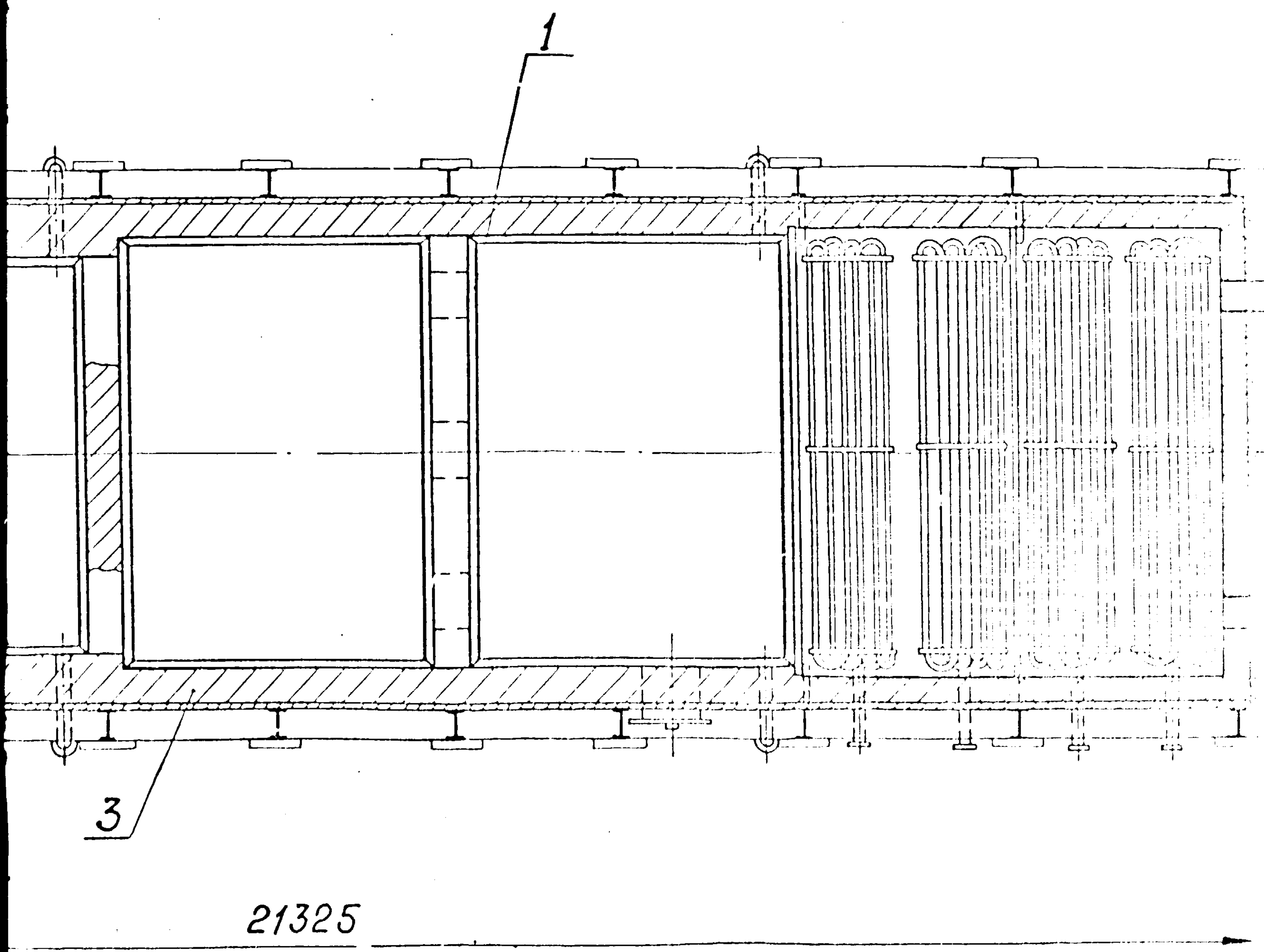
B - B Лист / SHEET 1



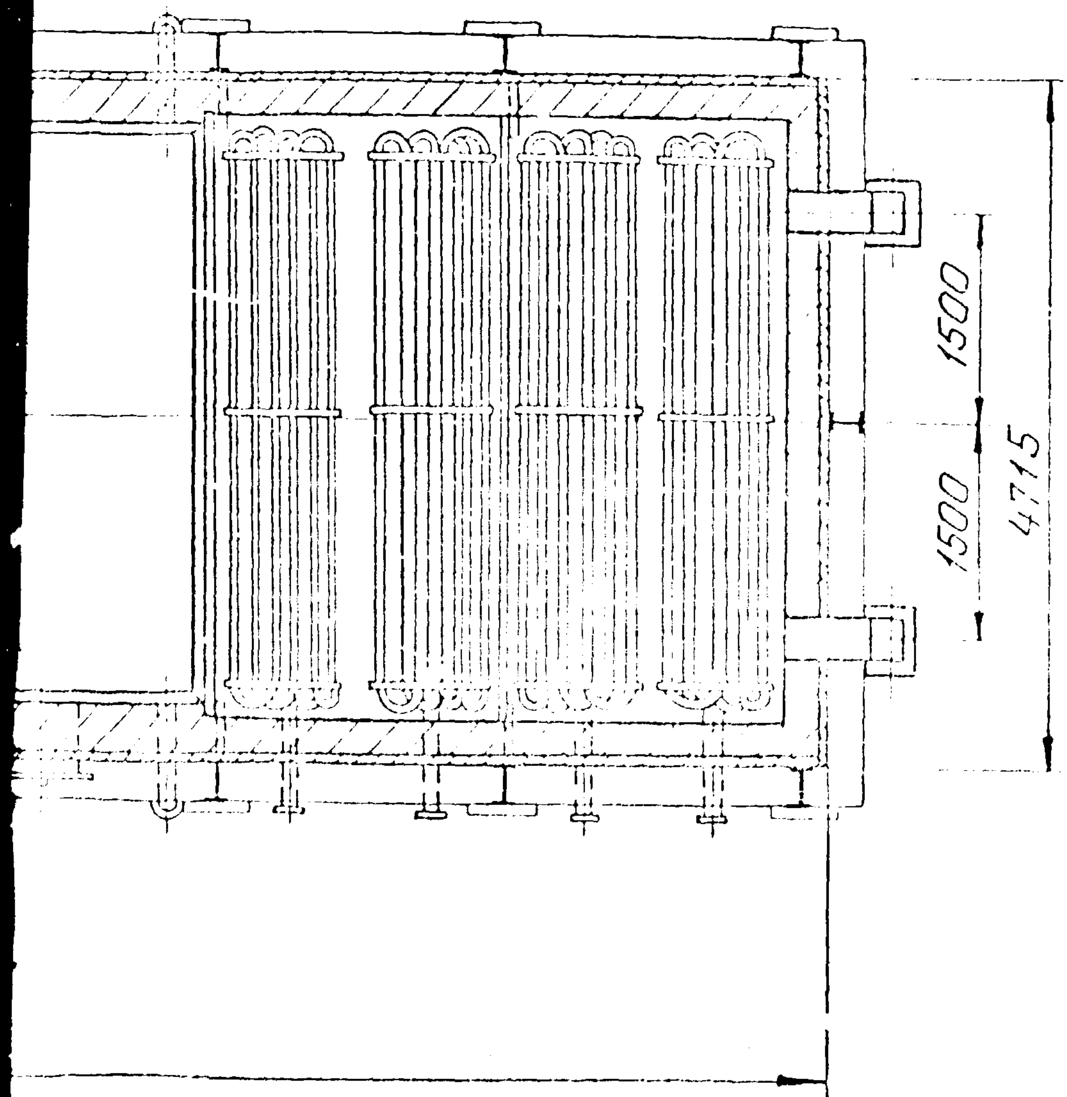

21325

SECTION 2

B - B   Лист / SHEET 1



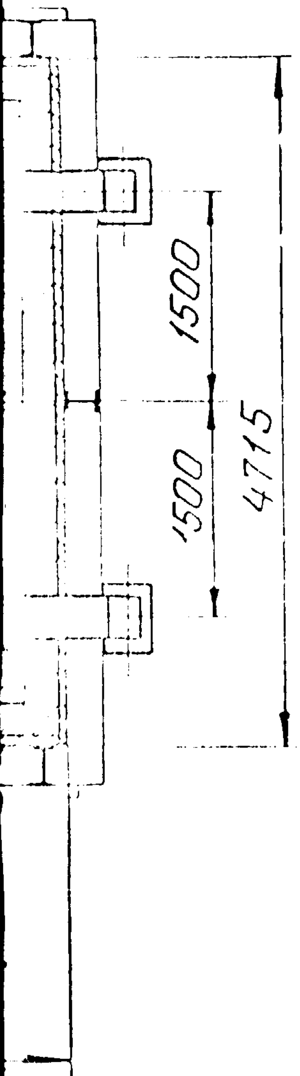

SECTION 3




SECTION 4

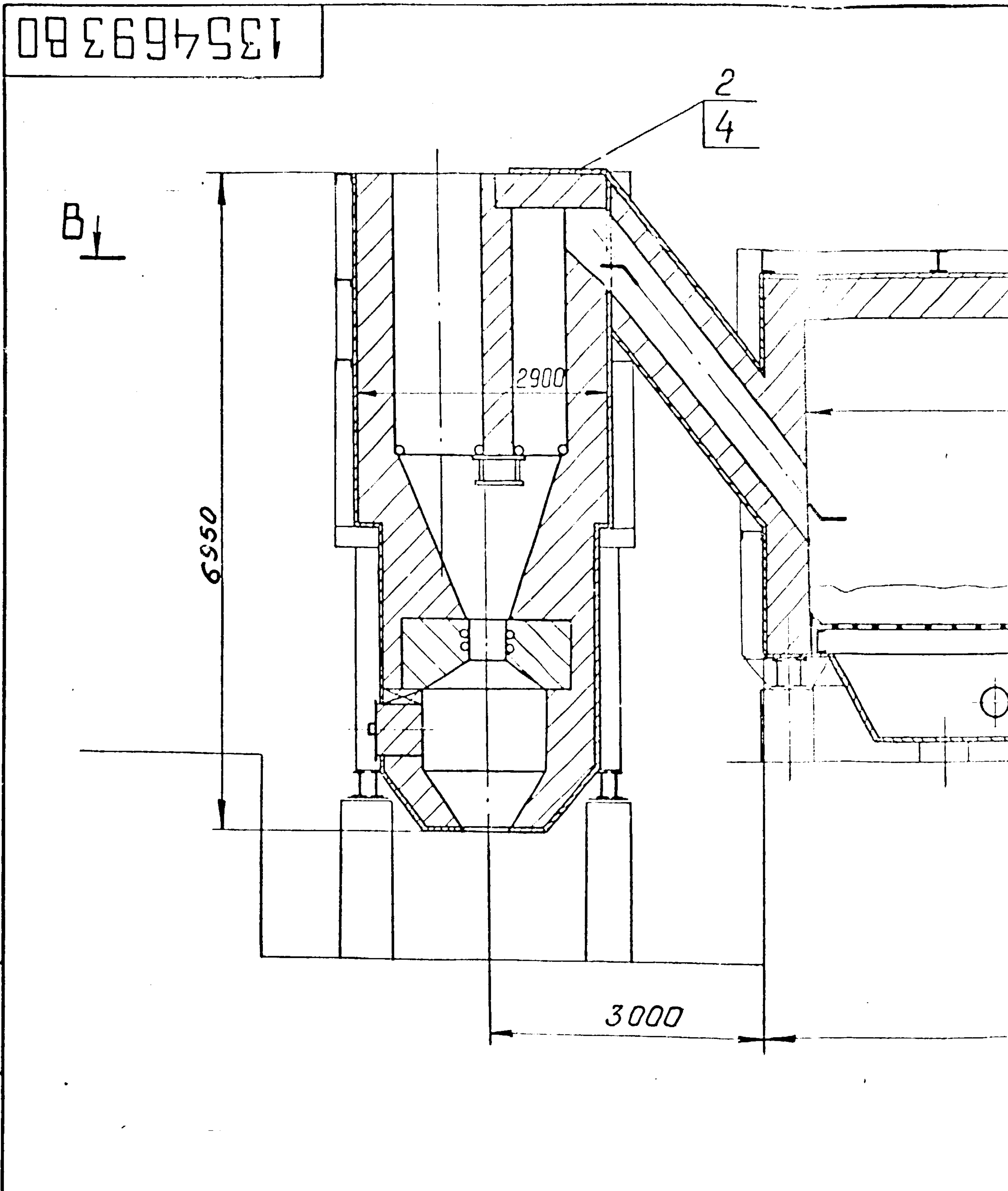
ВАМИ Л
VAMI L

| | |
|---|---|
| Масштаб SCALE 1:50 | Для Индии |
| Данный чертеж является собственностью института ВАМИ и не может быть скопирован и использован без его разрешения | FOR BHARAT |
| THIS DRAWING IS THE PROPERTY OF VAMI AND NOT TO BE COPIED OR USED WITHOUT OUR PERMISSION | Глиноземный Кальцинаци слоя с шамо KORBA ALUMI STAGE II FL GENE |
| | 13 |

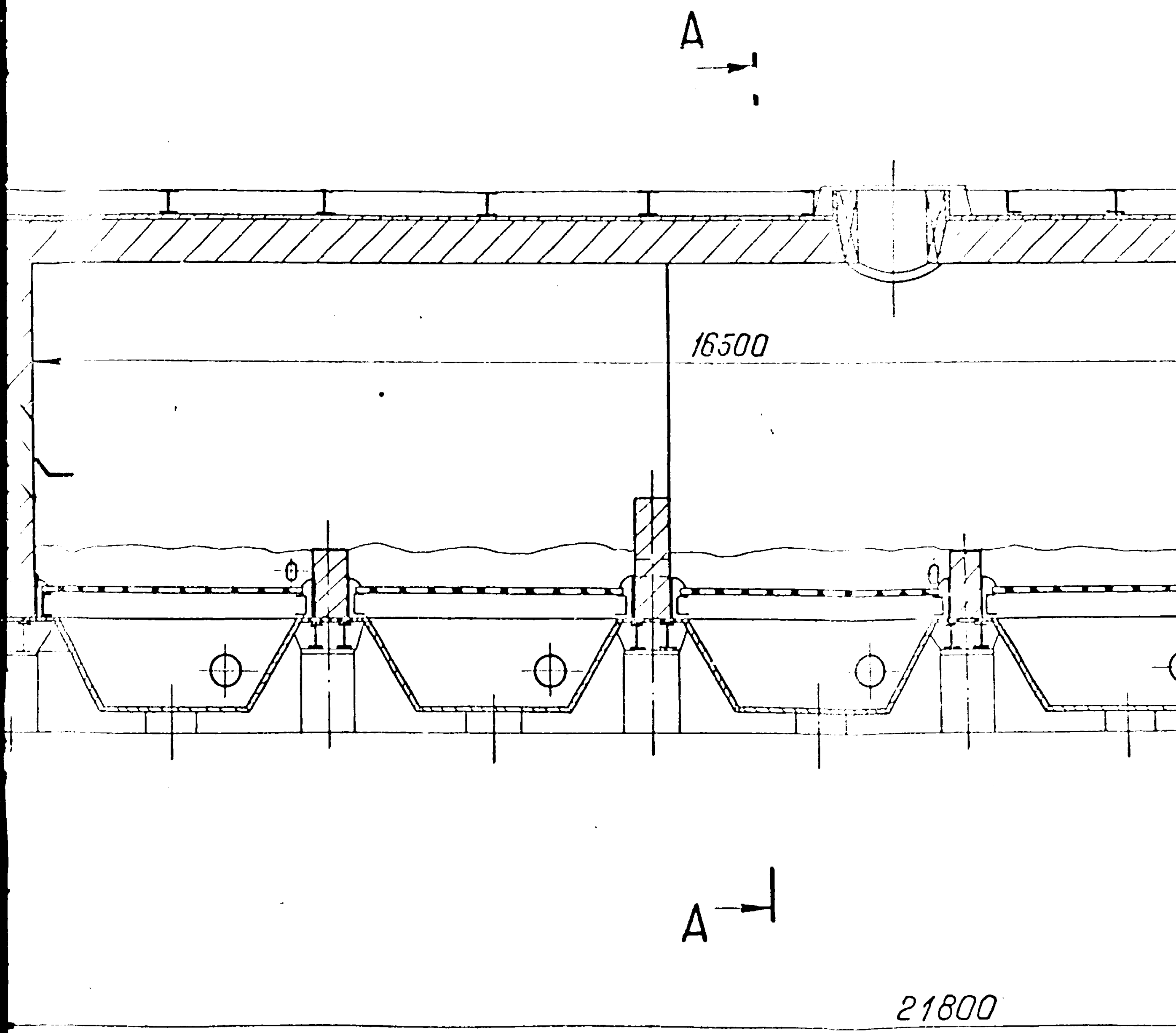



SECTION 5

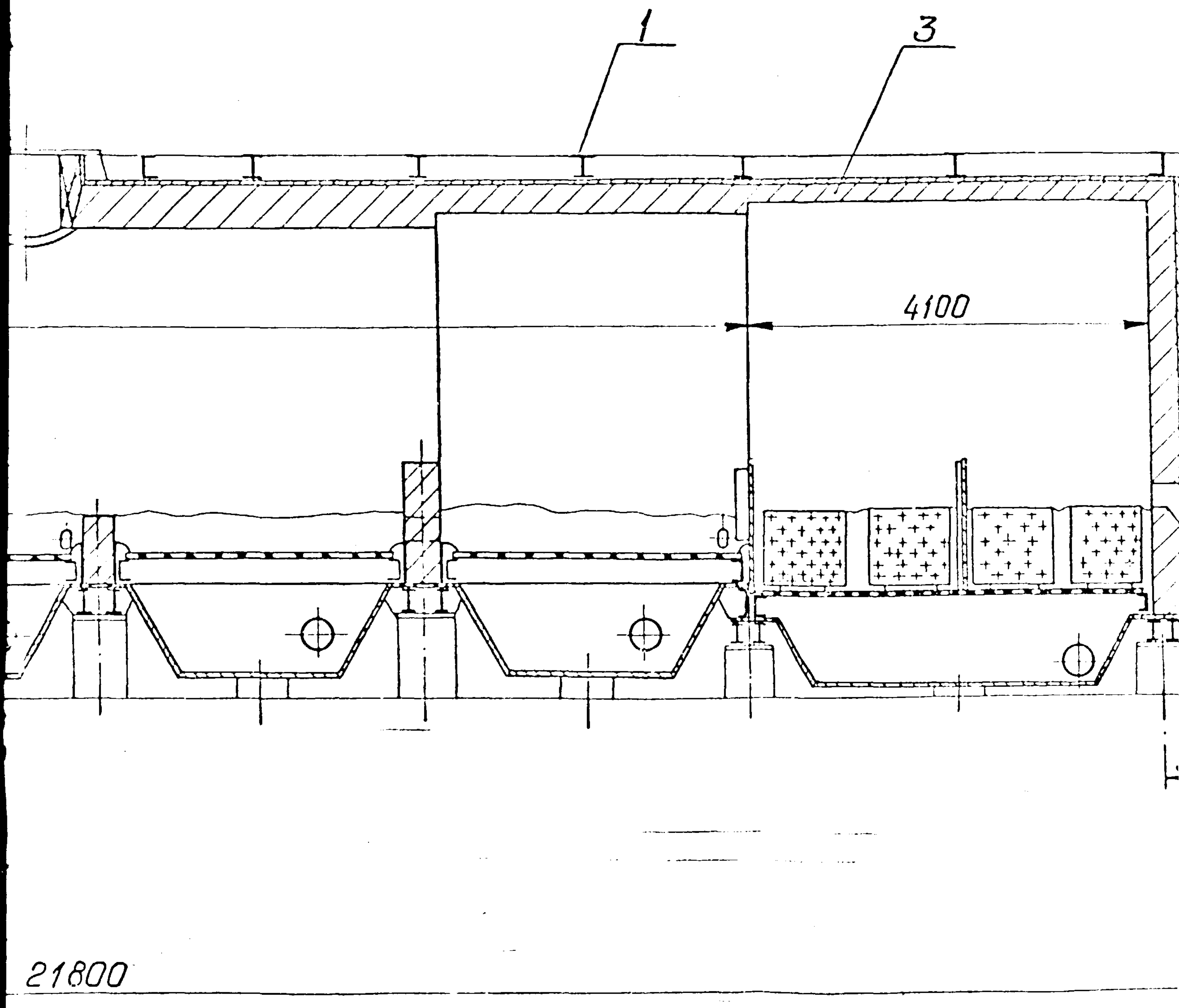
| | |
|---|---|
| ВАМИ ЛЕНИНГРАД<br>VAMI LENINGRAD | |
| Масштаб SCALE 1:50 | ДЛЯ ИНДИЙСКОЙ ФИРМЫ БХАРАТ АЛЮМИНИУМ КОМПАНИ<br>FOR BHARAT ALUMINIUM COMPANY LTD, INDIA. |
| Данный чертеж является собственностью института ВАМИ и не может быть скопирован и использован без его разрешения<br>THIS DRAWING IS THE PROPERTY OF VAMI AND NOT TO BE COPIED OR USED WITHOUT OUR PERMISSION | ГЛИНОЗЕМНЫЙ ЗАВОД В КОРБЕ. РЕКОНСТРУКЦИЯ ЦЕХА КАЛЬЦИНАЦИИ. II ЭТАП. ХОЛОДИЛЬНИК КИПЯЩЕГО СЛОЯ С ШАМОТООТДЕЛИТЕЛЕМ. ЧЕРТЕЖ ОБЩЕГО ВИДА. ПЛАН<br>KORBA ALUMINA PLANT. RECONSTRUCTION OF CALCINATION STAGE II FLUID BED COOLER WITH FIRECLAY SEPARATOR GENERAL VIEW DRAWING PLAN<br>1354693 BO — Лист SHEET 1 — Листов SHEETS 2 |




SECTION 1

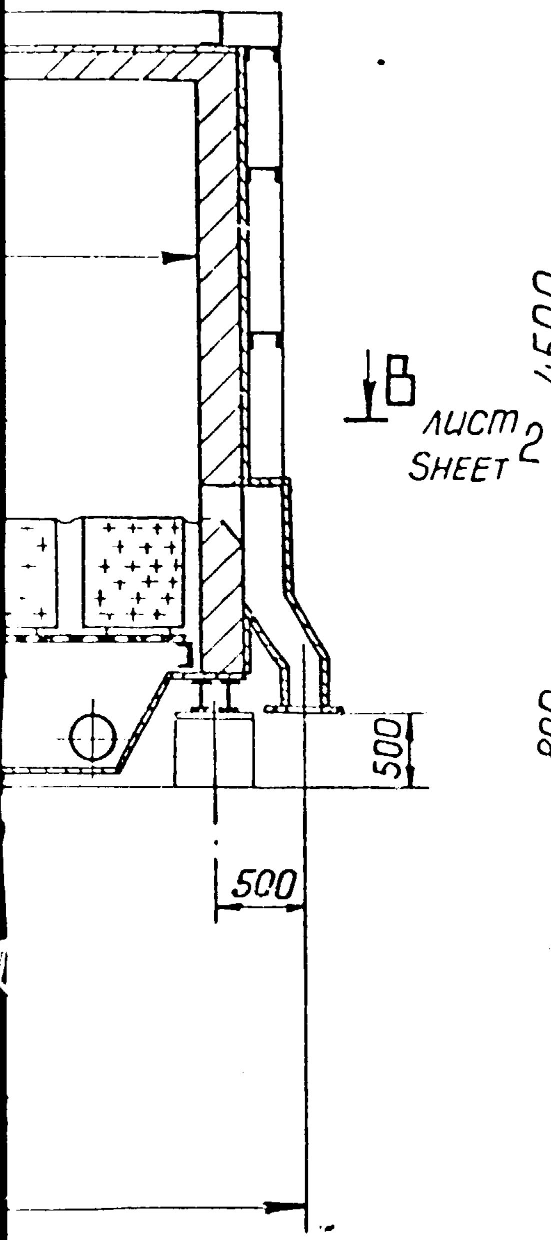


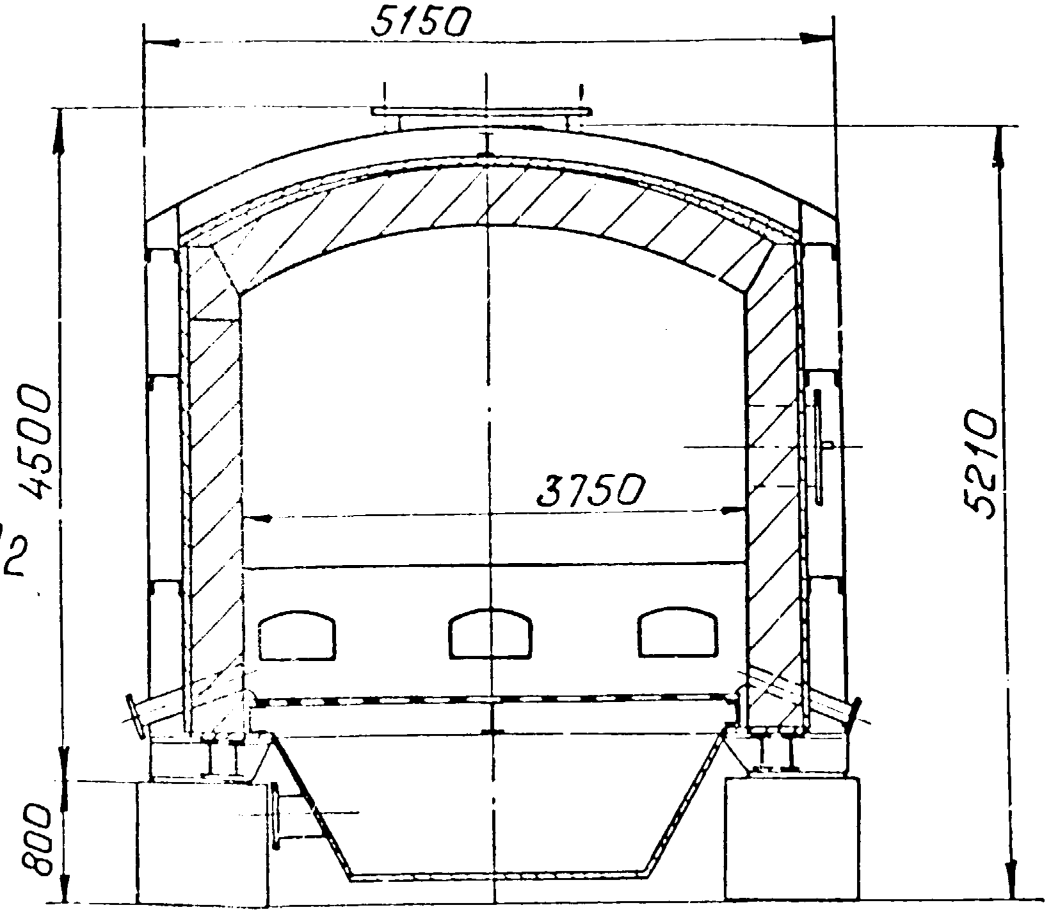

SECTION 2




SECTION 3

## A - A



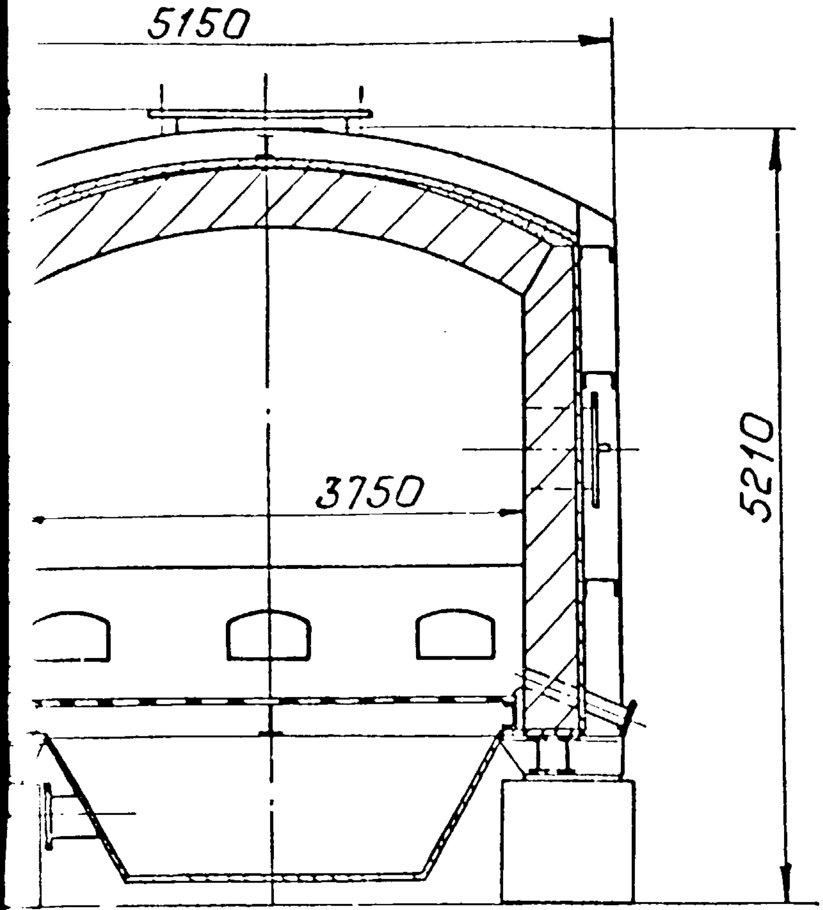




### Техническая характеристика
TECHNICAL DATA

| | |
|---|---|
| Производительность, т/ч<br>PRODUCTION, T/h | 20-21 |
| Расход воздуха на охлаждение, тысяч м³/ч<br>AIR CONSUMPTION FOR COOLING, 000 m³/h | 19-20 |
| Температура нагрева воздуха, °С<br>AIR HEATING TEMPERATURE | 450-550 |
| Площадь аппарата, м²<br>COOLER SURFACE, m² | 75 |
| Площадь теплообменной поверхности, м²<br>HEAT-EXCHANGE SURFACE, m² | 63 |

SECTION 4

## A - A




| N° позиции<br>Item No | Обозначение<br>Designation | Наименов-<br>Nam |
|---|---|---|
| 1 | —— | Корпус хол- ника „КС<br>FLUID BED CASE |
| 2 | —— | Корпус шамотоотд-<br>FIRECLAY SEPA- |
| 3 | —— | Футеров- холодильн-<br>COOLER LIN- |
| 4 | —— | Футеров- шамотоот-<br>FIRECLAY SE- LINING |

## Техническая характеристика

TECHNICAL DATA

| | |
|---|---|
| -ительность, т/ч<br>-TION, T/h | 20-21 |
| -здуха на охлаждение, тысяч м³/ч<br>-PTION FOR COOLING, 000 m³/h | 19-20 |
| -ра нагрева воздуха, °C<br>-NG TEMPERATURE | 450-550 |
| -аппарата, м²<br>SURFACE, m² | 75 |
| -теплообменной поверхности, м²<br>-CHANGE SURFACE, m² | 63 |

SECTION 5

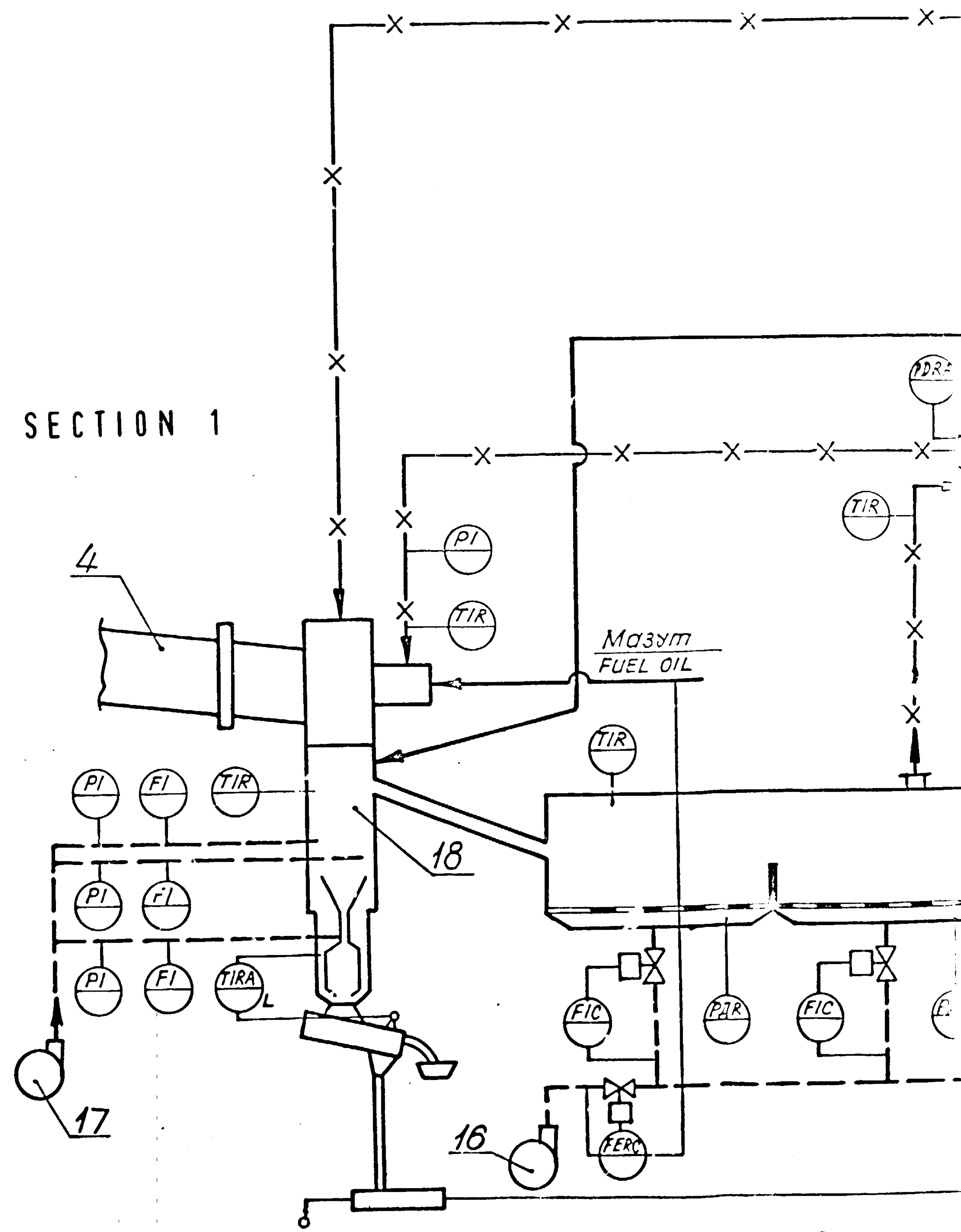
| | |
|---|---|
| | В-<br>VA- |
| Масштаб 1:50<br>SCALE | Для-<br>FOR - |
| Данный чертеж является собственностью института ВАМИ и не может быть скопирован и использован без его разрешения<br>THIS DRAWING IS THE PROPERTY OF VAMI AND NOT TO BE COPIED OR USED WITHOUT OUR PERMISSION | Глин- калн- слои- кипя- STAG- SEE - |

| № позиции Item No | Обозначение Designation | Наименование Name | Количество Quantity | Материал Material | Масса, кг Mass, kg 1 шт. Of one piece | Масса, кг Mass, kg Общ. Total | Примечание Remark |
|---|---|---|---|---|---|---|---|
| 1 | — | Корпус холодильника „КС" / FLUID BED COOLER CASE | 1 | Сталь / STEEL | — | 80000 | |
| 2 | — | Корпус шамотоотделителя / FIRECLAY SEPARATOR CASE | 1 | Сталь / STEEL | — | 10000 | |
| 3 | — | Футеровка холодильника / COOLER LINING | 1 | Шамот / FIREBRICK | — | 200000 | |
| 4 | — | Футеровка шамотоотделителя / FIRECLAY SEPARATOR LINING | 1 | Шамот / FIREBRICK | — | 70000 | |

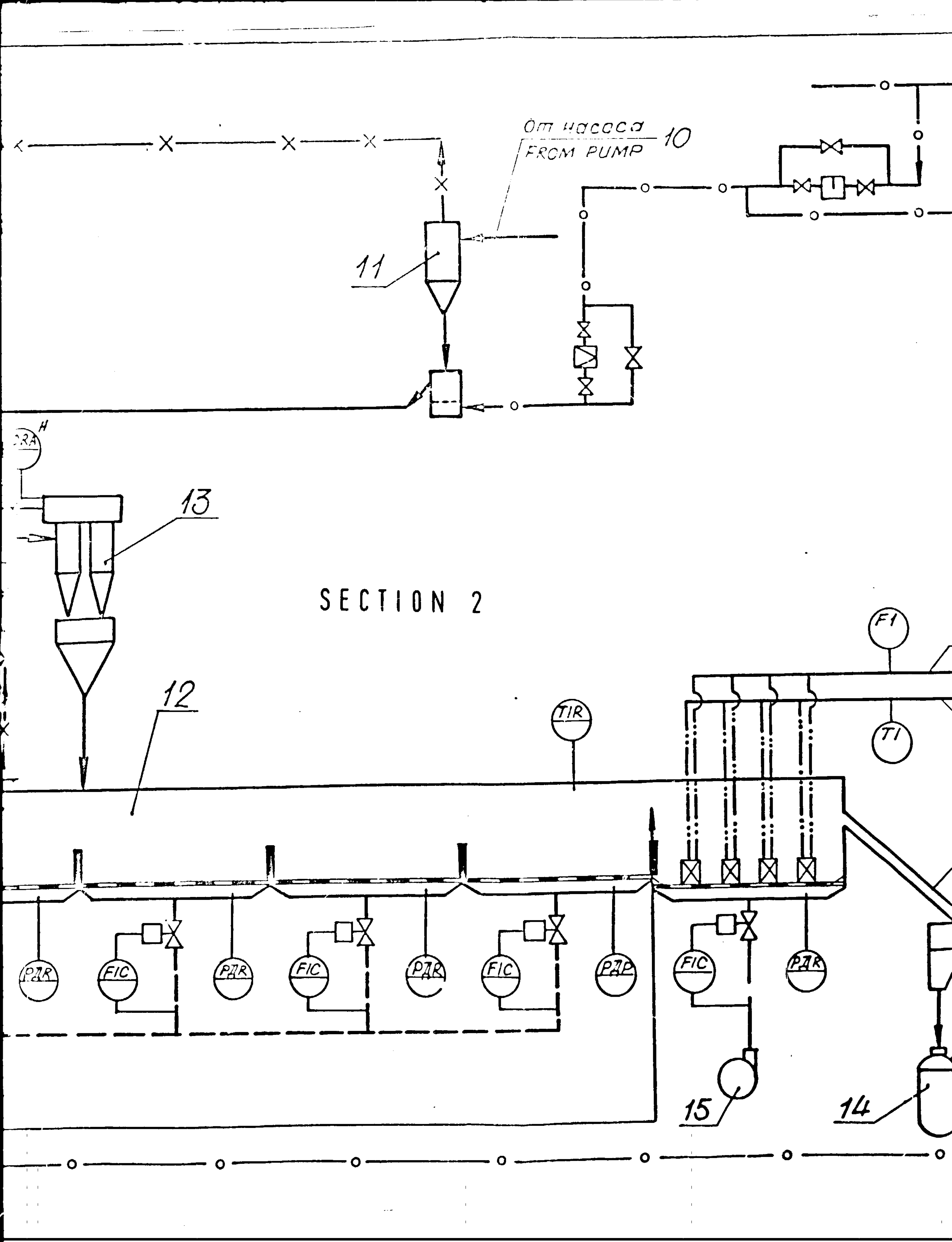
# SECTION 6

| | |
|---|---|
| ВАМИ ЛЕНИНГРАД<br>VAMI LENINGRAD | |
| Масштаб SCALE 1:50 | ДЛЯ ИНДИЙСКОЙ ФИРМЫ БХАРАТ АЛЮМИНИУМ КОМПАНИ<br>FOR BHARAT ALUMINIUM COMPANY LTD, INDIA |
| Данный чертеж является собственностью института ВАМИ и не может быть скопирован и использован без его разрешения<br>THIS DRAWING IS THE PROPERTY OF VAMI AND NOT TO BE COPIED OR USED WITHOUT OUR PERMISSION | ГЛИНОЗЕМНЫЙ ЗАВОД В КОРБЕ. РЕКОНСТРУКЦИЯ ЦЕХА КАЛЬЦИНАЦИИ. II ЭТАП. ХОЛОДИЛЬНИК КИПЯЩЕГО СЛОЯ С ШАМОТООТДЕЛИТЕЛЕМ. ЧЕРТЕЖ ОБЩЕГО ВИДА. РАЗРЕЗЫ<br>KORBA ALUMINA PLANT RECONSTRUCTION OF CALCINATION. STAGE II. FLUID BED COOLER WITH FIRECLAY SEPARATOR. GENERAL VIEW DRAWING. SECTIONS |
| | 1354693 ВО — Лист / Sheet 2 — Листов / Sheets 2 |

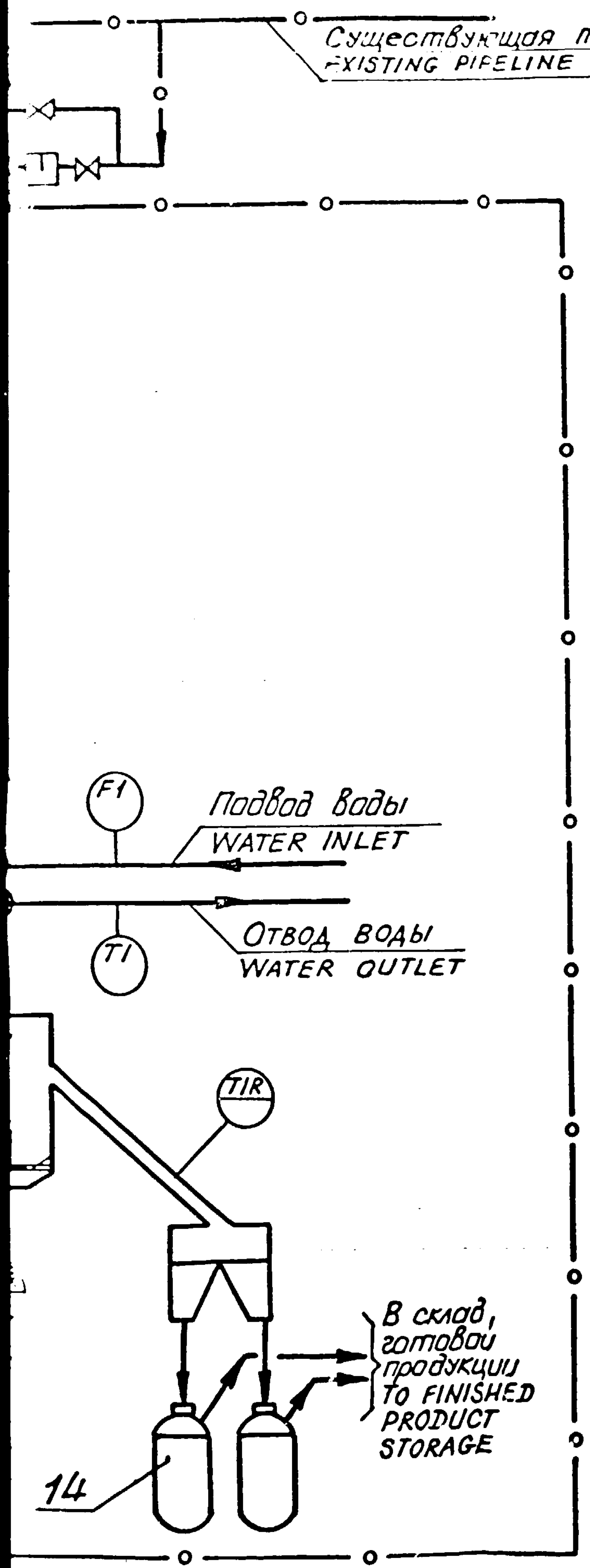
## SECTION 1




Инв № подл. | Подп. и дата | Взам. инв. №



От насоса
FROM PUMP
10
11
13
12
14
15
SECTION 2
TIR
FI
TI
FIC
FIC
FIC
FIC
PДR
PДR
PДR
PДP
PДR




SECTION 3

## Условные обозначения
## LEGEND

Материал / MATERIAL

Отходящие газы / FLUE GASES

Сжатый воздух / COMPRESSED AIR

Воздух / AIR

1. Схема в...
2. Количес... дано н...
3. Условные... автомат...

1. THE FLO...
2. THE NU... GIVEN ...
3. THE S... DEVICE...

Масштаб
SCALE

Данный черте... собственность... ВАМИ и немо... скопирован и и... без его разре...

THIS DRAWING IS ... OF VAMI AND ... COPIED OR USED ... OUR PERMISSIO...

…ВНЫЕ ОБОЗНАЧЕНИЯ
LEGEND

Материал
MATERIAL

—x— Отходящие газы
FLUE GASES

—o— Сжатый воздух
COMPRESSED AIR

— — Воздух
AIR

| | | |
|---|---|---|
| Контуры контроля | MONITORING CIRCUIT | 23 |
| Контуры регулирования | CONTROL CIRCUIT | 7 |

1. Схема выполнена на основании чертежа 1354691-ТМ.СХ
2. Количество точек контроля и регулирования дано на одну установку.
3. Условные обозначения приборов и средств автоматизации даны на чертеже 1355573-КА

1. THE FLOWSHEET IS BASED ON DWG. 1354691-TM.CX.
2. THE NUMBER OF CONTROL AND MONITORING POINTS IS GIVEN PER ONE UNIT.
3. THE SYMBOLS OF INSTRUMENTS AND AUTOMATION DEVICES ARE GIVEN ON DWG. 1355573-KA

SECTION 4

ВАМИ Ленинград
VAMI LENINGRAD

Масштаб
SCALE —

ДЛЯ ИНДИЙСКОЙ ФИРМЫ БХАРАТ АЛЮМИНИУМ КОМПАНИ.
FOR BHARAT ALUMINIUM COMPANY LTD, INDIA

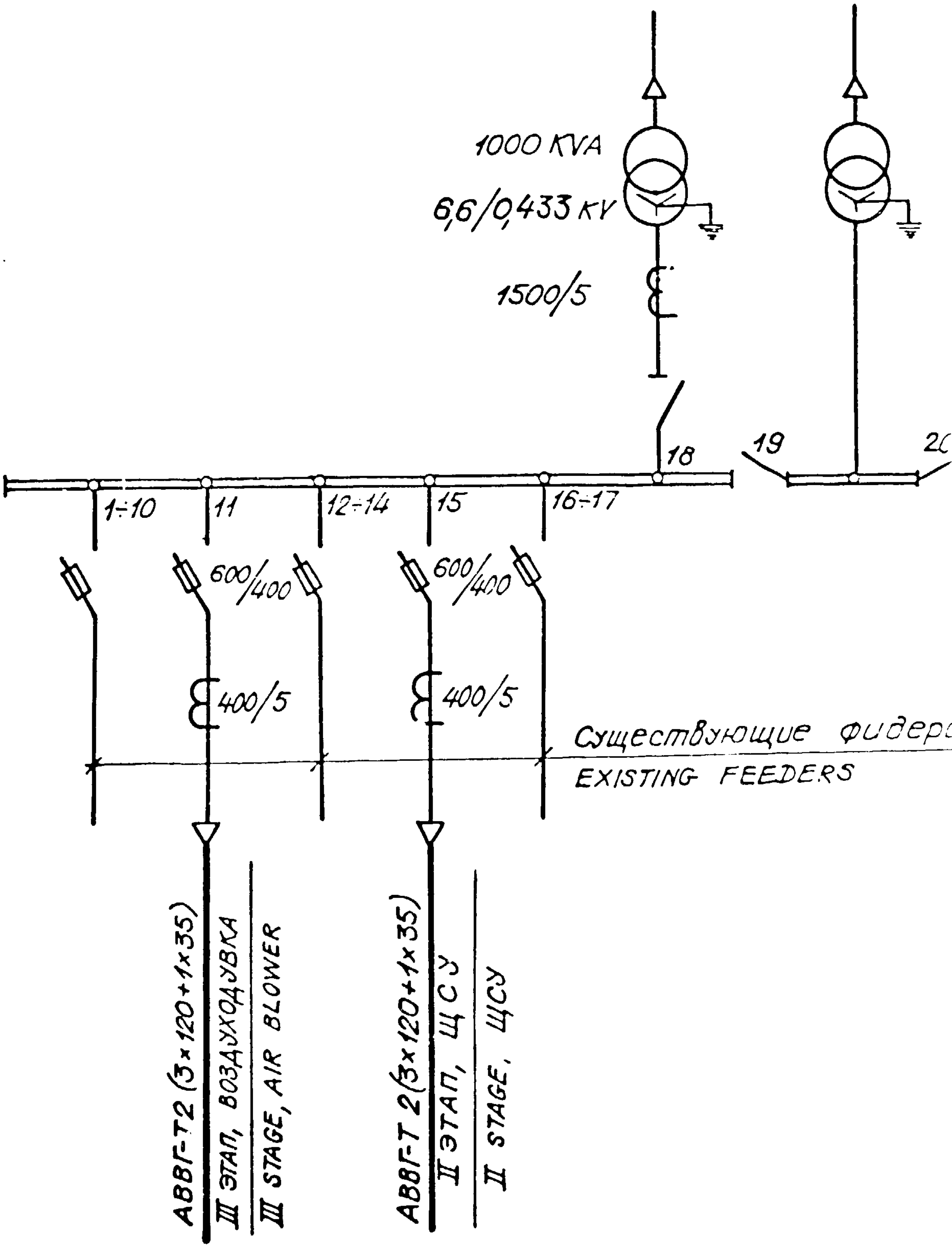


ГЛИНОЗЕМНЫЙ ЗАВОД В КОРБЕ. РЕКОНСТРУКЦИЯ ЦЕХА КАЛЬЦИНАЦИИ. II ЭТАП. СХЕМА АППАРАТУРНО-ТЕХНОЛОГИЧЕСКАЯ С ТОЧКАМИ КОНТРОЛЯ И РЕГУЛИРОВАНИЯ.
KORBA ALUMINA PLANT. RECONSTRUCTION OF CALCINATION. II STAGE. EQUIPMENT AND PROCESS FLOWSHEET WITH MONITORING AND CONTROL POINTS

1355575 - KA

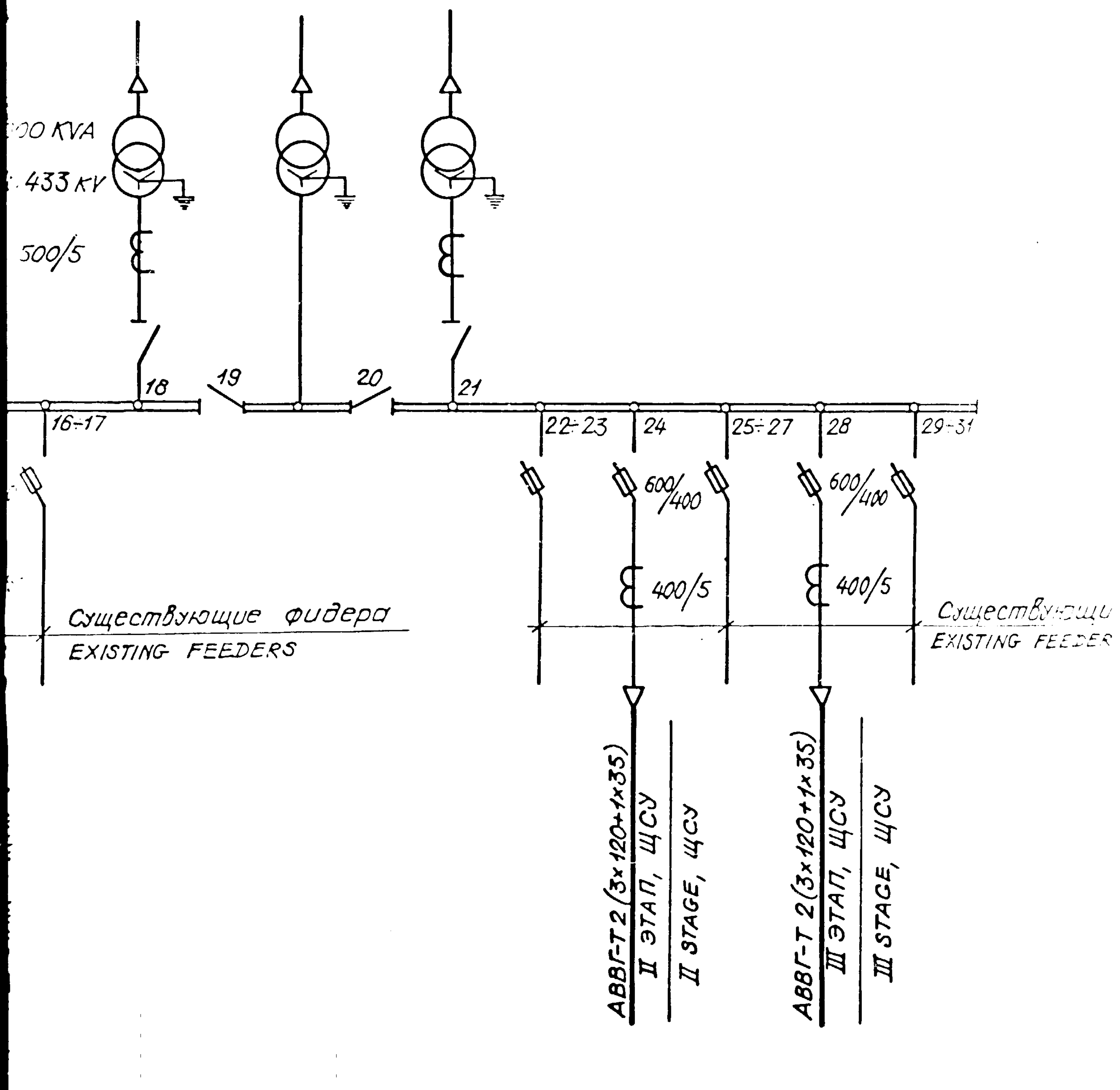
Лист
SHEET

Листов
SHEETS 1




SECTION 1

| Инв. № подл. | Подп. и дата | Взам. инв. № |
|---|---|---|
| | | |


00 KVA
433 KV
500/5
18
19
20
21
16÷17
22÷23
24
25÷27
28
29÷31
600/400
400/5
Существующие фидера
EXISTING FEEDERS
EXISTING FEEDER
АВВГ-Т 2 (3×120+1×35)
II ЭТАП, ЩСУ
II STAGE, ЩСУ
III ЭТАП, ЩСУ
III STAGE, ЩСУ

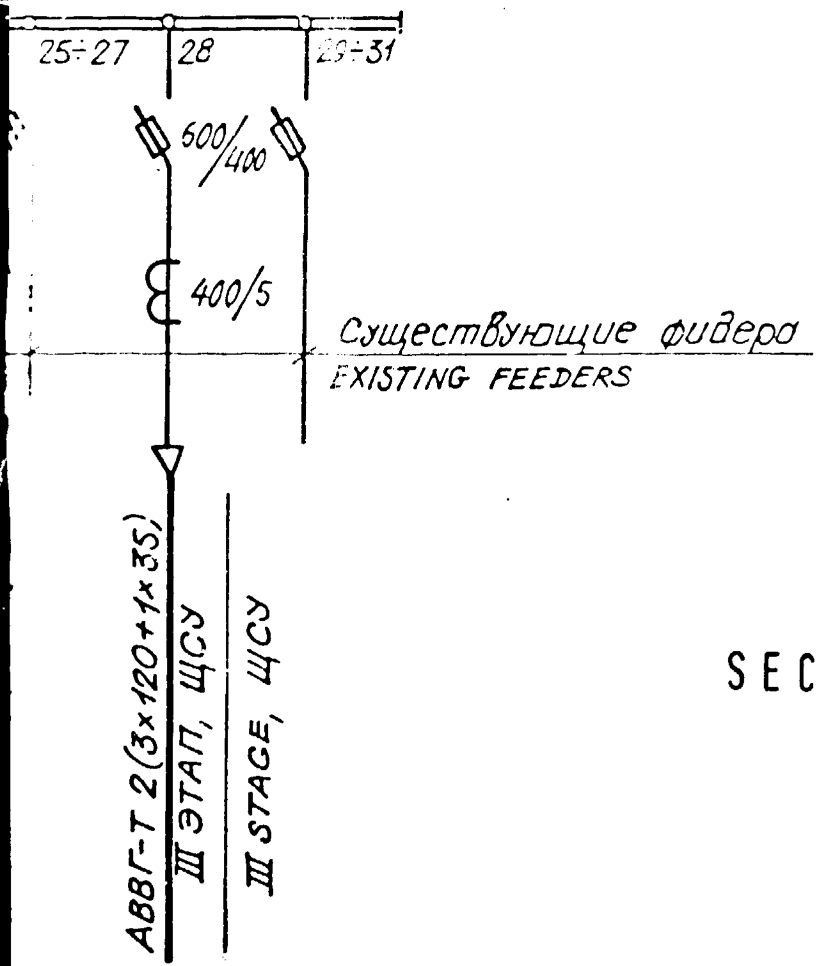
SECTION 2

Условные обозначе

LEGEND

ЩСУ – Щит станции упр

CONTROL STATION BOAR




SECTION 3

| | |
|---|---|
| | ВАМИ Ленинград<br>VAMI LENINGRAD |
| Масштаб<br>SCALE | Для Индийской фирм<br>Компан |
| Данный чертеж является собственностью института ВАМИ и не может быть скопирован и использован без его разрешения<br><br>THIS DRAWING IS THE PROPERTY OF VAMI AND NOT TO BE COPIED OR USED WITHOUT OUR PERMISSION | FOR BHARAT ALUMINIUM<br><br>Глиноземный завод в Ко<br>кальцинации. ТП-5 Доос<br>низкого напряжения II<br>KORBA ALUMINA PLANT. RE<br>TS-5 ADDITIONAL EQUIPMEN<br>II AND<br><br>19474.2 |

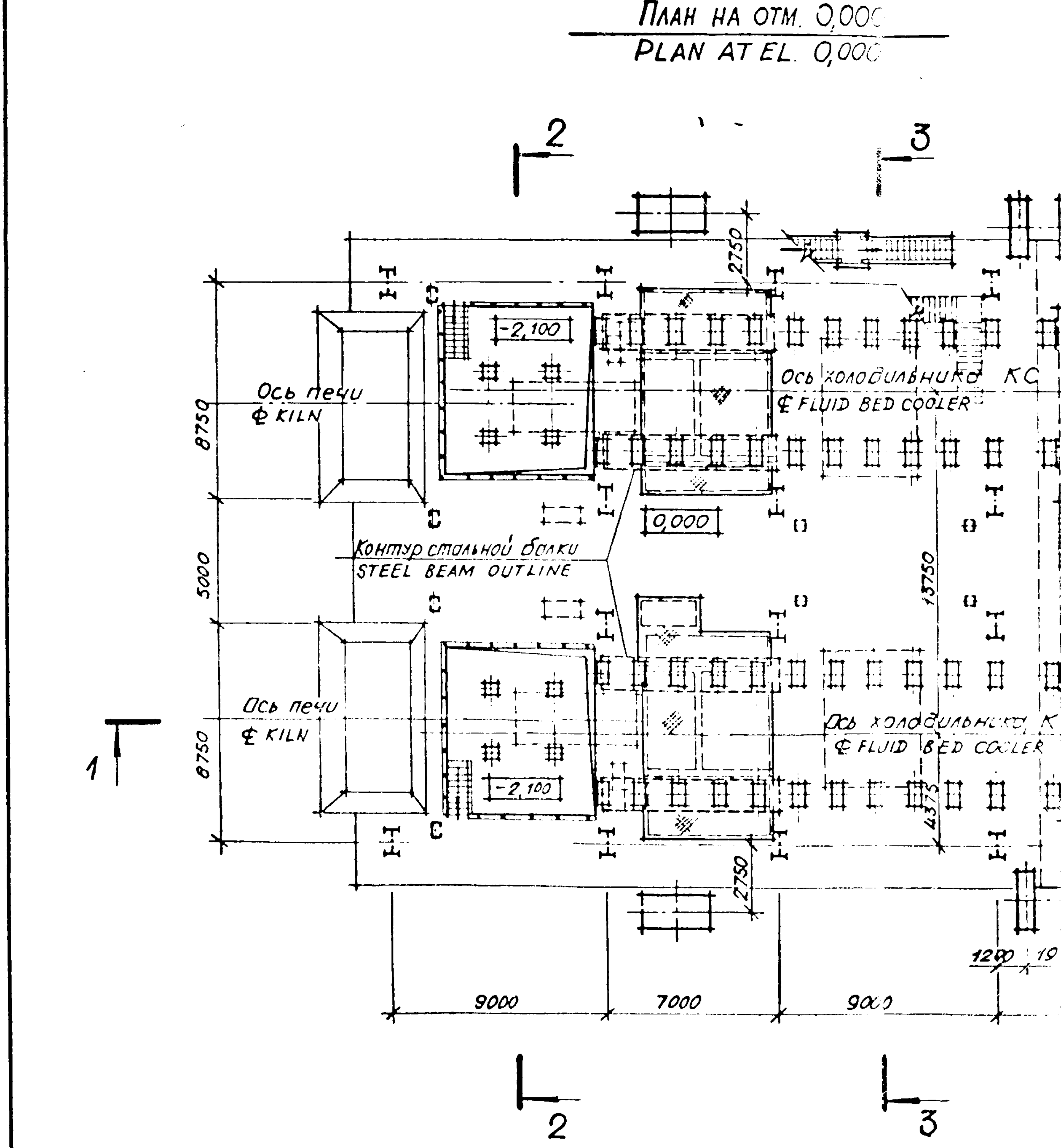
## Условные обозначения:
## LEGEND

ЩСУ – Щит станции управления
CONTROL STATION BOARD

ɪ: фидера
s

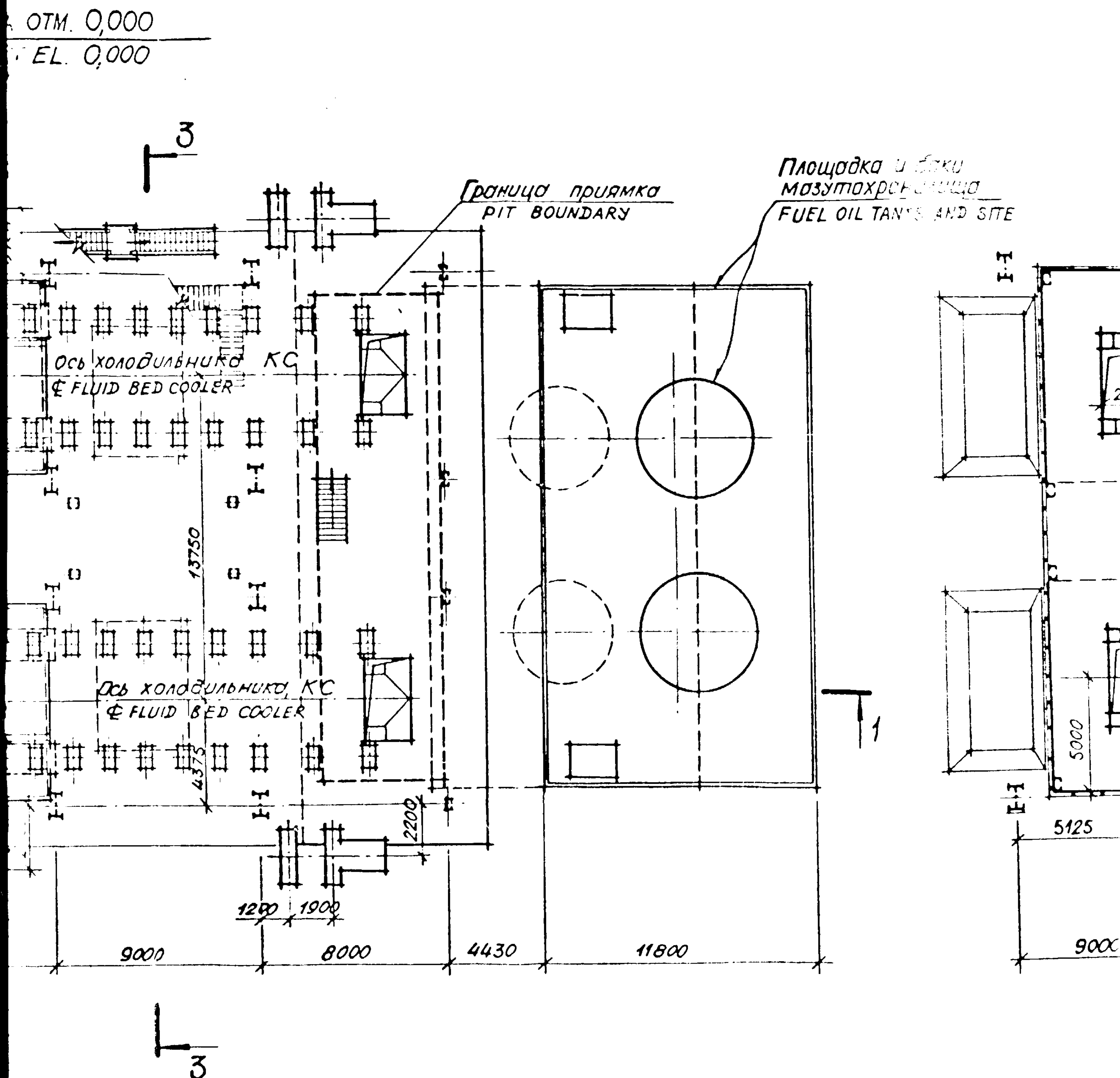
SECTION 4

| | | | |
|---|---|---|---|
| ВАМИ Ленинград<br>VAMI LENINGRAD | | | |
| Масштаб<br>SCALE | Для индийской фирмы Бхарат Алюминиум Компани.<br>FOR BHARAT ALUMINIUM COMPANY LTD, INDIA | | |
| Данный чертеж является собственностью института ВАМИ и не может быть скопирован и использован без его разрешения<br>THIS DRAWING IS THE PROPERTY OF VAMI AND NOT TO BE COPIED OR USED WITHOUT OUR PERMISSION | Глиноземный завод в Корбе. Реконструкция цеха кальцинации. ТП-5 Дооборудование. Схема щита низкого напряжения. II и III этапы.<br>KORBA ALUMINA PLANT. RECONSTRUCTION OF CALCINATION TS-5 ADDITIONAL EQUIPMENT. LOW VOLTAGE PANEL DIAGRAM II AND III STAGE | | |
| | 1947412-ЭС | Лист<br>SHEET | Листов 1<br>SHEETS |



План на отм. 0,000
Plan at el. 0,000
2
3
2750
-2,100
Ось печи
℄ KILN
Ось холодильника КС
℄ FLUID BED COOLER
8750
5000
8750
0,000
Контур стальной балки
STEEL BEAM OUTLINE
13750
4375
1
-2,100
2750
1290
9000
7000
9000
2
3

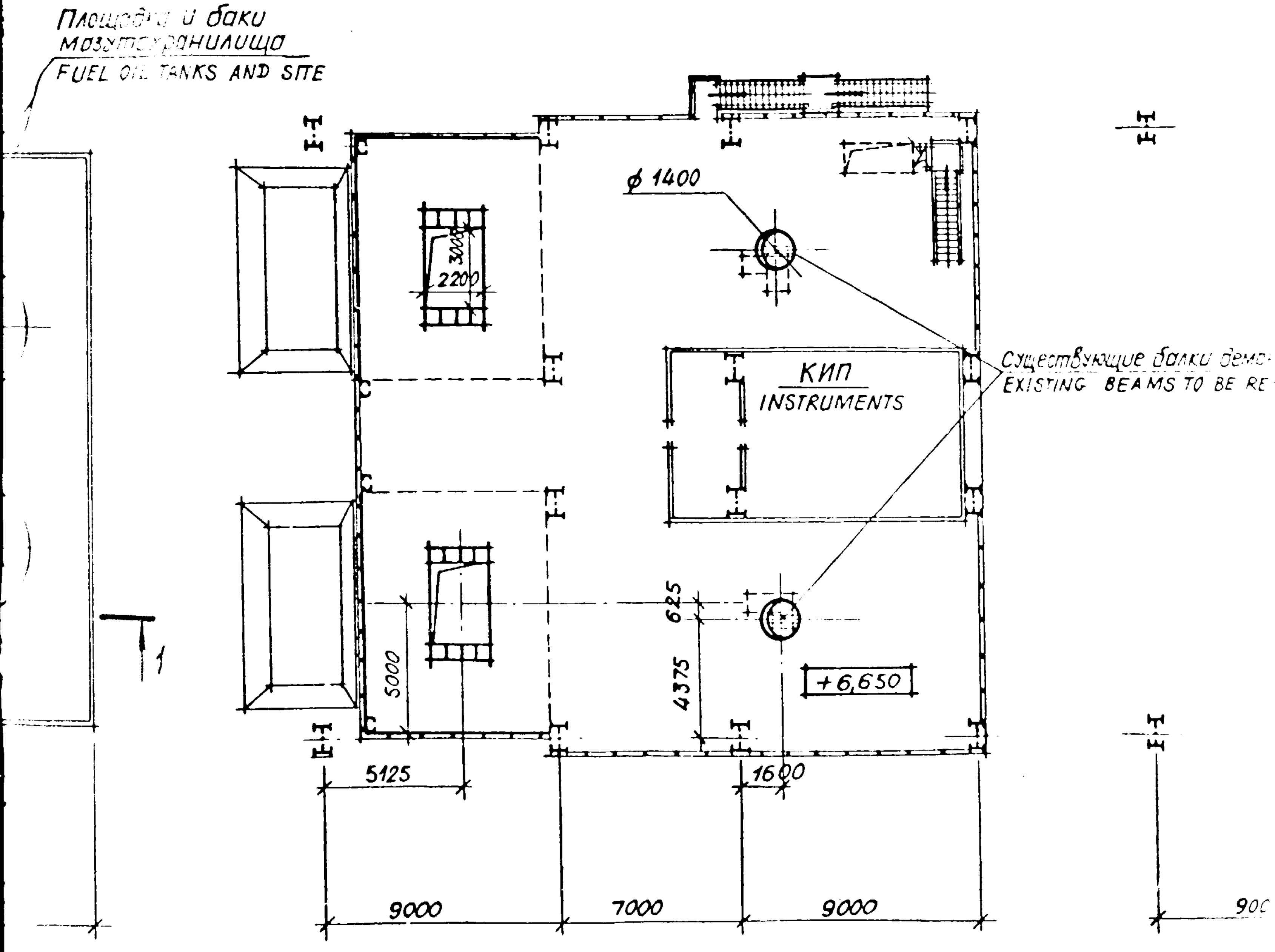

SECTION 1



ОТМ. 0,000
EL. 0,000
3
Граница приямка
PIT BOUNDARY
Площадка и
Мазутохр
FUEL OIL TAN
SITE
Ось холодильника КС
℄ FLUID BED COOLER
Ось холодильника КС
℄ FLUID BED COOLER
13750
4375
2200
1290
1900
9000
8000
4430
11800
1
5000
5125
3


SECTION 2

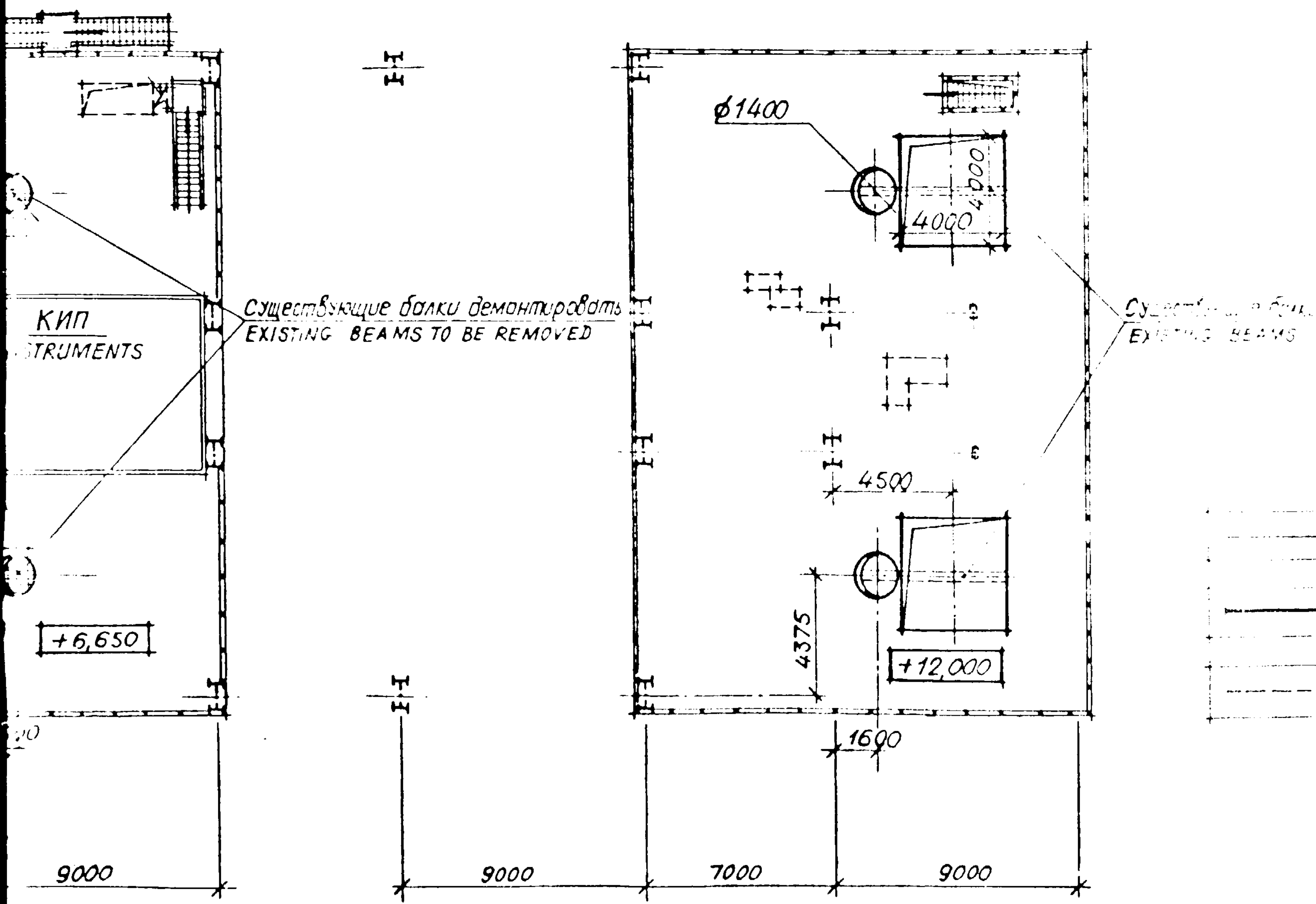
## ПЛАН НА ОТМ. 6,650
## PLAN AT EL. 6,650




SECTION 3

:50
50

## ПЛАН НА ОТМ. 12 000
## PLAN AT EL 12.000



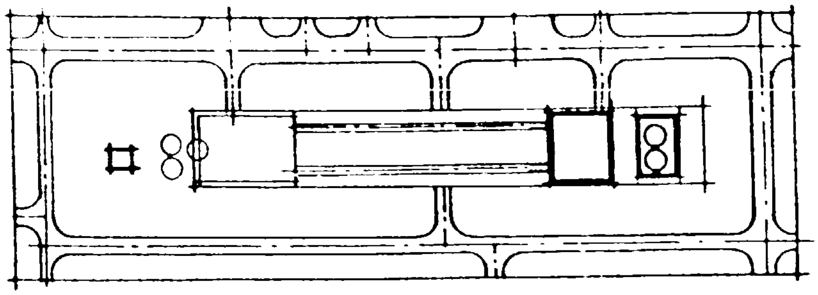

SECTION 4

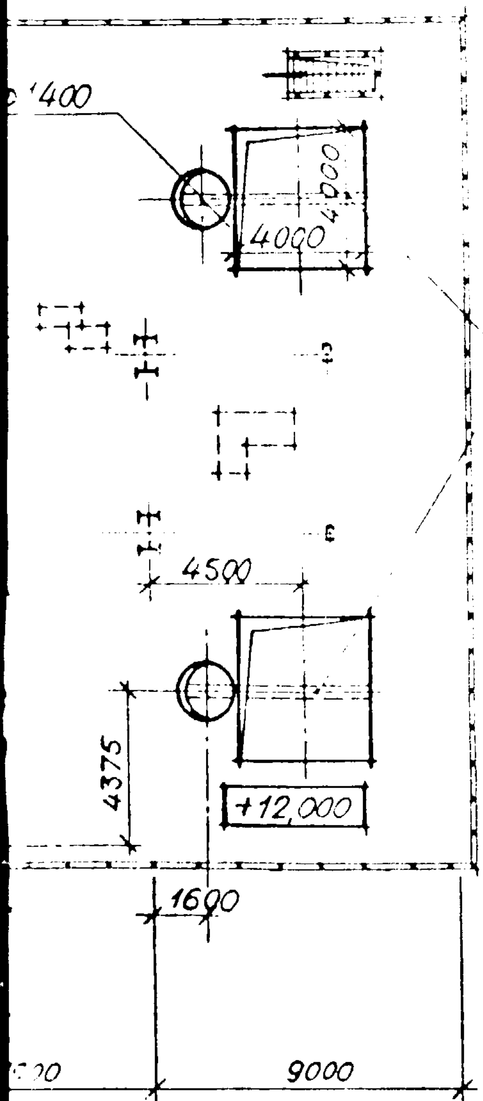
Масштаб
SCALE 1:

Данный чертеж
собственностью
ВАМИ и не мож
скопирован и ис
без его разреш

THIS DRAWING IS THE PROPERTY
OF VAMI AND
COPIED OR USED
OUR PERMISSIO

… HA OTM. 12 000
… AT EL. 12.000






Существующие балки демонтировать
EXISTING BEAMS TO BE REMOVED

## УСЛОВНЫЕ ОБОЗНАЧЕНИЯ
## LEGEND

Существующие конструкции
EXISTING STRUCTURES

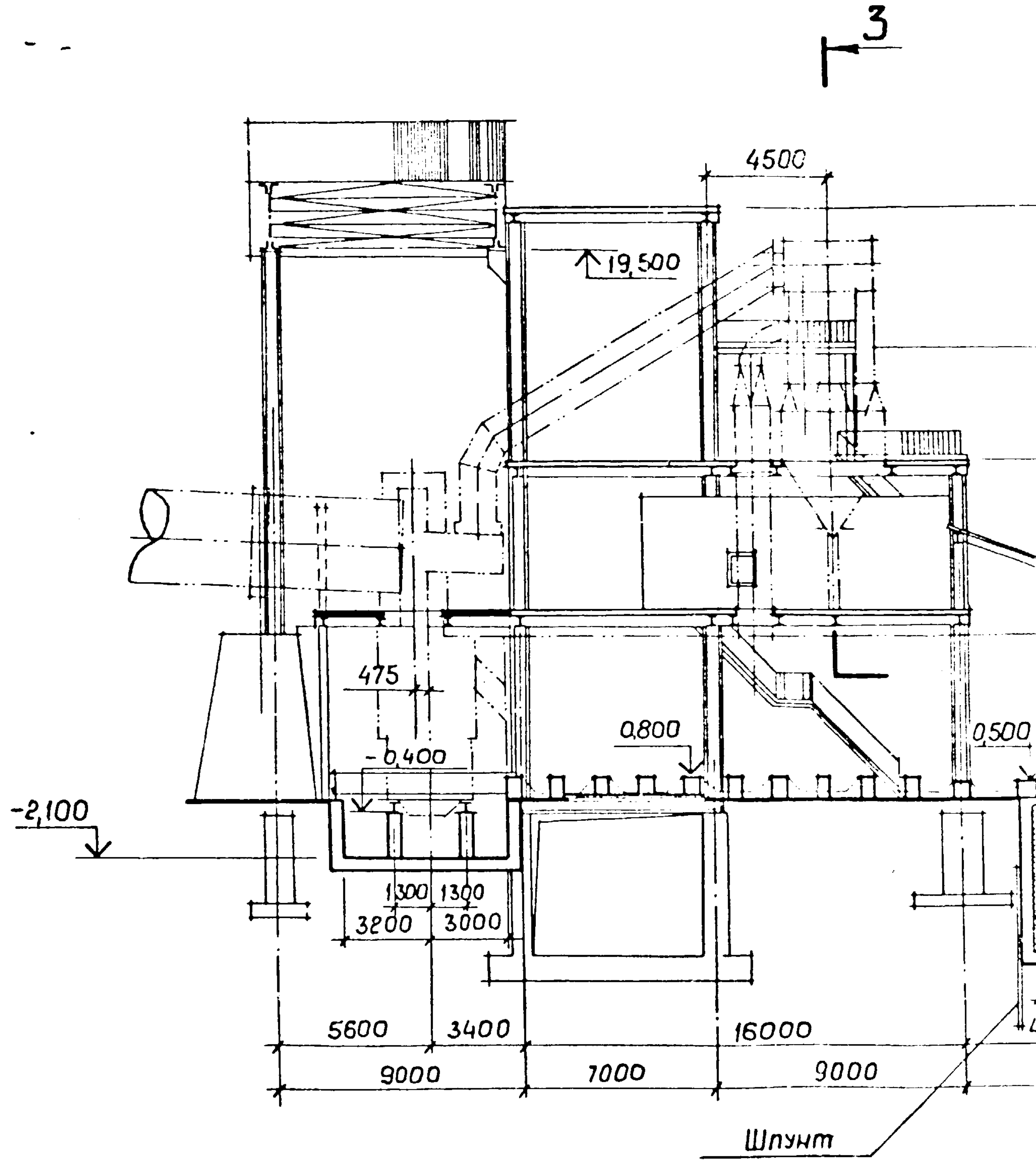
Новые конструкции и отверстия
NEW STRUCTURES AND OPENINGS

Разбираемые конструкции
STRUCTURES TO BE REMOVED

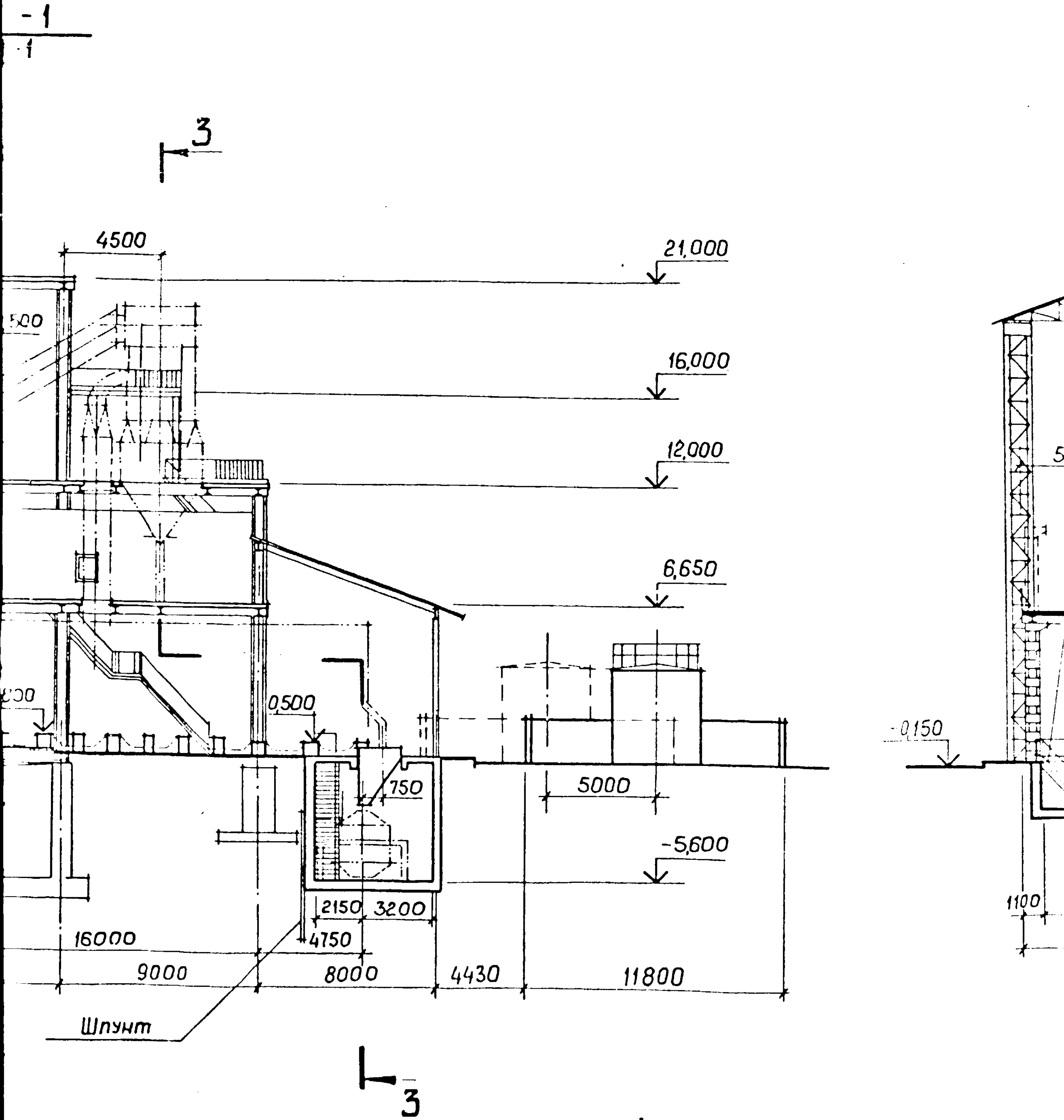
# SECTION 5

| | |
|---|---|
| ВАМИ Ленинград<br>VAMI LENINGRAD | |
| Масштаб<br>SCALE 1:200 | ДЛЯ ИНДИЙСКОЙ ФИРМЫ БХАРАТ АЛЮМИНИУМ КОМПАНИ,<br>FOR BHARAT ALUMINIUM COMPANY LTD., INDIA |
| Данный чертеж является собственностью института ВАМИ и не может быть скопирован и использован без его разрешения<br>THIS DRAWING IS THE PROPERTY OF VAMI AND NOT TO BE COPIED OR USED WITHOUT OUR PERMISSION | ГЛИНОЗЕМНЫЙ ЗАВОД В КОРБЕ. РЕКОНСТРУКЦИЯ ЦЕХА КАЛЬЦИНАЦИИ. II ЭТАП. ПЛАНЫ НА ОТМ. 0,000; 6,650; 12,000<br>KORBA ALUMINA PLANT. RECONSTRUCTION OF CALCINATION STAGE II. PLANS AT EL. 0,000; 6,650; 12,000 |
| | 1332928-AC — Лист / SHEET 1 — Листов / SHEETS 2 |

## Разрез 1-1
## SECTION 1-1



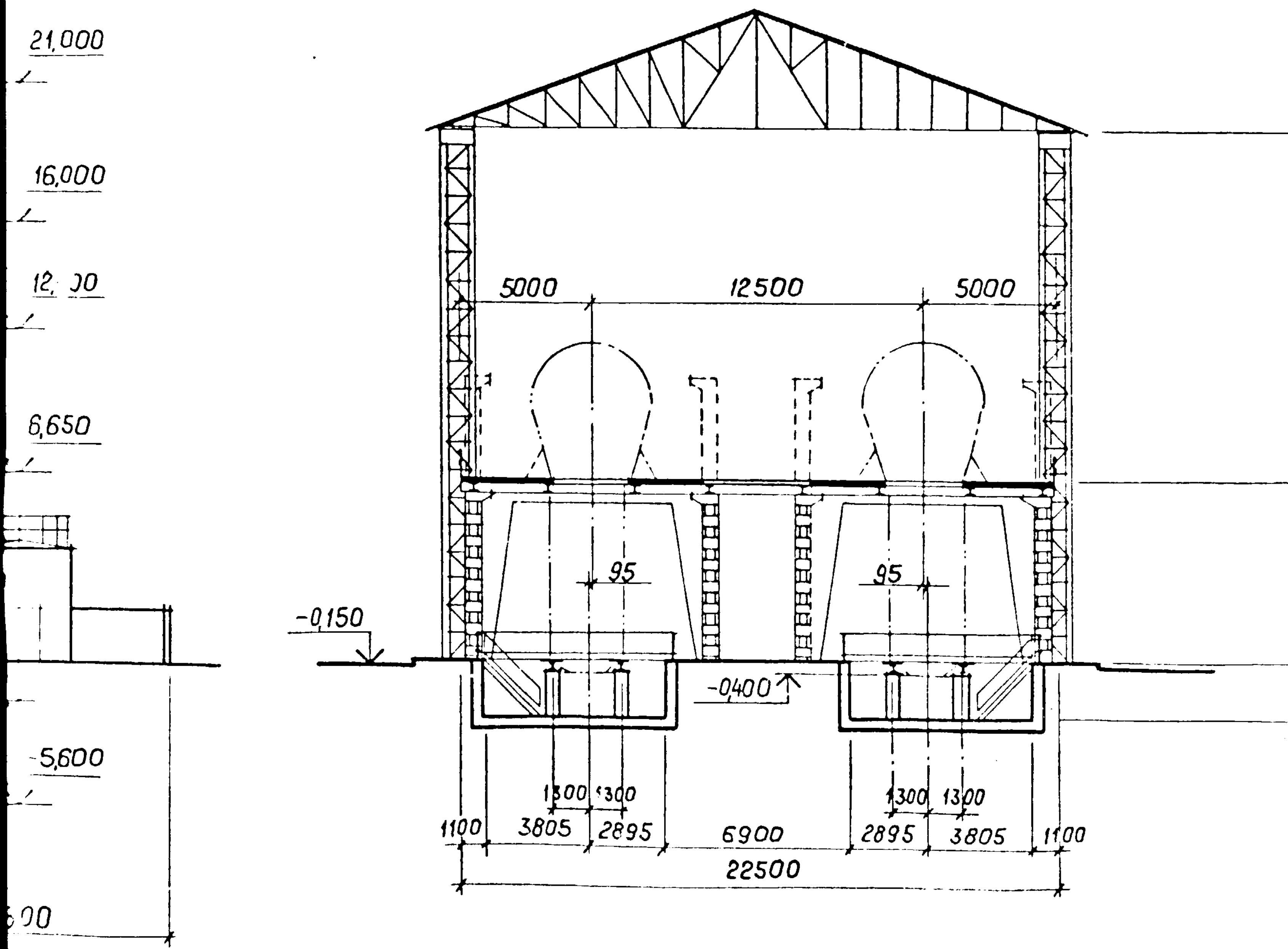

SECTION 1



3
4500
21,000
16,000
12,000
6,650
0,500
-0,150
750
5000
-5,600
2150
3200
4750
16000
9000
8000
4430
11800
1100
Шпунт
3


SECTION 2

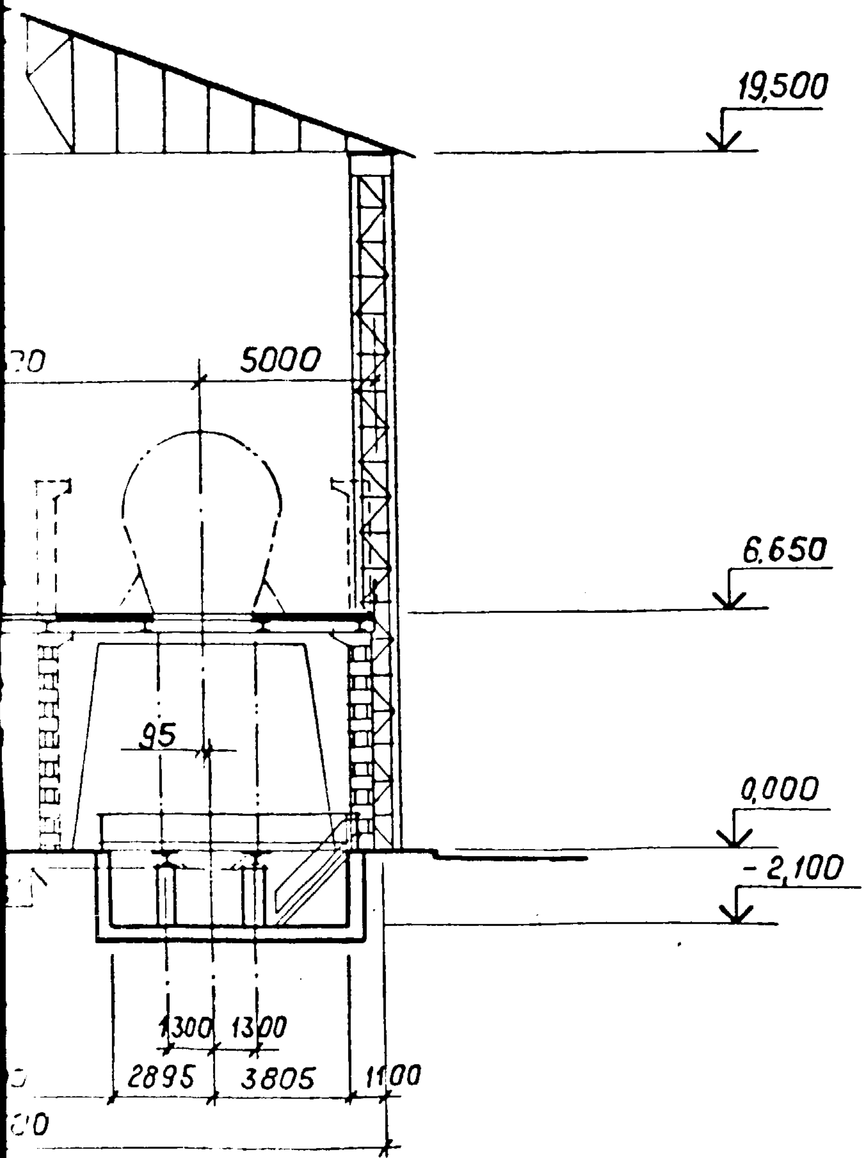
## Разрез 2-2
## SECTION 2-2




SECTION 3

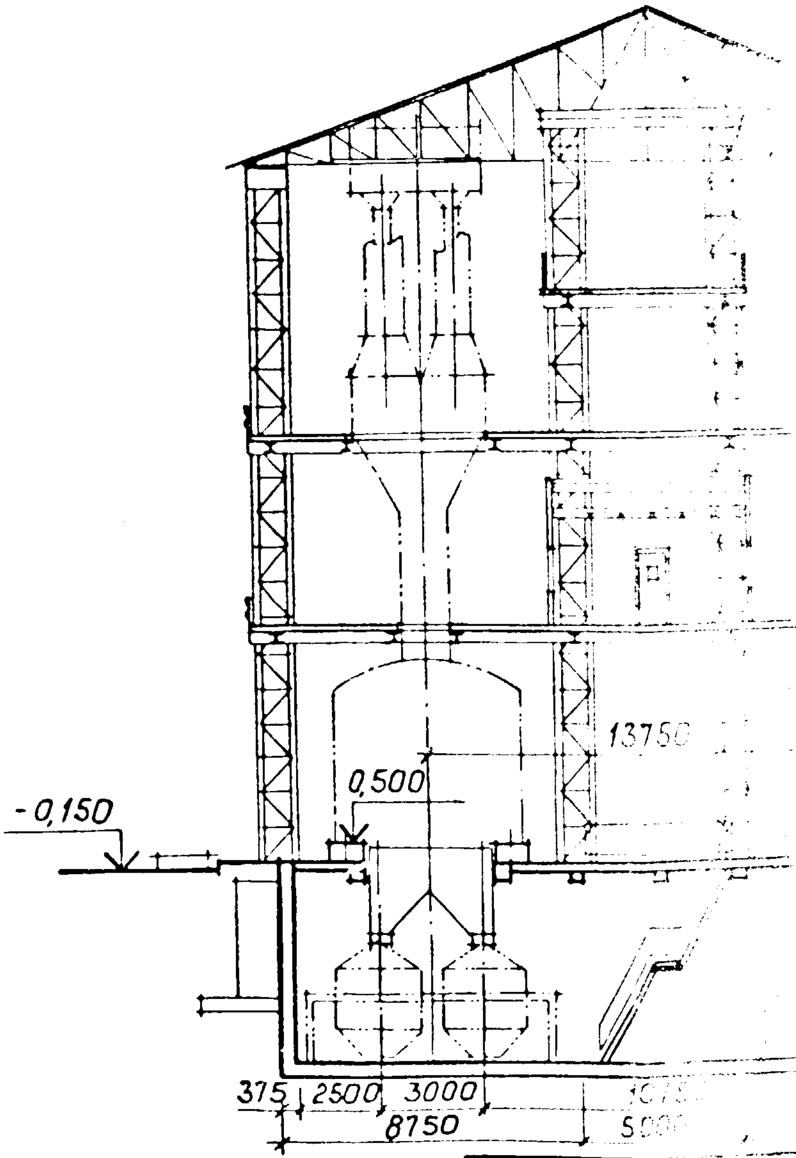
2-2

2-2




РАЗРЕЗ 3

SECTION 3-3



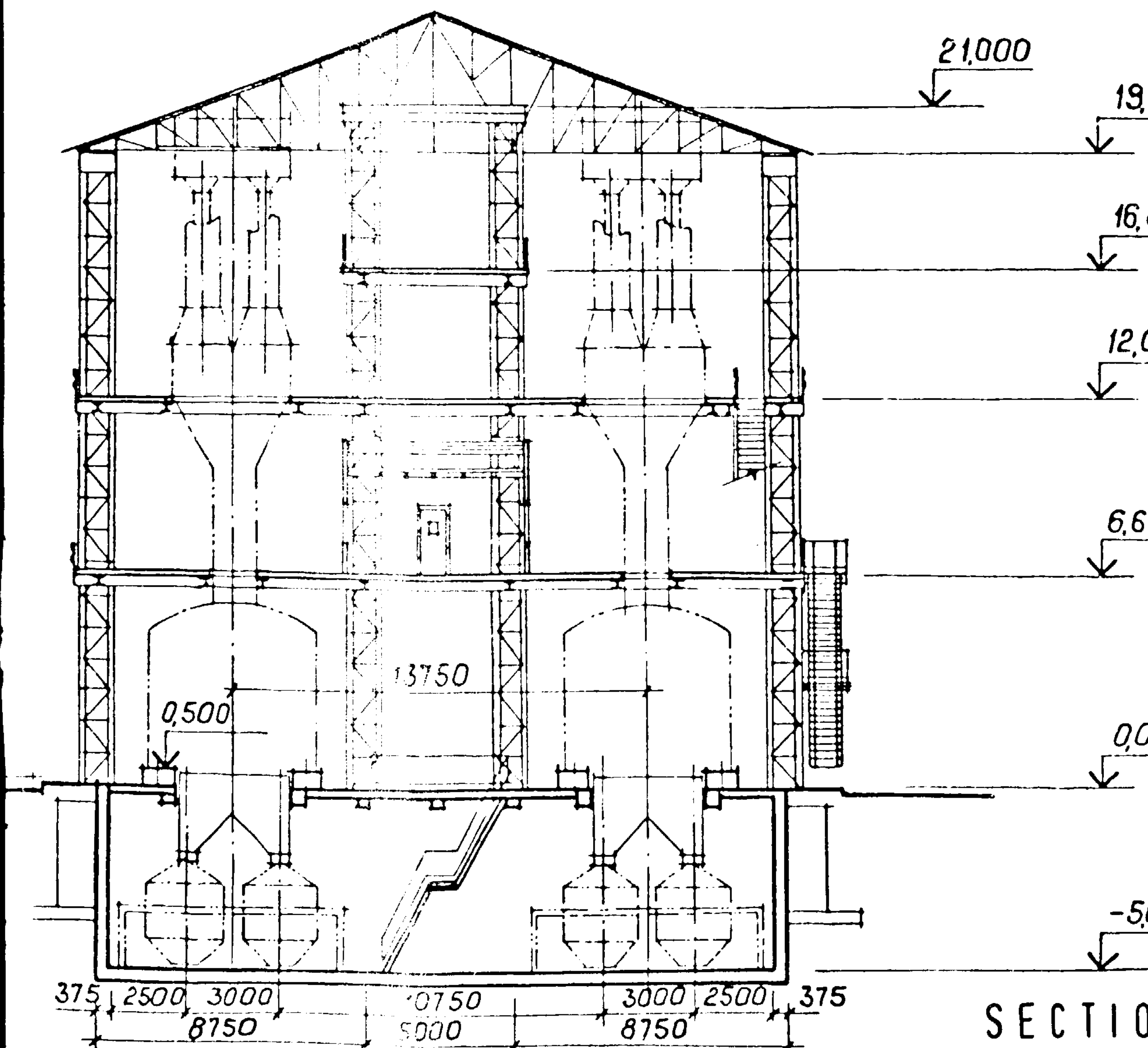

SECTION 4

Масштаб
SCALE

Данный чер...
собственност...
ВАМИ и не ...
скопирован ...
без его раз...

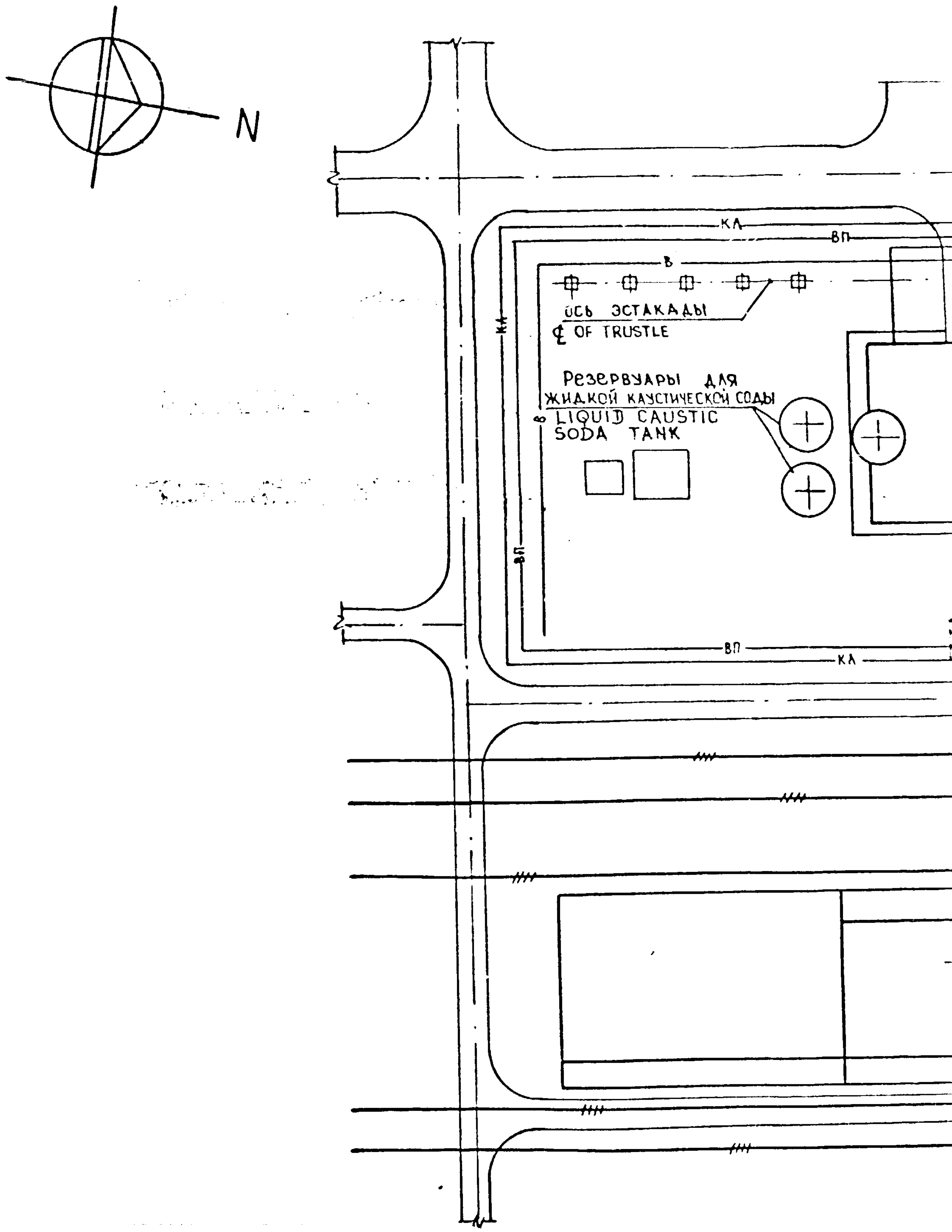
THIS DRAWING ...
TY OF VAMI A...
COPIED OR US...
OUR PERMIS...

## Разрез 3-3
## Section 3-3

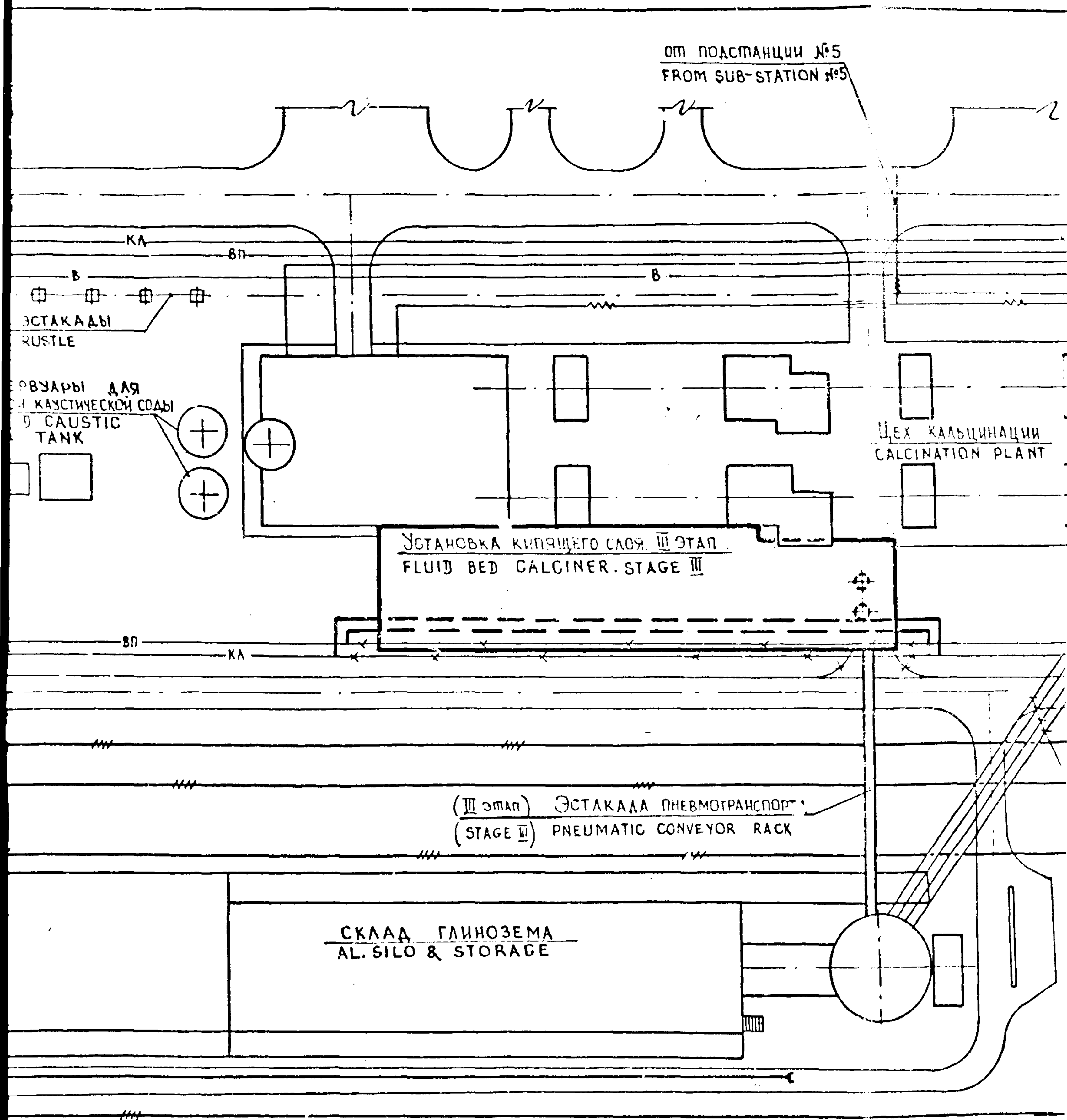



SECTION 5

| | | | |
|---|---|---|---|
| ВАМИ Ленинград<br>VAMI Leningrad | | | |
| Масштаб<br>Scale 1:200 | Для Индийской фирмы Бхарат Алюминиум Компани.<br>For Bharat Aluminium Company Ltd. India | | |
| Данный чертеж является собственностью института ВАМИ и не может быть скопирован и использован без его разрешения<br>This drawing is the property of VAMI and not to be copied or used without our permission | Глиноземный завод в Корбе. Реконструкция цеха кальцинации. II этап. Разрезы 1-1, 2-2, 3-3.<br>Korba alumina plant. Reconstruction of calcinatiom. Stage II. Sections 1-1, 2-2, 3-3. | | |
| | 1332928-АС | Лист<br>Sheet 2 | Листов<br>Sheets 2 |

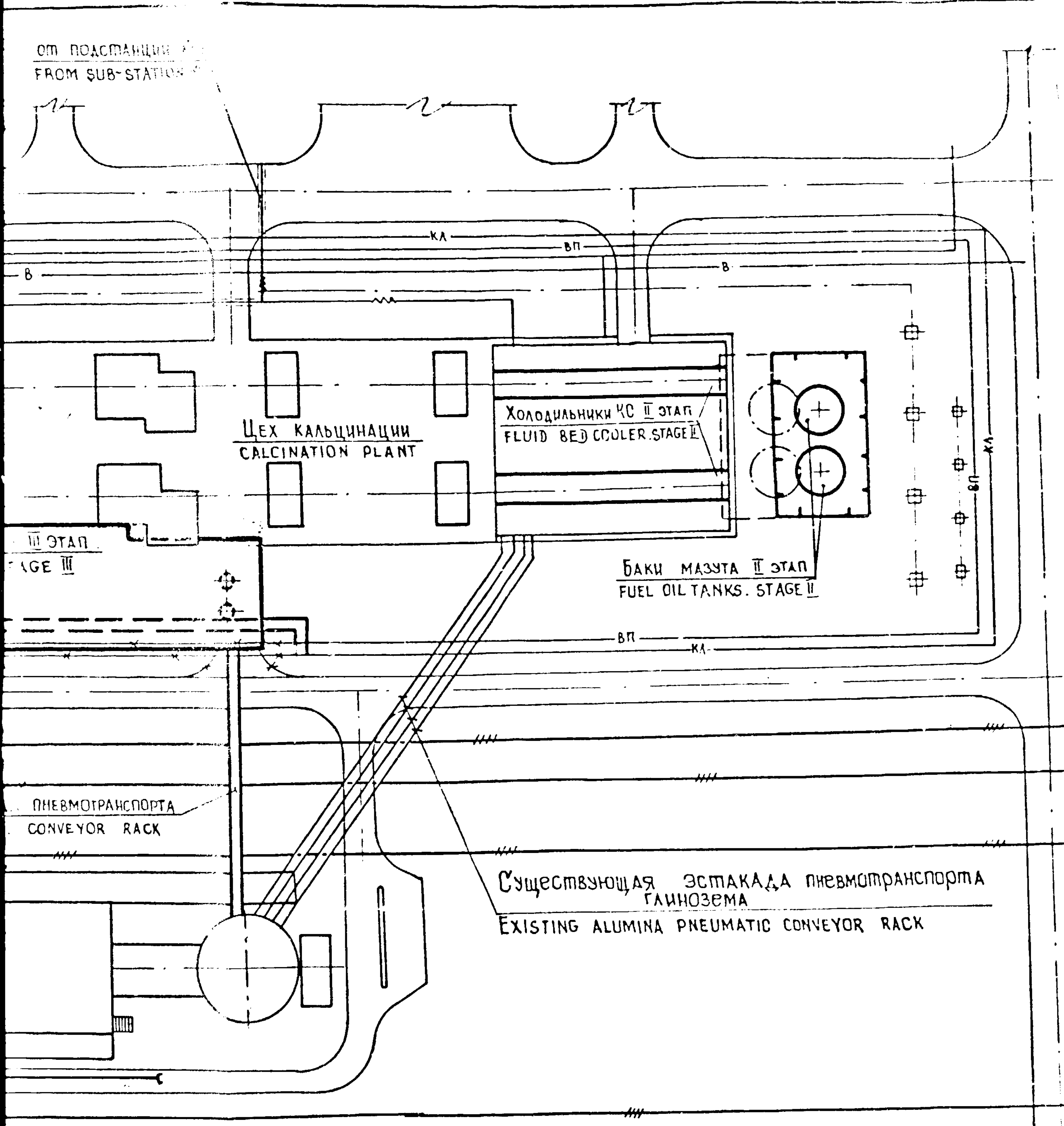

N
КЛ
ВП
В
ОСЬ ЭСТАКАДЫ
℄ OF TRUSTLE
Резервуары для
жидкой каустической соды
LIQUID CAUSTIC
SODA TANK

SECTION 1



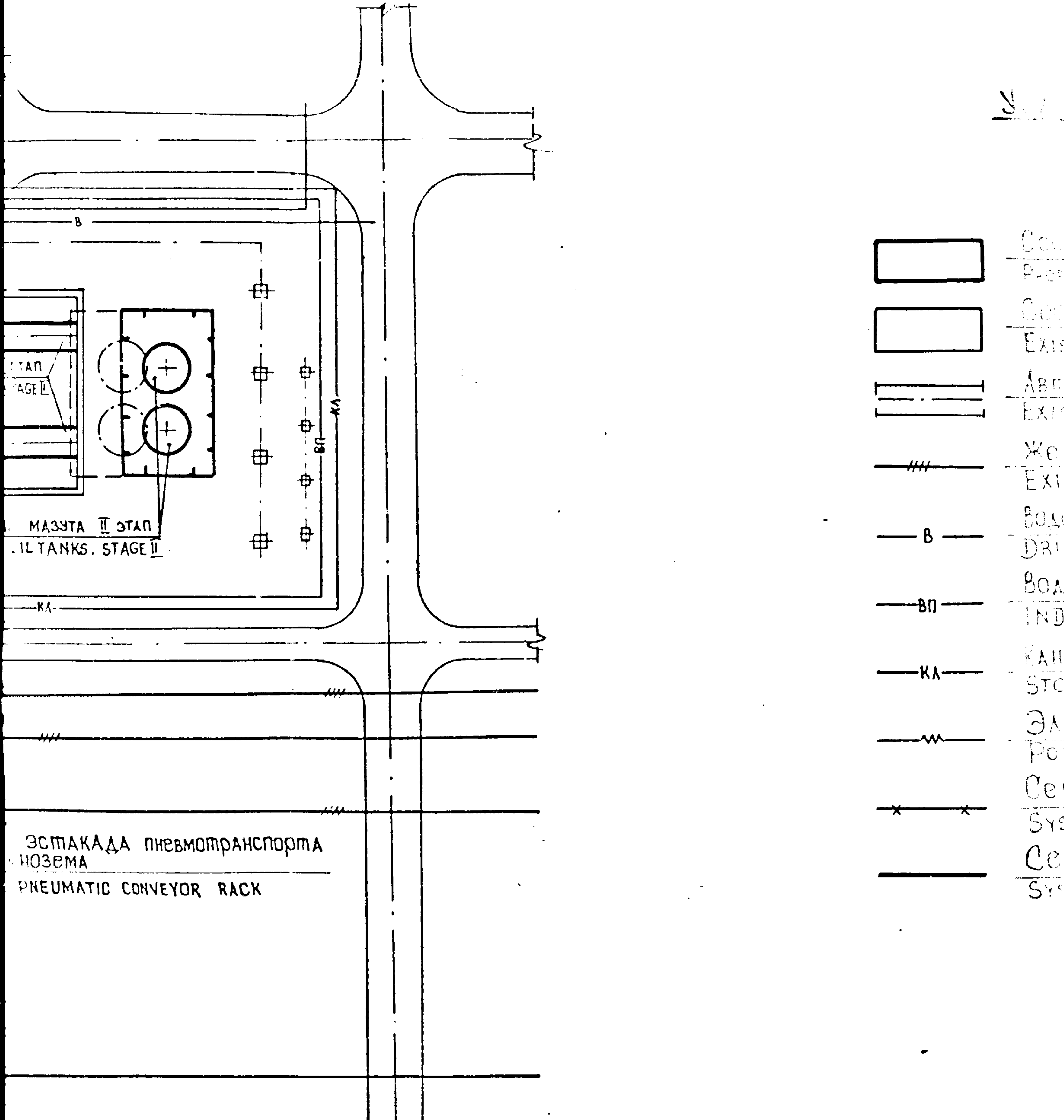
от подстанции №5
FROM SUB-STATION №5
КЛ
ВП
В
В
ЭСТАКАДЫ
RUSTLE
ЕРВУАРЫ ДЛЯ
Й КАУСТИЧЕСКОЙ СОДЫ
D CAUSTIC
TANK
Цех кальцинации
CALCINATION PLANT
Установка кипящего слоя. III этап
FLUID BED CALCINER. STAGE III
ВП
КЛ
(III этап) Эстакада пневмотранспорт
(STAGE III) PNEUMATIC CONVEYOR RACK
СКЛАД ГЛИНОЗЕМА
AL. SILO & STORAGE


SECTION 2



от подстанции
FROM SUB-STATION
КЛ
ВП
В
Цех кальцинации
CALCINATION PLANT
Холодильники КС II этап
FLUID BED COOLER. STAGE II
Баки мазута II этап
FUEL OIL TANKS. STAGE II
III ЭТАП
AGE III
пневмотранспорта
CONVEYOR RACK
Существующая эстакада пневмотранспорта глинозема
EXISTING ALUMINA PNEUMATIC CONVEYOR RACK


SECTION 3


МАЗУТА II ЭТАП
.ILTANKS. STAGE II
В
КЛ
ВП
ЭСТАКАДА ПНЕВМОТРАНСПОРТА
НОЗЕМА
PNEUMATIC CONVEYOR RACK

SECTION 4

# Условные обозначения
# LEGEND

| Symbol | Description |
|---|---|
| | Сооружения проектируемые<br>PROPOSED STRUCTURES |
| | Сооружения существующие<br>EXISTING STRUCTURES |
| | Автомобильные дороги существующие<br>EXISTING MOTOR ROADS |
| | Железнодорожные пути существующие<br>EXISTING RAILWAYS |
| — В — | Водопровод питьевой<br>DRINKING WATER PIPELINE |
| — ВП — | Водопровод производственный<br>INDUSTRIAL WATER PIPELINE |
| — КЛ — | Канализация ливневая<br>STORM WATER SEWERAGE |
| | Электрокабель<br>POWER CABLE |
| —×—×— | Сети разбираемые<br>SYSTEMS TO BE REMOVED |
| | Сети перекладываемые<br>SYSTEMS TO BE MOVED |

SECTION 5

...е

...ествующие

...цествующие

...й

## Примечания
## NOTES

1. На данном чертеже показаны сооружения, осуществляемые на II и III этапах реконстр... цеха кальцинации. Мероприятия, осуществля... на I этапе, ввиду их незначительного объема, на данном чертеже не показаны.

1. This drawing shows units to be installe... stages II and III of calcination plant recon... Work to be carried out at stage I is no... on this drawing, because of insignificant quan...

SECTION 6

| | |
|---|---|
| ВАМИ Ленинград<br>VAMI Leningrad | |
| Масштаб<br>Scale 1:500 | Для Индийской фирмы Бхарат Алюм... Компани.<br>For Bharat Aluminium Company Ltd, I... |
| Данный чертеж является собственностью института ВАМИ и не может быть скопирован и использован без его разрешения.<br>This drawing is the property of VAMI and not to be copied or used without our permission. | Глиноземный завод в Корбе. Реконструк... кальцинации. Генеральный па...<br>Korba alumina plant. Reconstruction of... General lay-out. (Stage II ...<br>1219643-ГП |

Формат А4х5

## Примечания
## NOTES

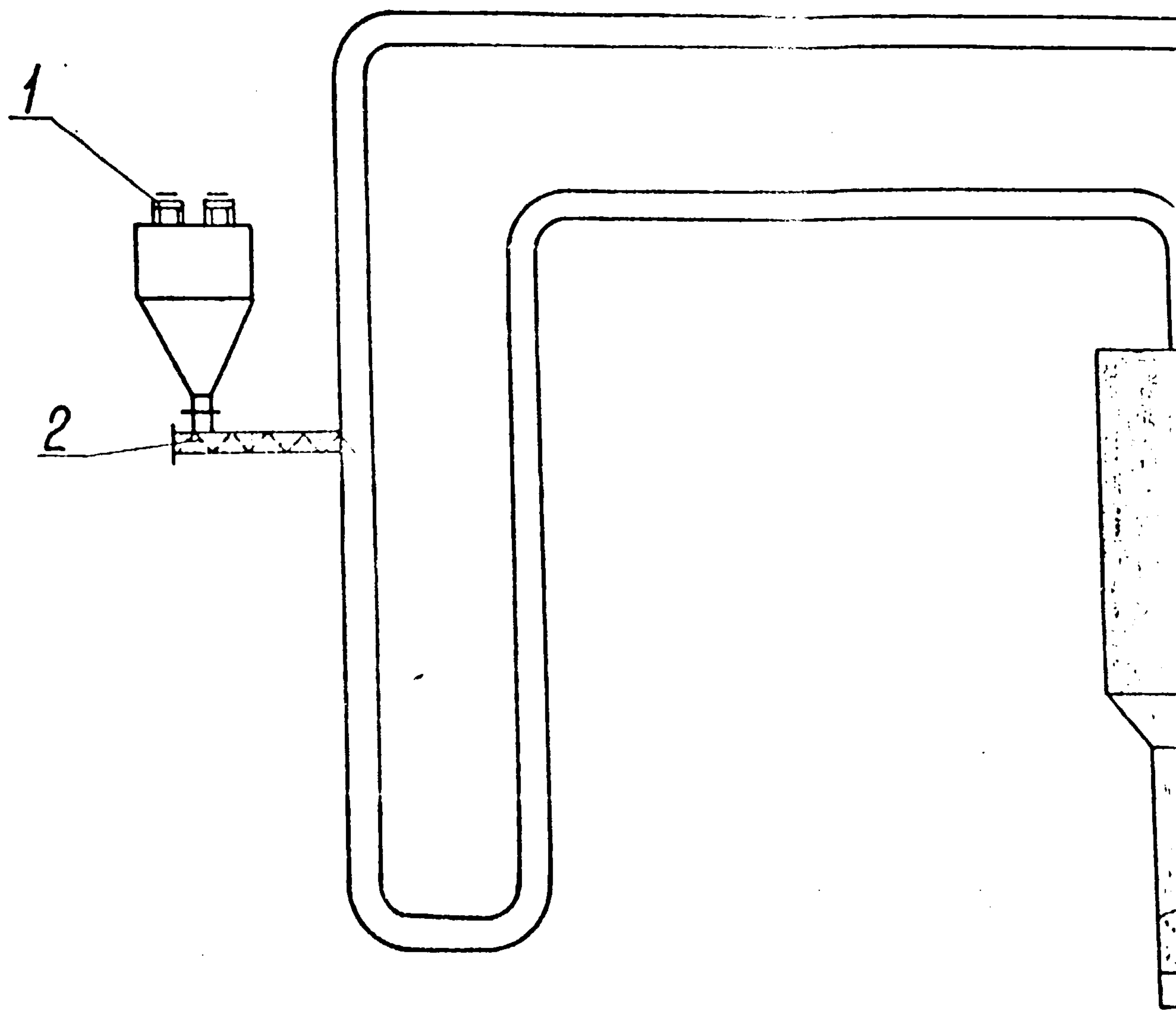
1. На данном чертеже показаны сооружения, осуществляемые на II и III этапах реконструкции цеха кальцинации. Мероприятия, осуществляемые на I этапе, ввиду их незначительного объема, на данном чертеже не показаны.

1. THIS DRAWING SHOWS UNITS TO BE INSTALLED AT STAGES II AND III OF CALCINATION PLANT RECONSTRUCTION. WORK TO BE CARRIED OUT AT STAGE I IS NOT SHOWN ON THIS DRAWING, BECAUSE OF INSIGNIFICANT QUANTITY.

SECTION 7

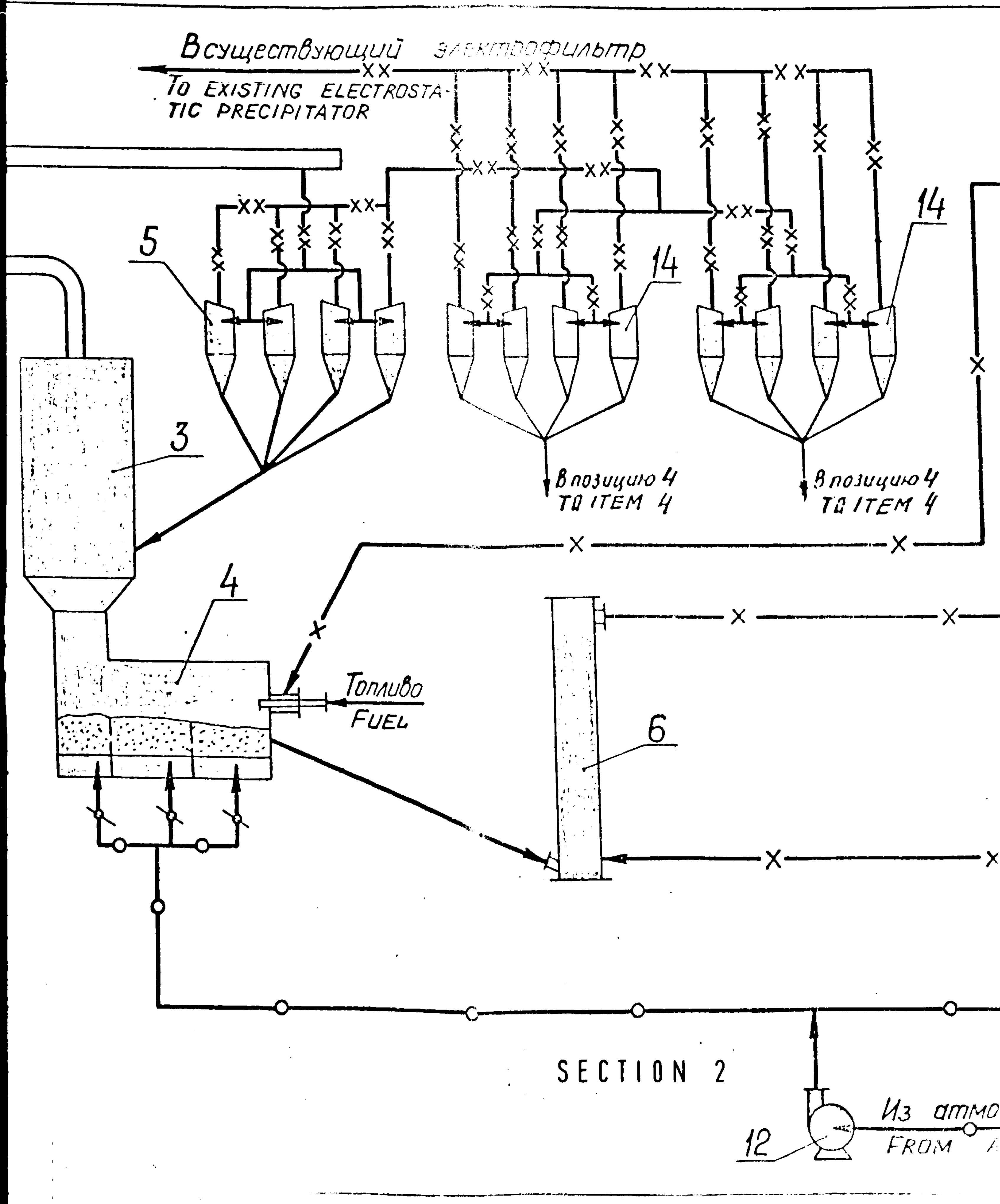
| | | | |
|---|---|---|---|
| ВАМИ Ленинград<br>VAMI Leningrad | | | |
| Масштаб<br>Scale 1:500 | Для Индийской фирмы Бхарат Алюминиум Компани.<br>For Bharat Aluminium Company LTD, India. | | |
| Данный чертеж является собственностью института ВАМИ и не может быть скопирован и использован без его разрешения.<br>This drawing is the property of VAMI and not to be copied or used without our permission. | Глиноземный завод в Корбе. Реконструкция цеха кальцинации. Генеральный план. (II, III этапы)<br>Korba alumina plant. Reconstruction of calcination. General lay-out. (Stage II, III) | | |
| | 1219643-ГП | Лист<br>Sheet | Листов<br>Sheets |

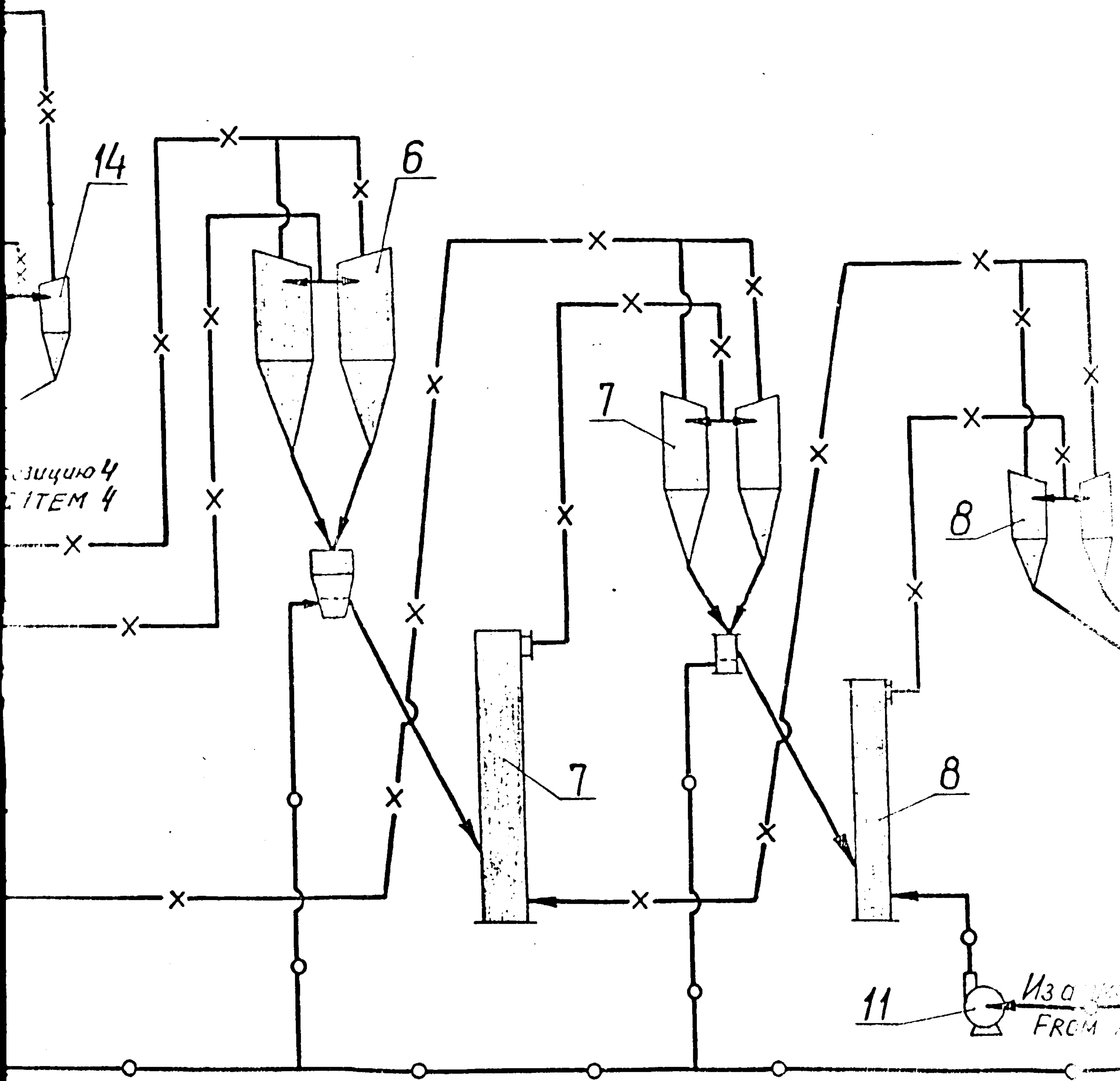
формат А4х5 size А4х5




SECTION 1

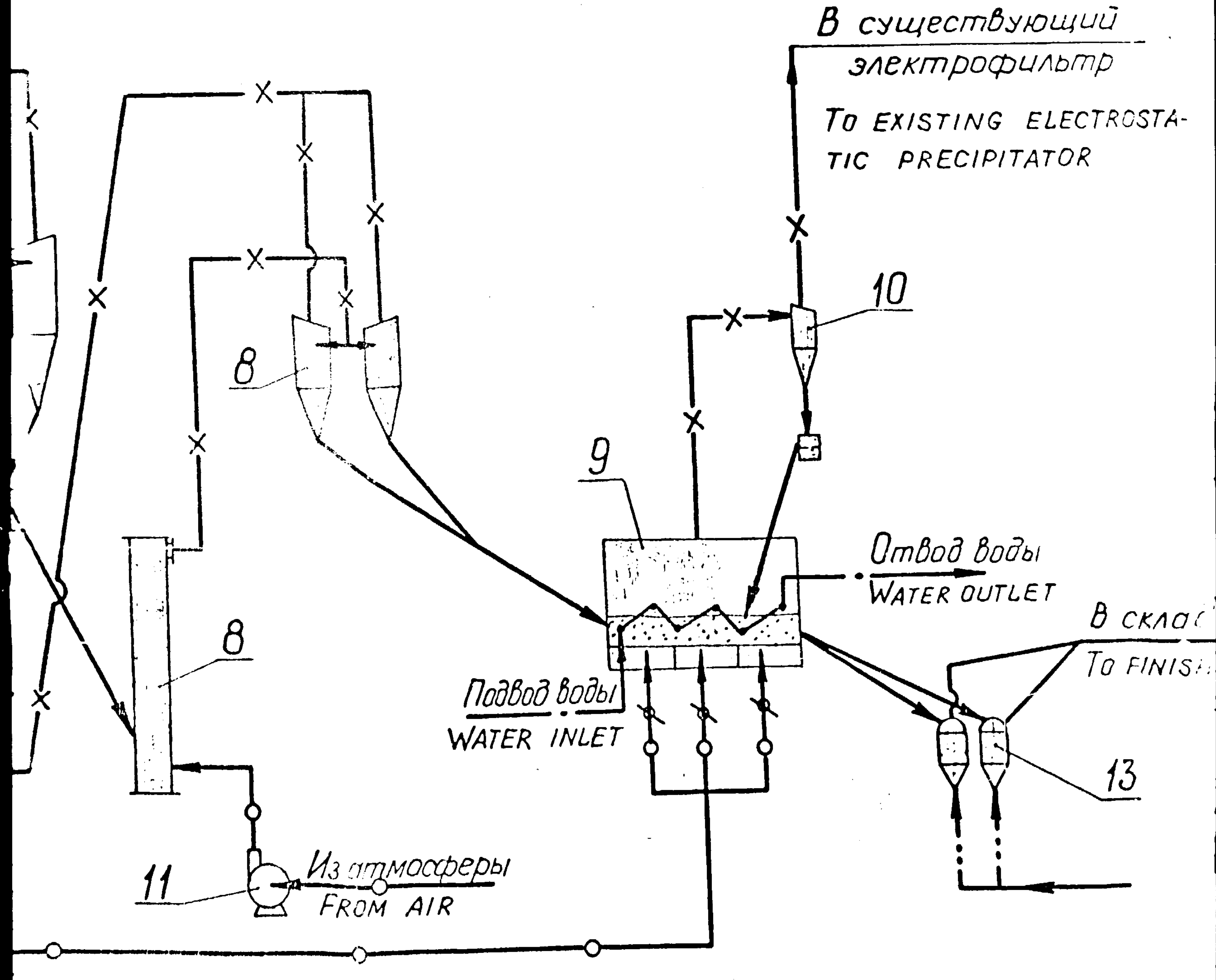
Взам. инв. N°
Подп. и дата
Инв. N° подл.


В существующий электрофильтр
TO EXISTING ELECTROSTATIC PRECIPITATOR
5
14
14
3
В позицию 4
TO ITEM 4
В позицию 4
TO ITEM 4
4
Топливо
FUEL
6
SECTION 2
12
Из атмо
FROM




SECTION 3

Из атмосферы
FROM AIR


В существующий
электрофильтр
To EXISTING ELECTROSTATIC PRECIPITATOR
10
8
9
Отвод воды
WATER OUTLET
В склад
To FINIS
8
Подвод воды
WATER INLET
13
11
Из атмосферы
FROM AIR

SECTION 4

## Условные обозначения
## LEGEND

Материал
MATERIAL

Отходящие газы
FLUE GASES

Воздух
AIR

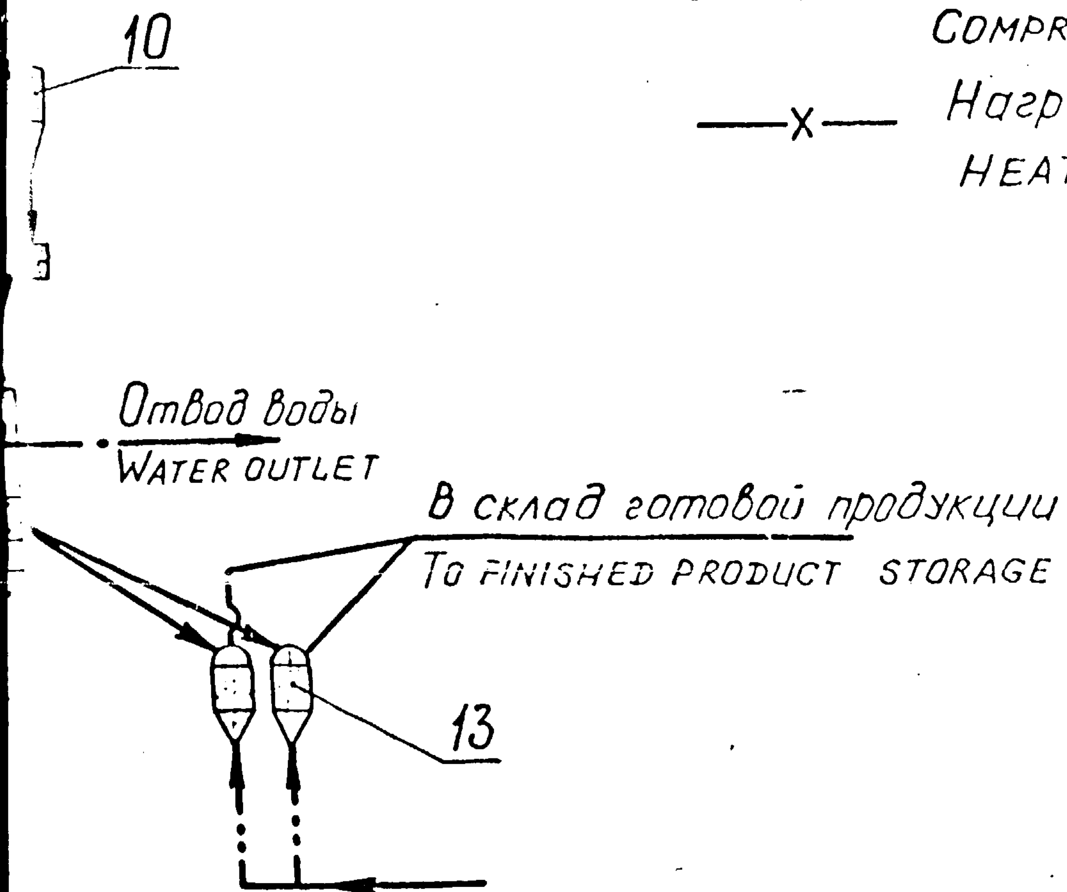
Вода
WATER

Сжатый воздух
COMPRESSED AIR

Нагретый воздух
HEATED AIR

В существующий электрофильтр

TO EXISTING ELECTROSTATIC PRECIPITATOR




SECTION 5

…ные обозначения
…EGEND

…ериал
…ERIAL

…дящие газы
…E GASES

…дух

…та
…TER

…тый воздух
…RESSED AIR

…ретый воздух
…TED AIR

| N позиции SN | Наименован… DESCRIPTION |
|---|---|
| 9 | Доохладител… FLUID BED COO… |
| 10 | Циклон CYCLONE |
| 11 | Вентилятор FAN |
| 12 | Воздуходувка… AIR BLOWER |
| 13 | Насос камерн… CHAMBER PUM… |
| 14 | I ступень цик… I STAGE OF CYCL… |

Вновь устанав…
на схеме …
THE EQUIPMENT …
ON THE DIAGR…

SECTION 6

| № позиции SN | Наименование DESCRIPTION | Техническая характеристика SPECIFICATION | Количество QTY | Примечание REMARK |
|---|---|---|---|---|
| 9 | Доохладитель „КС" FLUID BED COOLER | $S = 15\ м^2$ | 1 | |
| 10 | Циклон CYCLONE | Ф 900 мм mm | 1 | |
| 11 | Вентилятор FAN | Q = 44000 м³/ч m³/h; H = 240 мм вод. ст. mm WATER GAUGE | 1 | |
| 12 | Воздуходувка AIR BLOWER | Q = 15000 м³/ч m³/h; H = 1500 мм вод. ст. mm WATER GAUGE | 1 | |
| 13 | Насос камерный CHAMBER PUMP | Ф 1800 мм mm | 2 | |
| 14 | I ступень циклонов I STAGE OF CYCLONES | 4 циклона 4 CYCLONS Ф 1370 мм mm | 2 | 1 существующ. 1 EXISTING |

| № позиции SN | Наименование DESCRIPTION |
|---|---|
| 1 | Конвейер лент... BELT CONVE... |
| 2 | Питатель шне... SCREW FEEDE... |
| 3 | Теплообменник ш... SHAFT TYPE EXC... |
| 4 | Камера кипящ... FLUID BED CHAM... |
| 5 | Теплообменник цик... CYCLONE HEAT ...GER |
| 6 | I ступень хол... циклонное... I STAGE OF CYC... COOLER |
| 7 | II ступень хо... циклонн... II STAGE OF CYC... COOLER |
| 8 | III ступень хо... цикло... III STAGE OF C... COOLER |

Вновь устанавливаемое оборудование на схеме затушевано.

THE EQUIPMENT TO BE INSTALLED IS DARKENED ON THE DIAGRAM.

SECTION 7

Масштаб
SCALE

| ...ика ...N | Количество QTY | Примечание REMARK | Позиции SN | Наименование DESCRIPTION | Техническая характеристика SPECIFICATION | Количество QTY | Примечание REMARK |
|---|---|---|---|---|---|---|---|
| | 1 | | 1 | Конвейер ленточный<br>BELT CONVEYOR | B = 650 мм / mm | 2 | Реконструкция<br>RECONSTRUCTION |
| | 1 | | 2 | Питатель шнековый<br>SCREW FEEDER | Ф500 мм / mm | 1 | |
| ...³/н<br>... GAUGE | 1 | | 3 | Теплообменник шахтный<br>SHAFT TYPE EXCHANGER | Ф5400 | 1 | |
| ...m³/н<br>...T.<br>... GAUGE | 1 | | 4 | Камера кипящего слоя<br>FLUID BED CHAMBER | S = 20 м² / m² | 1 | |
| ... | 2 | | 5 | Теплообменник циклонный<br>CYCLONE HEAT EXCHANGER | 4 циклона / 4 CYCLONES Ф1400 мм / mm | 1 | |
| ...70мм / mm | 2 | 1 существующ.<br>1 EXISTING | 6 | I ступень холодильника циклонного<br>I STAGE OF CYCLONE COOLER | 2 циклона - Ф2,04м<br>Ф колонки - 1,4м<br>2 CYCLONES DIA - 2,04m<br>COLUMN, DIA - 1,4m | 1 | |
| | | | 7 | II ступень холодильника циклонного<br>II STAGE OF CYCLONE COOLER | 2 циклона - Ф1,8м<br>Ф колонки - 1,2м<br>2 CYCLONE DIA - 1,8m<br>COLUMN DIA - 1,2m | 1 | |
| | | | 8 | III ступень холодильника циклонного<br>III STAGE OF CYCLONE COOLER | 2 циклона - Ф1,52м<br>Ф колонки - 1м<br>2 CYCLONE DIA = 1,52m<br>COLUMN DIA - 1m | 1 | |

...ние

...ARKENED

SECTION 8

ВАМИ Ленинград
VAMI LENINGRAD

| | |
|---|---|
| Масштаб — SCALE | Для Индийской фирмы Бхарат Алюминиум Компани.<br>FOR BHARAT ALUMINIUM COMPANY LTD, INDIA |
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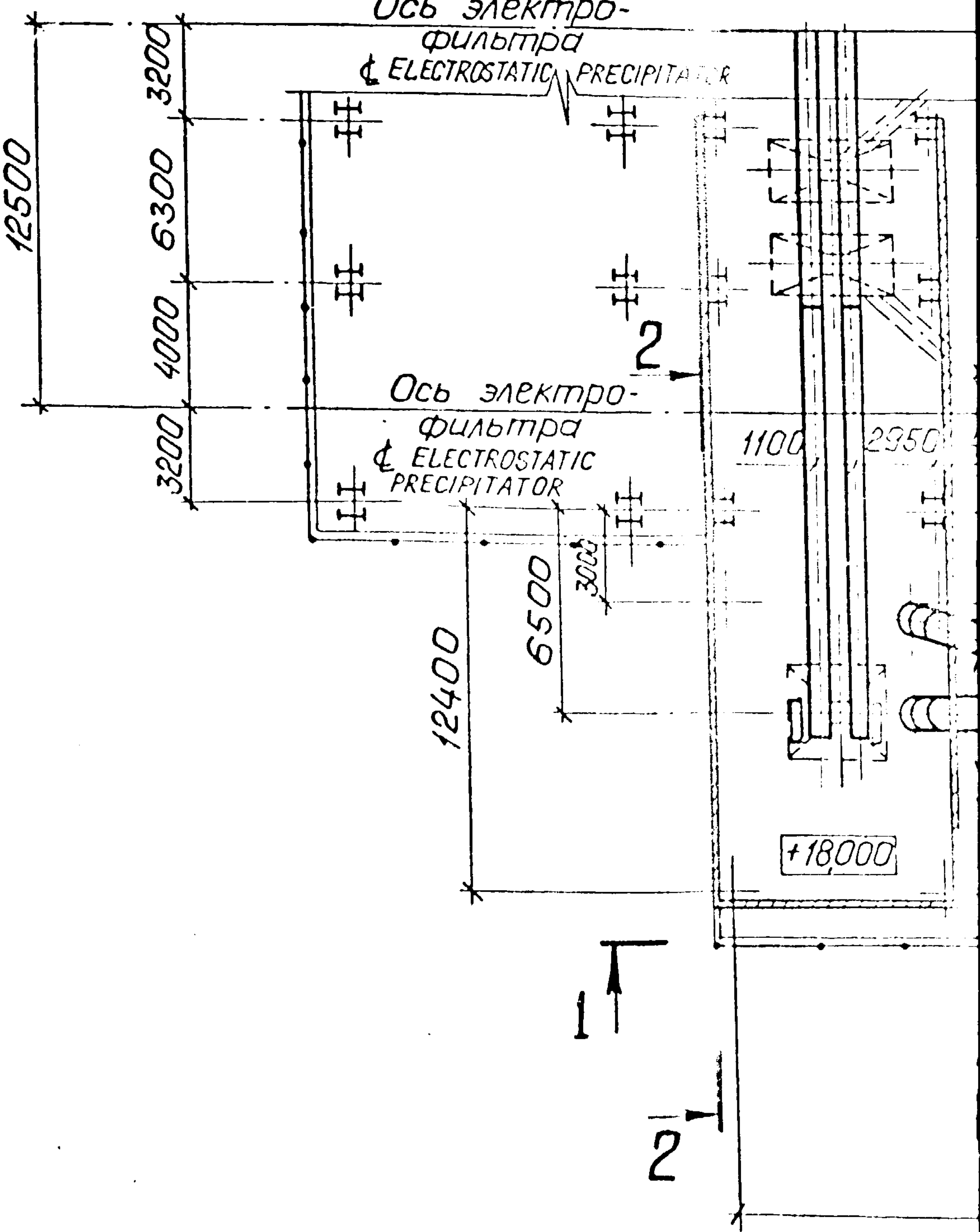
| | 1354697-ТМ \| Лист SHEET 1 \| Листов SHEETS 3 |

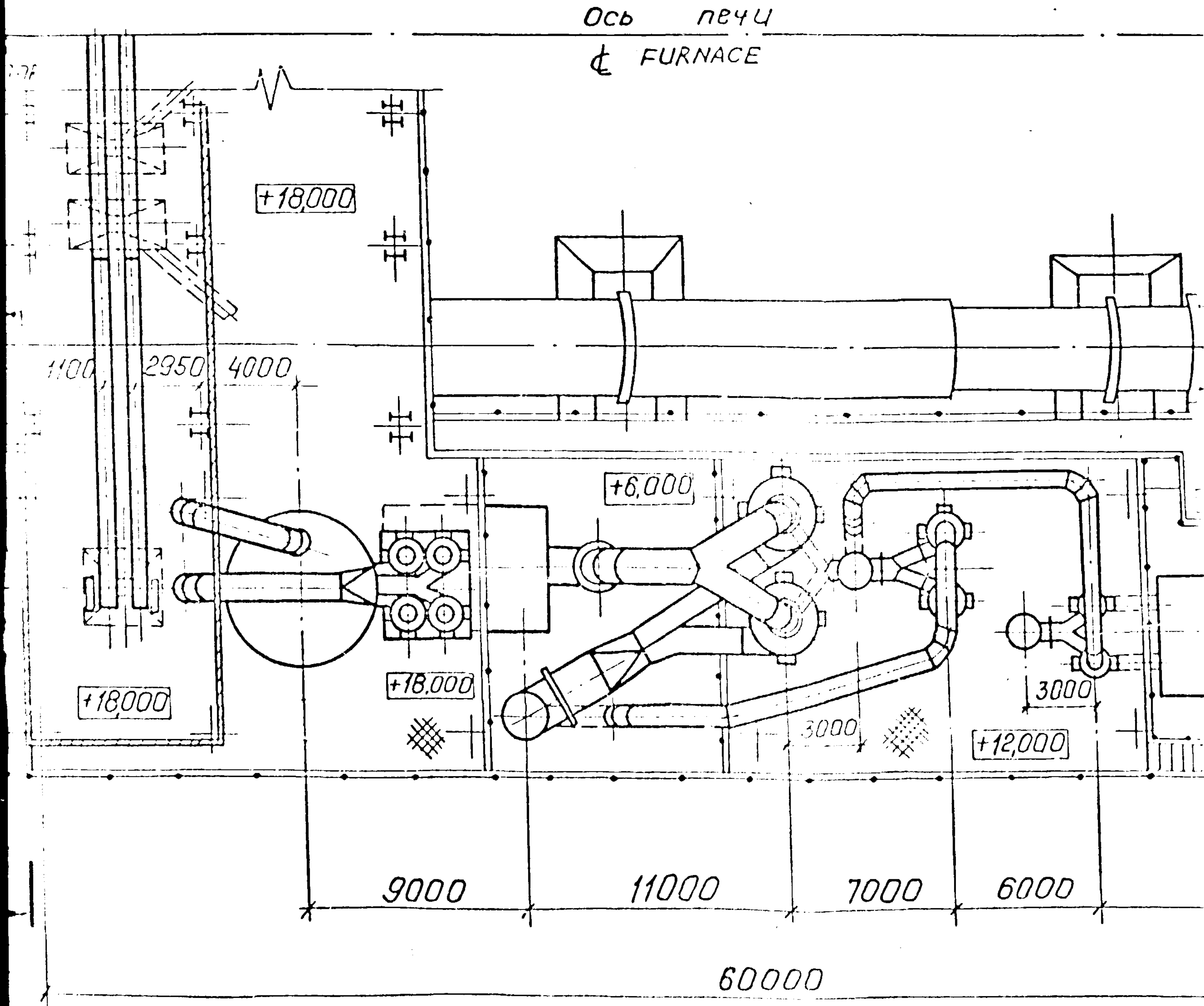


Ось электро-
фильтра
℄ ELECTROSTATIC PRECIPITATOR
Ось электро-
фильтра
℄ ELECTROSTATIC
PRECIPITATOR
12500
3200
6300
4000
3200
2
1100
2950
6500
3000
12400
+18,000
1
2


SECTION 1

План на отм. +6,000;

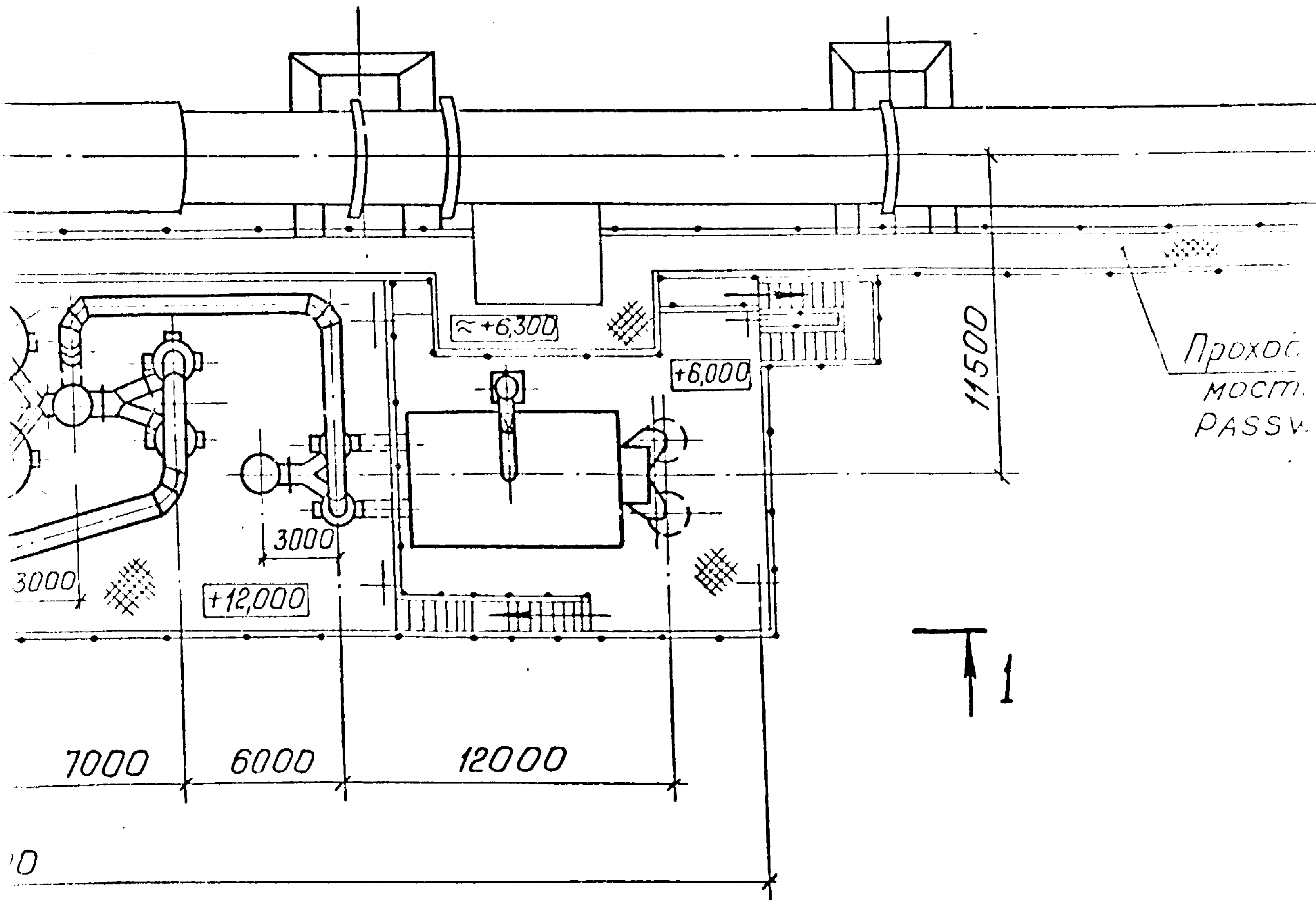
Plan at EL +6,000; +



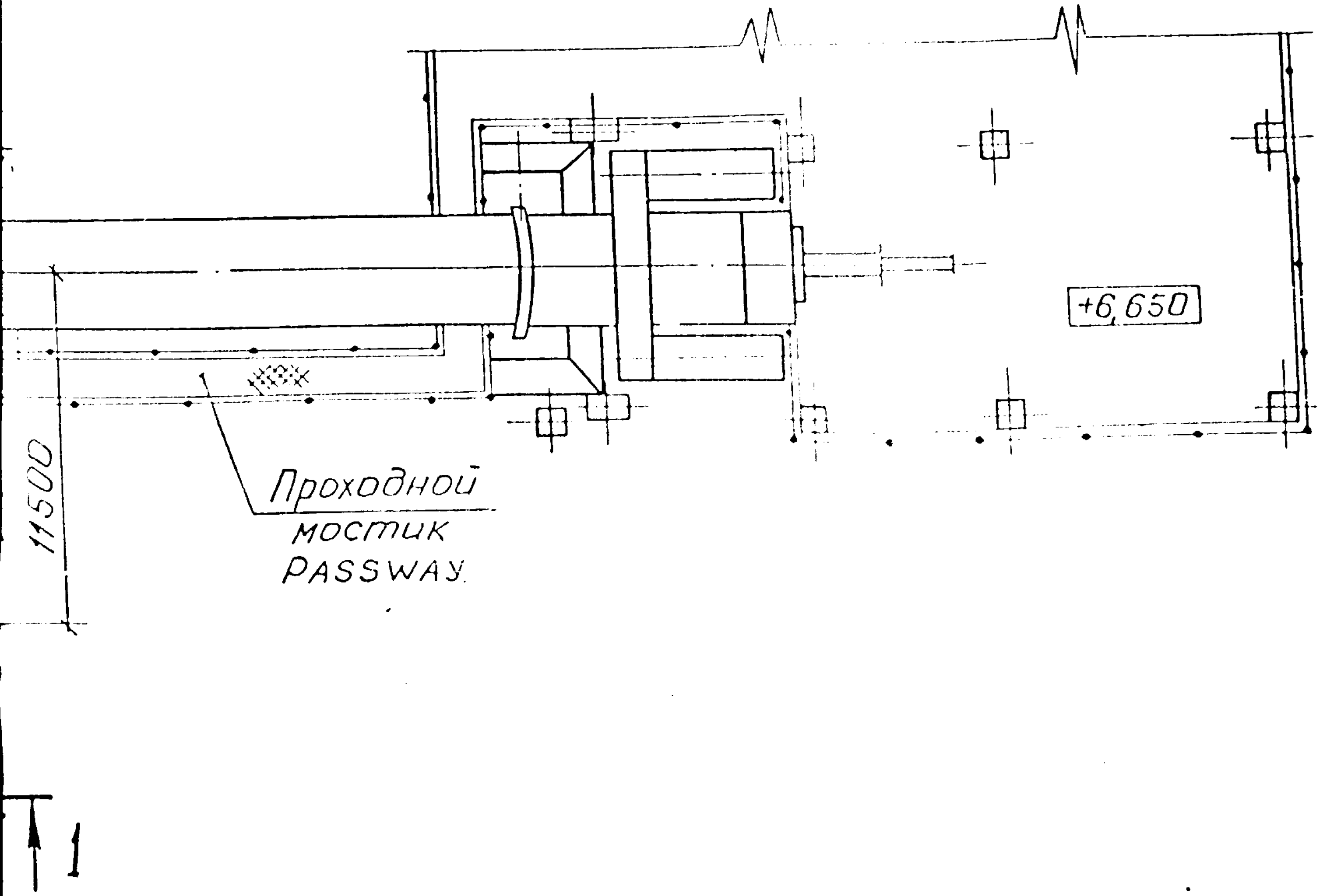

SECTION 2

АН НА ОТМ. +6,000; + 12,000 и + 18,000

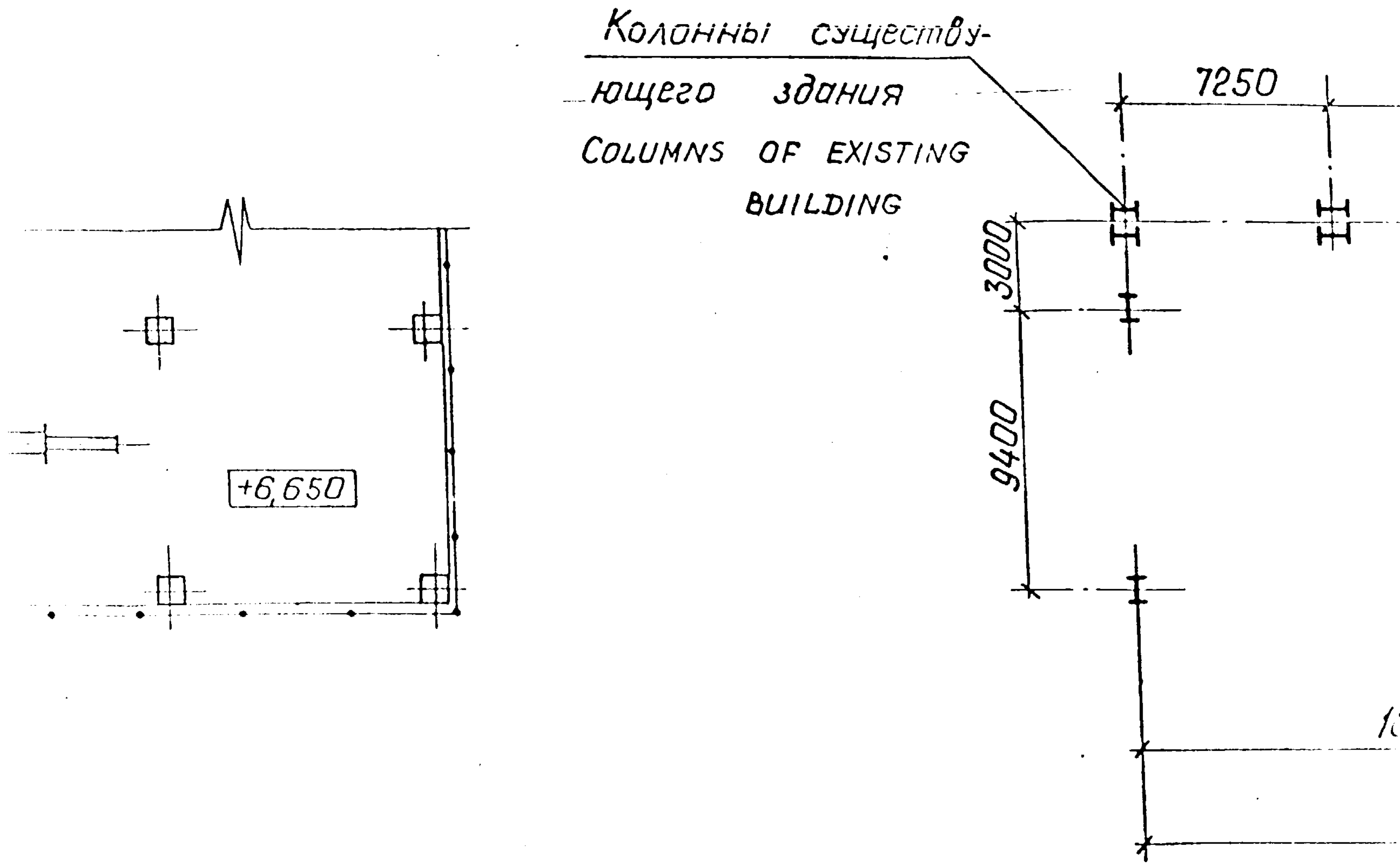
AN AT EL +6,000; + 12,000 AND + 18,000




SECTION 3



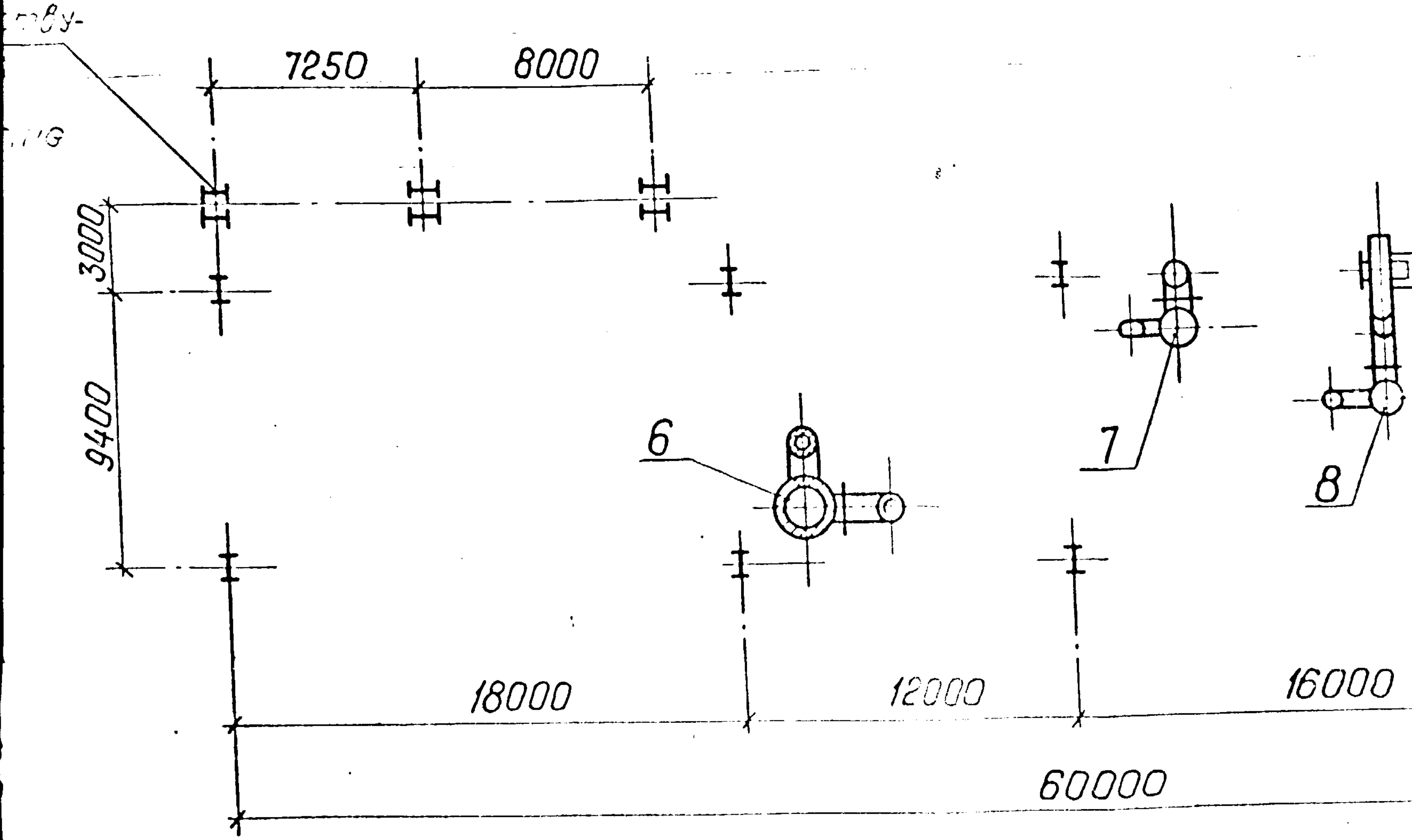

SECTION 4


Колонны существующего здания
COLUMNS OF EXISTING BUILDING
7250
3000
9400
+6,650

SECTION 5

План на отм. 0,000

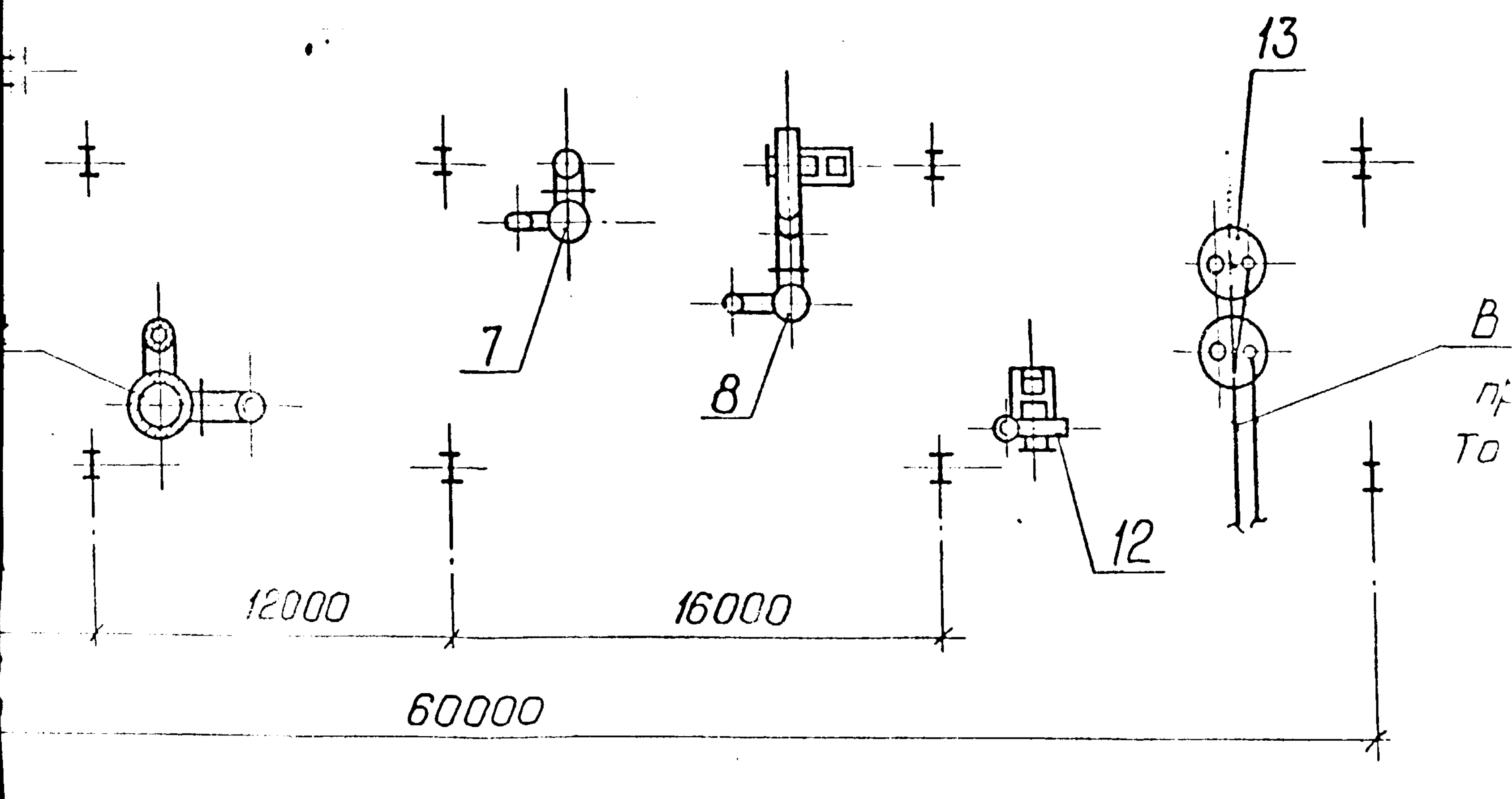
PLAN AT EL 0,000




SECTION 6

План на отм. 0,000

PLAN AT EL 0,000




SECTION 7

ВАМИ ЛЕНИНГРА
VAMI LENINGRA

Масштаб
SCALE 1:200

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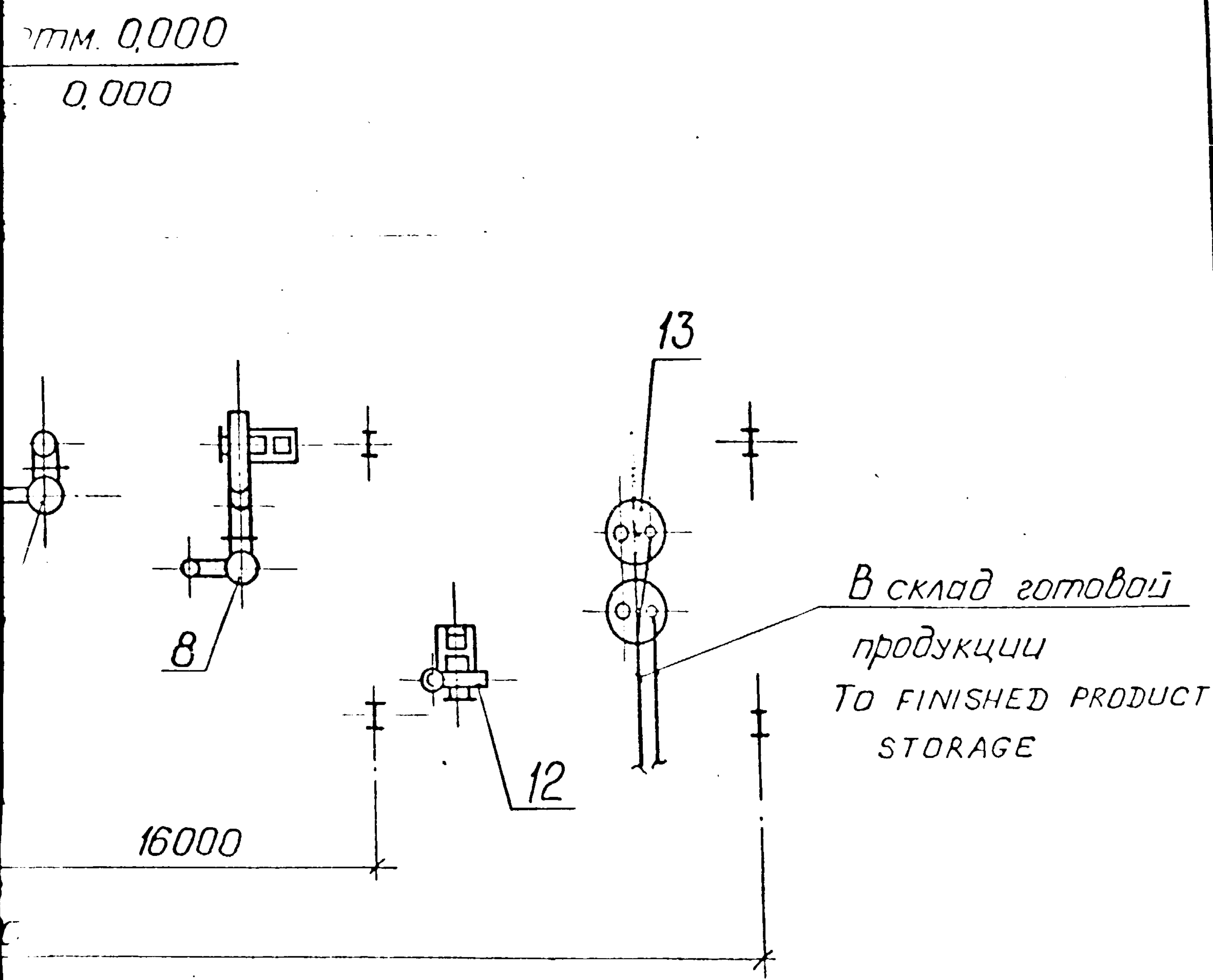
ДЛЯ ИНДИЙСКОЙ
КОМПА

FOR BHARAT ALUMINIUM

ГЛИНОЗЕМНЫЙ ЗАВОД
КАЛЬЦИНАЦИИ. III ЭТА
КИПЯЩЕГО

KORBA ALUMINA PLANT
STAGE III. FLUID

13546




SECTION 8

ВАМИ ЛЕНИНГРАД
VAMI LENINGRAD

| | |
|---|---|
| Масштаб SCALE 1:200 | ДЛЯ ИНДИЙСКОЙ ФИРМЫ БХАРАТ АЛЮМИНИУМ КОМПАНИ<br>FOR BHARAT ALUMINIUM COMPANY LTD, INDIA |
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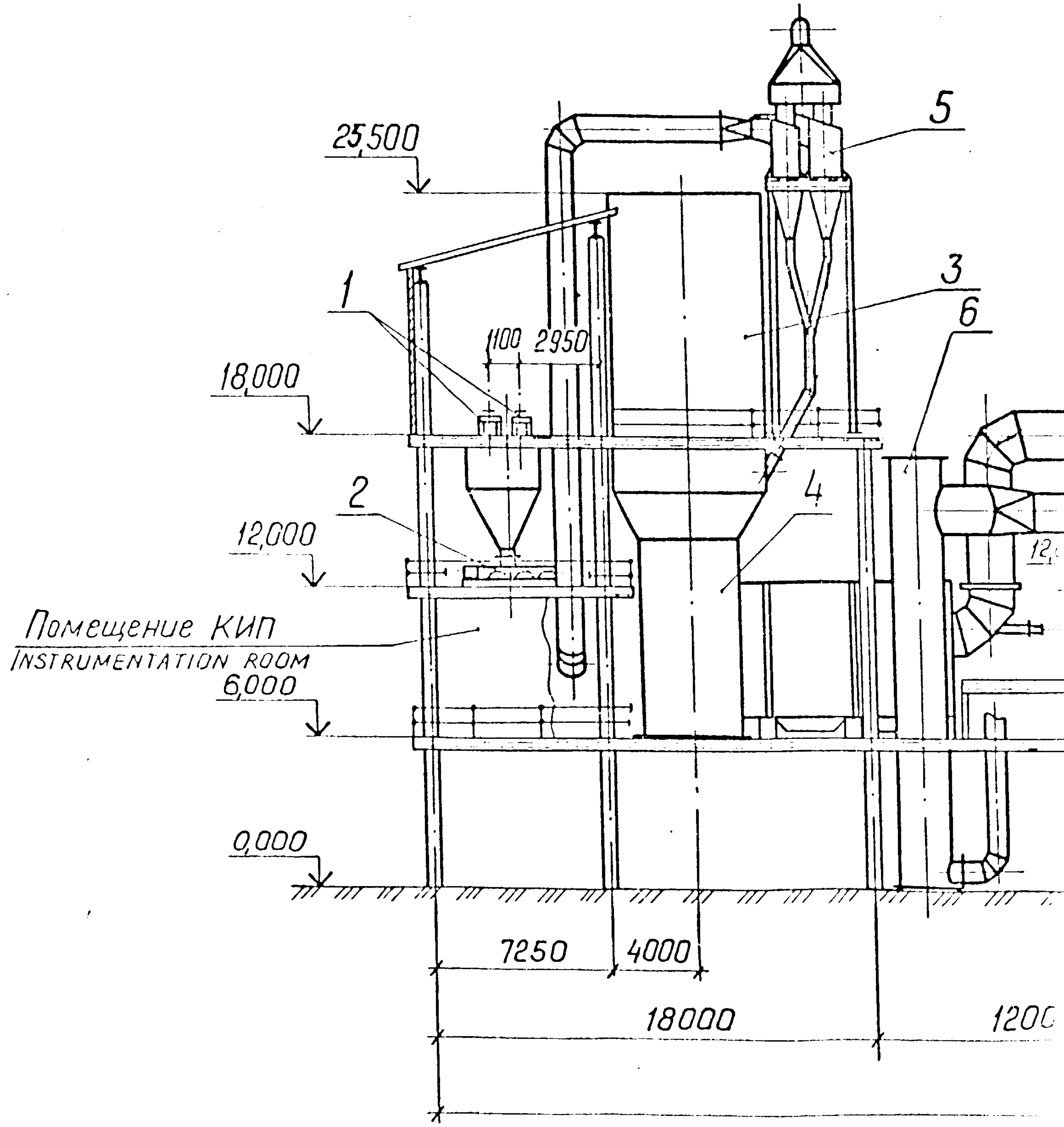
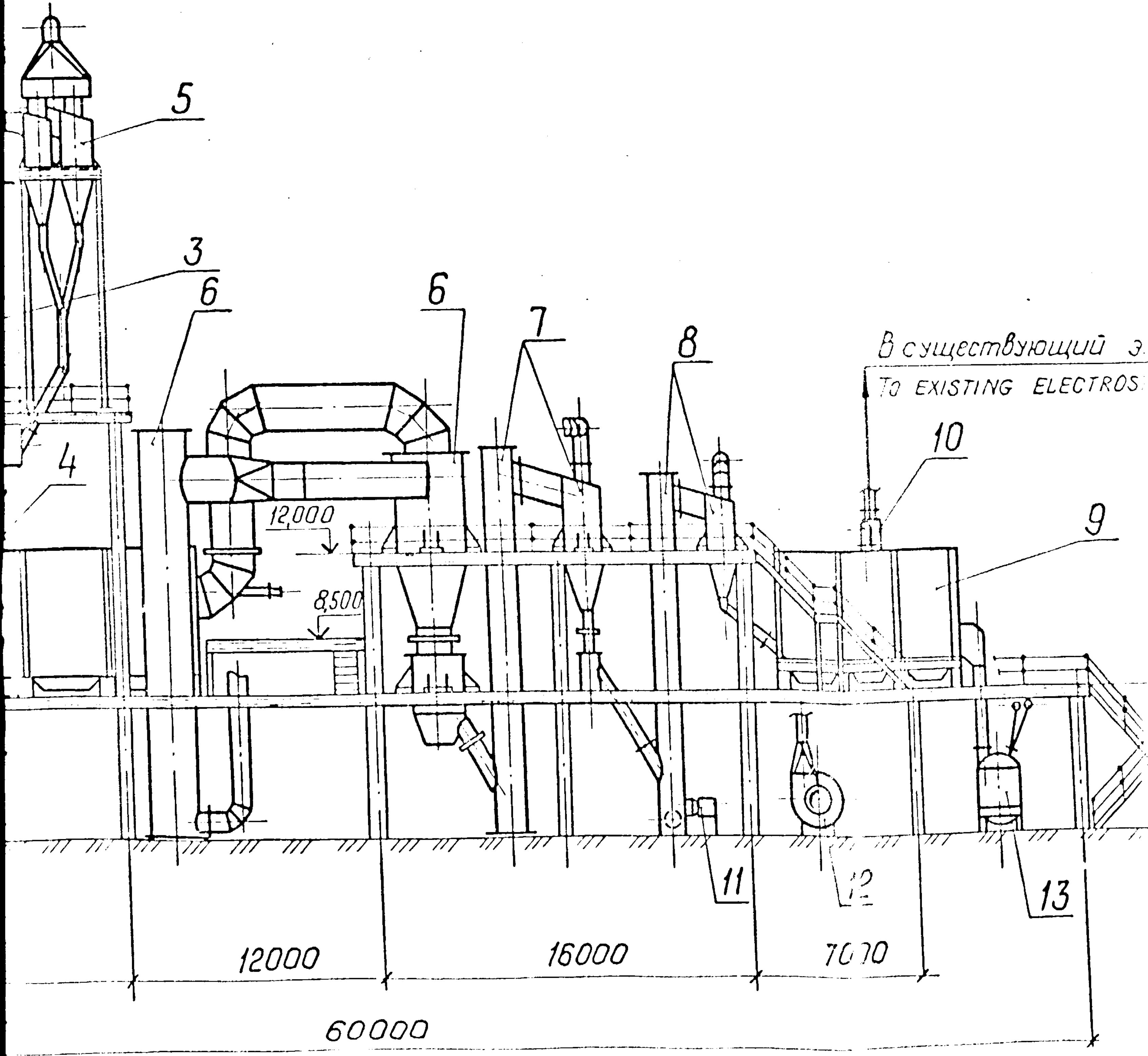
| | 1354697-TM \| Лист SHEET 2 \| Листов SHEETS 3 |



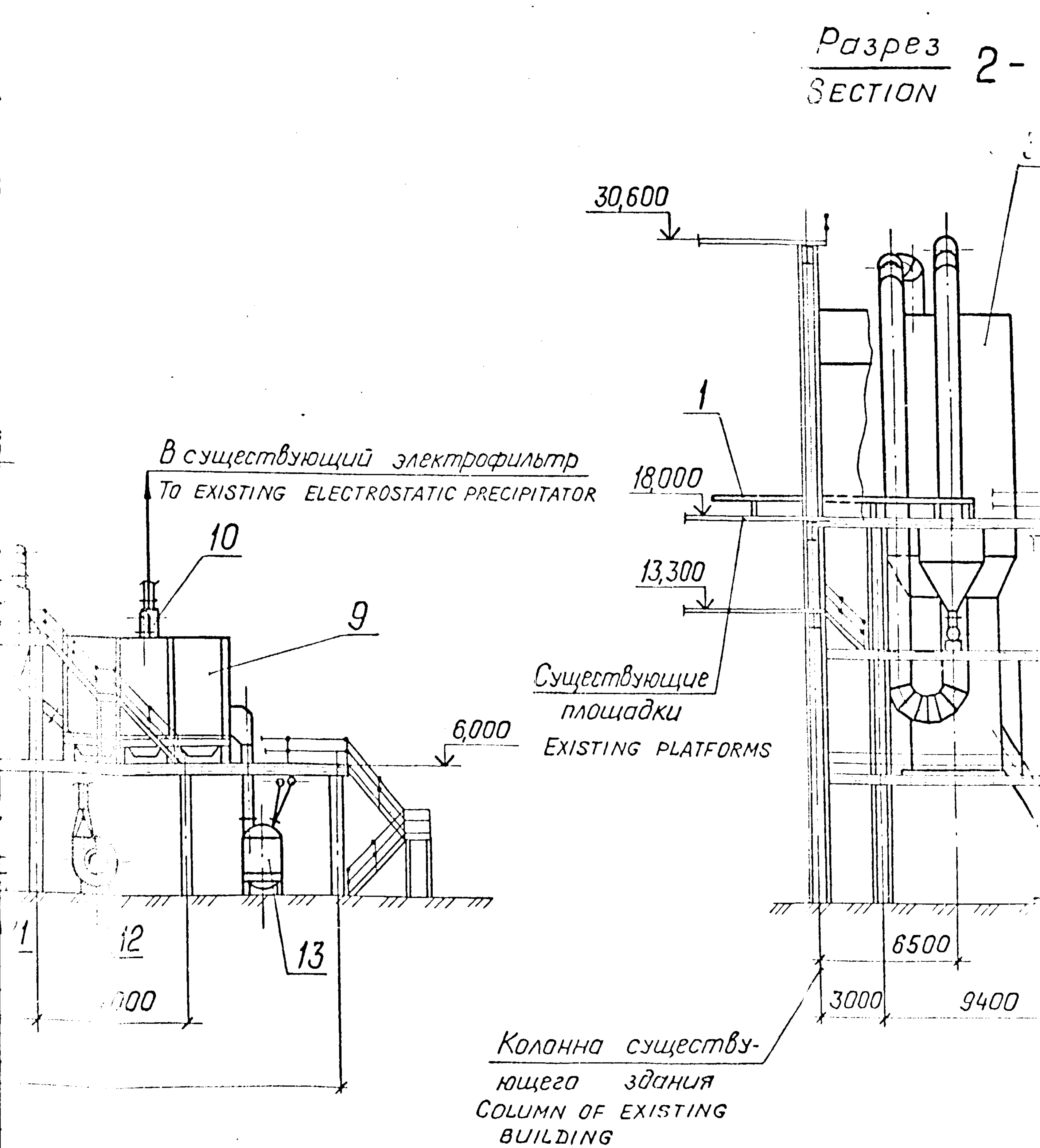

SECTION 1

Инв. № подл. | Подп. и дата | Взам. инв. №

Разрез / SECTION 1-1



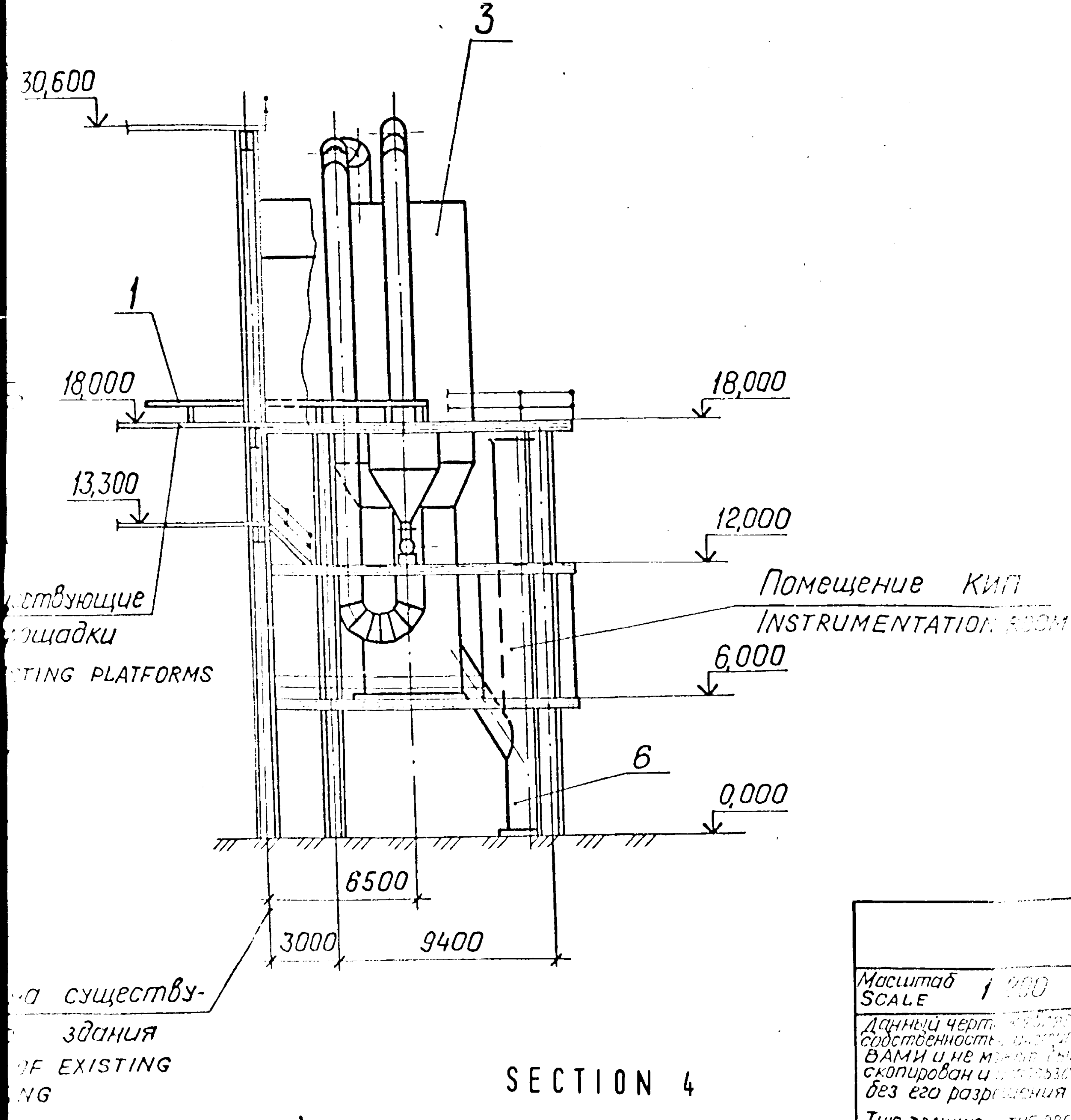

SECTION 2



Разрез
SECTION
2-
30,600
1
18,000
13,300
Существующие
площадки
EXISTING PLATFORMS
В существующий электрофильтр
TO EXISTING ELECTROSTATIC PRECIPITATOR
10
9
6,000
11
12
13
6500
3000
9400
Колонна существу-
ющего здания
COLUMN OF EXISTING
BUILDING


SECTION 3

Разрез / SECTION 2-2




SECTION 4

Масштаб / SCALE 1:200

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18,000

12,000

Помещение КИП

INSTRUMENTATION ROOM

6,000

0,000

SECTION 5

ВАМИ ЛЕНИНГРАД

VAMI LENINGRAD

| | |
|---|---|
| Масштаб 1:200<br>SCALE | Для Индийской Фирмы Бхарат Алюминиум Компани.<br>FOR BHARAT ALUMINIUM COMPANY LTD, INDIA |
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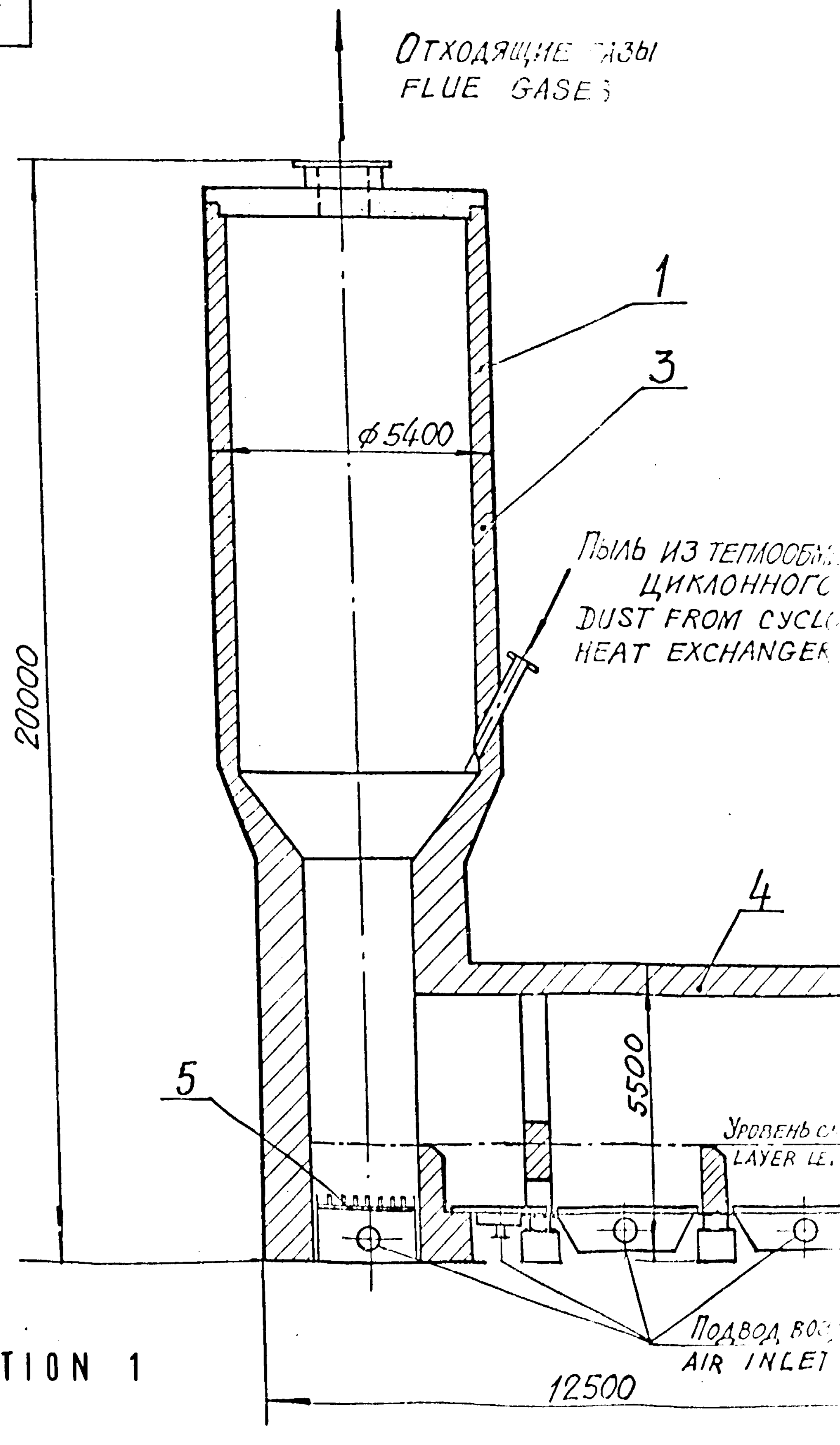
| | 1354697-TM — Лист / SHEET 3 — Листов / SHEETS 3 |




SECTION 1

Инв. N подл. | Подп. и дата | Взам.инв.N

ТЕХНИЧЕСК

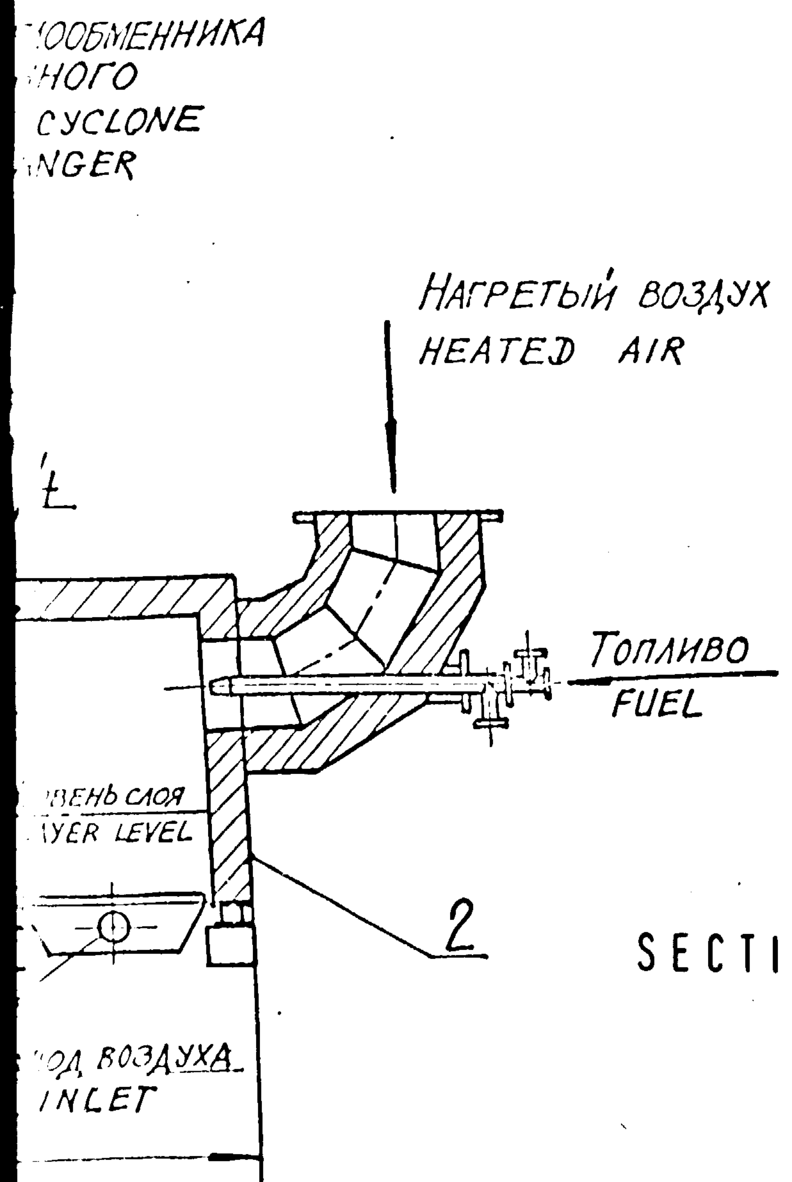
SPE

1 ПРОИЗВОДИТЕЛЬНОС
PRODUCTION OF C

2 РАСХОД ТОПЛИВА (
FUEL CONSUMPTIO

3 РАСХОД ВОЗДУХ
AIR CONSUMPTIO

4 ГИДРАВЛИЧЕСКОЕ
HYDRAULIC RESIS




SECTION 2

## ТЕХНИЧЕСКАЯ ХАРАКТЕРИСТИКА
## SPECIFICATION

| | | | |
|---|---|---|---|
| 1 | Производительность по прокаленному глинозему<br>PRODUCTION OF CALCINED ALUMINA | т/ч<br>T/H | — |
| 2 | Расход топлива (мазута Q=9600 ккал/кг)<br>FUEL CONSUMPTION (FUEL OIL Q=9600 KCAL/KG) | нм³/ч<br>Nm³/H | —2 |
| 3 | Расход воздуха<br>AIR CONSUMPTION | нм³/ч<br>Nm³/H | —2 |
| 4 | Гидравлическое сопротивление печи<br>HYDRAULIC RESISTANCE OF FURNACE | Па<br>Pa | —1 |

SECTION 3

ТЕ ИСТИКА

ЕННОМУ ГЛИНОЗЕМУ Т/Ч — 25÷30
INA Т/Н

500 ккал/кг) НМ³/Ч —2100÷2500
7600 KCAL/KG) Nm³/H

НМ³/Ч —25000÷30000
Nm³/H

ЕНИЕ ПЕЧИ Па —11000÷12000
RNACE Pa

| № позиции SN. | Обозначение DESIGNATION | Наименование DESCRIPTION | Количество QTY | Ма MAT |
|---|---|---|---|---|
| 1 | — | Корпус теплообменника шахтного CASE OF SHAFT HEAT EXCHANGER | 1 | Ст STE |
| 2 | — | Корпус камеры кипящего слоя CASE OF FLUID BED CHAMBER | 1 | Ст ST |
| 3 | — | Футеровка теплообменника шахтного LINING OF SHAFT HEAT EXCHANGER | 1 | Ш FI |
| 4 | — | Футеровка камеры к ящего слоя LINING OF FLUID BED CHAMBER | 1 | Ш FI |
| 5 | — | Подина BOTTOM | 4 | Ст 15 ST 15 |

SECTION 4

| | |
|---|---|
| | ВАМИ Ленингр VAMI LENINGR |
| Масштаб SCALE 1:100 | Для Индийской фир Комп For BHARAT ALUMINI |
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25÷30
2100÷2500
25000÷30000
11000÷12000

| № позиции SN. | Обозначение DESIGNATION | Наименование DESCRIPTION | Количество QTY | Материал MATERIAL | Масса, кг MASS, KG 1 шт. 1 PC | Общ. TOTAL | Примечание REMARK |
|---|---|---|---|---|---|---|---|
| 1 | — | Корпус теплообменника шахтного / CASE OF SHAFT HEAT EXCHANGER | 1 | Сталь / STEEL | — | 35000 | |
| 2 | — | Корпус камеры кипящего слоя / CASE OF FLUID BED CHAMBER | 1 | Сталь / STEEL | — | 25000 | |
| 3 | — | Футеровка теплообменника шахтного / LINING OF SHAFT HEAT EXCHANGER | 1 | Шамот / FIRECLAY | — | 238000 | |
| 4 | — | Футеровка камеры кипящего слоя / LINING OF FLUID BED CHAMBER | 1 | Шамот / FIRECLAY | — | 102000 | |
| 5 | — | Подина / BOTTOM | 4 | Сталь 15Х5М / STEEL 15X5M | — | 5000 | |

SECTION 5

| | |
|---|---|
| ВАМИ Ленинград<br>VAMI LENINGRAD | |
| Масштаб SCALE 1:100 | Для индийской фирмы Бхарат Алюминиум Компани.<br>For BHARAT ALUMINIUM COMPANY LTD, INDIA |
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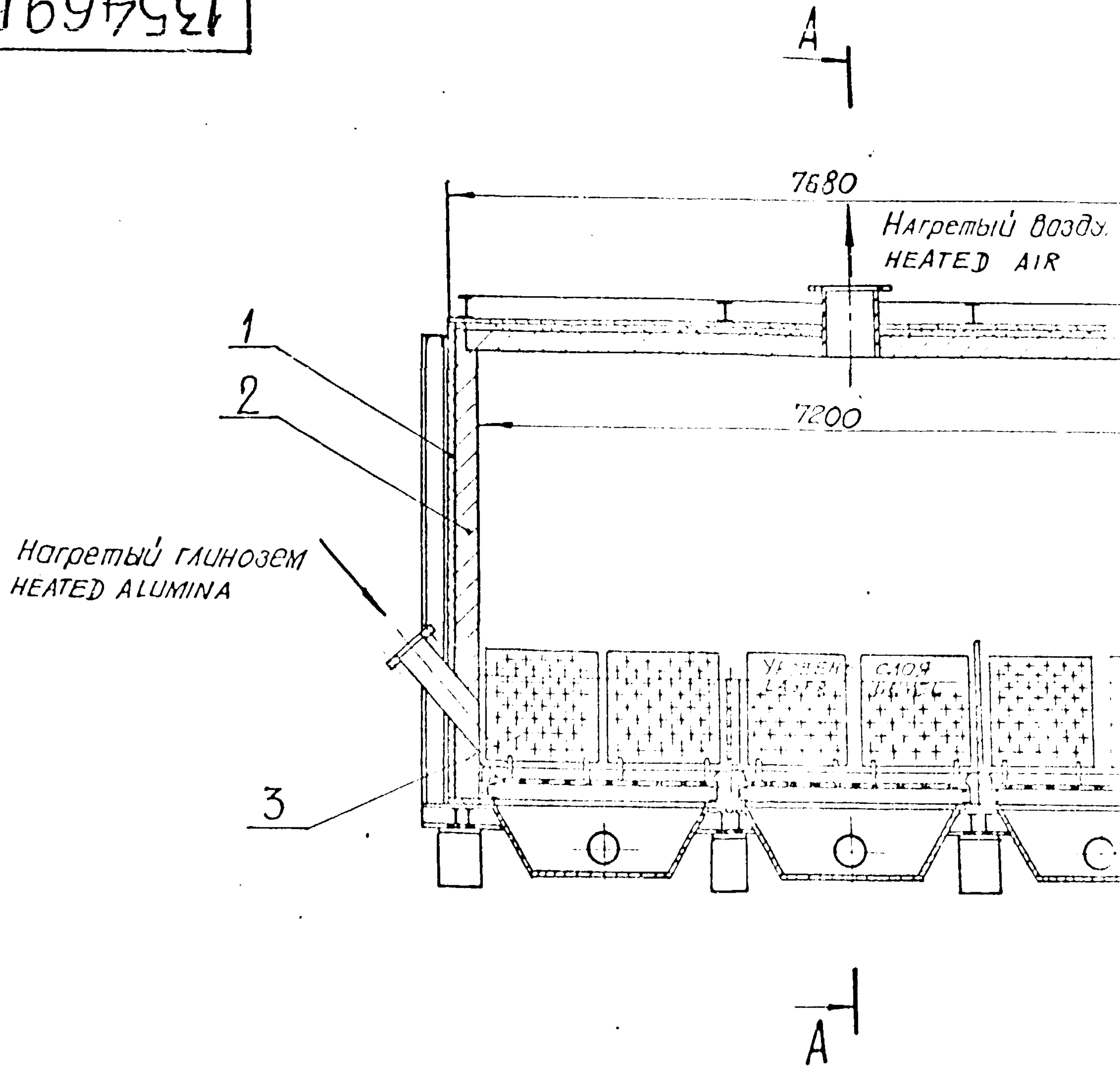
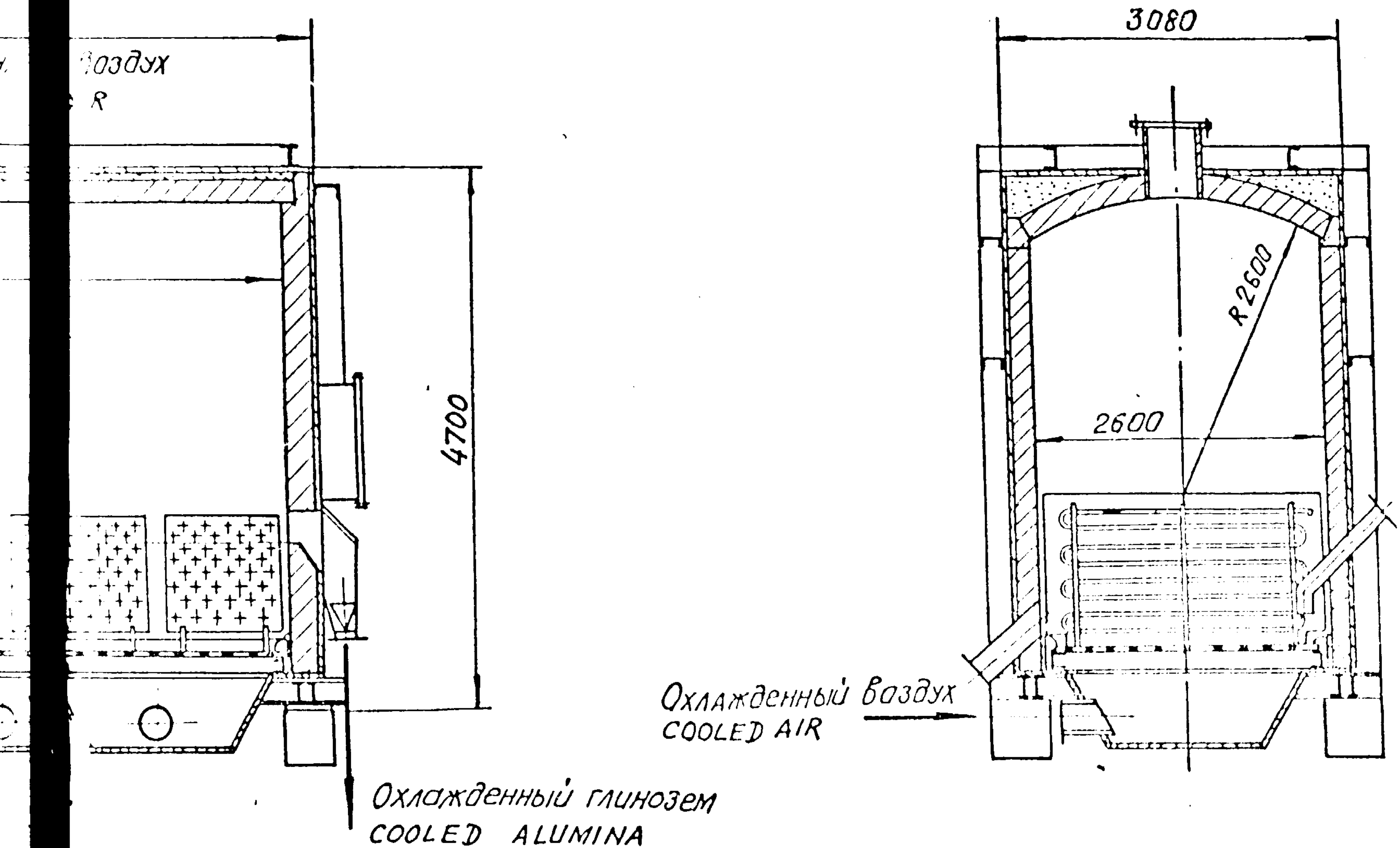
| | 1354696 ВО — Лист SHEET — Листов SHEETS 1 |



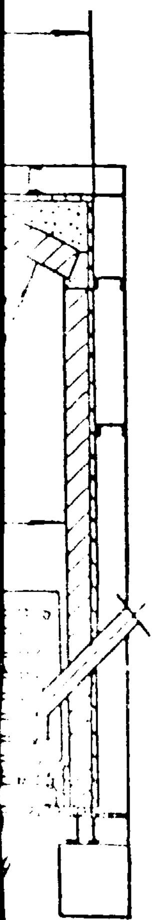
A
7680
Нагретый возд.
HEATED AIR
1
2
7200
Нагретый глинозем
HEATED ALUMINA
3
A


SECTION 1

## A – A


4700
Охлажденный глинозем
COOLED ALUMINA
3080
R2600
2600
Охлажденный воздух
COOLED AIR

SECTION 2



## ТЕХНИЧЕСКАЯ ХАРАКТЕРИСТИКА
## SPECIFICATION

1. Производительность т/ч ——— 25÷30
   CAPACITY T/H

2. Площадь теплообменной поверхности $м^2$ ——— 150
   HEAT EXCHANGE SURFACE $m^2$

3. Площадь доохладителя, $м^2$ ——— 18
   COOLING AREA, $m^2$

4. Гидравлическое сопротивление аппарата, Па ——— 12000÷13000
   HYDRAULIC RESISTANCE OF UNIT, PA

| N позиции / ITEM No | Обозначе... / DESIGNA... |
|---|---|
| 1 | — |
| 2 | — |
| 3 | — |
| | |
| | |
| | |

SECTION 3

Масштаб
SCALE 1

…СТИКА

25÷30

150

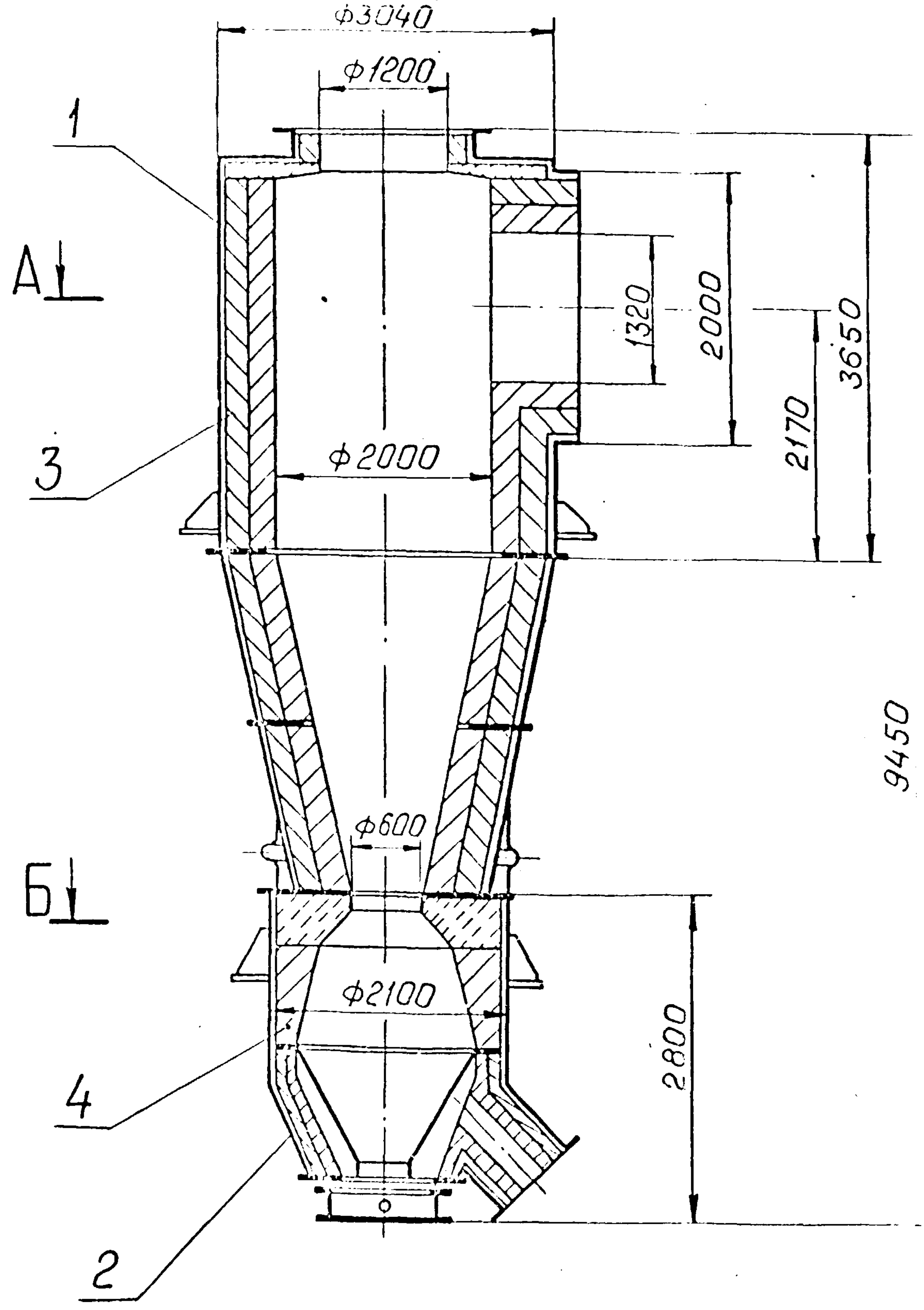
18

12000÷13000

| N позиции / ITEM No | Обозначение / DESIGNATION | Наименование / NAME | Количество / QUANTITY | Материал / MATERIAL | Масса, кг / MASS, KG: 1 шт / OF ONE PIECE | Масса, кг / MASS, KG: Общ. / TOTAL | Примечание / REMARK |
|---|---|---|---|---|---|---|---|
| 1 | — | Корпус CASING | 1 | Сталь / STEEL | — | 60000 | |
| 2 | — | Футеровка LINING | 1 | Шамот / FIRECLAY | — | 60000 | |
| 3 | — | Теплообменник змеевиковый COIL TYPE EXCHANGER | 1 | Сталь / STEEL | — | 9000 | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

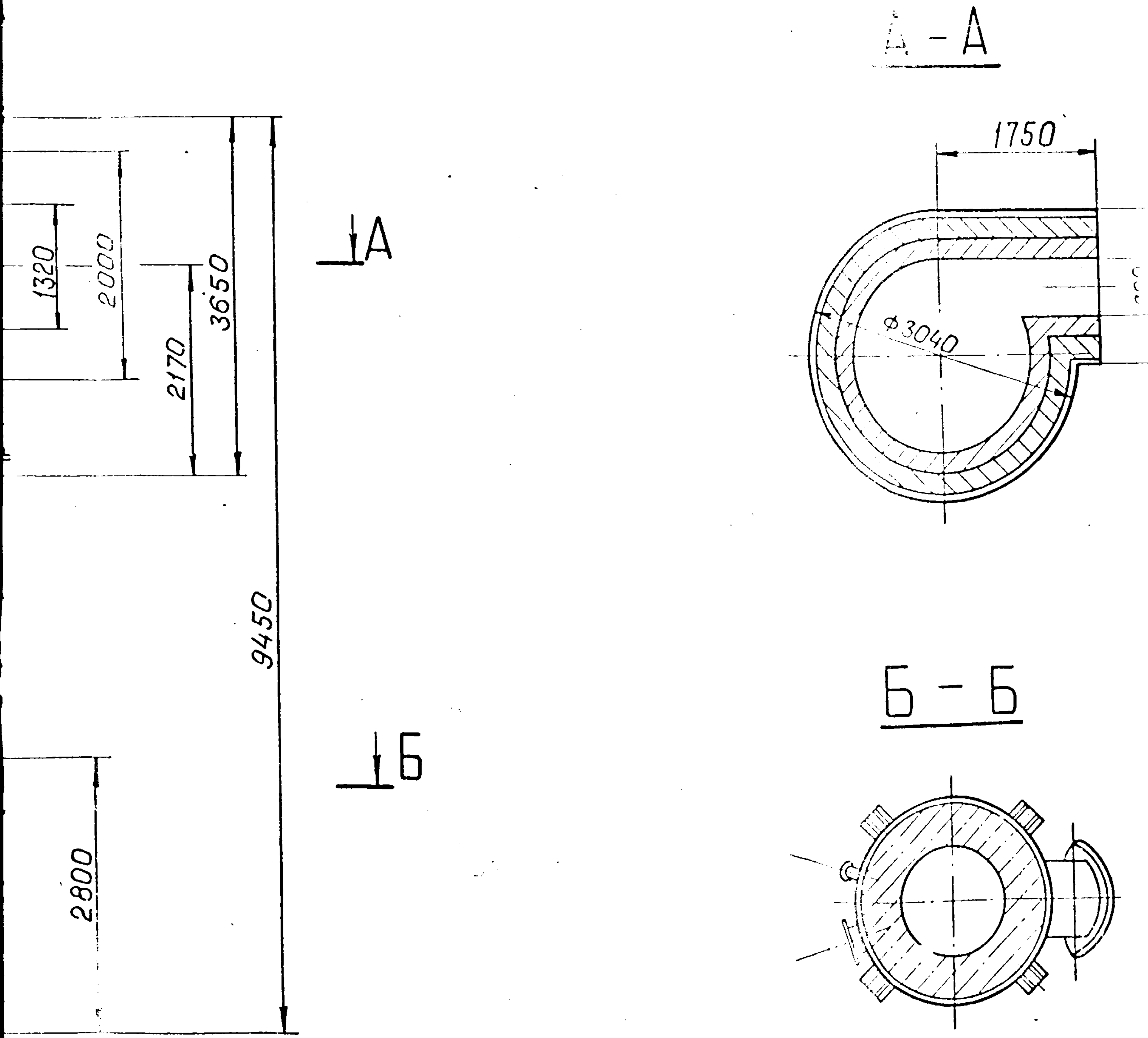
SECTION 4

| | |
|---|---|
| ВАМИ ЛЕНИНГРАД<br>VAMI LENINGRAD | |
| Масштаб SCALE 1:50 | ДЛЯ ИНДИЙСКОЙ ФИРМЫ БХАРАТ АЛЮМИНИУМ КОМПАНИ.<br>FOR BHARAT ALUMINIUM COMPANY LTD, INDIA |
| Данный [illegible] является собств[illegible] института ВАМИ и не может быть скопирован [illegible] без [illegible]<br>THIS [illegible] PROPERTY OF VAMI [illegible] TO BE COPIED [illegible] WITHOUT OUR [illegible] | ГЛИНОЗЕМНЫЙ ЗАВОД В КОРБЕ РЕКОНСТРУКЦИЯ ЦЕХА КАЛЬЦИНАЦИИ. III ЭТАП. ДООХЛАДИТЕЛЬ КИПЯЩЕГО СЛОЯ. ЧЕРТЕЖ ОБЩЕГО ВИДА.<br>KORBA ALUMINA PLANT. RECONSTRUCTION OF CALCINATION. STAGE III FLUID BED COOLER GENERAL VIEW DRAWING |
| | 1354695 ВО — Лист SHEET — Листов SHEETS 1 |



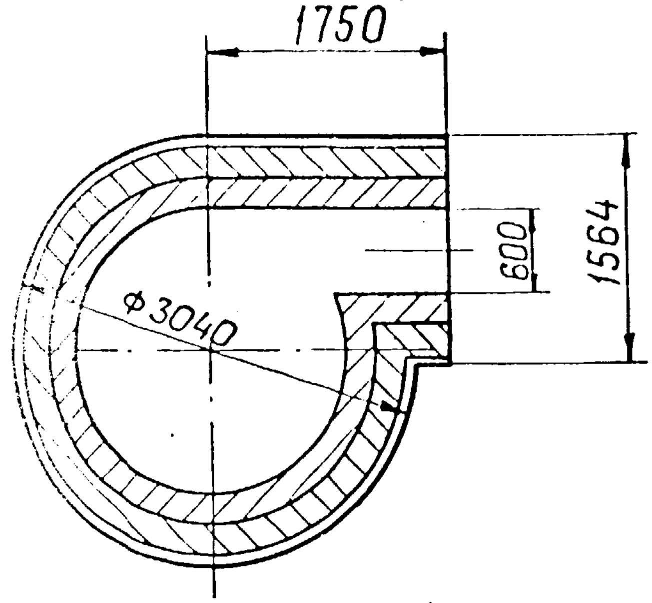
ф3040
ф1200
1
А
1320
2000
3650
2170
3
ф2000
9450
ф600
Б
ф2100
2800
4
2


SECTION 1




SECTION 2

## А - А




Техническая ха

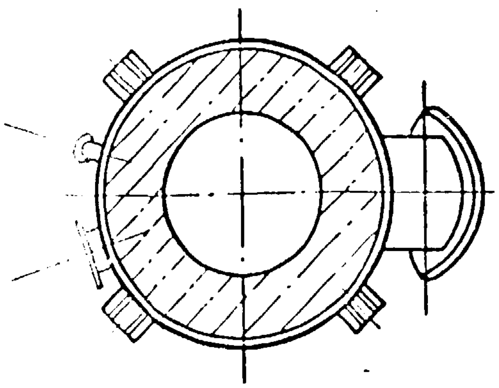
SPECIFICATIO

1. Количество воздуха, $м^3/ч$
AIR VOLUME, $m^3/H$

2. Температура нагретого воздух
TEMPERATURE OF HEATED AIR,

3. Гидравлическое сопротивление
HYDRAULIC RESISTANCE OF CYC

## Б - Б



SECTION 3

| № позиции<br>Item No | Обозначение<br>Designation |
|---|---|
| 1 | — |
| 2 | — |
| 3 | — |
| 4 | — |

## Техническая характеристика
## SPECIFICATION

1. Количество воздуха, $м^3/ч$ 25000-30000
   AIR VOLUME, $m^3/H$
2. Температура нагретого воздуха, °C 700-800
   TEMPERATURE OF HEATED AIR, °C
3. Гидравлическое сопротивление циклона, Па 500-600
   HYDRAULIC RESISTANCE OF CYCLONE, Pa

SECTION 4

Масштаб
SCALE 1:5[illegible]

...истика

25000-30000

700-800

7а 500-600

| № позиции / Item No | Обозначение / Designation | Наименование / Name | Количество / Quantity | Материал / Material | Масса, кг / Mass, kg: 1 шт / Of one piece | Масса, кг / Mass, kg: Общ. / Total | Примечание / Remark |
|---|---|---|---|---|---|---|---|
| 1 | — | Корпус теплообменника циклонного / CYCLONE HEAT EXCHANGER CASING | 1 | Сталь / STEEL | — | 5000 | |
| 2 | — | Корпус бункера-затвора кипящего слоя. / CASING OF FIUID BED GATE BUNKER | 1 | Сталь / STEEL | — | 2000 | |
| 3 | — | Футеровка теплообменника циклонного / LINING OF CYCLONE HEAT EXCHANGER | 1 | Шамот / FIRECLAY | — | 60000 | |
| 4 | — | Футеровка бункера затвора кипящего слоя / LINING OF FLUID BED GATE BUNKER | 1 | Шамот / FIRECLAY | — | 9200 | |

SECTION 5

ВАМИ ЛЕНИНГРАД
VAMI LENINGRAD

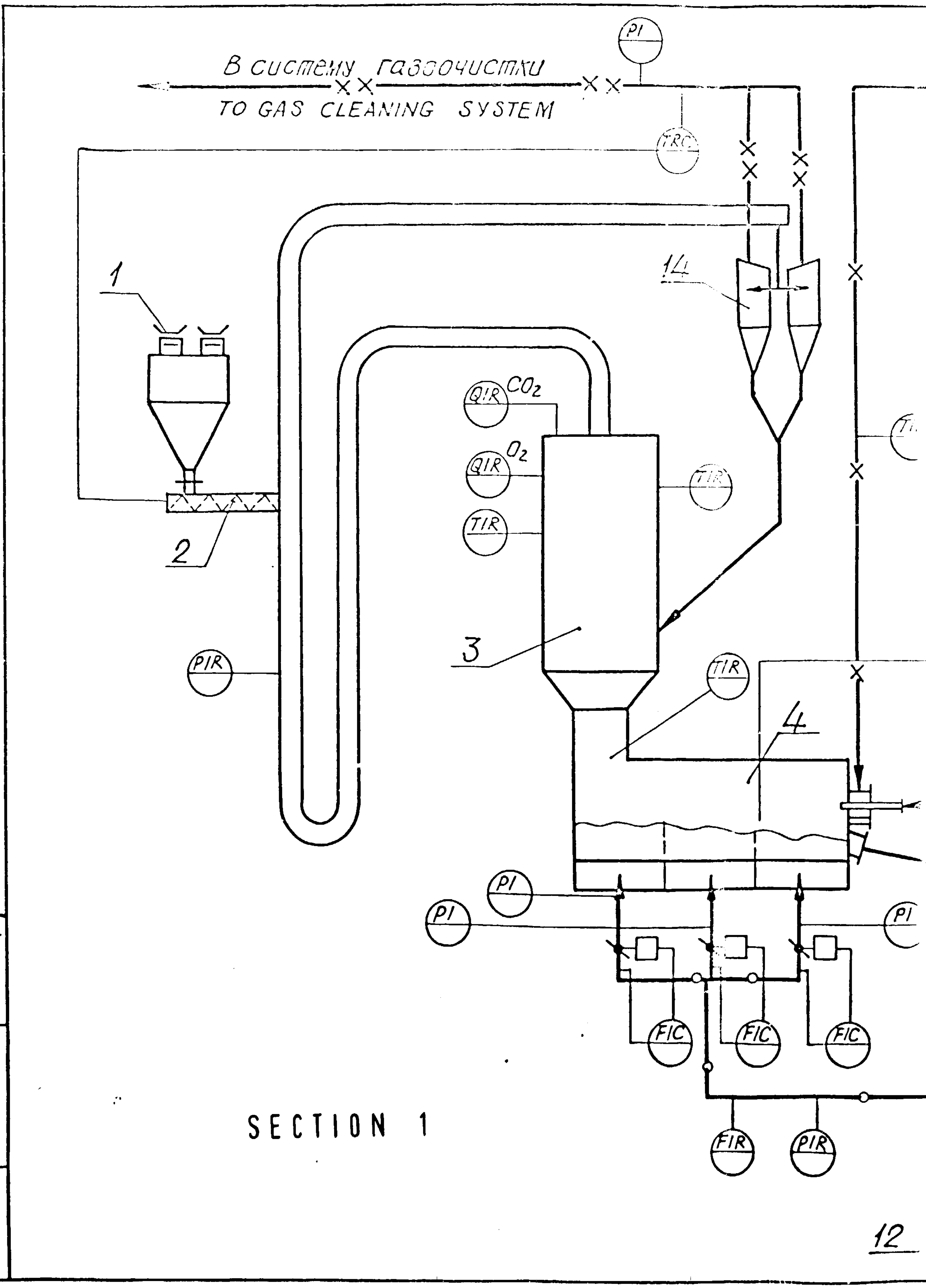
Масштаб / SCALE 1:50

Для Индийской фирмы Бхарат Алюминиум Компани
FOR BHARAT ALUMINIUM COMPANY LTD, INDIA



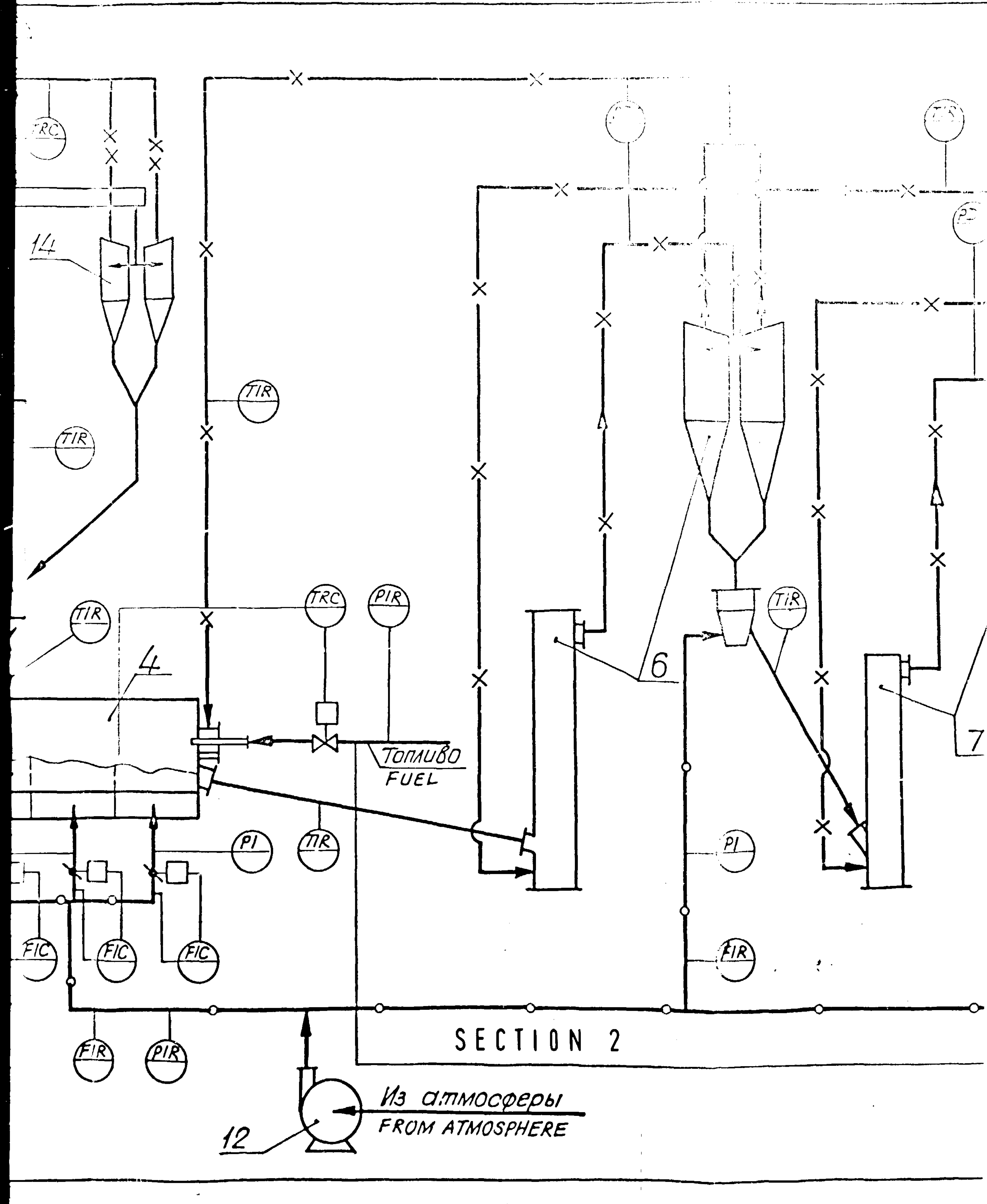
Глиноземный завод в Корбе. Реконструкция цеха кальцинации. III этап. Теплообменник циклонный. Чертеж общего вида.
KORBA ALUMINA PLANT. RECONSTRUCTION OF CALCINATION. STAGE III. CYCLONE HEAT EXCHANGER. GENERAL VIEW DRAWING.

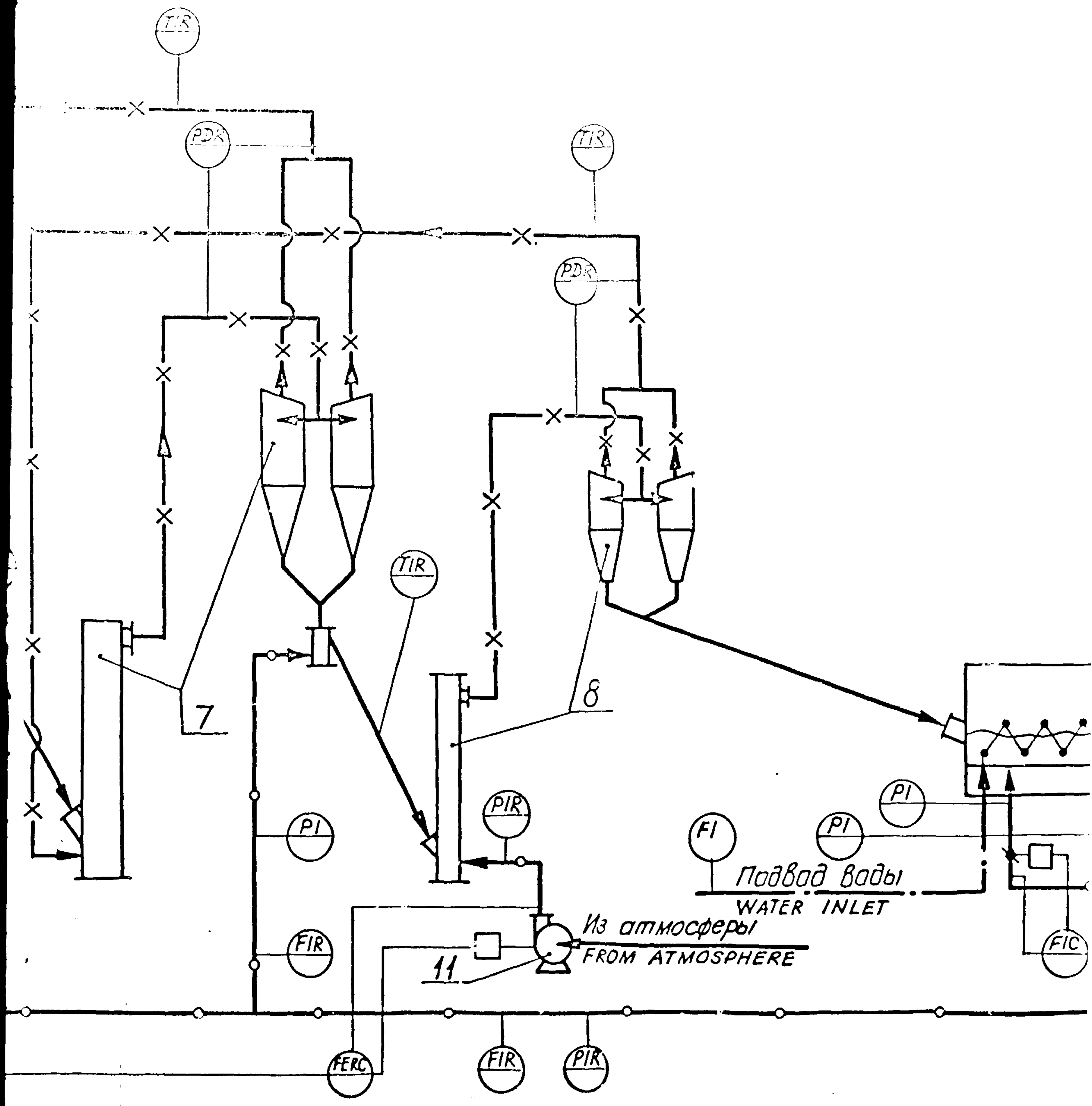
13546940 | Лист / SHEET | Листов / SHEETS 1




SECTION 1

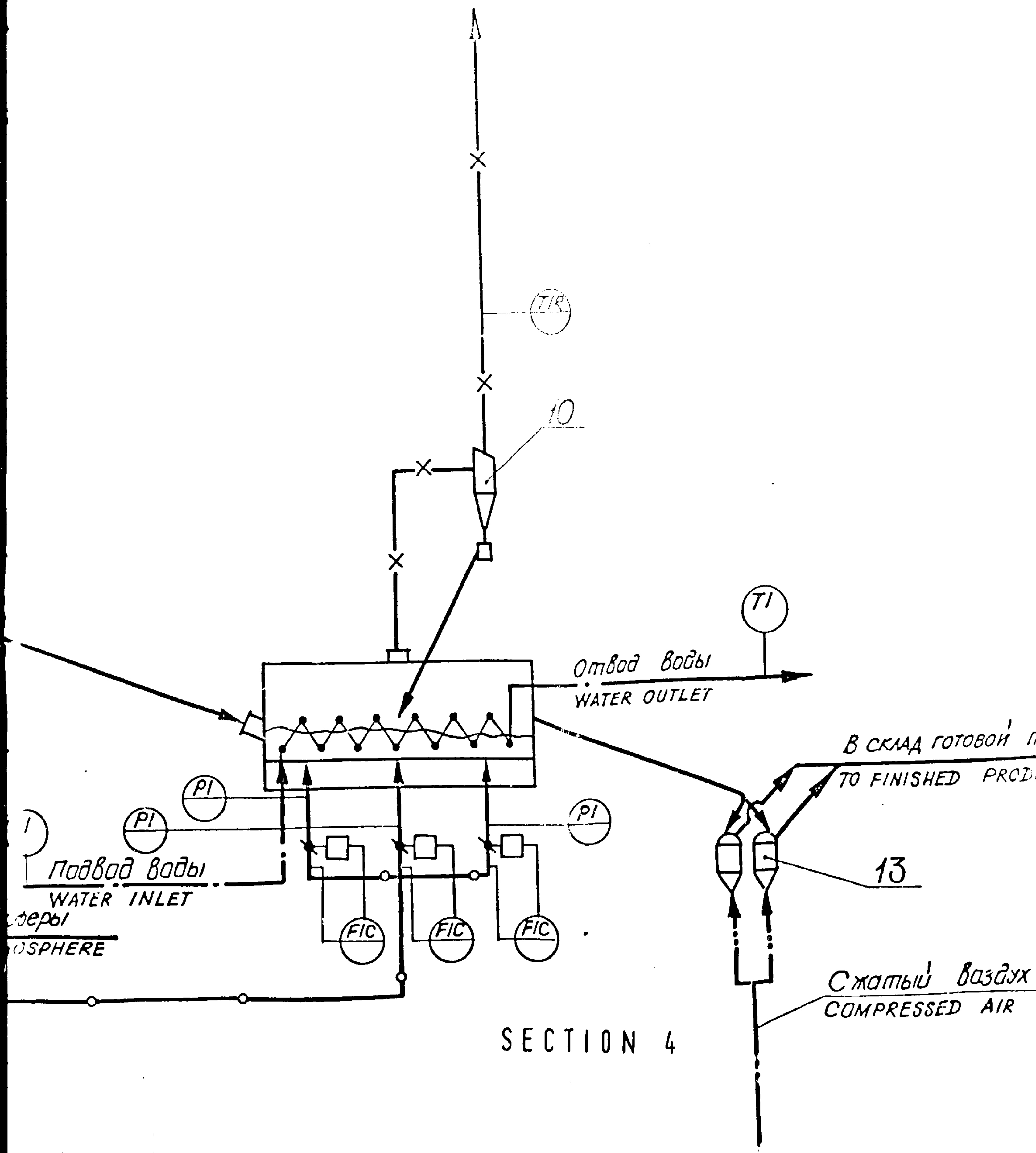
Инв. № подл. | Подп. и дата | Взам. инв. №


TRC
14
TIR
TIR
TIR
4
TRC
PIR
Топливо
FUEL
PI
TIR
FIC
FIC
FIC
FIR
PIR
6
TIR
7
PI
FIR
SECTION 2
Из атмосферы
FROM ATMOSPHERE
12



TIR
PDR
TIR
PDR
TIR
7
8
PIR
PI
FI
PI
PI
Подвод воды
WATER INLET
Из атмосферы
FROM ATMOSPHERE
FIR
11
FIC
FERC
FIR
PIR


SECTION 3


TIR
10
TI
Отвод воды
WATER OUTLET
В склад готовой п
TO FINISHED PROD
PI
PI
PI
Подвод воды
WATER INLET
FIC
FIC
FIC
13
Сжатый воздух
COMPRESSED AIR
сферы
OSPHERE

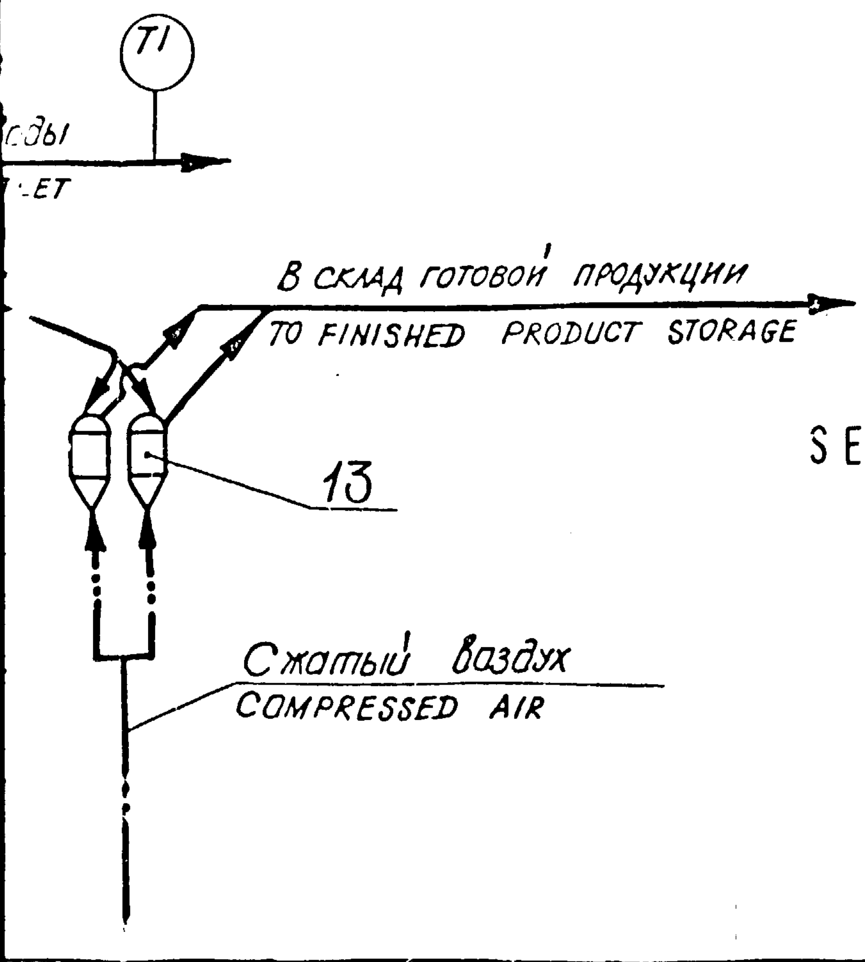
SECTION 4

## Условные обозначения
## LEGEND

| | |
|---|---|
| ——— | Материал / MATERIAL |
| —xx— | Отходящие газы / FLUE GASES |
| —o— | Воздух / AIR |
| —·— | Вода / WATER |
| —··— | Сжатый воздух / COMPRESSED AIR |
| —x— | Нагретый воздух / HEATED AIR |

1. Схема выполнена н
чертежа 1354697-т
2. Условные обозначен
автоматизации да

1. THE FLOWSHEET IS BAS
2. THE SYMBOLS OF INSTRU
DEVICES ARE GIVEN O




SECTION 5

ВАМИ
VAMI

Масштаб — / SCALE —

Для Инд / FOR BHARA

Данный чертеж является собственностью института ВАМИ и не может быть скопирован и использован без его разрешения



Глинозем
Кальцина
ская с точ
Корба ALU
III STAGE. E
MONITOR

13

## Условные обозначения
## LEGEND

Материал
MATERIAL

Отходящие газы
FLUE GASES

Воздух
AIR

Вода
WATER

Сжатый воздух
COMPRESSED AIR

Нагретый воздух
HEATED AIR

| | |
|---|---|
| Контуры контроля<br>MONITORING CIRCUITS | 44 |
| Контуры регулирования<br>CONTROL CIRCUITS | 9 |

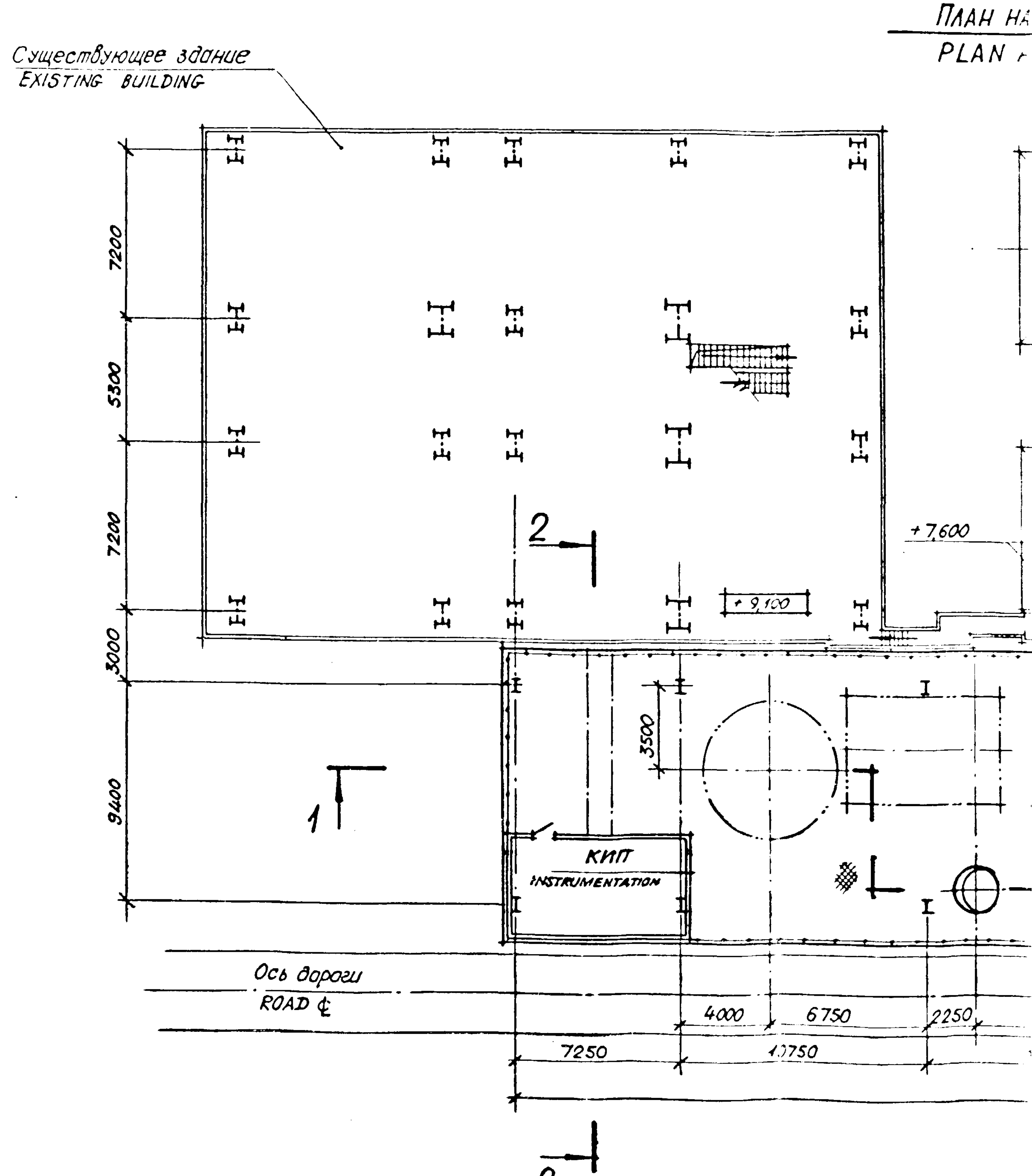
1. Схема выполнена на основании чертежа 1354697-ТМ
2. Условные обозначения приборов и средств автоматизации даны на чертеже 1355573-КА

1. THE FLOWSHEET IS BASED ON DWG 1354697-TM
2. THE SYMBOLS OF INSTRUMENTS AND AUTOMATION DEVICES ARE GIVEN ON DWG 1355573-KA

SECTION 6

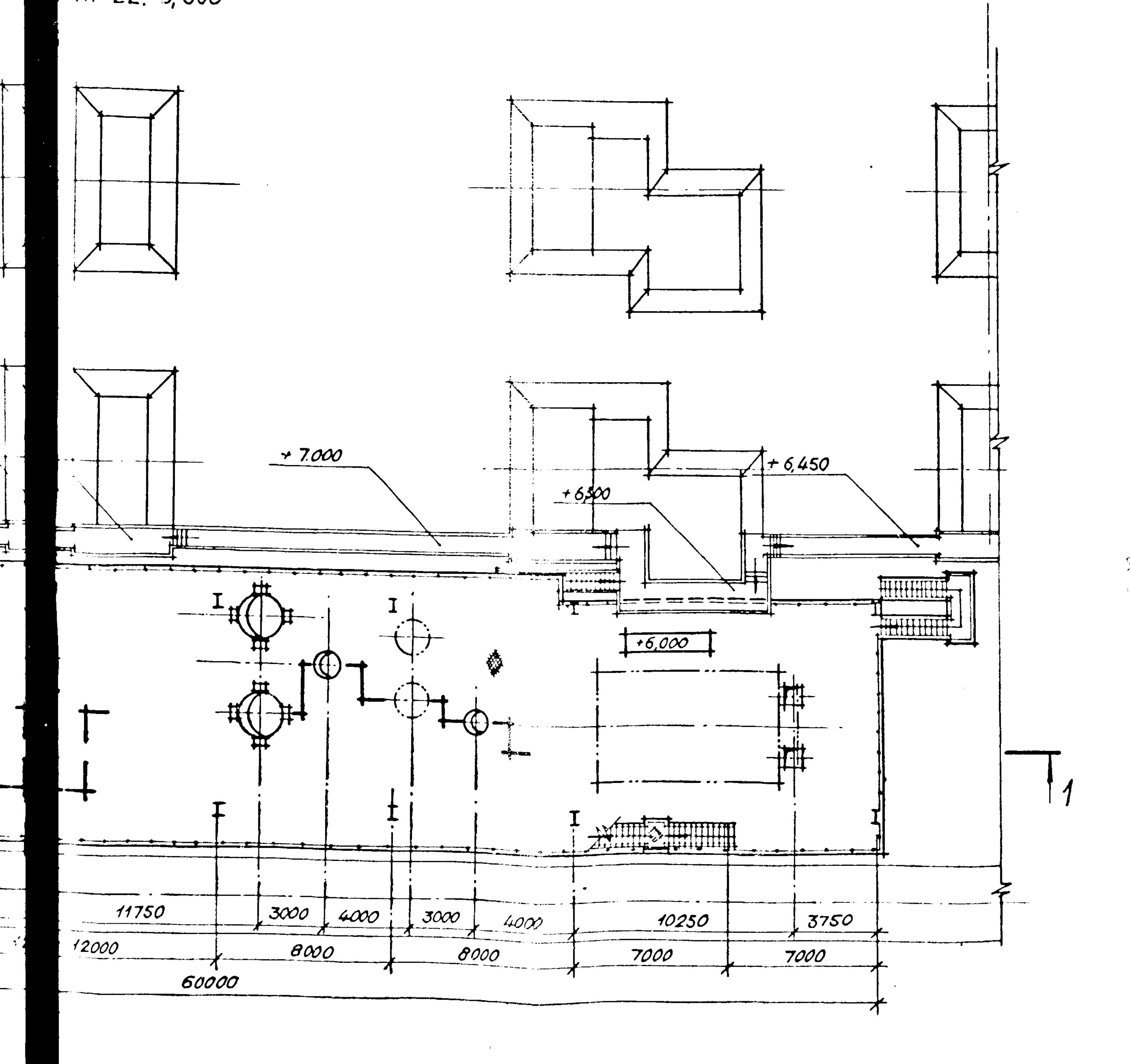
ВАМИ Ленинград
VAMI LENINGRAD

| | |
|---|---|
| Масштаб<br>SCALE — | Для Индийской фирмы Бхарат Алюминиум Компани.<br>FOR BHARAT ALUMINIUM COMPANY LTD, INDIA |
| Данный чертеж является собственностью института ВАМИ и не может быть скопирован и использован без его разрешения<br>THIS DRAWING IS THE PROPERTY OF VAMI AND NOT TO BE COPIED OR USED WITHOUT OUR PERMISSION | Глиноземный завод в Корбе. Реконструкция цеха кальцинации, III этап. Схема аппаратурно-технологическая с точками контроля и регулирования.<br>KORBA ALUMINA PLANT. RECONSTRUCTION OF CALCINATION. III STAGE. EQUIPMENT AND PROCESS FLOWSHEET WITH MONITORING AND CONTROL POINTS. |
| | 1355576-KA — Лист / SHEET — Листов / SHEETS 1 |


ПЛАН НА
PLAN
Существующее здание
EXISTING BUILDING
7200
5300
7200
3000
9400
3500
2
2
1
+7,600
+9,100
КИП
INSTRUMENTATION
Ось дороги
ROAD ¢
4000
6750
2250
7250
10750

SECTION 1

HA OTM. 6,000
AT EL. 6,000



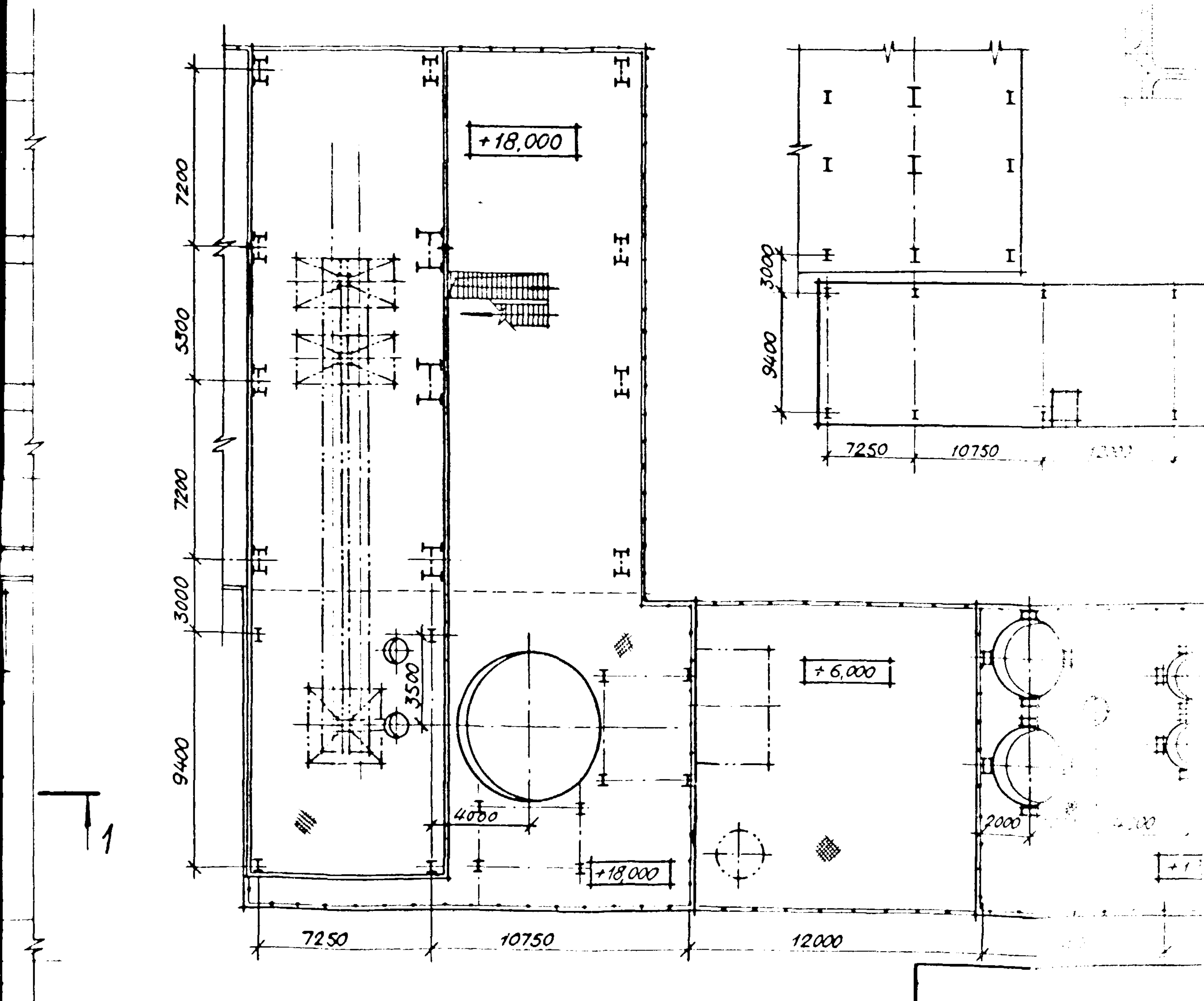

SECTION 2

ПЛАН НА ОТМ. 12,000; 18,000

PLAN AT EL. 12,000; 18,000

ПЛАН НА ОТМ. 0,000

PLAN AT EL. 0,000




SECTION 3

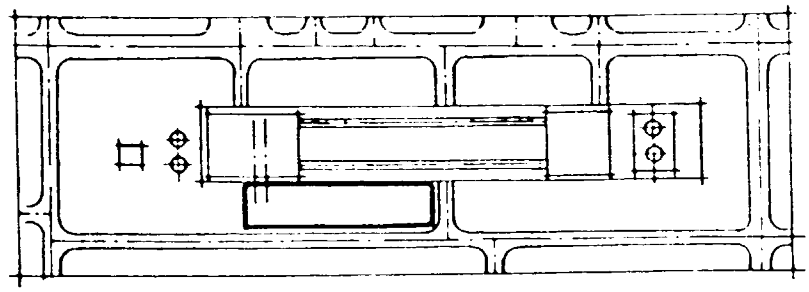
Масштаб
SCALE

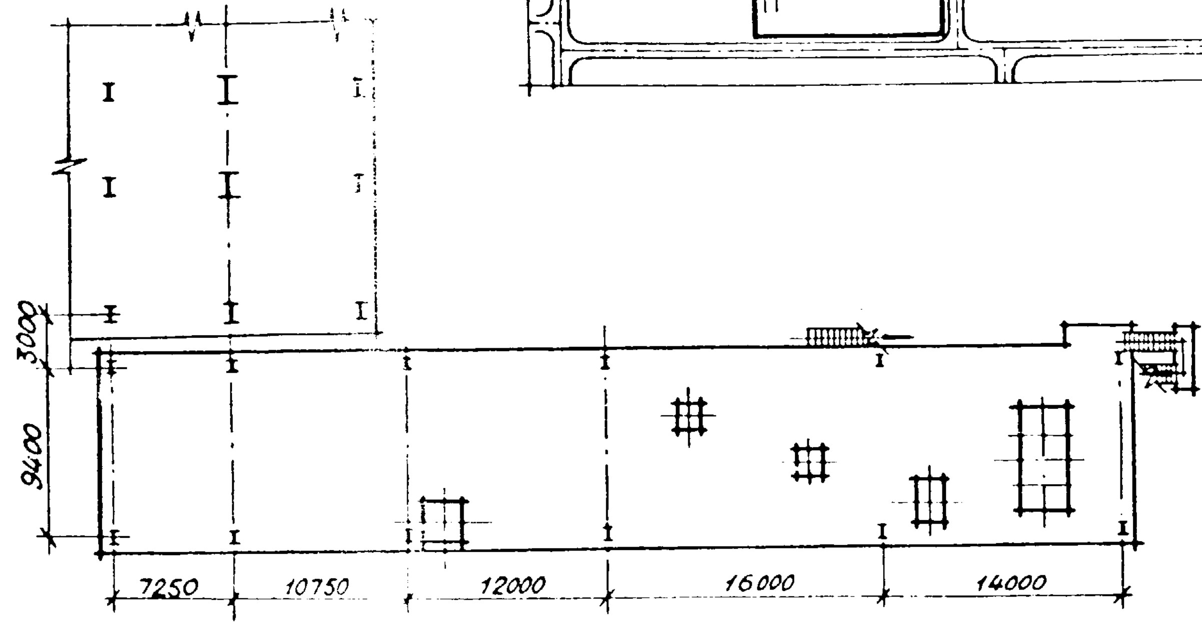
Данный чер...
собственно...
ВАМИ и н...
скопирован...
без его ра...

THIS DRAWIN... PROPER-
TY OF VAMI ...

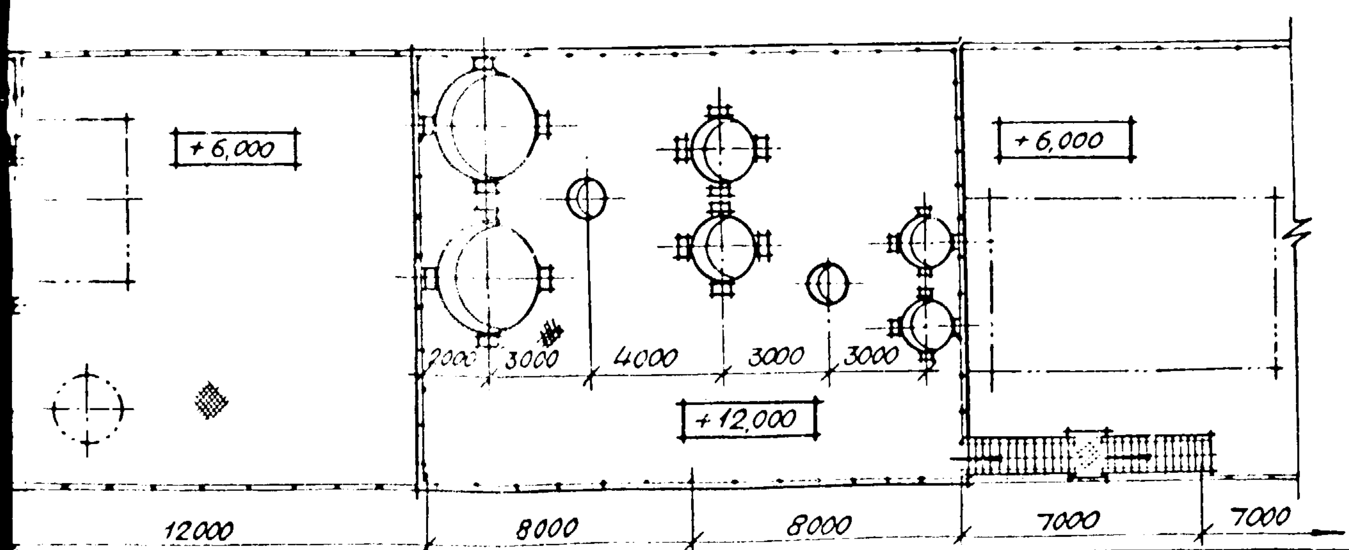
ПЛАН НА ОТМ. 0,000

PLAN AT EL. 0,000






SECTION 4




ВАМИ Ленинград

VAMI LENINGRAD

Масштаб
SCALE 1:200; 1:400

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ДЛЯ ИНДИЙСКОЙ ФИРМЫ БХАРАТ АЛЮМИНИУМ КОМПАНИ.

FOR BHARAT ALUMINIUM COMPANY LTD, INDIA

ГЛИНОЗЕМНЫЙ ЗАВОД В КОРБЕ. РЕКОНСТРУКЦИЯ ЦЕХА КАЛЬЦИНАЦИИ. III ЭТАП. ПЛАНЫ НА ОТМ. 0,000; 6,000; 12,000; 18,000

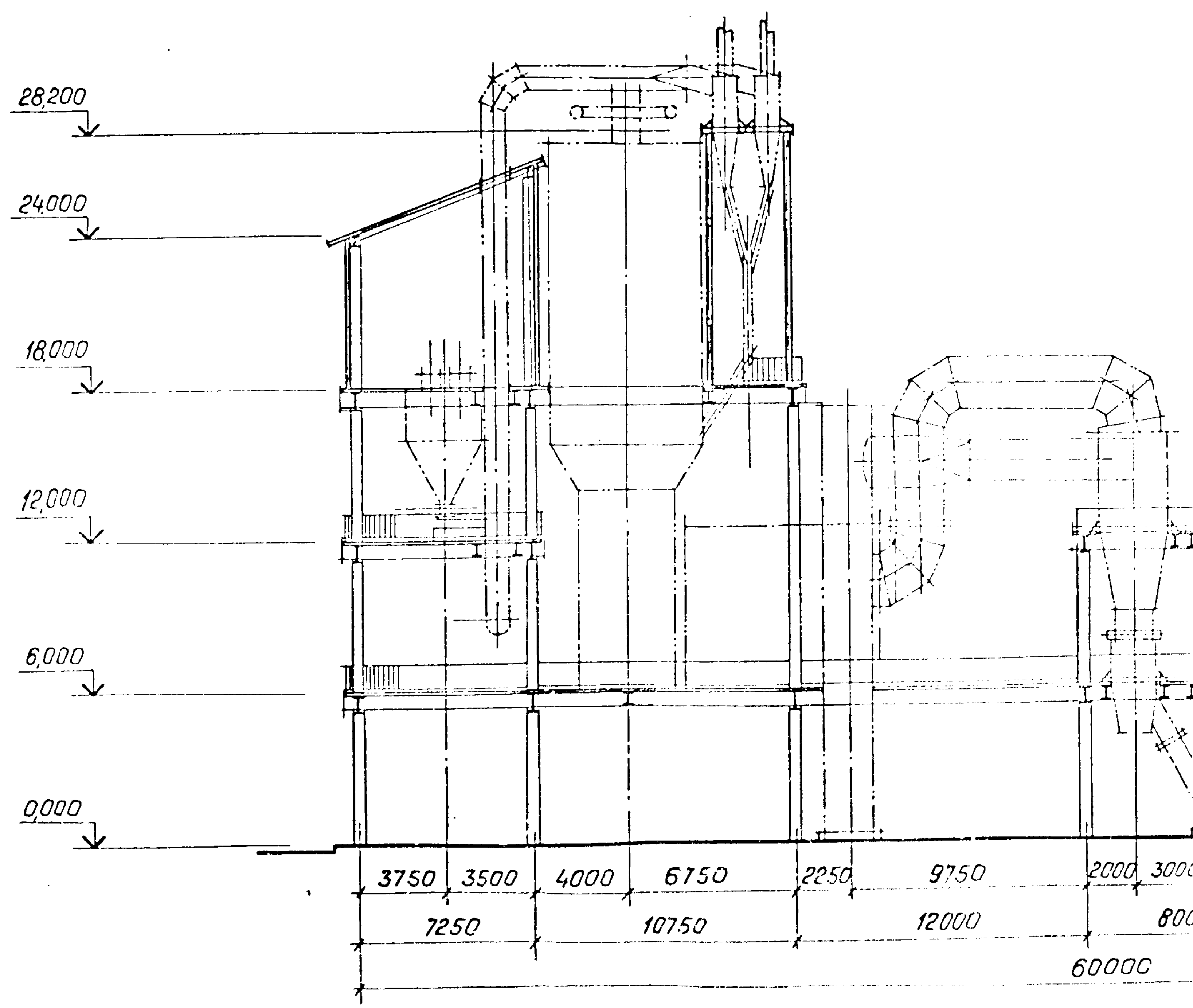
KORBA ALUMINA PLANT. RECONSTRUCTION OF CALCINATION STAGE III. PLANS AT EL. 0,000; 6,000; 12,000; 18,000

1332929-AC

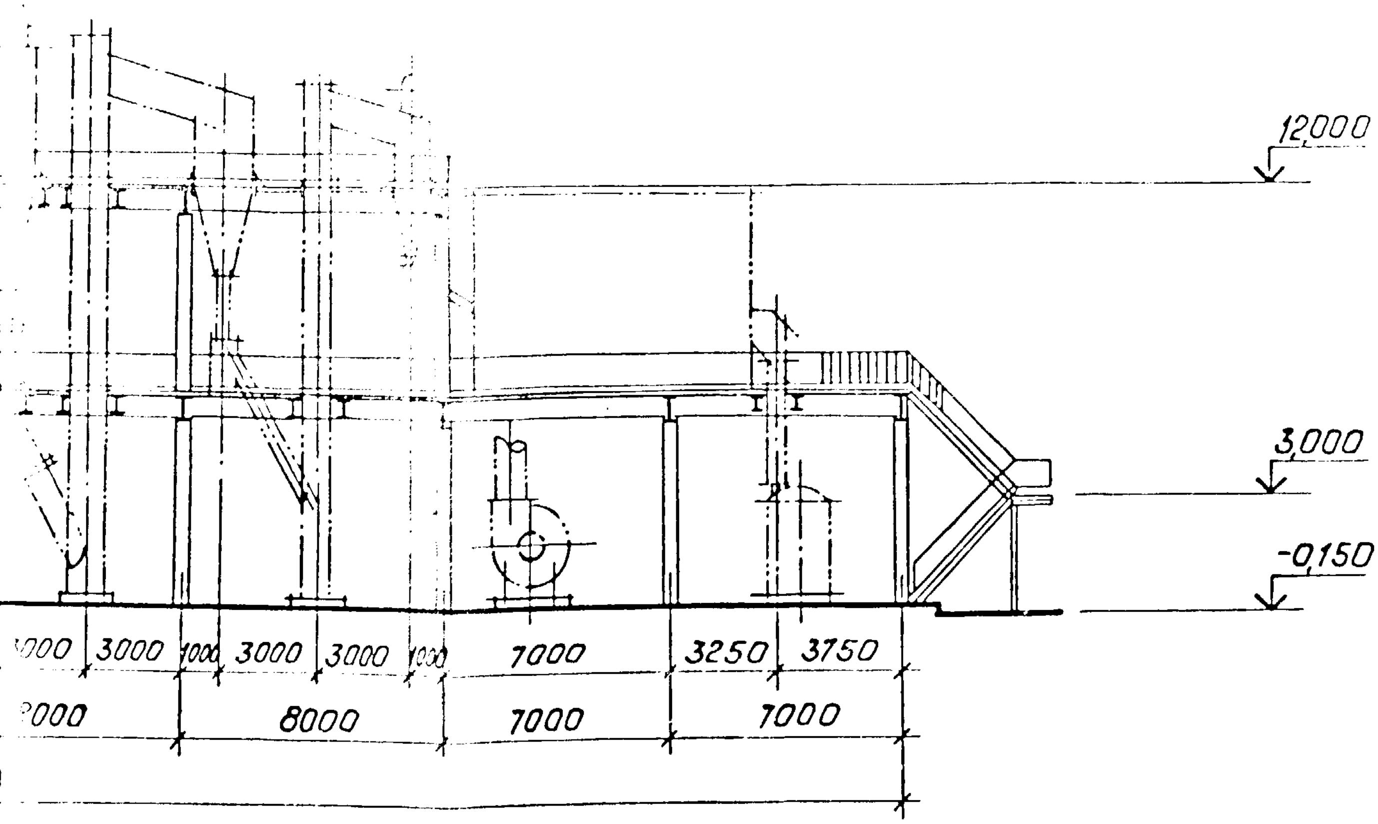
Лист
SHEET 1

Листов
SHEETS 2

Разрез 1-1
SECTION 1-1

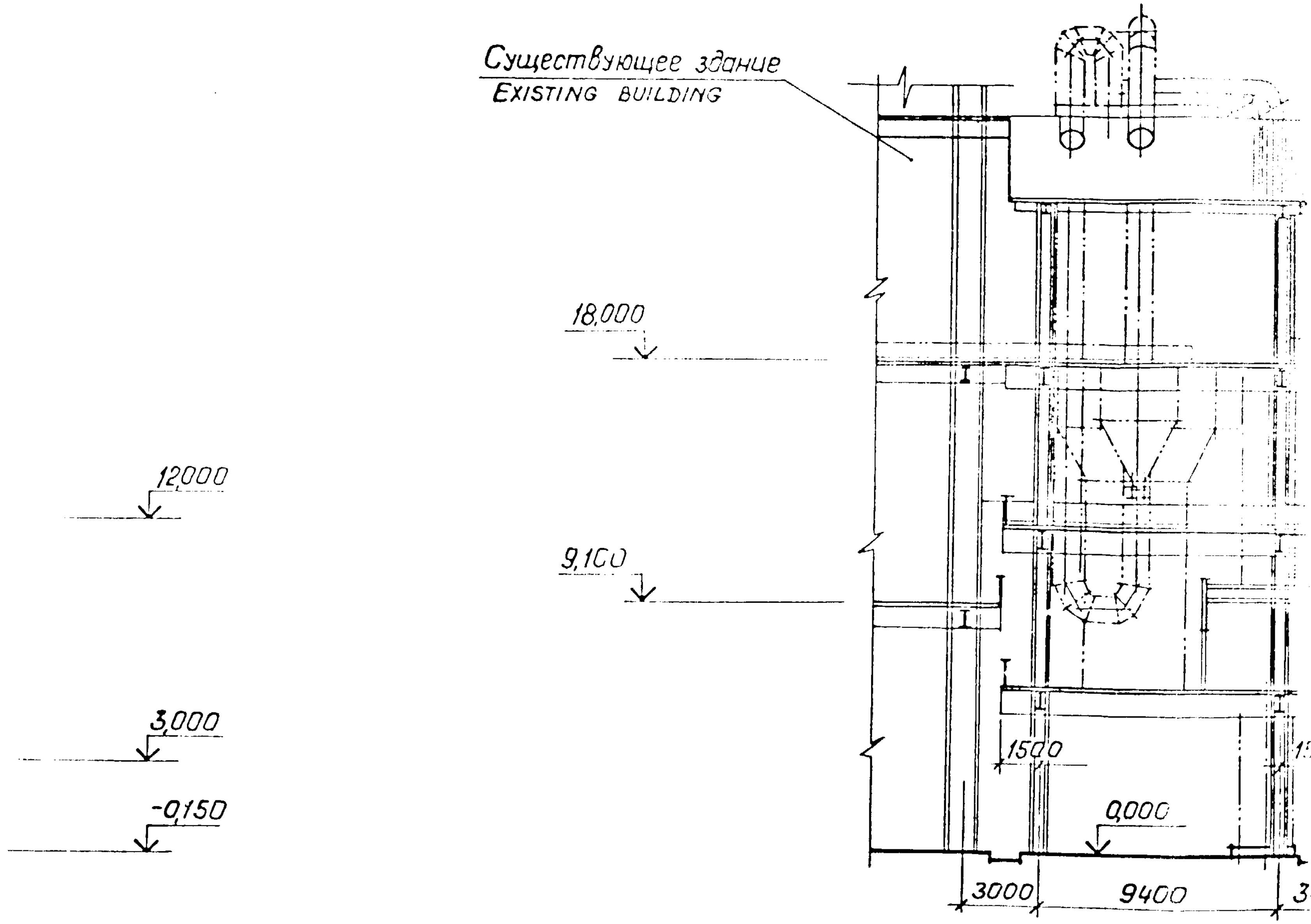



SECTION 1


12,000
3,000
-0,150
3000
1000
3000
3000
1000
7000
3250
3750
8000
7000
7000

SECTION 2

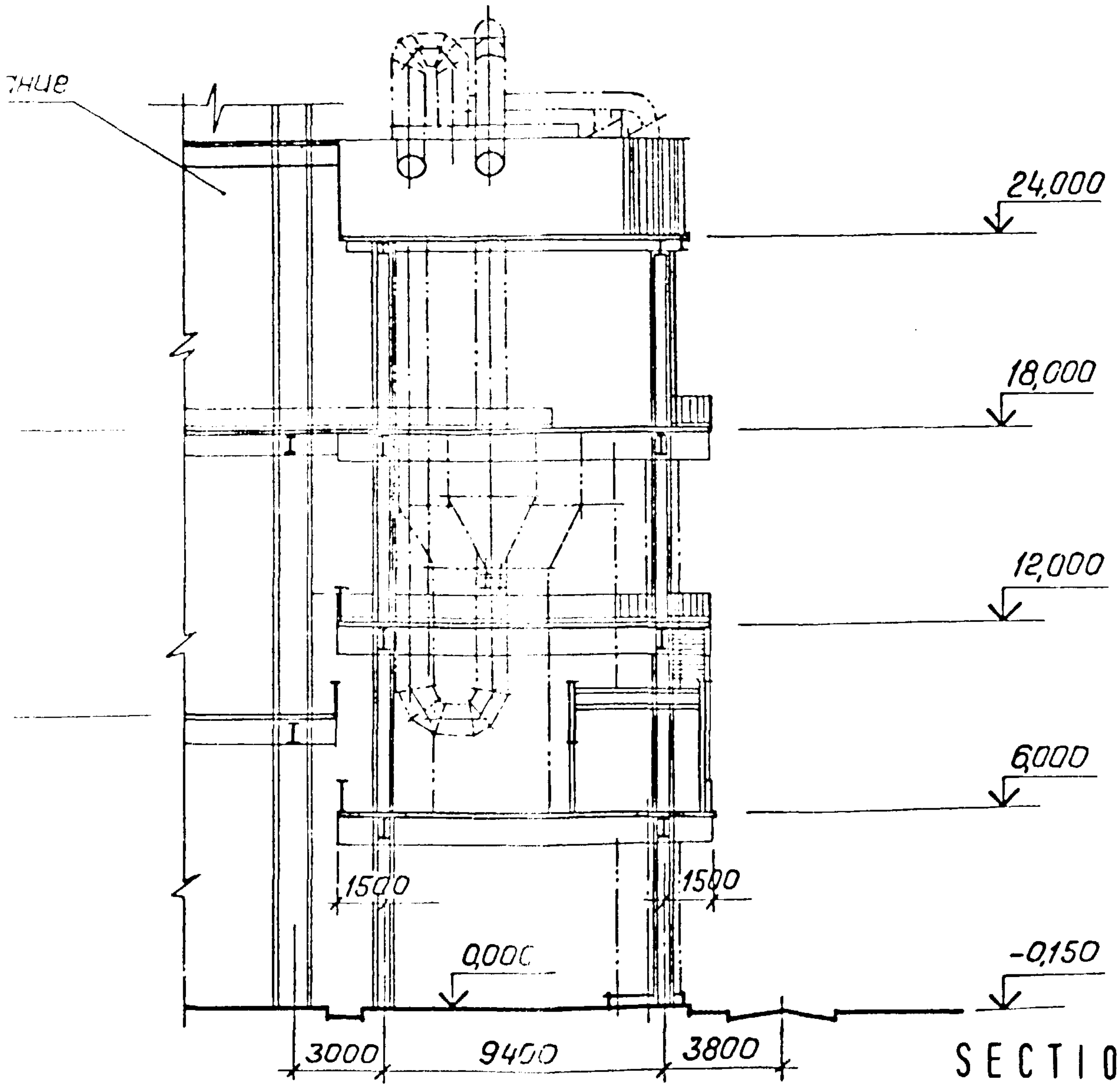
## Разрез 2-2
## SECTION 2-2




SECTION 3

| | |
|---|---|
| Масштаб SCALE 1:200 | Для |
| Данный чертеж является собственностью института ВАМИ и не может быть скопирован и использован без его разрешения | FOR |
| THIS DRAWING IS THE PROPERTY OF VAMI AND NOT TO BE COPIED OR USED WITHOUT OUR PERMISSION | Кон ST |

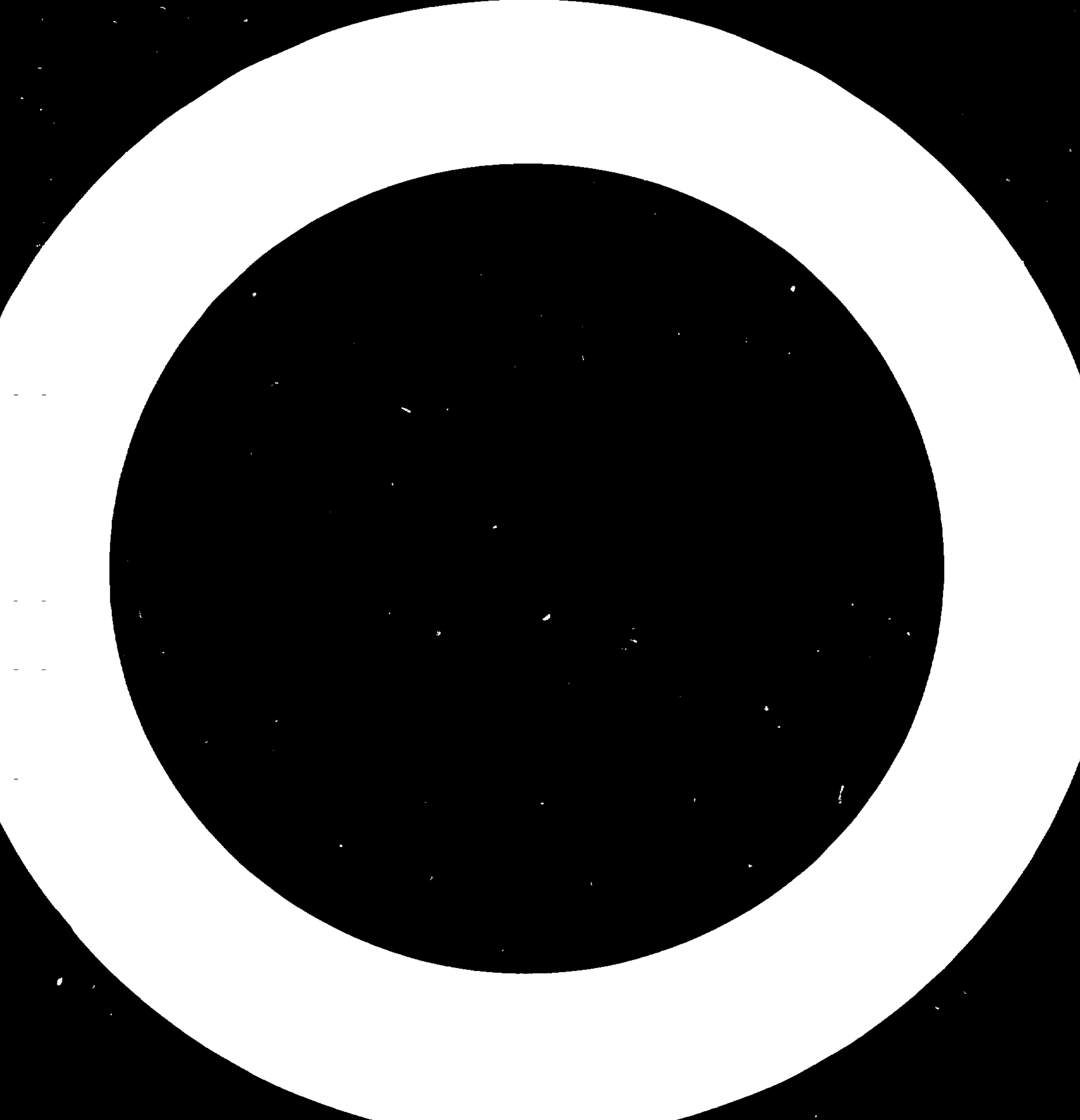
## Разрез 2-2
## Section 2-2

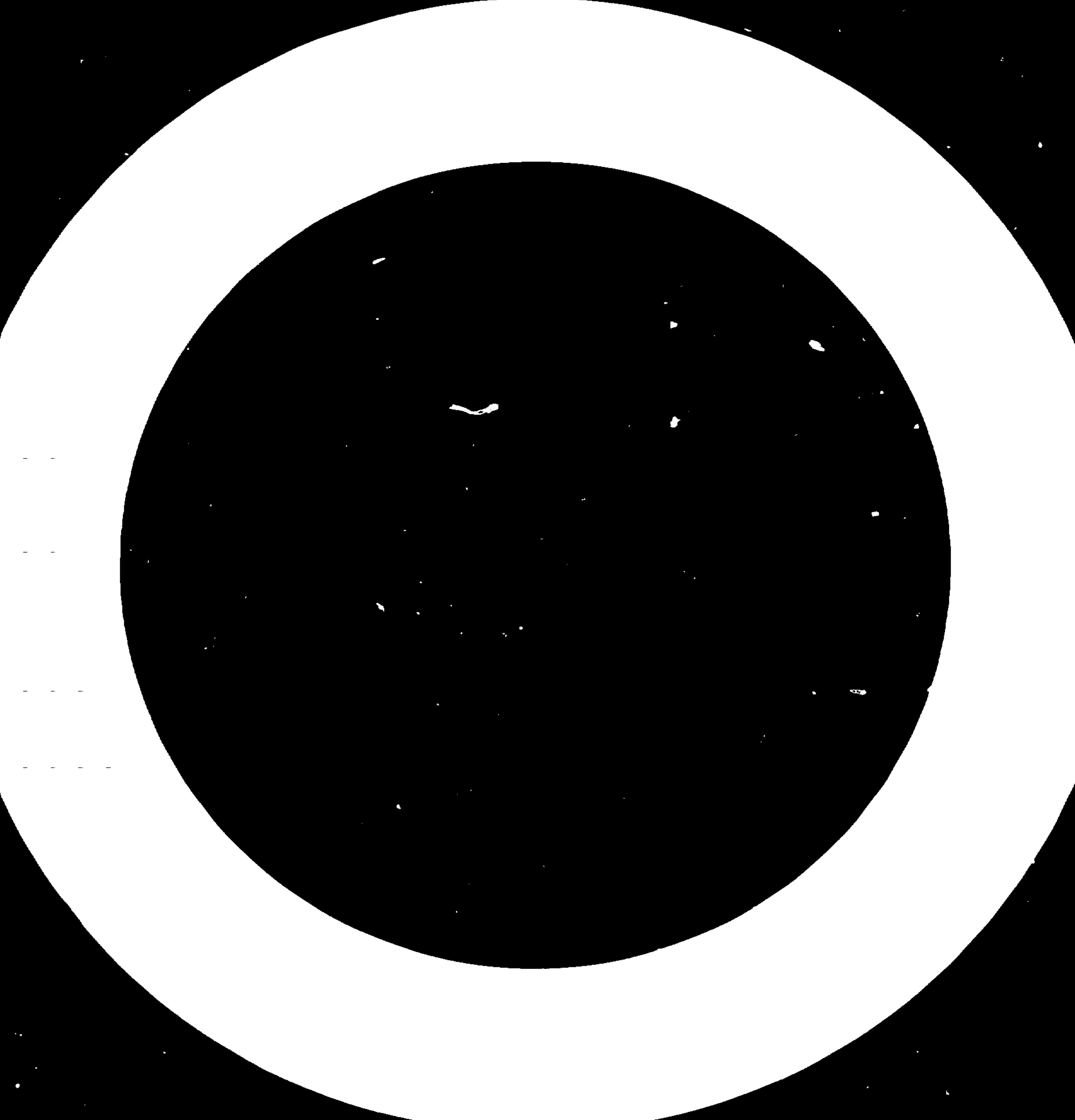



SECTION 4

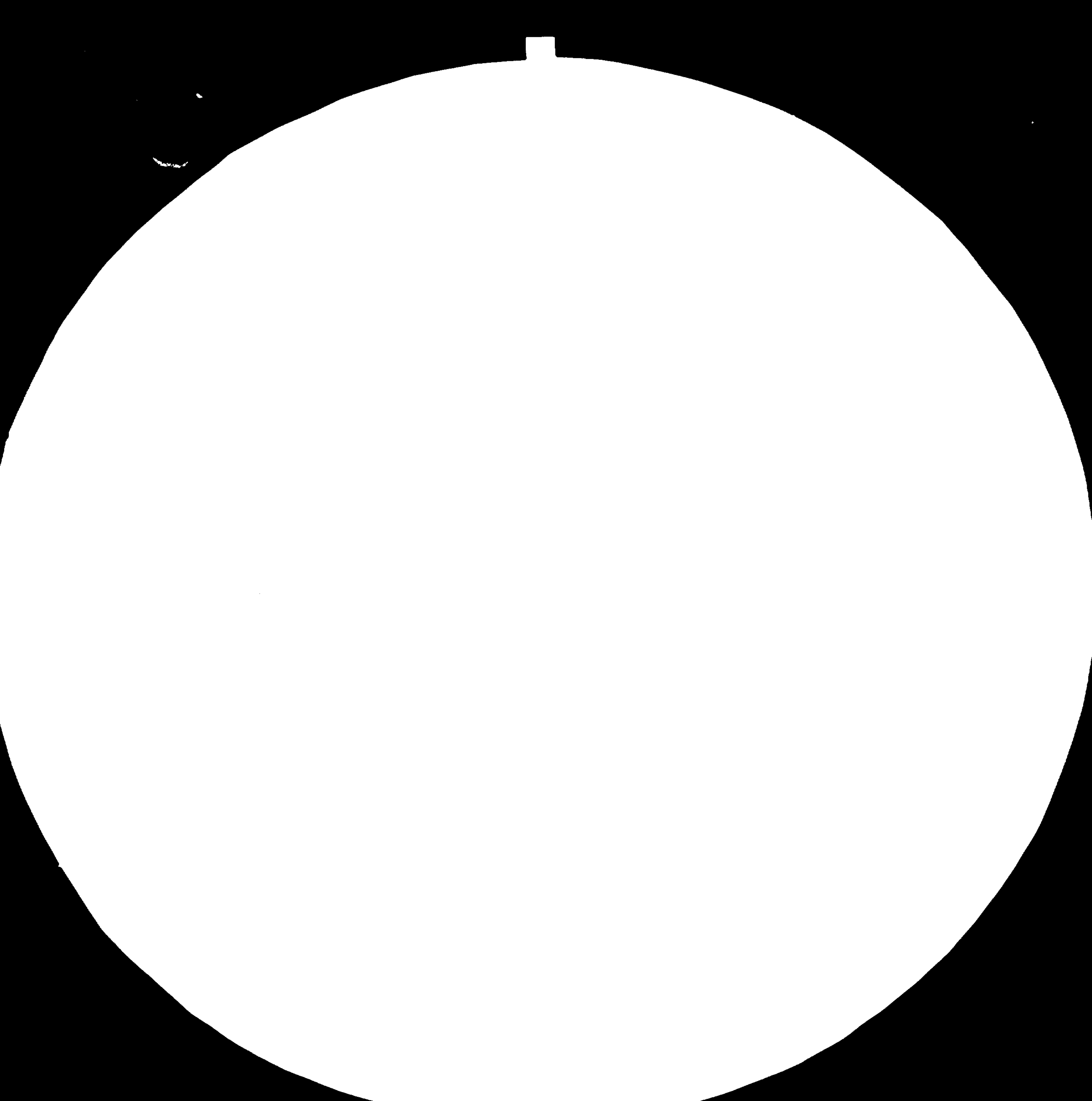
ВАМИ Ленинград
VAMI Leningrad

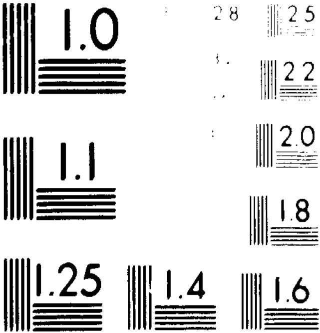
| | |
|---|---|
| Масштаб / Scale 1:200 | Для Индийской фирмы Бхарат Алюминиум Компани / For Bharat Aluminium Company Ltd, India |
| Данный чертеж является собственностью института ВАМИ и не может быть скопирован и использован без его разрешения | Глиноземный завод в Корбе. Реконструкция цеха кальцинации. III этап. Разрезы 1-1, 2-2. |
| This drawing is the property of VAMI and not to be copied or used without our permission | Korba alumina plant. Reconstruction of calcination stage III. Sections 1-1, 2-2. |
| | 1332929-AC — Лист / Sheet 2 — Листов / Sheets 2 |





83.11.29
AD.85-03




1.0
2.8
2.5
2.2
2.0
1.1
1.8
1.25
1.4
1.6

Contract No 82|61
United Nations Industrial Development Organization
(UNIDO)

12912
(3 of 3)

# FEASIBILITY REPORT FOR RECONSTRUCTION STUDY OF ALUMINA CALCINER FOR ENERGY CONSERVATION AT KORBA ALUMINA PLANT (INDIA)

Project No SI IND 82 802

## Volume III

## Specifications of equipment

VAMI

V O TSVETMETPROMEXPORT

Leningrad
1983

## Composition of Feasibility Study

Volume I – General Explanatory Note

Volume II – Drawings

Volume III – Equipment Specifications

C O N T E N T S


| | page |
|---|---|
| Introduction | I |
| 1. Lists of equipment and materials for the first stage of modification of the calcination kilns | 4 |
| 2. Lists of equipment and materials for the second stage of modification of the calcination kilns (installation of the fluid bed coolers) | 7 |
| 3. Lists of equipment and materials for the third stage of the calcination shop reconstruction (installation of the fluid bed calcination unit) | I3 |
| 4. Summary table of the main equipment and materials | 20 |

# I N T R O D U C T I O N

A Feasibility Report for modification of the calcination kilns for saving power (fuel) at Korba alumina plant in India was prepared on the basis of the contract No.82/61 between the UNIDO and V/O "Tsvetmetpromexport".

According to the Protocol dated February 4, 1983 (New Delhi) between the Indian Customer and the Supplier and in accordance with the UNIDO's protocol dated April 22, 1983 dealing with conside-ration of the initial data for preparation of the present Report, the modification of the calcinati kilns will be carried out in three stages as follows:

stage I - modification of an aluminium hydroxide drying zone, passing the dust from the electrostat precipitators into a kiln's cooling zone and improvement of a fuel oil burning process;

stage II- installation of the fluid bed coolers instead of the existing planetary coolers;

stage III- replacement of the existing rotary kilns by one fluid bed kiln.

It must be noted that the I and II stages involve modification of the existing calcination kil and the III stage involves construction of a new fluid bed installation.

Lists of equipment and materials are compiled separately for each stage. The Feasibility Repor was prepared with the maximum use of the Indian equipment and materials in mind. For the third stag equipment can be supplied from the third countries.

A summary of the equipment and materials required for all the stages of the calcination shop modification and sources of their supply are given in the following table.

| S/N | Description | Supply of equipment and materials | | | | | |
|---|---|---|---|---|---|---|---|
| | | for I, II, III stages | | for I and II stages | | for III stage | |
| | | weight, t | % | weight, t | % | weight, t | % |
| 1 | Equipment | | | | | | |
| | - from the USSR | 5,69 | 1,18 | 2,87 | 1,4 | 2,82 | 1,02 |
| | - from India | 477,19 | 98,82 | 202,49 | 98,6 | 274,7 | 98,98 |
| | Sub-total, equipment | 482,88 | 100 | 205,36 | 100 | 277,52 | 100 |
| 2 | Materials | | | | | | |
| | - from the USSR | 0,73 | 0,04 | 0,45 | 0,04 | 0,28 | 0,03 |
| | - from India | 1884,57 | 99,96 | 1068,66 | 99,96 | 815,91 | 99,97 |
| | Sub-total, materials | 1885,3 | 100 | 1069,11 | 100 | 816,19 | 100 |
| 3 | Total equipment and materials including | 2368,18 | | 1274,47 | | 1093,71 | |
| | - from the USSR | 6,42 | 0,27 | 3,32 | 0,26 | 3,1 | 0,28 |
| | - from India | 2361,76 | 99,73 | 1271,15 | 99,74 | 1090,61 | 99,72 |

The following should be noted to facilitate use of the data presented:

- the equipment and materials to be supplied from India will be specified,

- the equipment and materials shown in the lists where no supplier is given - to be supplied from the USSR.

# I. LISTS OF EQUIPMENT AND MATERIALS FOR THE FIRST STAGE OF MODIFICATION OF THE CALCINATION KILNS

| NOS No according to technological flowsheet | Trans. No | Name and technical characteristics | Type, brand, model, cipher | Unit of measurement | Quantity | Net weight, kg of one piece | total | Whom to be supplied b |
|---|---|---|---|---|---|---|---|---|
| | | 1.1. PROCESS DESIGN | | | | | | |
| | | Section 1.1.1. Equipment | | | | | | |
| | | Handling equipment | | | | | | |
| 1 | | Pneumatic transporting apparatus | VAMI drg. | pce | 2 | 250 | 500 | India |
| 2 | | Cyclone discharger, dia.600 mm with a fluid bed seal | " | " | 2 | 500 | 1000 | -"- |
| | | Total | | | | | 1500 | |
| | | Valves and fittings | | | | | | |
| 3 | | Steel valves and fittings | | | | | 1200 | India |
| | | Section 1.1.2. Materials | | | | | | |
| 4 | | Structural steel | | | | | 24100 | India |
| 5 | | Steel pipes | | | | | 11000 | -"- |
| 6 | | Lining materials | | | | | 160000 | -"- |
| | | 1.2. Instrumentation and Automation | | | | | | |
| | | Section 1.2.1. Equipment | | | | | | |
| | | Instrumentation and Automation Equipment | | | | | | |
| 1 | | Measuring transducer-flowmeter | ДНОР-М | pce | 4 | 10,5 | 42,0 | |

Тип. ВАМИ, зак. 564—8000. 16-IX-75 г.

| NOS No according technological flowsheet | Trans. No | Name and technical characteristics | Type, brand, model, cipher | Unit of measurement | Quantity | Net weight, kg of one piece | Net weight, kg total | Whom to be supplied by |
|---|---|---|---|---|---|---|---|---|
| 2 | | Single-channel secondary indicating device | А-502 | pce | 4 | 8,5 | 34,0 | |
| 3 | | Chamber diaphramg | ДК | " | 4 | 10,0 | 40,0 | |
| 4 | | Indicating manometer | МТП | " | 6 | 1,5 | 9,0 | |
| | | Total | | - | - | - | 125 | |
| | | Electrical Equipment | | | | | | |
| 5 | | Circuit breaker | А-63 | pce | 10 | 1,0 | 10,0 | |
| 6 | | Transformer 220/36 V | ОСМ | pce | 1 | 8,5 | 8,5 | |
| 7 | | Cabinet-type panel 2200x600x600mm | ШП-3Д | pce | 2 | 109,1 | 218,2 | |
| | | Total | | | | | 237,0 | |
| | | Valves and Fittings | | | | | | |
| 8 | | Cost-iron valves and fittings | | | | | 11,2 | India |
| | | Section 1.2.2. Materials | | | | | | |
| 9 | | Structural steel | | | | | 100,0 | India |
| 10 | | Steel pipes dia. 15-50 | | m | 300 | | 200,0 | India |
| 11 | | Cables | | km | 0,6 | | 80,0 | |
| 12 | | Electrical installation materials | | | | | 80,0 | |

ВАМИ, зак. 564—8000. 16-IX-75 г

## 2. LISTS OF EQUIPMENT AND MATERIALS FOR THE SECOND STAGE OF MODIFICATION OF THE CALCINATION KILNS (INSTALLATION OF THE FLUID BED COOLER)

| NOS No according to technological flowsheet | Trans. No | Name and technical characteristics | Type, brand, model, cipher | Unit of measurement | Quantity | Net weight, kg of one piece | total | Whom to be supplied by |
|---|---|---|---|---|---|---|---|---|
| | | 2.1.. PROCESS DESIGN | | | | | | |
| | | Section 2.1.1. Equipment | | | | | | |
| | | Main Process Equipment | | | | | | |
| 1 | | Fluid bed cooler with fireday separator and cyclones | VAMI drg. | pce | 2 | 92300 | 135000 | India |
| | | including: | | | | | | |
| | | a) steel "CT3" | | | | 75000 | 150000 | |
| | | b) steel "12x18H10t" | | | | 13500 | 27000 | |
| | | c) heat-resistant cast iron | | | | 4000 | 8000 | |
| | | Fans, blast blowers | | | | | | |
| 2 | | Fan with 72 kW electric motor | ВДН-I2,5 | " | 2 | 2500 | 5000 | India |
| 3 | | Blast blower with 30 kW electric motor | ТГ-65--I,06 | " | 2 | 1270 | 2540 | -"- |
| | | Sanitary Equipment | | | | | | |
| 4 | | Roll-type filter | ФРу4а | pce | 2 | 428 | 856 | India |
| | | Valves and Fittings | | | | | | |
| 5 | | Steel valves and fittings | | | | | 4800 | India |

Тип. ВАМИ, зак. 564—8000 16-IX-75 г.

| NOS No according technological flowsheet | Trans. No | Name and technical characteristics | Type, brand, model, cipher | Unit of measurement | Quantity | Net weight, kg | | Whom to be supplied by |
|---|---|---|---|---|---|---|---|---|
| | | | | | | of one piece | total | |
| | | Section 2.1.2. Materials | | | | | | |
| 6 | | Structural steel | | | | | 40000 | India |
| 7 | | Steel pipes | | | | | 62000 | India |
| 8 | | Lining materiald | | | | | 770000 | India |
| | | 2.2. ELECTRICAL DESIGN | | | | | | |
| | | Section 2.2.1.Electrical Equipment | | | | | | |
| 1 | | Control board, large block, open design | | st.pan. | 4 | 300 | 1200 | India |
| 2 | | Local control cubicle | | st.pan | 4 | 80 | 320 | -"- |
| | | Total | | | | | 1520 | |
| | | Section 2.2.2. Materials | | | | | | |
| 3 | | Cables | | | | | 1436 | India |
| | | 2.3.INSTRUMENTATION AND AUTOMATION | | | | | | |
| | | Section 2.3.1. Equipment | | | | | | |
| | | Instrumentation and Automation Equipment | | | | | | |
| 1 | | Resistance thermal converter, copper | TCM | pce | 2 | 0,8 | 1,6 | |

п. ВАМИ, зак. 564—8000. 16-IX-75 г.

| NOS No according to technological flowsheet | Trans. No | Name and technical characteristics | Type, brand, model, cipher | Unit of measurement | Quantity | Net weight, kg of one piece | total | Whom to be supplied by |
|---|---|---|---|---|---|---|---|---|
| 2 | | Thermal electric transducer, chromel-alumel | ТХА | pce | 12 | 1,2 | 14,4 | |
| 3 | | Industrial thermometer | П-4 | " | 4 | 0,9 | 3,6 | |
| 4 | | Measuring transducer pressure differential meter | ДМЭ-ММ | " | 16 | 10,5 | 168,0 | |
| 5 | | Measuring transducer manometer | МПЭ-МИ | " | 6 | 4,0 | 24,0 | |
| 6 | | Measuring transducer flowmeter | ДМЭР-М | " | 20 | 10,5 | 210,0 | |
| 7 | | Measuring transducer of low-level signals | Ш-71 | " | 14 | 5,0 | 70,0 | |
| 8 | | Single-channel secondary recording device | А-542 | " | 18 | 9,5 | 171,0 | |
| 9 | | Double-channel secondary recording device | А-542 | " | 6 | 10,0 | 60,0 | |
| 10 | | Single-channel secondary indicating device | А-502 | " | 26 | 8,5 | 221,0 | |
| 11 | | Electric actuating mechanism | МЭО | " | 14 | 30,0 | 420,0 | |
| 12 | | Contactless starter | ПБР | " | 14 | 7,0 | 98,0 | |
| 13 | | Position indicator | ДУП | " | 14 | 0,7 | 9,8 | |
| 14 | | Manual control unit | БРУ | " | 14 | 1,2 | 16,8 | |

Тип. ВАМИ, зак. 564—8000. 16-IX-75 г.

| NOS No according to technological flowsheet | Trans. No | Name and technical characteristics | Type, brand, model, cipher | Unit of measurement | Quantity | Net weight, kg of one piece | Net weight, kg total | Whom to be supplied by |
|---|---|---|---|---|---|---|---|---|
| 15 | | Regulating device | РП4 | pce | 2 | 6,5 | 13,0 | |
| 16 | | Signal conversion unit | БСД | " | 2 | 6,0 | 12,0 | |
| 17 | | 'Indicators' unit | БИ2 | " | 2 | 0,35 | 0,7 | |
| 18 | | Setting unit | РЗД | " | 2 | 0,2 | 0,4 | |
| 19 | | Conductive separation unit | БКР | " | 2 | 6,0 | 12,0 | |
| 20 | | Chamber diaphragm | ДК | " | 20 | 20,0 | 400,0 | |
| 21 | | Cold water meter, vane-type | ВТ | " | 2 | 14,0 | 28,0 | |
| | | Total | | | | | 1954 | |
| | | Electrical Equipment | | | | | | |
| 22 | | Electromagnetic relay | РПУ | pce | 20 | 1,0 | 20,0 | |
| 23 | | Illuminated indicator board | ТСБ | " | 10 | 0,3 | 3,0 | |
| 24 | | Control pushbutton | КЕ | " | 6 | 0,2 | 1,2 | |
| 25 | | Circuit breaker | А-63 | " | 70 | 1,0 | 70,0 | |
| 26 | | Transformer 220/36 V | ОСМ | " | 2 | 8,5 | 17,0 | |
| 27 | | Incandescent lamp | РНЦ | " | 30 | 0,05 | 1,5 | |
| 28 | | Plug socket | ШР | " | 4 | 0,11 | 0,44 | |

Тип. ВАМИ, зак. 554—8000. 16-IX-75 г.

| NOS<br>No according to technological flowsheet | Trans. No | Name and technical characteristics | Type, brand, model, cipher | Unit of measurement | Quantity | Net weight, kg<br>of one piece | <br>total | Whom to be supplied by |
|---|---|---|---|---|---|---|---|---|
| 29 | | Cabinet-type panel 2200x600x600 | ЩП-3Д | pce | 4 | 109,1 | 436,4 | |
| | | Total | | | | | 550 | |
| | | Valves and Fittings | | | | | | |
| 30 | | Cast iron valves, fittings | | | | | 65,8 | India |
| 3 | | Section 2.3.2. Materials | | | | | | |
| 31 | | Structural steel | | | | | 300,0 | India |
| 32 | | Steel pipes dia. 15-25 | | m | 150 | | 120,0 | India |
| 33 | | Cables | | km | 1,7 | | 210,0 | |
| 34 | | Electrical installation materials | | | | | 80,0 | |

п. ВАМИ, зак. 564—6000. 16-IX-75 г.

3. LISTS OF EQUIPMENT AND MATERIALS FOR THE THIRD STAGE OF THE CALCINATION SHOP RECONSTRUCTION (INSTALLATION OF THE FLUID BED CALCINATION UNIT)

| NOS No according to technological flowsheet | Trans. No | Name and technical characteristics | Type, brand, model, cipher | Unit of measurement | Quantity | Net weight, kg of one piece | Net weight, kg total | Whom to be supplied by |
|---|---|---|---|---|---|---|---|---|
| | | 3.1. PROCESS DESIGN | | | | | | |
| | | Section 3.1.1. Equipment | | | | | | |
| | | Main Process Equipment | | | | | | |
| 1 | | Fluid bed unit | VAMI drg. | pce | 1 | | 223500 | India |
| | | including: | | | | | | |
| | | a) steel "CT3" | | | | | 153500 | |
| | | b) steel "15xM70" | | | | | 70000 | |
| 2 | | Four-cyclone battery, dia.1370 mm | " | " | 1 | | 7000 | -"- |
| | | Total | | | | | 230500 | |
| | | Handling Equipment | | | | | | |
| 3 | | Screw feeder, dia.500 mm with 22 kW electric motor | VAMI drg | " | 1 | | 1000 | India |
| 4 | | Belt coveyor, 500 mm wide | | " | 2 | 3000 | 6000 | India |
| | | Total | | | | | 7000 | |
| | | Fans, Blowers, Pumps, I.D. Fans | | | | | | |
| 5 | | Fan with 72 kW electric motor | BЦП-I2,5 | pce | 1 | | 2500 | India |

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| NOS No according technological flowsheet | Trans. No | Name and technical characteristics | Type, brand, model, cipher | Unit of measurement | Quantity | Net weight, kg of one piece | Net weight, kg total | When to be supplied by |
|---|---|---|---|---|---|---|---|---|
| 6 | | Blower with 125 kW electric motor | B-15/1500 | pce | 1 | | 3200 | India |
| 7 | | Pneumatic chamber pump, dia. 1800mm | TA-29 | pce | 2 | 8000 | 16000 | India |
| 8 | | I.D. fan with 172 kW electric motor | ДН-22 | pce | 1 | | 8400 | -"- |
| | | Total | | | | | 30100 | |
| | | Sanitary Equipment | | | | | | |
| 9 | | Roll-type filter | ф4py4A | pce | 1 | | 428 | India |
| | | Valves and Fittings | | | | | | |
| 10 | | Steel valves and fittings | | | | | 5500 | India |
| | | Section 3.1.2. Materials | | | | | | |
| 11 | | Structural steel | | | | | 73000 | India |
| 12 | | Steel pipes | | | | | 21600 | -"- |
| 13 | | Lining materials | | | | | 720000 | -"- |
| | | 3.2. ELECTRICAL DESIGN | | | | | | |
| | | Section 3.2.1. Electrical Equipment | | | | | | |
| 1 | | Control board, large-block, open design | | st.pan | 3 | 300 | 900 | India |

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| NOS<br>No according technological flowsheet | Trans. No | Name and technical characteristics | Type, brand, model, cipher | Unit of measurement | Quantity | Net weight, kg | | Whom to be supplied by |
|---|---|---|---|---|---|---|---|---|
| | | | | | | of one piece | total | |
| 2 | | Local control cubicle | | st.pan | 3 | 80 | 240 | India |
| | | Total | | | | | 1140 | |
| | | Section 3.2.2. Materials | | | | | | |
| 3 | | Cables | | | | | 1147 | India |
| | | 3.3. INSTRUMENTATION AND AUTOMATION | | | | | | |
| | | Section 3.3.1. Equipment | | | | | | |
| | | Instrumantation and Automation Equipment | | | | | | |
| 1 | | Resistance thermal converter, copper | TCM | pce | 1 | 0,8 | 0,3 | |
| 2 | | Thermal electric transducer chromel-alumel | TXA | " | 10 | 1,2 | 12,0 | |
| 3 | | Thermal electric transducer platinum-rodium - platinum | TПП | " | 2 | 1,2 | 2,4 | |
| 4 | | Industrial thermometer | П-4 | " | 2 | 0,9 | 1,3 | |
| 5 | | Measuring tranducer-manometer | МПЭ | " | 1 | 4,0 | 4,0 | |
| 6 | | Measuring transducer pressure differential meter | ДМЭ-М4 | " | 3 | 10,5 | 31,5 | |

Тип. ВАМИ, зак. 564—8000. 16-IX-75 г.

| NoNo according technological flowsheet | Trans. No | Name and technical characteristics | Type, brand, model, cipher | Unit of measurement | Quantity | Net weight, kg | | Whom to be supplied by |
|---|---|---|---|---|---|---|---|---|
| | | | | | | of one piece | total | |
| 7 | | Measuring transducer flowmeter | ДМЭР-М | pce | 11 | 10,5 | 115,5 | |
| 8 | | Measuring transducer of low-level signals | Ш-71 | " | 13 | 5,0 | 65,0 | |
| 9 | | Measuring transducer-headmeter | ДМЭУ-МИ | " | 13 | 10,5 | 136,5 | |
| 10 | | Electrical pneumatic transducer | ЭПП | pce | 1 | 5,2 | 5,2 | |
| 11 | | Single-channel secondary recording device | A-542 | " | 17 | 9,5 | 161.5 | |
| 12 | | Double-channel secondary recording device | A-542 | " | 5 | 10,0 | 50,0 | |
| 13 | | Single-channel secondary indicating device | A-502 | " | 12 | 8,5 | 102,0 | |
| 14 | | Regulating device | P17 | " | 2 | 6,5 | 13,0 | |
| 15 | | Regulating device | РП4 | " | 1 | 6,5 | 6,5 | |
| 16 | | Setting unit | ЗУ | " | 3 | 0,2 | 0,6 | |
| 17 | | Conductive separation unit | БКР | " | 3 | 6,0 | 18,0 | |
| 18 | | Signal conversion unit | БСД | " | 3 | 6,0 | 18,0 | |
| 19 | | Indicators' unit | Б12 m | " | 3 | 0,35 | 1,05 | |
| 20 | | Setting unit | РЗД | " | 3 | 0,2 | 0,6 | |

п. ВАМИ, зак. 564—8000. 16-IX-75 г.

| NOS according technological flowsheet | Trans. No | Name and technical characteristics | Type, brand, model, cipher | Unit of measurement | Quantity | Net weight, kg of one piece | Net weight, kg total | Whom to be supplied by |
|---|---|---|---|---|---|---|---|---|
| 21 | | Electric actuating mechanism | МЭО | pce | 7 | 30,0 | 210,0 | |
| 22 | | Contactless starter | ПБР | " | 7 | 7,0 | 49,0 | |
| 23 | | Position indicator | ДУП | " | 7 | 0,7 | 4,9 | |
| 24 | | Manual control unit | БРУ | " | 9 | 1,2 | 10,8 | |
| 25 | | Automatic gas analyser (oxygen) | МН | set | 1 | 77,0 | 77,0 | |
| 26 | | Automatic gas analyser ($CO_2$) | ТП | set | 1 | 43,0 | 43,0 | |
| 27 | | Fuel oil meter | СМ | set | 1 | 56,0 | 56,0 | |
| 28 | | Cold water flowmeter, vane-type | ВТ | pce | 1 | 14,0 | 14,0 | |
| 29 | | Chamber diaphragm | ДК | pce | 11 | 20,0 | 220,0 | |
| 30 | | Pneumatic actuating mechanism | ПОУ | pce | 1 | 13,5 | 13,5 | |
| | | Total | | | | | 1444 | |
| | | Electrical Equipment | | | | | | |
| 31 | | Thyristor electric drive | ЭКТ | set | 1 | | 970 | |
| 32 | | Electromagnetic drive | РПУ | pce | 15 | 1,0 | 15,0 | |
| 33 | | Illuminated indicator board | ТСБ | pce | 10 | 0,3 | 3,0 | |
| 34 | | Control pushbutton | КЕ | pce | 2 | 0,2 | 0,4 | |

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| № according technological flowsheet | Trans. No | Name and technical characteristics | Type, brand, model, cipher | Unit of measurement | Quantity | Net weight, kg | | Whom to be supplied by |
|---|---|---|---|---|---|---|---|---|
| | | | | | | of one piece | total | |
| 35 | | Circuit breaker | A-63 | pce | 45 | 1,0 | 45,0 | |
| 36 | | Transformer | OCM | pce | 2 | 8,5 | 17,0 | |
| 37 | | Incandescent lamp | РНЦ | pce | 40 | 0,05 | 2.0 | |
| 38 | | Plug socket | ШР | pce | 2 | 0,11 | 0,22 | |
| 39 | | Cabinet-type panel 2200x600x600 | ШП-3Д | pce | 3 | 109,1 | 327,3 | |
| | | Total | | | | | 1320 | |
| | | Valves and Fitting | | | | | | |
| 40 | | Cast-iron valves and fittings | | | | | 30,8 | India |
| | | Section 3.3.2. Materials | | | | | | |
| 41 | | Structural steel | | | | | 200,0 | India |
| 42 | | Steel pipes dia. 15-25 | | m | 200 | | 160,0 | India |
| 43 | | Cables | | km | 1,5 | | 193,0 | |
| 44 | | Electrical installation materials | | | | | 90,0 | |

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## 4. SUMMARY TABLE OF MAIN EQUIPMENT AND MATERIALS

in tonnes

| S/N | Description | 1 stage | 2 stage | Total 1 stage+ +2 stage | 3 stage |
|---|---|---|---|---|---|
| | Equipment | | | | |
| 1 | Main process equipment | - | 185,0 | 185,0 | 230,5 |
| 2 | Electrical equipment | 0,24 | 2,07 | 2,31 | 2,52 |
| 3 | Handling equipment | 1,5 | - | 1,5 | 7,0 |
| 4 | Fans, blowers, pumps | - | 7,54 | 7,54 | 30,1 |
| 5 | Instrumentation and automation equipment | 0,13 | 1,95 | 2,08 | 1,44 |
| 6 | Sanitary equipment | - | 0,86 | 0,86 | 0,43 |
| 7 | Valves and fittings | 1,2 | 4,87 | 6,07 | 5,53 |
| | Sub-total: | 3,07 | 202,29 | 205,36 | 277.52 |
| | Materials | | | | |
| 1 | Structural steel | 24,1 | 40,0 | 64,1 | 73,0 |
| 2 | Steel pipes | 11,0 | 62,12 | 73,12 | 21,76 |
| 3 | Cables | 0,08 | 1,65 | 1,73 | 1,34 |
| 4 | Electrical installation materials | 0,06 | 0,08 | 0,16 | 0,09 |
| 5 | Lining materials | 160,0 | 770,0 | 930,0 | 720,0 |
| | Sub-total: | 195,26 | 873,85 | 1069,11 | 816,19 |
| | TOTAL: | 198,33 | 1076,14 | 1274,47 | 1093.71 |