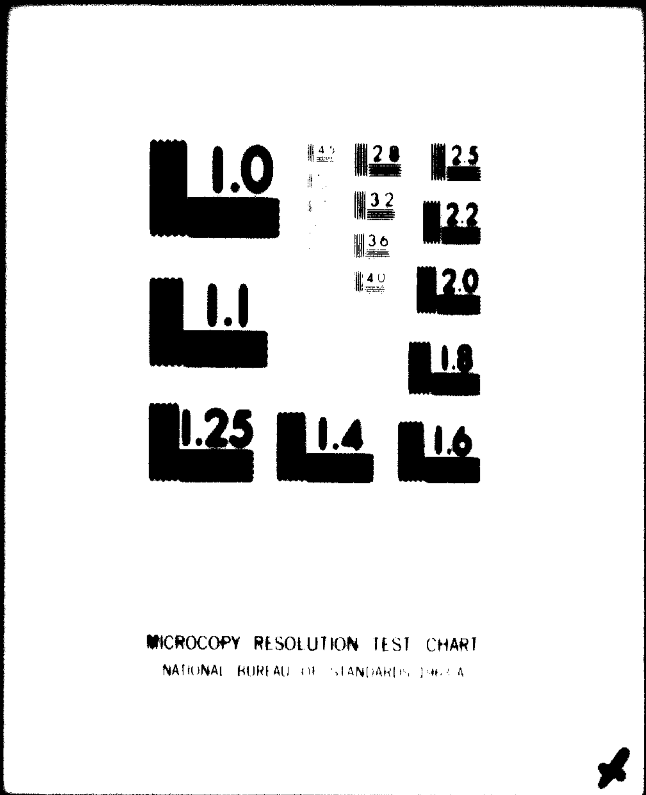
1 OF 2

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INGENIEURBÜRO
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BERATUNG · PROJEKTIERUNG · ÜBERWACHUNG · ABNAHMEN · GUTACHTEN
UNITED NATIONS EXPERT Production of Building material

F. SOBEK Ingenieurbüro, 4 Düsseldorf, Friedrichstraße 37

FÜR INDUSTRIEOFENBAU
VOR- UND NACHGESCHALTETE ANLAGEN
VERFAHREN IN DER WÄRMETECHNIK
FEUERUNGSBAU

Friedrichstraße 37, Tel. 18789
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Von der Industrie- u. Handelskammer zu Düsseldorf öffentlich bestellter u. vereidigter Sachverständiger f. Kalköfen u. Feuerungsbau
Ständig beeideter gerichtlicher Sachverständiger des Landesgerichtes für Zivilrechtssachen in Wien für den Industrieofenbau

Ihr Zeichen | Ihre Nachricht | Mein Zeichen

1.

Indonesia. FINAL REPORT. (Lime industry).

## JOB DESCRIPTION

On base of the Job Description DP/INS/72/058/11-01/03 an expert was to be set at disposal of the Indonesian government to assist and advise in the establishment of lime industrie on an industrial basis. Specifically, he is expected to :

1) Examine the lime resources at Gunung Misigit for suitability of industrial processing, and in accordance with the market and with available combustibles, make recommendations for the establishment of modern lime industry,

2) Prepare a technical and economic feasibility study, including technical and financial analysis of the project.

1972

In the frame of this mission it should furthermore, be stated if and what kind of anorganic building material can be developed with lime as binder and which method on part of the Institutes concerned is given priority.

**Prehistory and its connections**

As a consequence of urgent requirements on the building material sector and economic considerations, the Department of Public Works, Electric/Power and the Department of Industry agreed upon a close cooperation in the field of promoting and research of building materials to be produced from domestic mineral resources.

In order to facilitate this co-operation and in order to establish contact with the UN-expert and the relevant research institutes, a co-ordinator was set at disposal in the person of Dr. Ing. Mulio Harsono.

The more than three thousand islands of Indonesia are inhabited by about 125 million people, 60 millions of which are living in Java.

Out of this reason and as a consequence of the fact that a greater number of smaller lime producing plants are already existing in Western Java, especially in the area of Padalarang, the government is determined to start the industrial development and the building of a pilote plant in this very area.

A further and no less significant consideration is also the fact that a number of institutes are situated besides the technical university at Bandung, who are to be regarded as appropriate to give support to the industrialization project, both with regard to their technical equipment and the quality and skill of the leading executive organs.

It is well worth mentioning that a group of people of these institutes had induced the local lime producers already in the sixties to turn to fuel instead of wood fired kilns, a fact by which a considerable amount of national income could be saved in form of wood.

Proof is given by the conditions in Eastern Java where lime is produced in woodfired kilns even up to our days, a fact by which already great damage was made by errosion, as big wood areas had to be cut in order to get material for firing the kilns for the so badly needed lime.

The applied method for fuel firing, however, did not bring all the success which would be necessary as basis for a further development of this method also in the frame of a new construction of modern kilns. It is, therefore, understandable that there are producers, dealers and consumers in other districts of Indonesia and also in Padalarang who prefer the deacified lime produced with a long wooden flame.

Due to the lack of other technologies, measures and especially expert knowledge of the lime producers, in almost all cases the following method is applied which, as already described, can be considered as good with regard to economic considerations, which can, however, not be regarded as sufficient in the sense of industrial further development.

This method is always applied with kilns which are called "Roman field kilns". Shaft form and effective height have remained unaltered after introduction of the fuel firing but are not suitable for production of uniform firing quality in economic form. In spite of shaft diameters of 2,5 3 and sometimes even 4 meters the firing is done on one level only, sometimes even only by one or two firing processes, which is due to the hitherto used way of construction and the only small shaft height to be used.

In spite of a cylindric kiln shaft necessary for the requirements of an effective fuel firing as a certain proportion of height to diameter, the heat is produced by a diffusion flame. The immediate surrounding is, therefore, given radiant heat surpassing the admissible limit.

The remaining part of the firing zone holds the heat in form of hot waste gases, for which a difference of temperature of 400°C between the flame radiation and the sensible heat of the waste gas is necessary.

For obtaining the oxygen supply necessary for a diffusion flame on the surface of flame, the entire combustion air is lead into the shaft through the firing hole. This is how, on one hand, the cooling of the lime by counter-current air is avoided, while, on the other hand, an economical preheating of the combustion air is not possible.

The specific consume of fuel for lime per kg was, on occasion of his visits to the plants, calculated by the writer with 2 to 2,500 kcal/kg of lime, a fact which is due to bad thermal economy and the not assorted dressing of raw material.

As a consequence of the different sizes of the stones remaining in the available burning zone, an equal long time, the finished product shows hard burnt lime with the small, middle burnt lime with the medium and soft burnt lime with the big lime stones.

This brings us close to the consideration, that the existing technology be not further developed or improved, but to offer another tecanology coming up to the circumstances of the country on one hand, and on the other hand a technology representing at least a part of the way serving for industrialization of this branch.

Establishing contacts and co-operation with officials and institutes:

The contacts taken up by the writer in Jacarta have in so far proved significant for his activity in Bandung, as all of the Institutes visited in Bandung have already been instructed of the reason and aim of the writers presence.

Mr. Ir. S. Danunagoro, First Executive Chairman board of Directors, State Contractors & Consulting Engineers, has proved as promoter of the co-operation between the Ministry of Public Works and Power and the Ministry of Industry concerning the right industrial effort of the lime expert.

[illegible] - 2 -

# INDEX



## [illegible]

**Mining and Metallurg Research Center**

Ir. S.L. Tobing

Ir. Komar

Ir. Alim Dhama

**Institute of Ceramic**

Ir. Darubroto m.s.e.

Gesang Singugroho

Hartono UMV.

Uli Sutrima

**The Regional Housing Centre**

Dir. Ir. A. Kartaharja

**Building Mate[illegible]als Development Laboratory**

Ir. Abbas

Ir. S.M. Ritonga

Sutijan

Z. Aksa

The writer had the opportunity to visit the laboratories and research labs of the above mentioned Institutes. The Buil ing Material Development Laboratory has built an oil fired test kiln on their own area, the first test run of which is to be carried through together with the writer.

F. [illegible]
[illegible]



In order to get exact data for the layout of a kiln according to the new technology and in order to adapt this technology to the requirements of the market to an extent as far reaching as possible, the writer visited several plants in three different areas: These three different areas are the most important centres of the domestic lime industry:

Padalarang
Bongas
Tasikmalaya.

The following works respectively companies have been visited:

Padalarang: (Gunung Misigit):

Beta-Works
P.K. Tjisaladah, A. Sudirdjo, Ci Hegar Manah Bandung
P.K. Giri Mukti, (Pekapuran) Pamucatan
P.K. Makmur TJIA Ek Kian, Ciburay

Bongas:

P.K. Sumedang, Sumberjaya (Suparman, the owners)
Mr. Syafii, Gunung Kromong (Chairman of the Lime Owners Corporation)

F. [illegible]
[illegible] VDI



Tasikmalaja:

1) Mr. Mohamad Toha, Head of Regional Service Industry in Tasikmalaja

2) Small field kilns in Leuwisari Sukaraja, about 10 km South of Tasikmalaja.

As a matter of fact, three different production methods are represented in the visited areas, i.e.: lime production with fuel, natural gas and wood.

The already described firing method with fuel is almost entirely used in Padalarang, however, also in Bengas, where they have no gas pipelines.

It is well worth mentioning, that several large ceramic industries are situated in Udjungberung, 10 km from Bandung, which do not only produce clay bricks, roof tiles and ridge tiles but also glazed and unglazed stoneware tubes in a [illegible] surprising for domestic production.

In Nagrek there can be found Puzzolane-Trass which is used until today. Already before the second world war they effected mining at that place.

The material is ground with hammer mills and over grains are simply screened out.

Without any other addition this product is than filled into stamped natron paper bags and sold under the name of Puzzolan Trass.

On occasion of the visits with the various mentioned Institutes it has repeatedly been pointed out that it should be tried to make the existing kilns suitable for new firing methods.

After close investigations it can be stated that this will not at all be possible, as not one of the investigated kilns is suitable for this purpose.

After the visits made, a meeting was held under the chairmanship of Mr. Dir. Ir. A. Kartaharja and Dr. Ing. Mulio Marsono, which had the purpose of co-ordinating the views of the present interested parties and the writer on the kiln type to be standardized.

Furthermore a working program was set up and a group of counterparts selected for the writer, which, after the completion of the layout of the kiln and the additional fittings is to begin with the drawings according to the expert's instruction straight away.

[redacted]



It was clearly defined that the construction drawings be fabricated without consideration of the available materials and appliances as well as possibilities of production in Indonesia. All facts have been considered in order to guarantee that the kind of the chosen kiln construction can be produced everywhere.

At the same time a program for setting the kiln into work in the Building Materials Development Laboratory was discussed, and agreed upon. The measures taken as well as the sequence and the success of the setting to work will be described in the frame of the present final report.

Finally the short range objective, an obligation of the writer towards UNIDO, was discussed. This from two points of view:

1) Further development of the reasearch and projecting of building materials out of domestic raw material sources,
2) Choice of corresponding experts.

With regard to the already existing Puzzolan-Trass industry the decision was taken at the favour and on base of the writer's suggestion, to create a natural cement industry.

[illegible]



As raw materials lime stone and Puzzolane soil is to be used, lime hydrate is to be used as binder and fine grained wind separated Puzzolan-Trass as filler, packed in bags and sold.

As further development the production of Laterite Blocks also with lime hydrate as binder, is to be tested.

As third and last building material for the purpose of production of construction elements for prefabricated houses, expanded clay as aggregate has been taken into consideration.

For the first two production processes a corresponding expert is to be found, who is able to suggest - on base of his training and experience - the choice of the light raw material and the corresponding ratio of components for production of a suitable natural cement. At the same time this expert should have experience on the field of production of construction stones in cool processing made of soils and lime as binder.

Last but not least, and corresponding to the wishes of the relevant Institute, a second expert is wanted, who has to have the ability of making the layout for a [illegible]-bed kiln for production of expanded clay.

The writer recommends Ing. Dr. T. Ringsholt, Denmark, as expert for the first two mentioned tasks.

The writer, however, doubts the existence of an expert for the technology for production of expanded clay. This especially with regard to the fact as this expert is, according to the wishes of the Institute, expected to carry out the layout of a fluid-bed kiln.

As a consequence of the sufficient resources of natural aggregates to be used as filler, which is vulcanic tuff, solid Puzzolane, etc, the writer regards the artificial production of aggregates such as expanded clay as not necessary. Instead of the expert for expanded clay, an expert for clay products could be engaged, who could, in co-operation with the already mention d expert, carry out a technical study for the long range program in the frame of the short range program.

Furthermore,the writer recommends that for the arrangement of the long range program an expert member of the regular UNIDO staff should at the same time be present in Indonesia for some weeks, preferably Mr. Ryder.

P. [illegible]
[illegible]



**Raw material, its chemical and physical structure and site of resource:**

A geological map attached to this report in the proportion 1 : 2,000.000 gives a view on the lime stone resources in Java, Madura and Bali.

The Institute for Geology, Geological Survey of Indonesia, has, furthermore, set an average of chemical composition of lime stone occurrences of the enti e area at disposal of the writer, which could be of significance for a later classification with regard to the site of lime factories to be built.

The areas relevant to the report have been marked with

No. 14 for Tagogapu (Gunung Misigit)
No. 16 for Bongas / Palimanan
No. 17 for Tasikmalaja.

The available chemical analysis of the area No. 14, are with a total content of 0,13 % of Sesquioxides and no further contaminations at a loss of ignition of 43,36 % to be defined as, seen from the chemical side, best suitable stone.

The same is valid for the raw stone figuring in the area

[illegible]



No. 16, although the average analysis shows a $SiO_2$ content of 1,07 %.

With the average values attained in several areas of field 17, a rather high $SiO_2$ content (3,09 %) can be stated a fact which could affect the free CaO content.

No written report is available on the physical structure of the lime stone in the mentioned three areas. The writer could, however, state that the industries can very well distinguish between lime stone of rough or fine structure and that they are chosing the harder lime stone which is better suitable for burning, if lime stones of various hardness are available.

Neither is existing any printed material on the extent of the resources in the mentioned areas. It can, nevertheless, be ascertained, that sufficient quantity is available in the massives stretching out for kilometers in Tagogapu (Padalarang) and Bongas/Palimanan, quantities which will do for a couple of decades, since the hitherto mining operations have not even yet shown a visible alteration of the respective sites as might be industrial exploitation.

If a bigger lime industry should be planned in the field No. 17, Tasikmalaja, it is recommended to test the sources available in vast quantity in detail.

**Extract from the Average Chemical Composition of lime stone occurences in Java, Madura and Bali**

| | 14 Pagogapu Gunung Misikit | 16 Bongas Palimanan | 17 Tasikmalaya |
|---|---|---|---|
| CaO | 56,0 | 54,12 | 51,24 |
| MgO | -,- | 0,27 | 0,55 |
| $Fe_2O_3$ | 0,13 | 0,32 | 1,62 |
| $Al_2O_3$ | | 0,39 | |
| $SiO_2$ | | 1,07 | 3,89 |
| $SO_3$ | | | |
| $H_2O-$ | 0,13 | | |
| $H_2O+$ | | | |
| Ignlos. | 43,36 | 45,32 | |

[illegible]
[illegible]

## Layout of an oil fired lime shaft kiln

| | |
|---|---|
| Kiln capacity | 10 tons/day |
| Specific capacity | 5 to/m2/24 h |
| granulometry | 100 - 160 mm |
| fuel | heavy fuel 9600 kcal/kg |

**shaft dimensions:**

| | |
|---|---|
| effective shaft height | 11 m |
| Light shaft diameter | 1,6 m |
| shaft form | cylindrical |
| number of firing holes | 4 |
| number of firings | 1 |
| size of firings in the operating lining ( [illegible]lusive are height) | 0,6 . 0,8 m |
| height of the cooling zone from ± 0 until the lower edge of the firing holes | 3,67 |
| Specific consume of fuel | 1150 kcal/kg lime |

**Calculation of the sinking speed:**

| | |
|---|---|
| capacity 420 kg/h | = 0,42 m3/h |
| 1 m shaft height | = 2 m3 |
| therefore: $\frac{0,42\ m3}{2m3}$ | = 0,21 m/h |

**Burning time:**

The difference of temperature $\Delta \vartheta$ m = 170°C

[illegible]

fuel gas to stone cpm k = 0,84 kcal/m/h/°C

specific kiln capacity = 3 to/m2/24 h

Altered value of the heat transfer figure with specific capacity = 28 kcal/m2/h/°C

maximum stone size = 160 mm

firing time according to Balazsovics 17 h 30'

Calculation of height of firing zone:

According to the formula height of firing zone =

= sinking speed . firing time

17,5 h . 0,21 m = 3,675 m necessary height of firing zone

Calculation of the necessary amount of cooling air:

At 1000°C entering temperature of the lime into the cooling zone and 80°C lime temperature in the discharging part

(1000 - 80°C) . 0,214 (cpm lime) = 196 kcal/kg lime

$$\frac{196}{920 \cdot 0{,}32 \text{ (cpm air)}} = 0{,}666 \text{ Nm3} = 0{,}7 \text{ Nm3/kg lime}$$

Comparison of the nexessary minimum cooling air with the necessary amount of combustion air:

cooling air:

0,7 Nm3/kg lime . 420 kg/h lime = 294 Nm3/h

[illegible]

combustion air:

$$\frac{420 \text{ kg} \cdot 1150 \text{ kcal/kg}}{9600 \text{ kcal/kg fuel}} = 50 \text{ kg/h fuel}$$

50 kg . 10,81 Nm3 air (stoichiometrically) = 540,5 Nm3/h
===========

Calculation of the height of cooling zone:

$$\frac{1 \text{ m (shaft height)}}{0{,}21 \text{ m}} = 4 \text{ h } 45'$$

540,5 Nm3 are passing the cooling zone in 4 h 45 '.

[illegible] Nm3 (amount of combustion air/h) . 4,7[illegible] h = 2565 Nm3

With this amount can be cooled

$$\frac{2565 \text{ Nm3}}{[illegible],7 \text{ Nm3}} = 3663 \text{ kg lime}$$

that makes in 1 hour $\frac{3663 \text{ kg}}{4{,}75 \text{ h}}$ = 772 kg lime

capacity of kiln per hour = 420 kg lime

reserve 352 kg lime

this is by [illegible]3,9 % more cooling capacity than necessary.

| | |
|---|---|
| With a post firing zone of | 1,5[illegible] m |
| plus a cooling zone of | 1,00 m |
| entire cooling zone | [illegible],5[illegible] m |
| With a discharge zone height of | 1,17 m |
| plus entire cooling zone of | 2,50 m |
| height of zone [illegible] until the lower edge of the firing holes | 3,67 m |

=======

**Amount of waste gas:**

4) From the combustion:

With a specific fuel demand of 1150 kcal/kg lime

the following quantity of S/fuel/h is needed:

[illegible]

$\frac{420 \text{ kg} \cdot 1120 \text{ kcal/kg}}{9600 \text{ kcal}}$ = 50,3 kg = 50 kg/fuel

With stoicheimetrical combustion of 1 kg S-fuel (according to Bois) the theoretical gas quantity is:

$$vgo = \frac{1,25 \cdot 9600 - 3052}{808} = 11 \text{ Nm3/kg}$$

The theoretical air quantity:

$$Vlo = \frac{9600 - 1115}{808} = 10,4 \text{ Nm3/kg}$$

With an access air of 20 % the real gas quantity is:

Vg = 11 Nm3 + 0,2 . 10,4 = 13,5 Nm3/kg fuel

50 kg / h S - fuel . 13,5 Nm3 = 675 Nm3/h

B) From deacidification:

Stone quantity $\frac{420 \text{ kg/h lime}}{58}$ . 100 = 725 kg of stone

(with a loss of ignition of 42%).

| | |
|---|---|
| Wastegas from combustion | 675 Nm3/h |
| $CO_2$ from lime stone | |
| $\frac{725 \cdot (100 - 2,0 \% H_2O) \cdot 0,42 \% \text{ loss of ignition}}{1,976 \ (\rho \text{ of } CO_2)}$ | = 151 Nm3/h |
| 2 % $H_2O$ from stone | |
| $\frac{725 \cdot 0,02}{0,804}$ | = 18 Nm3/h |
| total waste gas amount | 844 Nm3/h |

Calculation of the operating cubicmeter at a waste gas temperature of 200 °C

$$\frac{273 + 200}{273} \cdot 844 = 1462 \text{ m3}$$

from 300 °C

$$\frac{273 + 300}{273} \cdot 844 = 1780 \text{ m3}$$

[illegible]
[illegible]



Layout of the chimney:

With a waste gas quantity of 1800 m3/h = 0,5 m3/2

and an entrance speed of the waste gas of 5,5 m/s

into the chimney, a tube with an inner diameter of 340 mm

is chosen.

$F = 0,0908 \text{ m2}$

$$v = \frac{0,5 \text{ m/s}}{0,0908 \text{ m2}} = 5,5 \text{ m/s}$$

According to DIN 2448 outer diameter 355,6 mm

Wall thickness 8 mm

Layout of the injector tube:

With a quantity of pressure air of 1800 Nm3/h = 0,5 m3/s

and a discharge speed of the pressure air of 40,6 m/s

a tube with an inner diameter of 125 mm is chosen.

$F = 0,0123 \text{ m2}$

$$v = \frac{0,5 \text{ m3/s}}{0,0123 \text{ m2}} = 40,6 \text{ m/s}$$

according to DIN 2448 outer diameter 133 mm

wall thickness 4 mm

Waste gas speed in front of the nozzle:

Ring square = 0,0908 m2

$$- \quad \underline{0,0139 \text{ m2}}$$
$$0,0769 \text{ m2}$$

$$v = \frac{0,5 \text{ m3/s}}{0,0769 \text{ m2}} = 6,5 \text{ m/s}$$

Omit tube of the chimney:

An omit tube with an inner diameter of 310 mm is connected to a diminishing intermediate part of 150 mm.

According to DIN 2448 outer diameter 323,9 mm

Wall thickness 7,1 mm

F = 0,0735 m2

Prior to the mixing of the waste gas with the driving air a medial speed of 13,7 m/s is resulting in the

$$v = \frac{3600 \text{ m3}}{3600 \cdot 0,0735 \text{ m2}} = 13,7 \text{ m/s}$$

In addition to the quantity regulation of the drive air by a flap, an alterable streamline corpus (double cone) is installed which is placed axially in the tube.

By Alteration of this cone the sucking intensity can be regulated.

F. [illegible]
[illegible]

Layout of the blower:

High pressure fan

Wanted capacity $\frac{1800\ Nm3}{60'}$ Nm3/Min.

Q = 46 Nm3/Min (276I Nm3/h)

Δ p = [illegible] mm WS

Entry ∅ = 180 mm

Motor capacity = 5,5 kW (7,5 PS)

rpm = 2900

[redacted]

**Technology:**

As already described in the above mentioned final report, the kiln shape and the firing methods of the oil fired lime shaft kilns are not suitable for being improved or to undergo a further development.

The most essential symptoms of a technology for lime firing to be introduced in Indonesia as intermediate solution for a period of several years is the alteration of the firing shaft form and a corresponding proportion between the light shaft diameter and the effective shaft height.

Further an alteration of the firing method from the hitherto used diffusion flame to injection firing.

The injection firing, i.e. the creation of a moveable compact oil jet directly onto the glowing stones provokes, in technical respect, the combustion of the vaporizing later on cracked oil inbetween the burned goods, which also produces high temperatures their waste gases, however, have a preheating effect inbetween the burned goods.

With regard to the economic effect the specific fuel consumption is, by this method, considerably reduced, as the calory demand for maintaining the diffusion flame is omitted and, moreover, the combustion air is preheated as a consequence of the calory exchange with the lime in the cooling zone, a fact that entails a more favourable calory economic process.

Certainly, this technology is not applicable for kilns with an output of more than 30 tons/day , as consequence of their insufficiently kilns diameters. The requirements, however, which are posed to an "Indonesian standard kiln" now and in the next future, are absolutely corresponding to this new technology as well with regard to quantity as to quality.

Another most essential fact is that especially the simple way of the provided calory availability produced by an injection jet makes the application of this technology possible without complicated technical appliances, which need not be imported, a fact well worth mentioning.

The desired modest efficiency per kiln unit allows the kilns operating without an expensive hot gas exhauster, which would have otherwise to be imported, by means of an injection tube to be installed in the chimney, without this method becoming uneconomic with regard to power consumption.

[redacted]

Provided that the adjustment and the way of operating of the kiln are correct, a burning product of uniform quality and by all means of sufficient reaction can be obtained.

Setting into operation:

The shaft kiln filled with uniform classified stones of prescribed granulation up to the top of the kiln is set under drought at least an hour before start by switching on the blower.

A yute bag filled with coke is placed into the firings directly on the edge of the fired goods.

In front of this bag soft wood cleaved into small pieces is piled up, wrapped in rags, paper etc., sufficiently saturated with oil. The discharge openings on the bottom of the shaft are covered with wooden planks so that air can enter into the shaft through the opened firings.

Then fire is made in all the four firing holes at the same time. Then it needs waiting until the content of the coke bag gets sufficiently glowing.

Afterwards the throttle valves of the fuel injectors are set to the smallest possible quantity and the oil jets of the 4 injecters directed onto the glowing coke in the firings.

As, at this stage, the firings are closed, the entrance of the cool combustion air has to be guaranteed for at the same time by removing the wooden planks.

Operation:

It is recommended to start with the regular discharge of at first the stone material four to five houre after the kiln has been set to work, so that the goods to be fired can sink.

Containers are to be prepared for the discharge operation which can take up 0,42 m3/h of lime.

With a specific weight of the lime in a proportion of 1 t = 1 m3, the kiln is to be discharged with 420 kg/h. This is done in a way that the kiln observer walks around the kiln, taking away always an equal number of shovels from the four discharging holes.

The most favourable discharging to be attained amounts to 210 kg of burnt lime within 30 minutes interval each.

The loading of the raw stone is most favourably done in intervals of 1 hour, in a way, that the necessary load of the 720 kg lime stone is made in short intervals. During this procedure the cover of the hopper should be

[illegible]

opened only shortly. During the remaining time this cover has by all means be held closed that no false air can enter into the top of the kiln.

Controlling and measuring:

In order to regulate the combustion optimally, that means not to lead too little or too much combustion air into the burning zone, the flap for the regulation of the force air can be used; at the same time the alterable cone can be changed in order to alter the discharge angl of the force air.

It is recommended, however, to call on the relevant research institute at least on occasion of the first time a kiln is set into operation and to ask for an expert with an ORSAT - apparatus.

The waste gas quantity to be analized should be taken from the centre of the chimney below the entrance of the force air tube. A good result of the analysis, which is preassumption for obtaining a good burning product, would be:

| | |
|---|---|
| $CO_2$ | 28 - 33 % |
| CO | $<$ 2 % |
| $O_2$ | $<$ 4 % |

A 4 % $O_2$ content in the waste gas corresponds to an excess of air of 15 % and can be tolerated as maximum air access.

Once the kiln has the right regulation it can be run without any more control of the waste gases at the same throughput quantity.

<u>Examination of the calory offer:</u>

It is recommended to test the oil injectors with regard to their capacity prior to setting a kiln into operation. This is done by posing a sheet metal of about 1 m lenght and 1 meter breadth vertically of the traversed injector in about the same distance to the surface of the burning material.

This sheet metal is, on its lower edge, formed into a channel, its lower end under which a container is placed.

If the kiln is run with a kiln capacity of 10 t/day, this corresponds with 4 injectors with an oil througuput of 12,5 kg/h per injector.

This capacity should be obtained with a half opened throttle valve, and is measured in the following way: the injector is placed against the metal sheet within a period of 30 minutes.

[illegible]
[illegible]

The fuel which has flown into the container is weighed or measured volumetrically and the weighed or measured quantity, multiplied by 2, has to be 12,5 kg. With volumetrical measuring the specific weight of the used fuel has to be observed.

<u>Classification of the raw stone and kiln capacity:</u>

The maximum stone granulation corresponding to a kiln capacity of 10 t/day of burnt lime is 160 mm, the minimum 100 mm.

If the kiln capacity is to be raised, which is possible up to a specific capacity of 7 to/m2/24 h i.e.: 14 t/day, the maximum raw stone granulation has to be limited to 120 mm, the minimum to 80 mm.

<u>Other classifications as well as the use of smaller or bigger grained raw stones are not admitable!</u>

[illegible]

**Layout of gas burners for gas firing**

According to the lime burners in the area of Bongas, the PERTAMINA allows the use of one burner per kiln; only the firing gas tube has to correspond regarding to the light diameter and the section of 1/2 " tube.

It is intended that for the lime kiln the same basic construction be used than with the oil fired lime kilns. Also the capacity was fixed at 10 tons/day.

It is recommended to place 6 burners in equal distance along the periphery.

The burners are expected to work according to the principle of the Bunsen burner and should be put in a way which allows [illegible]

quantity of glowing stones has been obtained, [illegible]

With a gas speed of 72,3 m/s in the nozzle tube of the burner the latter can be done as 1/8 " tube with the outer measurements of 10,2 mm and inner diam. of 7,0 mm.

The tube diameter of 1/2 " tube of 236 mm2 allowed by PERTAMINA is enlarged by the use of 6 pieces of 1/8 " tubes, by a total square section of 231 mm2.

[illegible]
[illegible]

It can be assumed that the pressure in the gas net is sufficient to compensate the greater friction resistance on the tube mantle of the 1/8 " tubes.

With stoicheimetrical firing during the start of the kiln, 10 Nm3/h gas + burner are consumed with an amount of primary air of 133 Nm3/h and burner.

Between the tube arc of the mantle tube and an entrance funnel for reduction of the entrance friction, a throttle flap is provided.
This throttle flap is given a brake, so that it can be closed to a minimum air quantity of 20 % of 133 Nm3/h only.

[illegible]
[illegible]

**R 1/2 " tube** section 236 mm2

Da = 21,3 s = 2 Di = 17,3

$\frac{\pi}{4} \cdot 17,3^2 = \frac{\pi \cdot 299,29}{4} = 235,29$ 236 mm2

**R 1/8 " tube** section 38,5 mm2

Da = 10,2 s = 1,6 Di = 7,0 mm

$\frac{\pi}{4} \cdot 7^2 = \frac{\pi \cdot 49}{4} = 38,465 = 38,5$ mm2

With 6 tubes 6 · 38,465 = 230,79 = 231 mm2

Per burner:

$10 \text{ Nm3/h} = \frac{10}{3600} = 0,00278$ Nm3/s

R 1/8 " F = 38,5 mm2 = 0,0000385 m2

$v = \frac{0,00278}{0,0000385} = \frac{278}{3,85} = 72,5$ m/s

Air consumption:

Stoichoimetrical burning of $CH_4$ :

$CH_4 + 2O_2 = CO_2 + 2\,H_2O$

theoretical oxygen consumption 2 Nm3 per Nm3 of methan

theoretical air consumption $L\ min = \frac{O\ min}{0,21} = \frac{2}{0,21} = \frac{9,52 \text{ Nm3 air}}{\text{Nm3 methan}}$

With Netherland natural gas, for example, with a Hu = 7560 kcal/Nm3 the theoretical air quantity at 50 % air humidity, 20°C u 1013 mb : 8,51 Nm3/Nm3 natural gas.

[illegible]

This natural gas has 81,3 % $CH_4$, 14,35 % $N_2$, 0,87 % $CO_2$

Rest higher hydrocarbons

Air consumption presumed ca. 13,3 Nm3/Nm3 of gas at

10 Nm3 gas, than 133 Nm3 air/h.

$= \frac{133}{3600} = 0{,}037$ Nm3/s

or at v = 7,2 m/s, $\frac{0{,}037}{7{,}2} = 0{,}00514$ m2

In order to let the gas stream into the tube with a speed of

about 7,2 m/s we have to chose the following

gas quantity 10 Nm3/h = 0,00278 Nm3/s

v = 7,2 m/s    $F = \frac{0{,}00278}{7{,}2} = 0{,}000386$ m2 = 386 mm2

$\frac{\pi}{4} D^2 = 386$

$D \sqrt{\frac{386 \cdot 4}{\pi}} = \sqrt{\frac{1544}{\pi}} = \sqrt{492} = 22{,}4$ mm

<u>chosen R 3/4"</u>  Da = 26,9 mm    s = 2,3 mm    Di = 22,3 mm

F = 0,00038 m2

$v = \frac{0{,}00278}{0{,}00038} = 7{,}35$ m/s

As this tube is built into the air tube, the section has

to be considered.

Da = 26,9 mm    Fa = 0,000707 m2

Total square section:

0,00514 + 0,000707 = 0,005847 mm2 = 5847 mm2

$Di = \sqrt{\frac{5847 \cdot 4}{\pi}} = \sqrt{\frac{23388}{\pi}} = \sqrt{7450} = 86$ mm*

<u>Tube 3"</u>  Da = 88,9    s = 3,2    Di = 82,5 mm

F = 5345,6 m2

[illegible]
[illegible]

Square section of the ring

$$5345,6 - 707 = 4638,6 \ mm^2$$

$$F = 0,0046386 \ m^2$$

$$v = \frac{0,037}{0,0046386} \approx 8 \ m/s$$

[illegible]

## Structure of the injection burner

The injection burner consists, in its essential parts, of a foundation plate on which a geer box is built.

As moter an ordinary sewing machine motor is used. Its rotation speed of 1450 rpm is reduced to a final rotation speed of 0,5 rpm by means of the two counter shafts contained in the geer box.

The crank disk situated outside of the box steers a connecting rod which sets the moveable nozzle into a linear to and fro motion.

Between the flexible tube and the oil ring line connection fastened to the foundation plate, a manometer and a needle valve is situated for linear control of the quantity to be injected.

## Pressing of burning oil

As only light fuel is used, a preheating of the oil need not be effected.
The recommended operating pressure for the injection burners has to have between 2 and 3 atmospheres. Provided that the differences of level can be taken advantage of, which are higher than 20 m, it can be operated with fall pressure, in all other cases oil cog or screw pumps have to be used.

[redacted]

Due to the low nozzle diameters of the injection nozzle a thorough filtration of the oil is recommended.

[illegible]

## Recommendations for construction of the kiln shaft, the top of the kiln:

The single wall structures of the shaft are to be built up from the base together, so that the silicate stones within the shaft and the fire clay radial stone outside of the shaft are constructed in a way that the necessary intermediate space can be stamped with the stamp mass made of Puzzolane aggregate and a fire proof binder.

After completion of the built up shaft and the firings the entire shaft is coated with thin iron sheet, so that, if the wall gets fractions, no false air can enter into the inside of the shaft.

Care is to be taken that the whole kiln shaft gets 4 - 6 cm height by thermal expansions during the time while the kiln is cold until it gets operating temperature.

This is why a disconnected shell has to overlap or, especially at the botton of the shaft and in the area of the firing holes, has to be embeded profoundly in the concrete structure.
The charging hopper has to be closed with a tightening cover.

During the operation the charging tube connected with the hopper has to be constantly filled up with raw stone so that during the opening times of the cover only a very small amount of false air can enter the shaft.

**Test kiln**

The Building Materials Development Laboratory in Bandung has, a year ago, built an oil fired test kiln for lime production on the area of the Institute.

The shaft diameters are the following:

Light diameter 2 m
effective shaft height 8,[illegible] m

In an angle of about 60°C lateral on the burner shaft, there are three firing chambers. In about the height of the firing chambers the shaft is retracted in a light diameter up to 1 m.

The firing chambers are equipped with three automatical industrial burners. The capacity of the burners is 17 - 90 kg/fuel/

On the top of the kiln an exhausted is situated which, due to the lack of information on static pressure was measured by the writer by the air of Prandl tube and oblique tube barometer according to the Bernoulli-system.

The calculation attached to this final report shows a quantity of 1000 N3/h and a total pressure of 83 mm WC when measuring a throughput air quantity with a $\gamma$ of 1,16.

A burning test was started and given up again as it occured that the construction of the burner did not come up to the purpose.

This was what induced the management of the Building Materials Development Laboratory to take the decision of rebuilding the test kiln according to the writers in - structions, corresponding to the kiln planned and described in this report and according to the recommended technology.

On base of the shaft proportion not corresponding to this technology, the reconstruction was made in a way that the light shaft diameter was reduced by a further fireproof lining to reach the purpose that the new light shaft diameter can be brought into the right proportion to the effective shaft height.

The new data:

| | |
|---|---|
| Light shaft diameter | 1400 mm |
| Effective shaft height | 8000 mmm |
| shaft form = cylindrical | |
| Number of firings | four |
| Number of firing levels | one |

size of the firing holes in the working lining , included areas: 800 . 800 mm.

| | |
|---|---|
| Capacity of kiln | 7,7 tons/day |
| Specific capacity | 5 to/m2/24 h |
| Raw stone granulation | 100 - 160 mm or 80 -120mm |
| Fuel: | light fuel ca.9600 kcal/kg. |

[redacted]

The already existing kiln pedestal made of reinforced concrete allows the use of a discharging equipment.

The writer has, for this purpose, set at disposal an old patent being family property.

The mechanic part is a simple vibration shoot.

The top of the kiln can remain unchanged, only the exhaust fan is, according to instructions, run with lower rotation in order to reduce the quantity and static pressure.

With exception of the above mentioned differences the technological facts and the operating conditions are corresponding with the kiln of 10 tons/day as described in this report.

Due to the decision to reconstruct this kiln according to the recommended technology, the plans of the Department of Public Works and Power and of the Department of Industry are really becoming active help for the Indonesian lime industry and are of great support.

The risk for this demonstration object is, due to the intended project no more be taken by the industry but by a governmental department, a fact which will enable the interested industry to attain quicker and more effective decisions for construction of new objects.

[illegible]

<u>Calculation of a throughput of air quantity in m3/h</u>

according to the Bernoulli-method.

Impact pressure h = 38

density of air $\gamma$ = 1,16

tube diameter = 200 mm

F = 0,0349 m2 (349 cm2) calculation in m2

$$Q = F \cdot v = F \sqrt{2 \cdot 9{,}81 \cdot h} = m/s$$

$$v = \sqrt{\frac{19{,}62 \cdot (h) \quad 38}{1{,}16}}$$

= 8 m/2

L quantity = 8 m/s . 0,0349

= 0,279 Nm3/s

= 0,279 Nm2/s . 3600

L quantity = 1000 m3/h

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Recommandations:

**Uniformity of assortment, dry sla... ng and wet slakeing.**

Though, such as can already be seen in the report, an improvement of the existing burning technology and herewith an improvement of quality of the burned goods cannot be recommended, the remaining possibilities ought to be very well considered.

As this can be observed with ...most all li... producing plants, it can be recommended in general, to uniform the granulation of the raw stones and to keep the granulation [illegible]

Due to the fact that the shaft dimensions are very similar in most cases, the dimension 120 - 160 mm is recommended as uniform granulation. This is ...w a more thorough burning is obtained with lowe. quantity of rest-$Co_2$ content on one hand and a lower quantity of sintered material on the other hand.

A material burned in this way will also show a different behaviour with the dry slakeing process, that means, the slakeing process will be finished in a shorter time which remains constant.

In any case it is recommended to crush the lime before slakeing and not spray water on layers thicker than 10 cm.

[illegible]
[illegible]

The writer regards the application of wet slakeing as solution of this problem. In this case the lime is first to be slaked to lime milk than screened with narrow mesh and stored in rest pits. The walls of such rest pits can be made of concrete, the floor should be filled up by water permeable material (sand, Puzzolan etc.).

[illegible]
[illegible]

**Technical and economical feasibility study for a pilote plant:**

From the prehistory and its connotations as well as from the entire final report it can be seen that, to the benefit of the mission, a few unsignificant alterations of the working program described in the job description had to be made.

Especially item 1 of the Job Description concerning the creation of a new technology was carried out in detail.

In order to come up to the task with regard to giving recommendations for a modern lime industry, the writer has, on base of discussions held with the private industry, mentioned under item "sundry" a statement of a modern technology for a kiln with a capacity of 100 t/day, and specified such a kiln technically.

The mentioned weights are real weights, the price is an estimated counter value fob European port.

As, corresponding with the percentage of a partial delivery, in Indonesia, this price might be considerably varying, the financial analysis could not be made in the usual way.

[redacted]

The attached prime cost calculation bases on the real today Indonesian prices as far as the items raw materials, wages, current and fuel is concerned, the total production cost, however, and the supervising and operating costs were only assumed.

[illegible]

## 1.0 Plant Description

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## 1.1 General Data

**Induced draft kiln**

| | |
|---|---|
| Kiln capacity: | 100 tons of burnt lime per day |
| Lump size of lime stone: | 80 - 120 mm |
| Fuel: | fuel oil |
| Kiln size: | inside shaft diameter 3750 mm |
| | Height of shaft: approx. 25000 mm |

## 1.2 Kiln charging

An inclined hoist is provided for kiln charging operations. Should some other kind of raw limestone transportation to kiln top be required for local considerations, a belt conveyort or perhaps a pocket belt conveyor may be used instead of the inclined hoist.

The inclined hoist quoted for uses a skip bucket; approx. 5 - 6 trips being provided per operating hour.

Skip bucket travelling is initiated by operation of a push button. Once the impulse has been given, further charging operations are effected automatically. The kiln being operated with induced draft, the stock is passed through a sealed lock at kiln top. To prevent infiltrated air from getting into the shaft and hence into the pipework system, a single-chamber double lock has been provided.

featuring two sealing and material holding flappers. Flapper actuation is effected within the automatic charging operation cycle. An adjustable time-lag relay controls the time the bucket is kept in dumped position and also the bucket return travel.

A stock level indicator is provided for automatic kiln operation. By introducing a measuring probe into the upper shaft, this indicator checks the respective level of stock following each bucket charging operation. A rotary cam limit switch connected to the rope sheave indicates the stock levels.

## 1.3 Waste gas and carrier gas recovery plant

This plant consists of an exhaust line system including waste gas line with carrier gas throttling facility.

The kiln atmosphere pressure is controlled independent of the volume of waste gas to be evacuated and as called for by the process conditions by means of a speed control facility together with a remote-controlled throttle flap arranged ahead of the exhauster.

The speed control facility and the throttle flap facility with indicator and recorder are located in the control room.

Carrier gas i collected by means of an adequately long section in the waste gas line with remote-controlled dampfer; the damper position indicator and remote-control unit are located in the control room.

The oil gas produced in the reactors is added to the carrier gas, the volume and pressure of the carrier gas being controlled by varying the speed of waste gas blower and adjusting the throttle flap in the waste gas line.

This regulation permits the most favourable heating value of the fuel gases to be determined with a view to obtaining a slow-burning, long combustion zone for the production of soft burnt lime.

## 1.4 Gas generation plant for the firing of heavy fuel oil.

The main units of this plant are the 6 gas generation reactors. They are spaced at regular intervals and arranged laterally on the shaft shell in such a way that their axes meet the kiln axis and form an angle of $55^{o}$ with the latter.

The reactors comprise a reactor chamber and a mixing chamber arranged one behind the other in this order. The walls of the mixing chamber are provided with a fire-proof rammed lining.

A burner assembly is located at the chamber head for atomization of the heavy fuel oil and for feeding the primary combustion air. Dry steam is taken from a steam generation plant.

The waste gas (carrier gas) drawn off is fed between reactor and mixing chamber to the oil gas produced in the reactor in such a way that a combustion gas suitable for kiln operation is produced in the mixing chamber.

The pressure oil burner assemblies are supplied on the one hand with prepared heavy fuel oil via a treatment and dosing facility and on the other with primary combustion air through separate branch air lines.

In order to permit the carrier gas carburetted with cracked oil gas to be regulated at constant volume in respect of its pressure in conformity with the process conditions, the two material flows - primary air and carrier gas - are controlled separately as regards volumes and pressures before entering the reactor.

The heavy fuel oil supplied by the works to the foot of the kiln is forced via a fuel filter and an electric oil heater into an annular line system by a circulating pump. 6 dosing pumps belonging to the reactors withdraw from this system the oil volume required for the generation of gas. By locating the oil carburetor close to the kiln a favourable fuel economy is ensured when changing over from oil to oil gas.

1.5 <u>Primary air system</u>

A blower is provided to supply the primary combustion air necessary for the gas circuit.

The blower is followed by a throttling facility which permit the primary air to be controlled in respect of volume and pressure.

1.6 <u>Kiln discharge</u>

To ensure uniform discharge of the burnt lime over the entire shaft cross section, the stock is divided into 4 equal part flows by a concrete-filled saddle-shaped structure of sheet steel. The saddle tips are designed as air ducts which permit uniform distribution of air over the entire shaft cross section.

4 vibratory chutes are used for smooth discharge of the stock over the shaft cross section.

Discharging is effected automatically with the aid of two time-lag relays.

Discharging may be effected either by simultaneous operation of all 4 vibratory chutes or by separate control in clockwise order to cause any material bridges in the stock to be broken.

The burnt lime discharged at regular intervals is collected in ab beam from where it can be withdrawn by two vibratory chutes.

1.7 <u>Kiln shaft</u>

The kiln feature as shell of welded steel construction free-standing on the foundation.

In order to permit balancing of the pressure of the material flows with the kiln atmosphere conditions at any particular time, 6 pressure measuring points are equally spaced on the kiln shaft at the firing zone height; the remote controls and indicators are located in the control room. In conformity with the atmospheric pressure obtaining in the kiln at any one time, which can be pre-selected and recorded, the mixed gases can be correctly proportioned using the suitable appliances.

The kiln shaft is furthermore provided with inspection holes at different levels with thermo-couples arranged above the same. Flanged poker holes are provided in the cooling zone.

Service platforms of structural shapes with non-slip plate covering are provided at various levels.

The platforms are connected through stairs and landings to give safe access to the kiln up to its top part.

## 1,8 Waste gas analyses

One ORSAT unit is located in the control room for continuous monitoring of the waste gas $CO_2$ concent and the surplus air volume ($O_2$ measurement). The waste gas to be analysed is sucked in through a filter and a capillary line by an electrically operated pump which is also arranged in the control room.

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## 1.9 Start-up

The kiln shaft must be filled with material before the first start-up and before each subsequent start-up. Furthermore, the furnace atmosphere must be agitated by the waste gas exhaustor prior to start-ups, to allow the waste gases to escape as soon as the combustion and reaction processes start.

At the same time, prior to the first start-up or any subsequent start-up, it must be made certain that the heavy fuel oil hast the correct temperature as required in the burner operating instructions and the steam boiler has abtainied the necessary operating pressure. Then, the oil carburation plant is put into operation, the primary air blower switched on and 3 oil gas reactors ignited by slow-match.

The combustion must be set to a value above the superstoichiometric value, air surplus 20 - 30 %, by means of the manual primary air regulating flaps and the oil flow regulating valves at the burner assemblies.

On acount of the higher combustion chamber temperatures caused by superstoichiometric combustion, the carrier gas system is started when a chamber temperature of about 900 °C is reached.

After several hours of operation with that kiln setting, the $CO_2$-content of the waste gas will have increased. At the same time the exhaust volume of the exhaust system is increased through the speed governor.

As soon as there is asufficient amount of glowing material at the gas inlet in the kiln shaft - which can be observed through inspection holes - the reactors are gradually changed over to understoichiometric operation and the three remaining reactors are put into operation.

During full operation the 6 oil gas reactors use an air factor ranging between 0.45 and 0.50.

## Automatic steam generator

Steam of 4 atm. gauge operating pressure is required for atomizing the fuel oil and as reaction agent (water gas reaction).

The required volume of approx. 400 kg/h is produced in an automatic steam generator. This generator is arranged for oil firing and it operates fully automatically.

The facilities required for the treatment of boiler feed water are included.

Should steam be available in your works, the steam generator can be dispensed with.

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## 2.00 TECHNICAL SPECIFICATION OF LIME KILN HAVING A CAPACITY OF 100 TONS/DAY

**2.1.0 <u>Kiln charging equipment</u>**

2.1.01 1 skip bucket
consisting of:
skip, useful capacity approx. 1 $m^3$,
of welded steel plate construction with stiffeners
of structural steel, the cast steel track wheels,
anti-friction bearing mounted, axles and cross member
for rope suspension.

2.1.02 1 inclined hoist bridge
consisting of:
the inclined hoist structure of steel construction,
with main and cross girders,
the stiffeners,
the track rails on the runways,
the curved sections and
the supports on the kiln

2.1.03 1 kiln superstructure
to receive the rope pulley for the skip bucket, of
steel construction, with inspection platforms
and access ladders.

2.1.04 1 hoist winch
arranged for electric drive (20 kW) with a
rope speed of v = 0,5 m/sec.,
hoisting force: 3,2 tons,
consisting of:
a rope drum with cut-in rope grooves,
spur wheel drive, brake disc coupling with
service brake and brake release mechanism,
the machine frame of structural steel to receive
the parts of driving mechanism, the rope sheave and
return pulley including bearings, the wire rope of
18 mm dia.

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**2.2.0** **Kiln top equipment**

2.2.01 1 kiln top of steel plate,
designed for taking off gas at two end,
with connecting flanges for waste gas
line, emergency stack and the necessary
cleaning holes.

2.2.02 1 material guiding cone for lime stone
distribution, made of wear-resisting
material, with suspension gear in
the kiln top.

2.2.03 1 emergency stack NW 700,
including sealing flappers with hand
winch, rope and the necessary deflecting
and guide pulleys for actuation of the flapper
from kiln base.

2.2.04 1 kiln top closure
consisting of:

1 flapper casing to accommodate
the bearings and seals for the lower
sealing flapper and the material
retaining facility.

1 lower sealing flapper, complete,
with axle and operating lever,

1 material retaining facility, complete,
with axles and operating lever

1 lock chamber with replaceable wearing
plates, useful capacity approx. 1 $m^3$.

1 flapper casing, to receive the bearings and seals for the inner sealing flapper.

1 upper sealing flapper, complete, with axle and operating lever.

1 inlet funnel with replaceable wearing plates

Various fasteners for the electric servo mechanisms.

1 electric positioner, adjusting froce 1250 kg, for the lower sealing flapper

2 electric positioner, adjusting force 1250 kg, for the upper sealing flapper.

2.2.05 1 Stock level indicator
consisting of:
rope winch with indicator weight,
gear unit with driving motor,
electrical rotary cam limit switch for various stock levels, slag rope switch,
control system for troughs at kiln discharge.

## 2.3.0 Kiln shaft

2.3.01 Kiln shaft
consisting of:

1 bottom ring, diameter 5550 x 4750 x 30, with stiffeners,

1 shell bottom part, inside diameter 5050 x 18 mm, height 10,000 mm

1 shell centre part, inside dia. 5056 x 15 mm, height 8,000 mm,

1 shell top part, inside diameter 5062 x 12 mm, height 7,500 mm

1 edge angle 100 x 75 x 11

6 reactor shells, dia. 1100 x 10, with stiffeners

Various gauging and inspection holes.

2.3.02 Platforms and stairs
consisting of:

1 platform underneath the reactors, of welded structural steel bearers, the brackets, welded to the furnace shell and a non-slip plate covering as well as hand railing of structural steel.

1 platform at reactors, same as above,
3 platforms above reactors, same as above,
Stairs with landings and handrailing, of welded structural steel construction with non-slip plate covering.

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## 2.4.0 Refractory lining

As quality comparison products of Messr. Didier Werke AG, Wiesbaden have been listed.

### I. Interior lining

#### A) Firing zone

10 m vertical - wall thickness 230 mm
(minus 6 burner openings - reactors)
approx. 1920 shaped bricks SC 23
approx. 8.6 kg each = approx. 16.5 tons
approx. 8-7 kg each = approx. 66.8 tons
"Basal" quality

#### B) Preheating zone - 5.5 m vertical) Cooling zone - 6.0 m vertical) 250 mm thick

Approx. 70.0 tons of radial bricks
"Maxial 330" quality

#### C) Charging zone

4.5 m vertical - 250 mm thick
Approx. 28.5 tons of radial bricks
"Maxial 382" quality

#### D) Burner openings

(Arch - 6 burners 1000 mm dia double end)
Approx. 600 double-end arches 2 GG 24

"Basal" quality

Approx. 12.0 kg each = approx. 7.2 tons

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II. First backing brickwork

26 m vertical - 125 mm wall thickness

a) Approx. 8,320 standard bricks NF 2
Approx. 3,9 kg each = approx 32,5 tons
Apprix. 13,520 side arches 2 W 6
Approx. 3,9 kg each = approx. 52,7 tons
"Didier 130" quality

b) For the bruner opening arch
(3 backing brickword layers)
Approx. 280 end arches 2 G 16
"Didier 130" quality

Approx. 3,9 kg each = approx. 1,1 ton

III. Second backing brickwork

26 m vertical - 125 mm wall thickness
Approx. 22,600 standard bricks NF 2
Approx. 2,1 kg each = approx. 47,5 tons
"Legral 35/0" quality

IV. Insulation - 3rd backing brickwork

26 m vertical - 125 mm thickness
Approx. 23,920 standard bricks NF 2
Approx. 1,2 kg each = 28,7 tons
"Moler 06" quality

V. Backfill at plate shell

20 m vertical - 25 mm thick
Approx. 3,100 kg of insulating backfill material
(Vermiculit)

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VI. Burner branch lining

for 6 burners

a) Internal lining

1,25 m long - 200 mm thick

Approx. 10,500 kg of ramming compound "Firecrete 3 X"

b) Insulating layer at plate shell

Approx. 1,25 long - 100 mm thick

Approx. 2,700 kg of insulating ramming compound "Legrit 20/8"

VII. Mortar

Approx. 6,300 kgs Rasamur N
for brick quality "Rasal"

Approx. 1,600 kgs Sodium Silicate

Approx. 12,500 kgs Didomur 1
for brick quality "Maxial 310" and "Didier 130"

Approx. 1,600 kgs Didomur 5
for brick quality "Maxial 382"

Approx. 4,200 kgs Didotect 4
for brick quality "Legral 35/0"

Approx. 3,700 kgs special mortar
for insulating brick quality "Moler 06"

**2.500** **Kiln base**

**2.5.01** Basic plans showing foundation for
following contreting work,
foundations, supports, daily service bins,
kiln platform and stairs,
as well as the necessary insulation work.

**2.5.02** Steel structures
comprising:
handrailing for platforms and stairs
of welded construction
made of structural steel
6 fixing frames to be grouted in the concrete
structure,
for the suspension of discharge troughs.

**2.5.03** Kiln discharge equipment
to cope with a kiln output of over 100 tons of burnt
lime per day, consisting of:
4 vibratory chutes, complete, with one vibrator each
under the trough, including 4 suspension chains per
chute
4 thermostats, setting range 0 - 120 °C,
4 press key switches to control the volume discharged
1 complete saddle-shaped structure with central air
pipe and covering, to be grouted in the concrete
structure,
4 air ducts are arranged above the saddle tips to
ensure a uniform distribution of air over the entire
kiln cross section.

1 vibratory chutes underneath the kiln bin, with
fixing frames.

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3.6.0 **Firing system**

3.6.01 Waste gas plant
comprising:

1 descending pipe NW 800
from kiln top to waste gas blower, complete, with pipe bends,

2 expansion joints and supporting structures and fasteners.

1 waste gas blower having a delivery volume of approx. 10.500 $Nm^3/h$, suitable for 350 °C and p = 550 mm WC., N = 75 kW, n = 1470 rpm,
consisting of:
impeller with lateral cooling wings, most carefully balanced statically and dynamically, volute with inspection doors, attached base to receive bearing support, coupling and driving-motor,
shaft carried in self-aligning roller bearings, bearing housing protected against heat by a cooling plate.

1 coupling to connect motor and blower, for blower speed control, complete, with oil fill and oil cooler ; the oil being cooled by air.

1 exhauster,
consisting of:
the throttling space with elbow connector and flange for the throttle flap, 1 coupling flange for the overload control flap with pressure relief stack,

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the branch -off connection with flange
for the carrier gas volume to be throttled,
the elbow connector for the waste gas blower and
1 expansion joint.

3.0.03 Oil gas producer
consisting of:

6 gasifiers,
having a capacity of 75 kg/hour of heavy fuel oil (Mazout) and a maximum capacity up to 125 kg/hour.

6 spare atomisers

6 carrier gas mixing chambers, with the necessary refractory lining, provided with connection.

6 carrier gas control slide valves,

6 "gasifier" combustion air control slide valves

6 manually controlled dosing pump with Vernier controls, complete, including motors and starter

6 sets of combustion carburetor control equipment, complete, with connected solenoid oil valves.

6 hand-operated three-way control valves for feeding hot oil to the gasfiers.

6 hot oil thermostats, to ensure that the fuel oil has the proper temperature for atomising.

12 oil branch line separating valves

1 Duplex fuel oil filter for the ring main

1 main oil separating valve

1 Ring main circulating pump, with motor and starter.

1 electric fuel heater, complete, with contactor, temperature controls and all accessories

1 set of ring main oil pressure controls,

1 baseplate to receive the fuel filter, the heater and the circulating pump

1 line system, consisting of:
the oil supply line from the kiln foot to the ring main,

the ring main and the branch pipes leading to the 6 cyclones.

[illegible] Carrier gas line
consisting of:

1 supply line NW 150, leading from the control room to the ring main, with expansion joint.

1 ring main NW 150,
with 6 branch-off connections NW 150
to the branch lines, and various cleaning holes, connecting flanges and support assembly.

6 branch lines NW 150
from the branch-off connections of ring main
to the mixing chambers of the 6 cyclones with elbows and intermediate flanges for installation of the control elements and measuring orifices.

[illegible] Primary air system

1 primary air fan, 4500 Nm$^3$/h, temperature 20 $^{\circ}$C
200 mm WG, power requirement 7.5 kW,
consisting of:

impeller, most carefully balanced statically and dynamically, volute with attached base to receive the bearings and driving motor,

P. [illegible]
Beratender Ingenieur VDI

1 fan air supply line NW 150,
from the primary air fan to the ring main with elbows and flanges.

1 ring main NW 150,
with 6 branch-off connections NW 150 to the branch lines, with connecting flanges and support assembly.

6 branch lines NW 150,
from the branch-off connections of ring main to the air connections of 6 gasifiers, with elbows and intermediate flanges for installation of the control elements and measuring orifices.

3.6.08 Steam generator
consisting of:

1 automatic steam generator for fully automatic oil firing,
boiler capacity 400 kg/hour, max. admissible working pressure 8 atm. gauge, boiler efficiency [illegible] %,
complete with the necessary regulating accessories and instrument panel, insulation, water level limiting device, automatic feed water regulator.

1 fully-automatic oil firing system,
for an oil throughput of 29.5 kg/hour, calorific value 10,280 kcal/kg, complete with the necessary accessories, one fuel oil pump with oil filter, one primary oil heater.

F. [illegible]
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1 feeding system
consisting of:
2 centrifugal pumps, delivering 0.6 tons/hour, head 90 m WG, completem, including 1.5 kW motor.

1 electric fault indicator, for single fault signal line with optical indication.

1 waste gas stack 250 mm dia., approx. 5 m high

1 feed-water treatment plant, completem including water softener, feed water tank, dosing facility, boiler water test case.

1 reducing valve
for reducing 400 kg/hour of steam from 8 atm. gauge to 3 atm. gauge
including dirt trap and accessories.

1 steam line
from the steam generator to ring main, including all flanges.

1 ring main with 6 branch-off connections to the branch lines, with connecting flanges and supports.

6 branch lines
from the branch-off connections of ring main to the steam connections of the 6 gasifiers, including elbows and intermediate flanges

F. [illegible]
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2.7.0 **Insulating material**

2.7.01 Various pipe insulating materials, consisting of mineral wool insulating mats on galvanized wire netting, 40 - 100 mm thick, prepared, galvanized sheet iron, rounded, beaded, with the necessary bends, spring hooks, galvanized bolts, spacer rings of strip iron and galvanized binding wire for all hot lines.

P. [illegible]
Beratender Ingenieur VBI

2.8.0 **Metering and control equipment**

2.8.01 **Pressure in back-pressure pipe**

1 electrically operated single-colour recorder

2.8.02 **Pressure in mixing chambers**

6 local U-tubes,
range 0 - 100 mm WC,

12 shut-off valves

2.8.03 **Primary air overall pressure**

1 recording ring balance,
range 0 - 500 mm WC,

2 shut-off valves.

2.8.04 **Main pressure**

6 U-tube pressure gauges,
12 shut-off valves

2.8.05 **Waste gas pressure in front of waste gas blower**

1 recording ring balance,
range 0 - 500 mm WC,

2 shut-off valves,
second measuring range for Item 2.8.06

2.8.06 **Carrier gas overall pressure**

2 shut-off valves

2.8.07 **Oil volume measurement**
annular piston counter with
transducer and integrator

F. [illegible]
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2.8.08 **Measurement of carrier gas overall volume**

1 orifice,

2 shut-off valves

1 double ring balance,

second measuring range for Item 2,6,10

2.8.09 **Carrier gas volume in front of mixing gas chambers**

6 orifices,

12 shut-off valves,

6 change-over cocks,

3 indicating ring balances

2.8.10 **Measurement of primary air overall volume**

1 orifice NW 400,

2 shut-off valves,

2.8.11 **Measurement of primary air volume**

6 orifices

12 shut-off valves,

6 change-over cocks,

3 inclined tube pressure gauges

2.8.12 **Temperature measurement in kiln shaft**

6 thermo-couples NiCrNi,

1 sextuple thermostat,

1 six-colour recorder,

balancing line

F. [illegible]
Beratender Ingenieur VBI

3.8.13 <u>Temperature measurement in front of waste gas blower with maximum signal</u>

1 thermo-couple NiCrNi,
1 sextuple thermostat,
1 indicator with maximum contact,
1 horn,
1 horn silencing push-button,
2 auxiliary contactors

3.8.14 <u>Temperature measurement in combustion chambers with maximum signal</u>

6 thermo-couples NiCrNi,
1 six-colour recorder with maximum contact,
1 sextuple thermostat,
balancing line

3.8.15 <u>Measuring instrument cabinet</u>

accommodating the above apparatusses,
for installation in a room to be provided
by the customer.

3.8.16 <u>Throttle flapper control</u>

1 transducer,
2 shut-off valves
1 controller,
1 controller actuator,
1 actuator drive,
1 drive lever,
1 throttle flapper

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**3.8.17 Stack damper control**

1 transducer,
2 shut-off valves,
1 controller,
1 controller actuator,
1 pressure indicator,
1 actuator drive,
1 drive lever,
1 throttle flapper

**3.8.18 Waste gas analysis**

1 filter,
1 shut-off cock,
1 diaphragm pump,
1 ORSAT unit

**3.8.19 Semi-automatic control of wast gas flapper speed of waste gas blower**

1 throttle flapper,
1 flapper position indicator,
1 controller actuator,
1 actuator drive,
1 drive lever

**3.8.20 Pressure measurement in air and mixture gas lines**

12 U-tubes,
24 shut-off valves

[illegible]
[illegible] Ingenieur VBI

2.8.21 Semi-automatic control of primary air throttle flapper behind blower

1 throttle flapper,

1 flapper position indicator,

1 controller actuator,

1 actuator drive,

1 drive lever

2.8.22 1 luminous connection diagram

The measuring and control equipment for the oil gas producers are included in Item 2.6.02.

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Beratender Ingenieur VBI

3.9.0 **Electrical equipment**

The electrical equipment
comprising:

3.9.01 All prime movers and appliances
not marked "M" on the attached motor
list, sheet 36
The parts marked "M" are included in the
mechanical equipment.

1 complete switch cabinet to accommodate items 1-15
of motor list, sheet metal clad, for indoor
installation, without buld heads and modules,
including the necessary guards, switch and control
gear, and

2 Fuse outlets, 10 kW each, for standby purposes,
1 central control pulpit for operation of the complete
plant, as well as several local control points

3.9.02 The complete cabling
comprising:
PVC-sheathed cable and the cable trays required for
the laying of cables.

3.9.03 The lighting system, without the general yard and
approach way lighting system

3.9.04 One lightning protector

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| Item | Drive designation | | | kW | Rating % | RPM | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Waste gas blower | 1 | KL | 75 | 100 | 1500 | 1 | B3 | |
| 2 | Voith coupling | 1 | KL | 0,5 | | | 2 | | M |
| 3 | Primary air blower | 1 | KL | 7,5 | 100 | 2900 | 1 | B3 | |
| 4 | Hoist | 1 | KL | 22 | 60 | 1000 | 2 | B3 | |
| | Attached: 1 DE 4, 1 slack rope switch, 1 main current limit switch | | | | | | | | |
| 5 | Actuator drive (upper sealing flapper | 2 | KL | 5,5 | 40 | 1500 | 2 | | M |
| 6 | Acutator drive (material holding flapper) | 2 | KL | 3 | 40 | 1500 | 1 | | M |
| 7 | Stack depth indicator | 1 | | | | | | | M |
| 8 | Vibratory chutes | 1 | KL | 1,5 | 100 | | 1 | | M |
| | Kiln discharge | | | | | | | | |
| 9 | Vibratory chutes | 2 | KL | 1,5 | 100 | | 1 | | M |
| | Day bin discharge | | | | | | | | |
| 10 | Feeder for oil gasifiers | approx. 15 | | | | | | | |
| 11 | Feeder for metering and control system | | | 15 | | | | | |
| 12 | Feeder for automatic steam generator | | | | | | | | |

M = included in scope of mechanical supply

P. [illegible]
Beratender Ingenieur VSI

## 3.0 Weights and Prices

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3.1.0 **Supply of complete equipment from Germany**

| Item No | Description | Approx. weight (kg) |
|---|---|---|
| 2.1.0 | Kiln charging equipment | 24.400 |
| 2.2.0 | Kiln top equipment | 14.300 |
| 2.3.0 | Kiln shaft | 92.800 |
| 2.4.0 | Refractory lining material | 400.000 |
| 2.5.0 | Kiln base | 13.800 |
| 2.6.0 | Firing system | 29.300 |
| 2.7.0 | Insulating material | 500 |
| 2.8.0 | Metering and control equipment | 2.600 |
| 2.9.0 | Electrical equipment | 2.000 |

Approx. weight total 579.700 kg

Approx. price total 2.300.000 DM

FOB any European port

**Excluded items**

In the above mentioned specification the following is not included.

- the earthing and building work
- the fuel oil and water supply lines up to kiln base
- the electrical feeders up to the terminals of switch cabinet in the control room, the earthing system
- the montage
- lifting appliances and building huts for the erection
- bringing in the refractory lining material in the kiln.

[illegible]



## Prime cost calculation

capacity of 100 t/day

| | Cost per unit | Cost per ton |
|---|---|---|
| 1) Dressed lime stone | Rp [illegible] | Rp [illegible] |
| 2) Wages | Rp 530,-to 1.000,- [illegible] 8 hours<br>[illegible] aver[illegible] 9 workers, [illegible] | = [illegible] |
| 3) electrical power | Rp 15,- [illegible] | = [illegible] |
| 4) Fuel | Rp [illegible]<br>[illegible]<br>Rp 11,- average | = [illegible] |
| 5) Single costs 1)+2)+3)+4) | | = [illegible] |
| 6) General fabrication cost [illegible] average costs [illegible] | | = [illegible] |
| 7) Production cost 5)+6) | | = [illegible] |
| 8) Administrative and running cost assumed 10% | | = [illegible] |
| 9) Prime cost 7)+8) | | = [illegible] |

Assumed oil consumption = [illegible] kg/t lime.
This corresponds to 10[illegible] kcal/kg lime at [illegible] the fuel of 9600 kcal/kg.

Assumed electrical power consumption = 43 kWh/t lime

## SUMMARY

**Speech of the expert:**

On Oct 20, 1973 the Regional Housing Centre arranged for a meeting of the owners respectively the managers of the regional lime industry and several associates of the relevant Institute as well as of the Technical [illegible] of Bandung.

At this meeting the writer was given the opportunity to describe his impressions on the visited lime [illegible] in a detailed speech, as well as he was able to [illegible] the present parties familiar with the suggested [illegible]. Vivid reaction followed in the [illegible].

**Contacts with private companies:**

As already mentioned, the writer had, [illegible], the repeated opportunity to meet the leading [illegible] of the [illegible] Phobis.

During his presence in [illegible] the writer was [illegible] by the General H.A. [illegible], the [illegible] of the [illegible] of this company. These of [illegible] on [illegible] of a modern [illegible] plant for a capacity [illegible] of burnt lime for the [illegible] Steel Works with lime [illegible] industry.

Furthermore, the fact was pointed out that this company is also interested [illegible] construction [illegible] Plant [illegible] of natural cement on the base of lime as binder.

On Oct 15, 1973 the writer was invited by the [illegible] group of Mr. Dipl. Ing. S.M. Harjono, [illegible], [illegible] a speech on the most modern technologies in lime burning. The group Harjono intends to build up a plant for production of gas concrete between [illegible] and [illegible] and is interested in projects for production of the necessary quantity of burnt lime, [illegible].

In both cases the writer was asked whether a possible financial support would be possible for the above mentioned project on base of bilateral assistance.

Indonesia ought to take advantage of [illegible] of the fundamental [illegible].

[illegible]



## Summary and results

Indonesia is to be counted to the developing countries where the production and use of burnt lime has been carried out already for a long time. As a consequence of the existing and increasing demand, burning technologies have been developed in order to be able to use gasified and liquid fuels.

The mission with the aim of modernization and rationalization of existing technologies has, therefore, to be connected to the status already in development in order to be successful also under consideration of local conditions.
As the present report proves, a further development of the used burning methods would not have been of advantage, as neither an improvement of the present qualities nor a rationalization of the specific fuel consumption would have been obtained.

On the other hand, the recommendation of most modern high capacity lime burning equipment wouldn't have had any use in this industry branch, as the amortization cost of such plants, their maintenance as well as their production part to be imported have an, proportion with regard to the market price of the product in the construction industry.

It was, therefore, recommendable, to chose a technology which corresponds to the claims of the present time, i.e.:

1) production cost of the equipment and independence from import for certain parts of the plant,
2) quality of the product and
3) specification of fuel consumption.

Besides that the chosen technology ought to be expandable also in the course of the intensification of this branch of production with regard to method and equipment and well introduced, it ought to be used also for obtaining greater capacity per kiln unit.

All this was given consideration. The standard kiln for 10 tons per day, for fuel- and gas firing can, by doubling of the burning level, be brought to a capacity of 20 tons/day.

Furthermore, the country should be given the possibility to participate in the most modern production methods as a consequence of the quick development of high qualified lime burning consumers as well as steel works, construction industry, sugar industry, agriculture, etc.

[illegible]



In order to correspond to this consideration, two main [illegible] have been found out and the example of a [illegible] high capacity [illegible] was [illegible] in detail.

The attention just rightfully [illegible] by the [illegible] and [illegible] public and private [illegible] interested parties appears to be suitable for immediate realization of both projects.

VEI [illegible]

[illegible], [illegible]

Together with Mr. G. Kastengren, Senior Industrial Development Field Advisor of UNIDO, also Mr. Danunangoro was visited at his Ministry and thus the contacts of the writer with officials and people in Jacarta began.

The following people and ministries have been visited:

The Ministry of Mines, Mr. Ir. Bambang
Sulasmono
Institute For Industrial Reasearch and Training
Department of Industry, Dir. Ir. Benito Kodijat

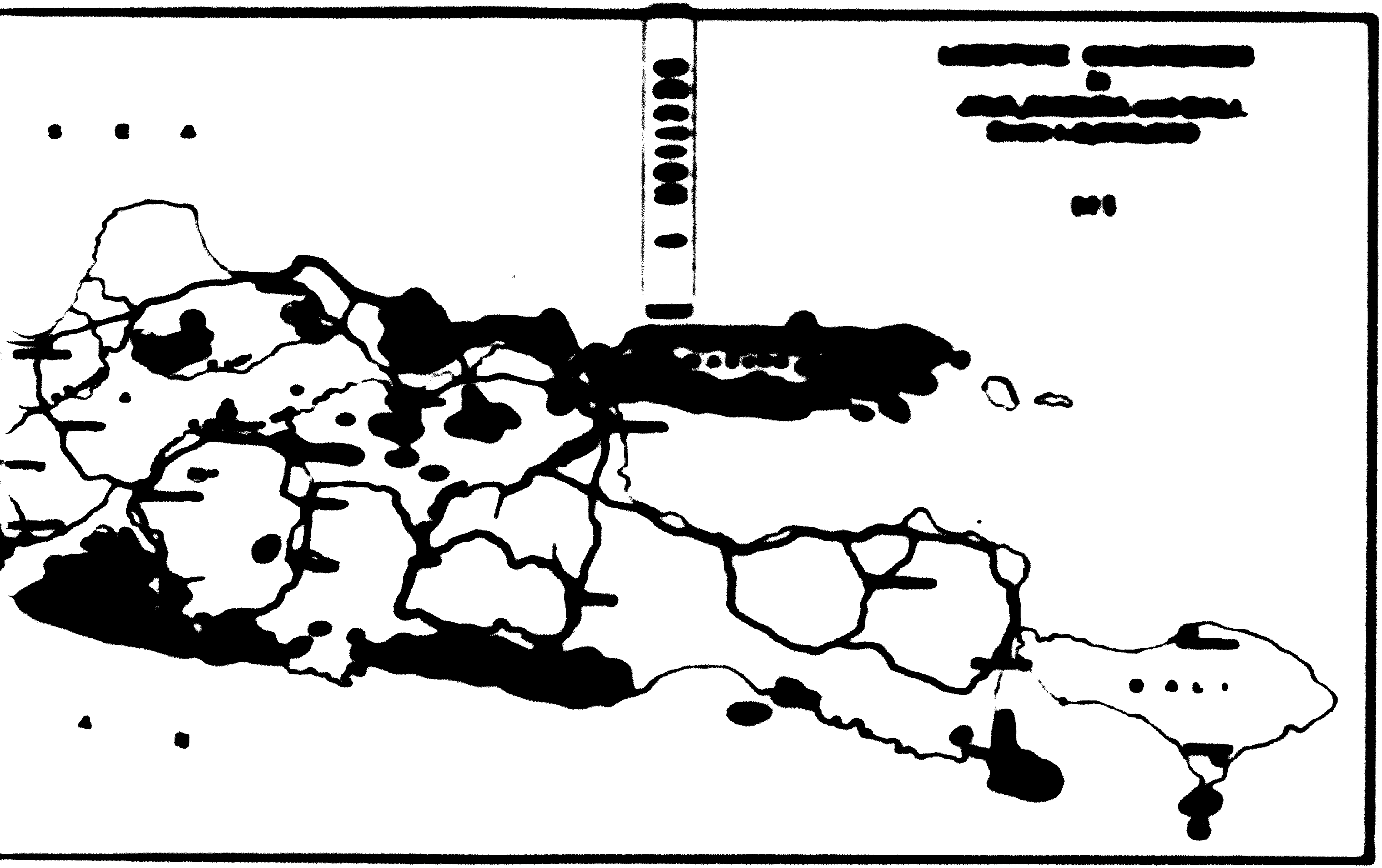
Tri Usaha Bhakti, Coll. R.M. Indropoetro
Tjokrodiningrat, Dr. Ing. P. Lastanja
Department of Industry, Secr. General Ir. Achmad
Slamet.

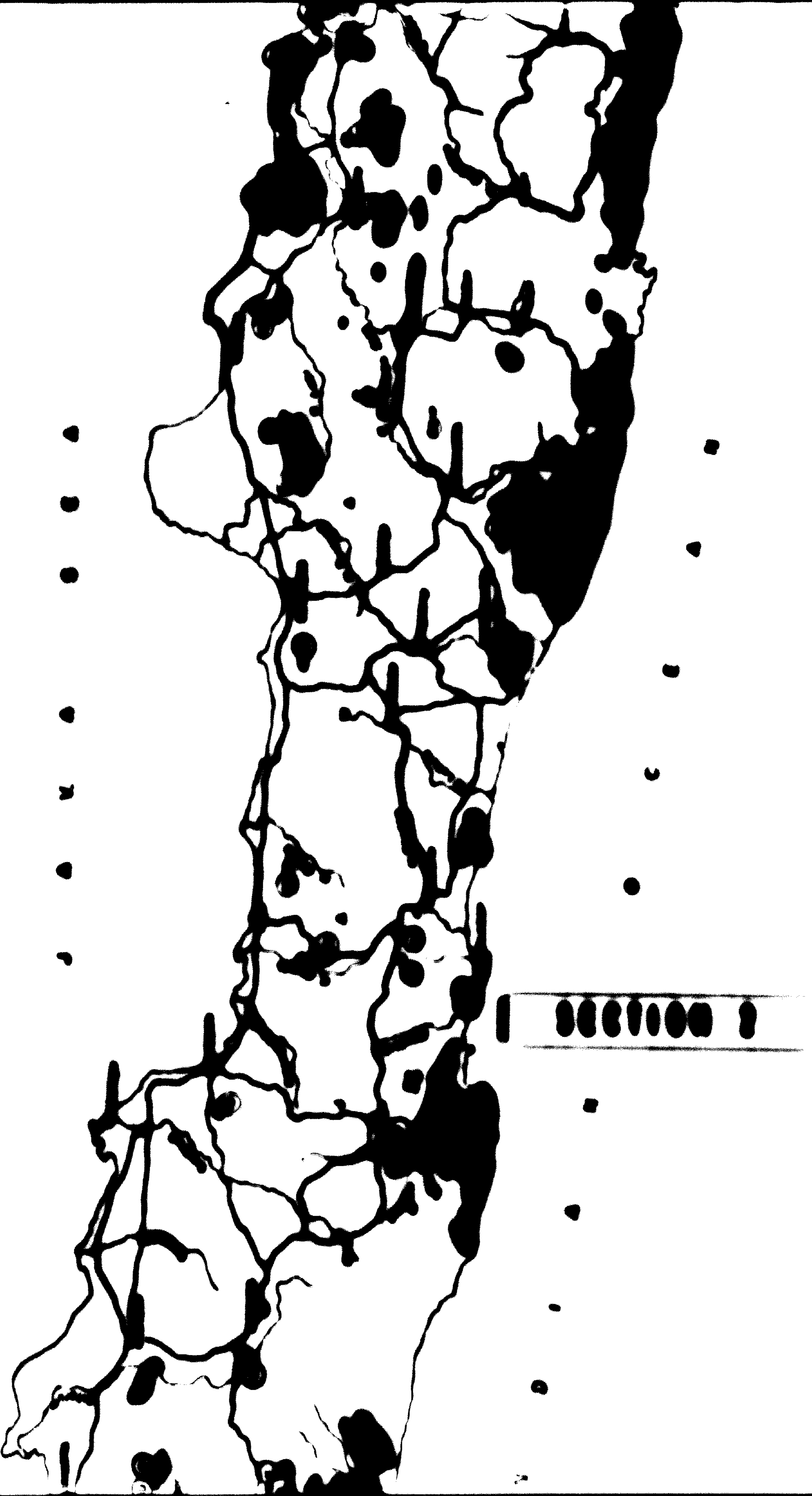
And further the Institutes

Institute for Geology, Geological Survey of Indonesia:
SM. JL. Diponegoro
IL. Salman Padmanagara
DRS. Hardjono

Department of Industry, Materials Testing Inst.
Dir. Ir. Kusnadi
Ir. Gandi
B. Kusan
Sumardi
Ir. Mustarsid

The author expresses his thanks to all public authorities and to all gentlemen who assisted him by giving him the necessary material and information and who thus enabled him to accomplish this report in so short a time.



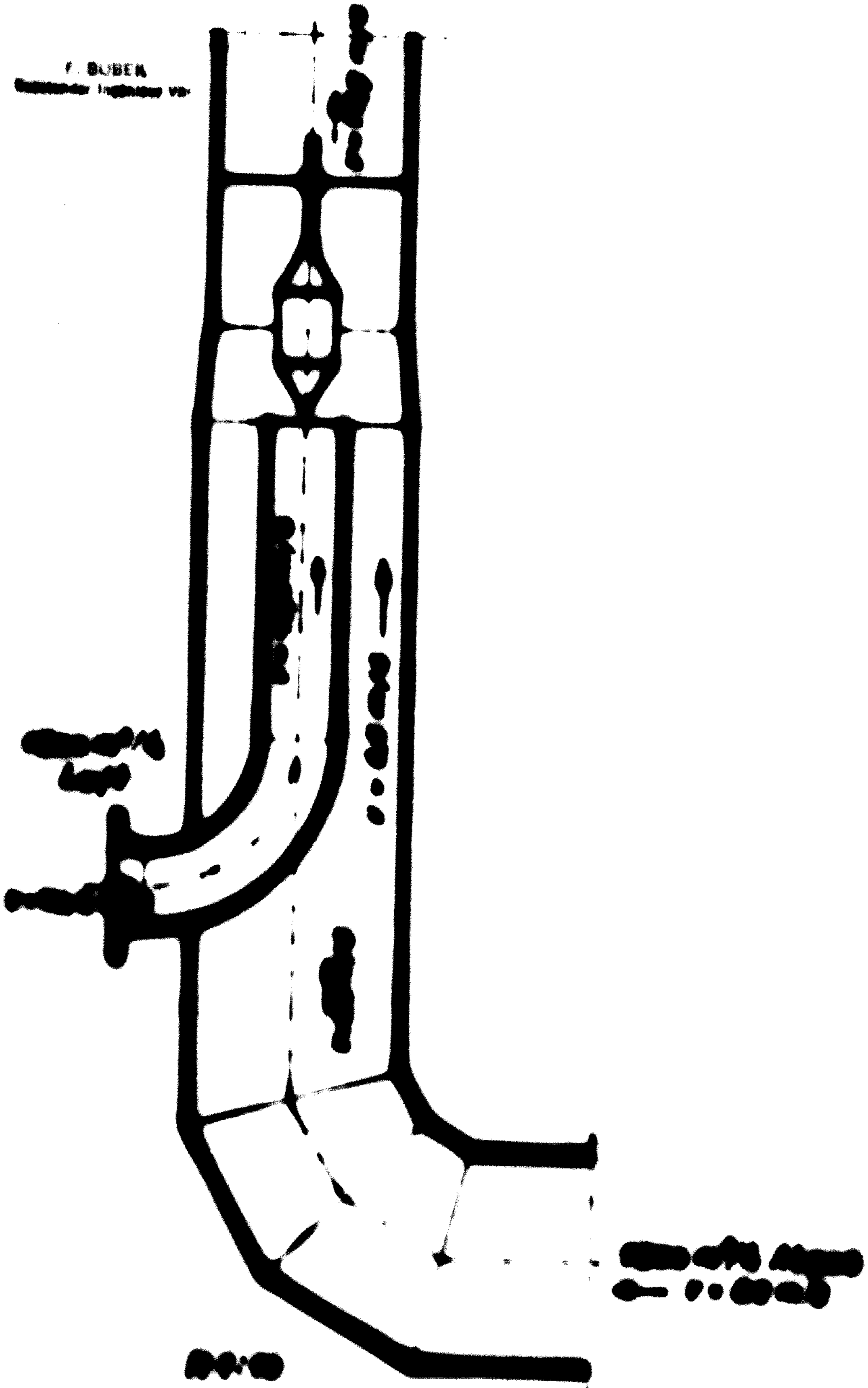

SECTION


SECTION 3

D2

F. BUBEK

D3



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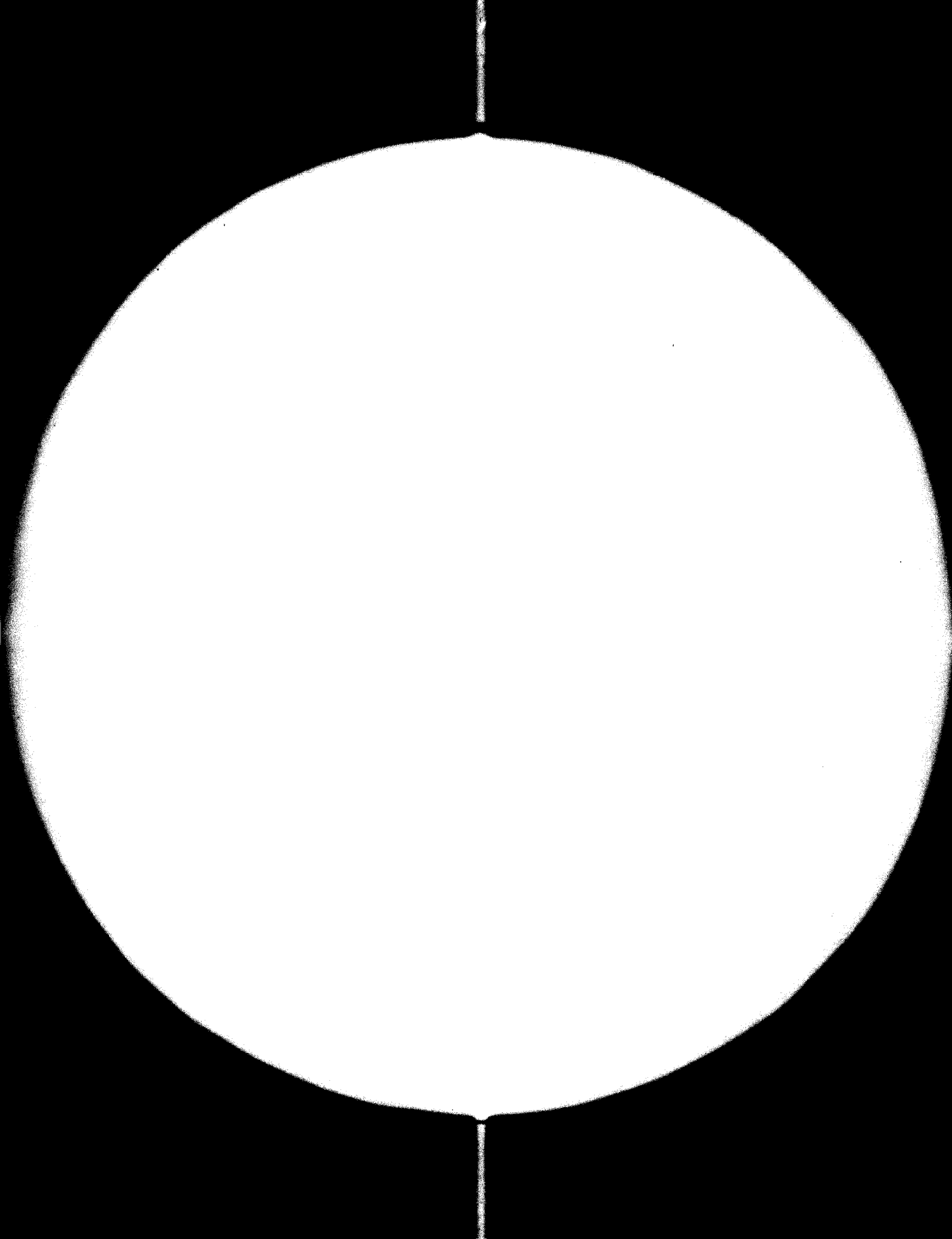
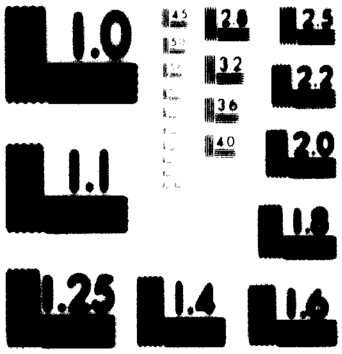
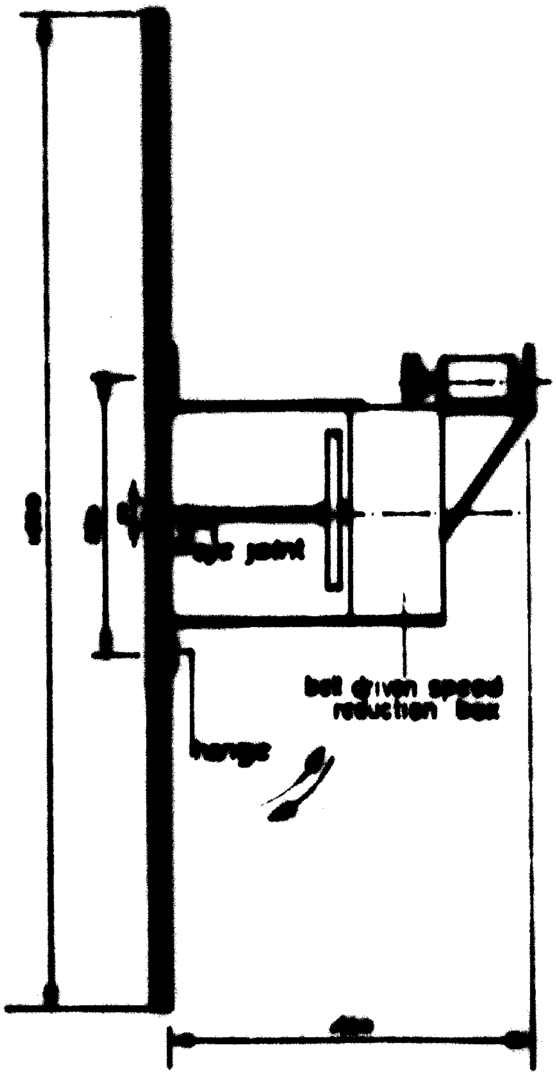
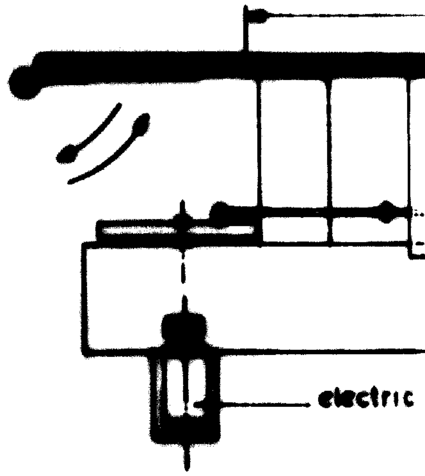
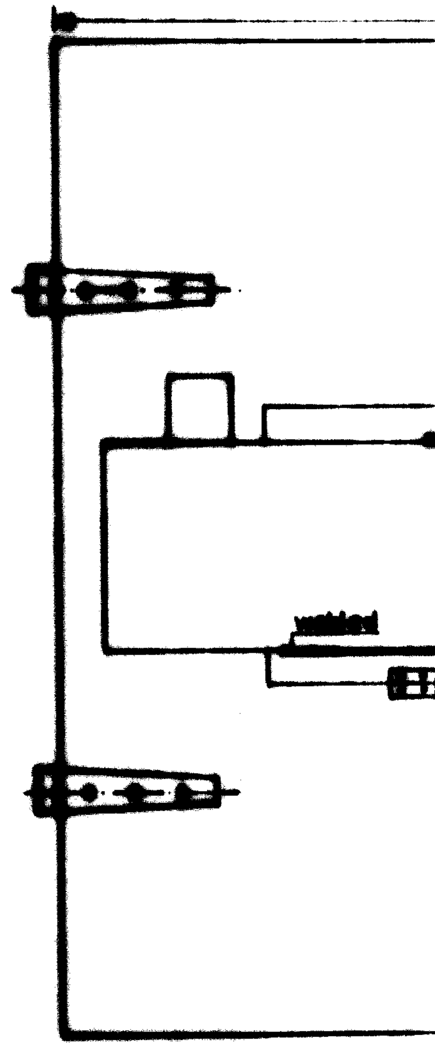





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A



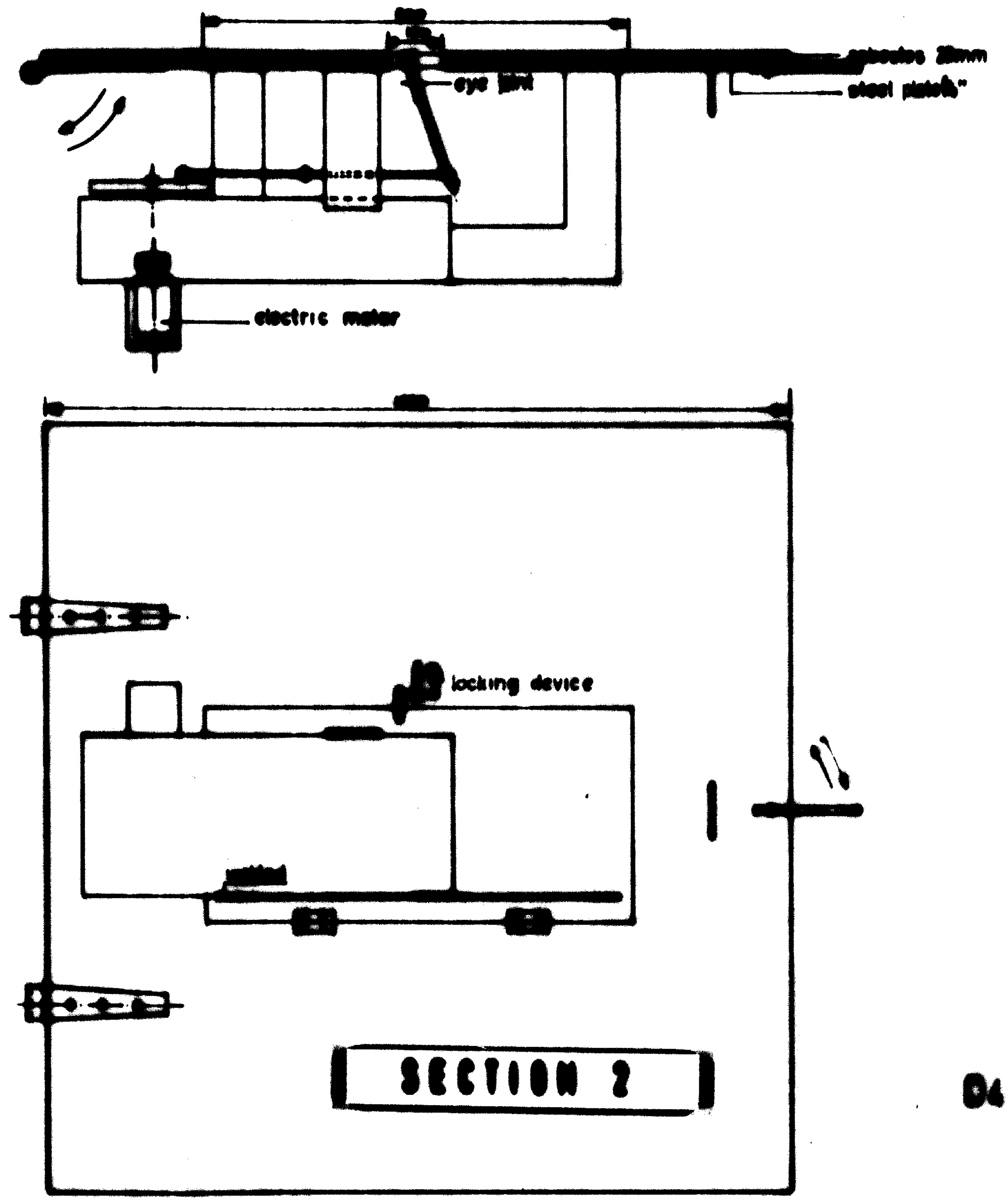


SECTION 1

LIME

Scale :
Designed :
Approved :
Drawn :

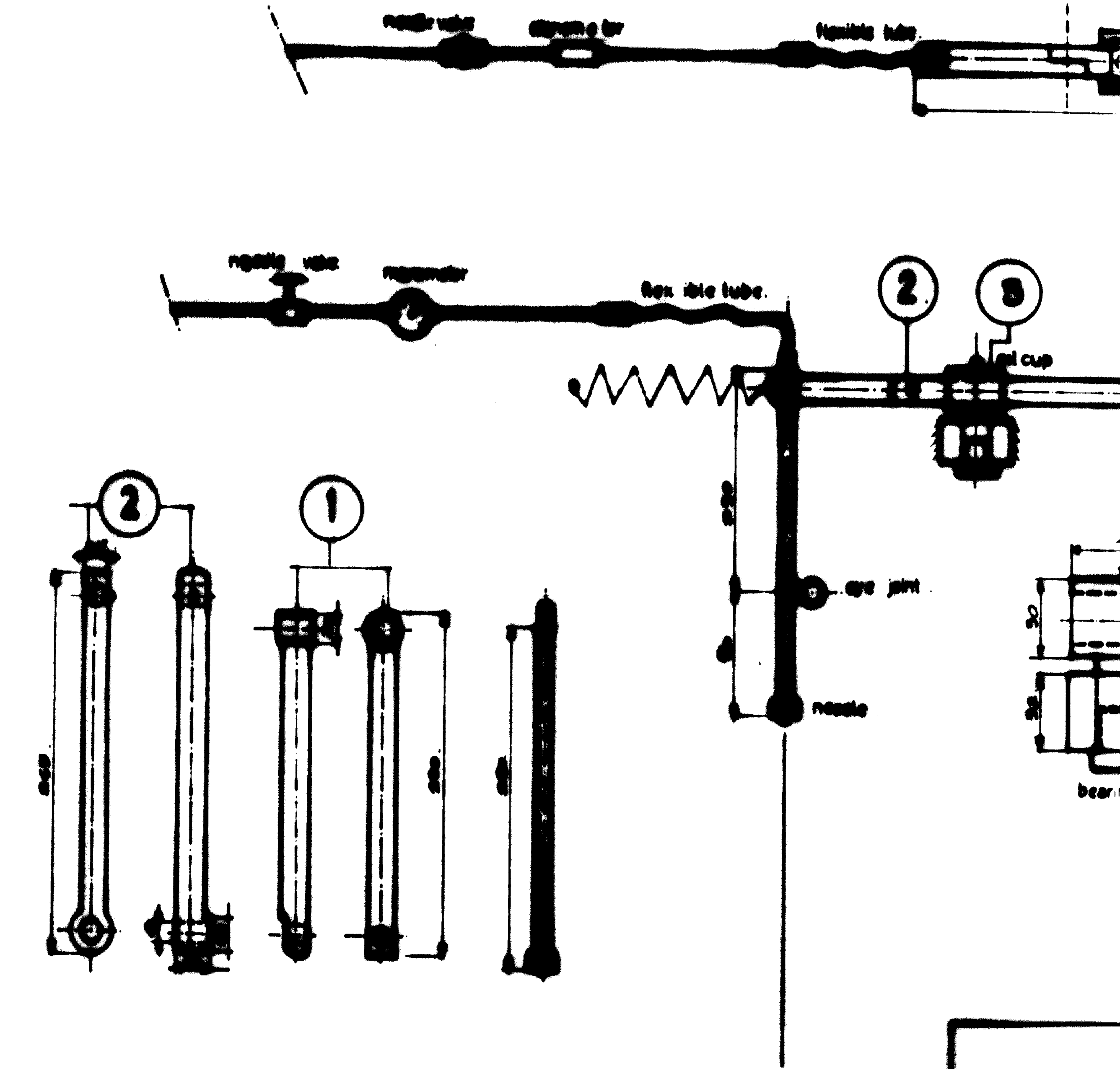



SECTION 2

D4

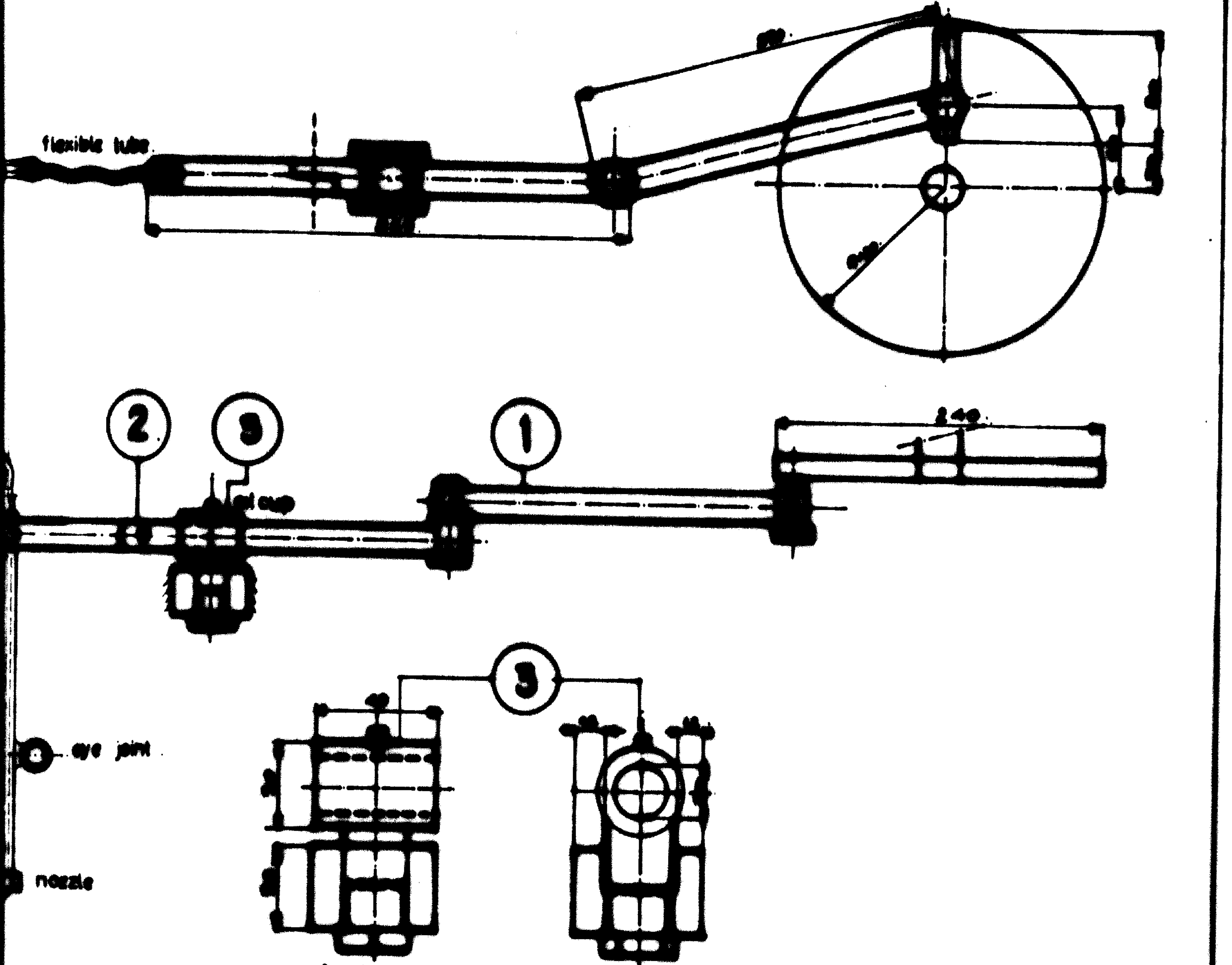
**LIME BURNING KILN DOOR WITH FUEL INJECTOR SYSTEM.**

| | | | |
|---|---|---|---|
| Scale | : 1 : 10 | Date | L . P . B . B . (Building Materials Development Laboratory) Regional Housing Centre BANDUNG_ INDONESIA |
| Designed | : F. S[illegible]EK | 10.10.1973 | |
| Approved | : [illegible] | | |
| Drawn | : S. Kusumah. | | |




**SECTION 1**

Approved :
Drawn :



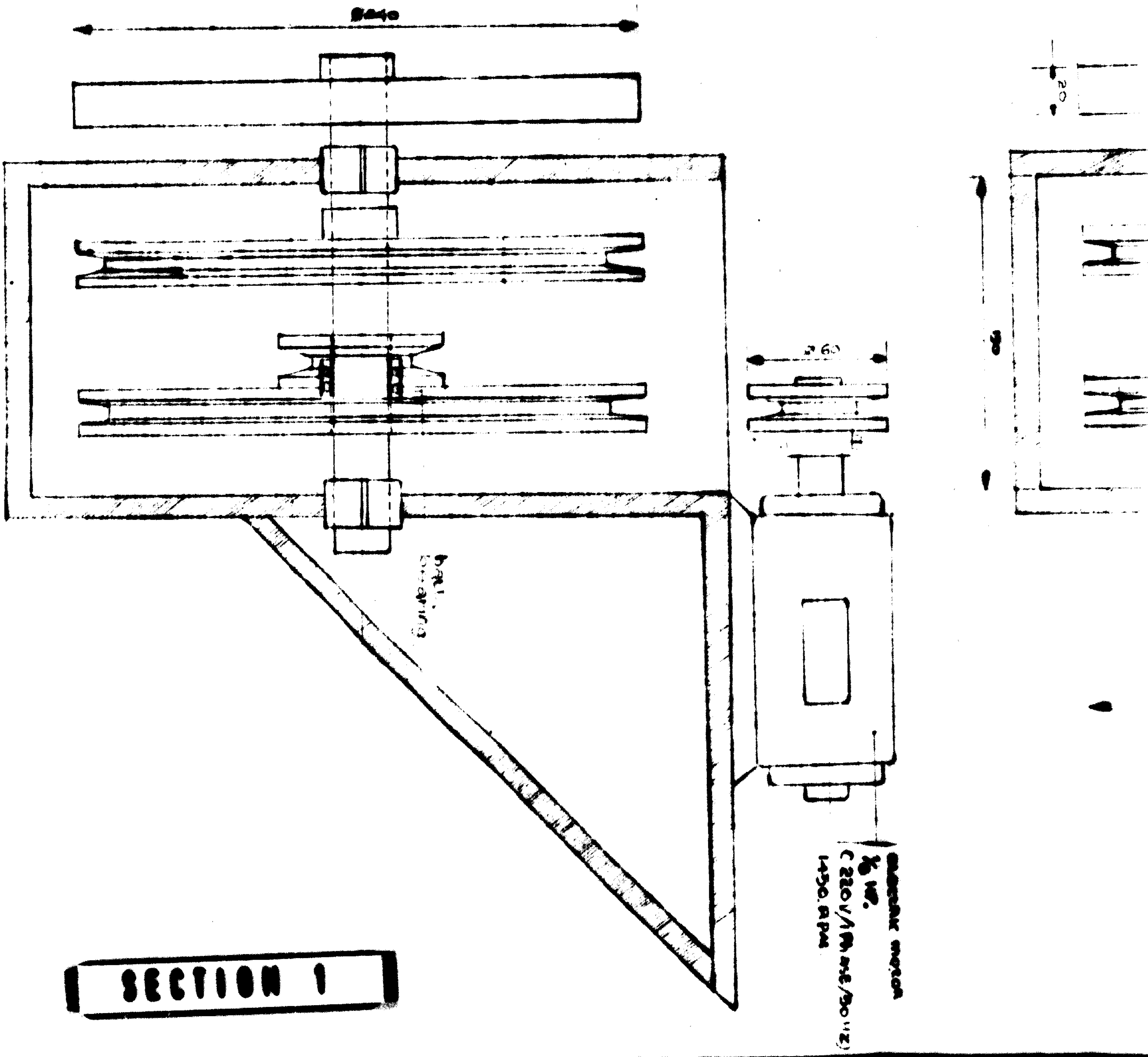

bearing with sliding friction.

SCALE. 1:2

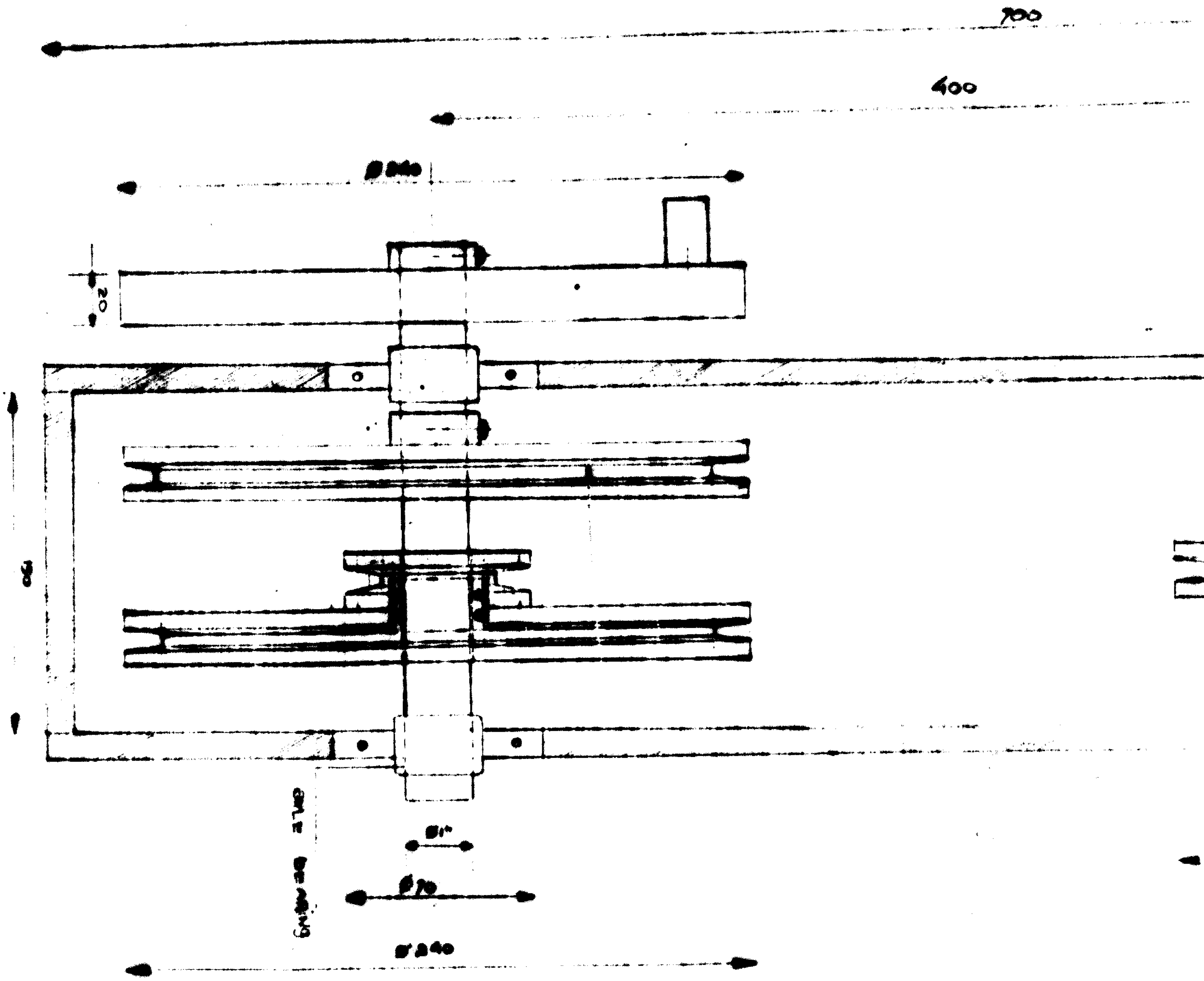
D5

**SECTION 2**

| | | | |
|---|---|---|---|
| FUEL INJECTOR FOR LIME BURNING KILN (1 STROKE = 2 SECONDS) | | | |
| Scale : | 1 : 5 | Date. | L.P.B.B. Building Materials Development Laboratory Regional Housing Centre. BANDUNG_INDONESIA |
| Designed : | F. [illegible] | 19.10.1973 | |
| Approved : | | | |
| Drawn : | D.[illegible].A. | | |



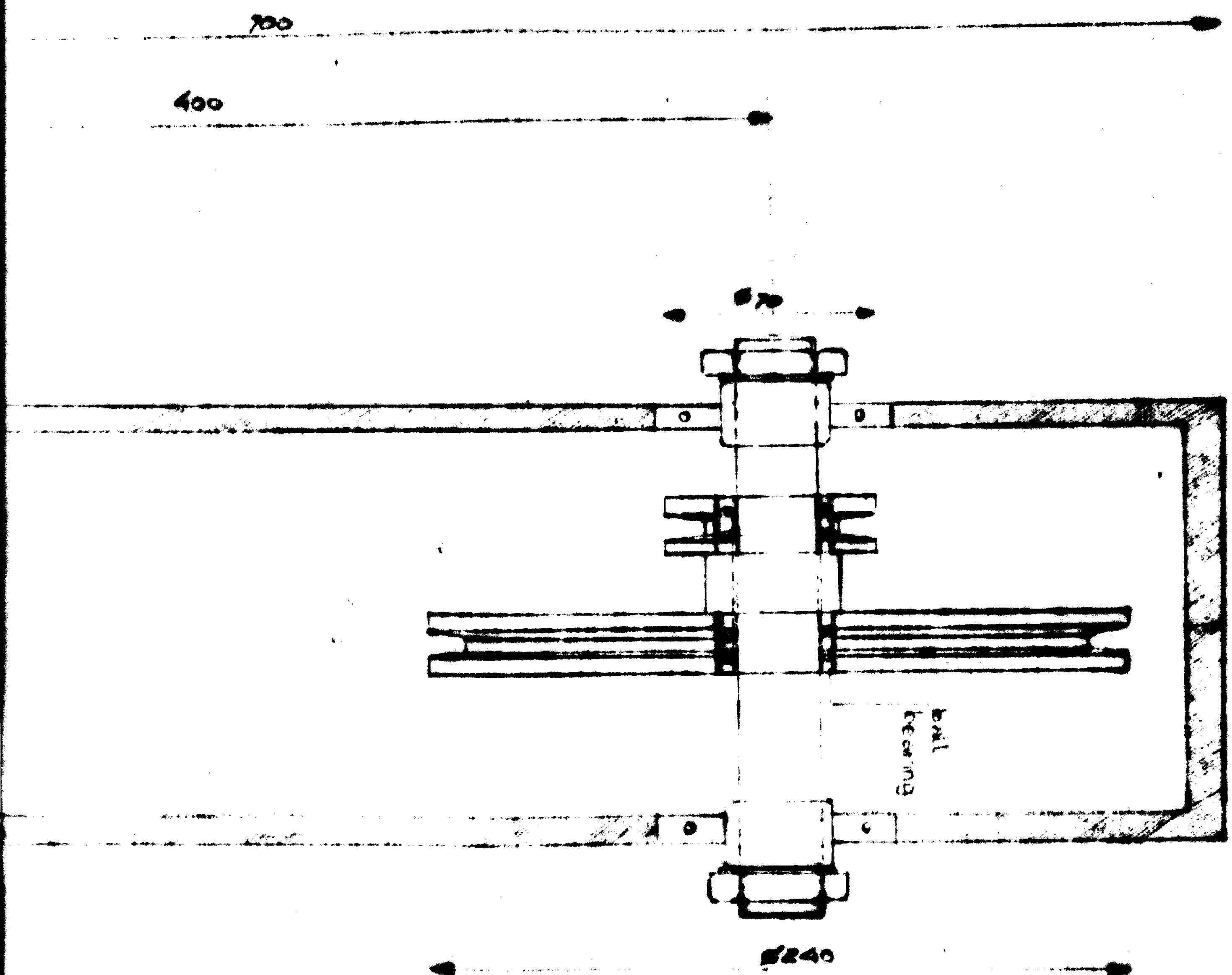

SECTION 1




SECTION 2

Belt Dri

Scale : 1 :
Designed : F.
Approved :
Drawn : S.



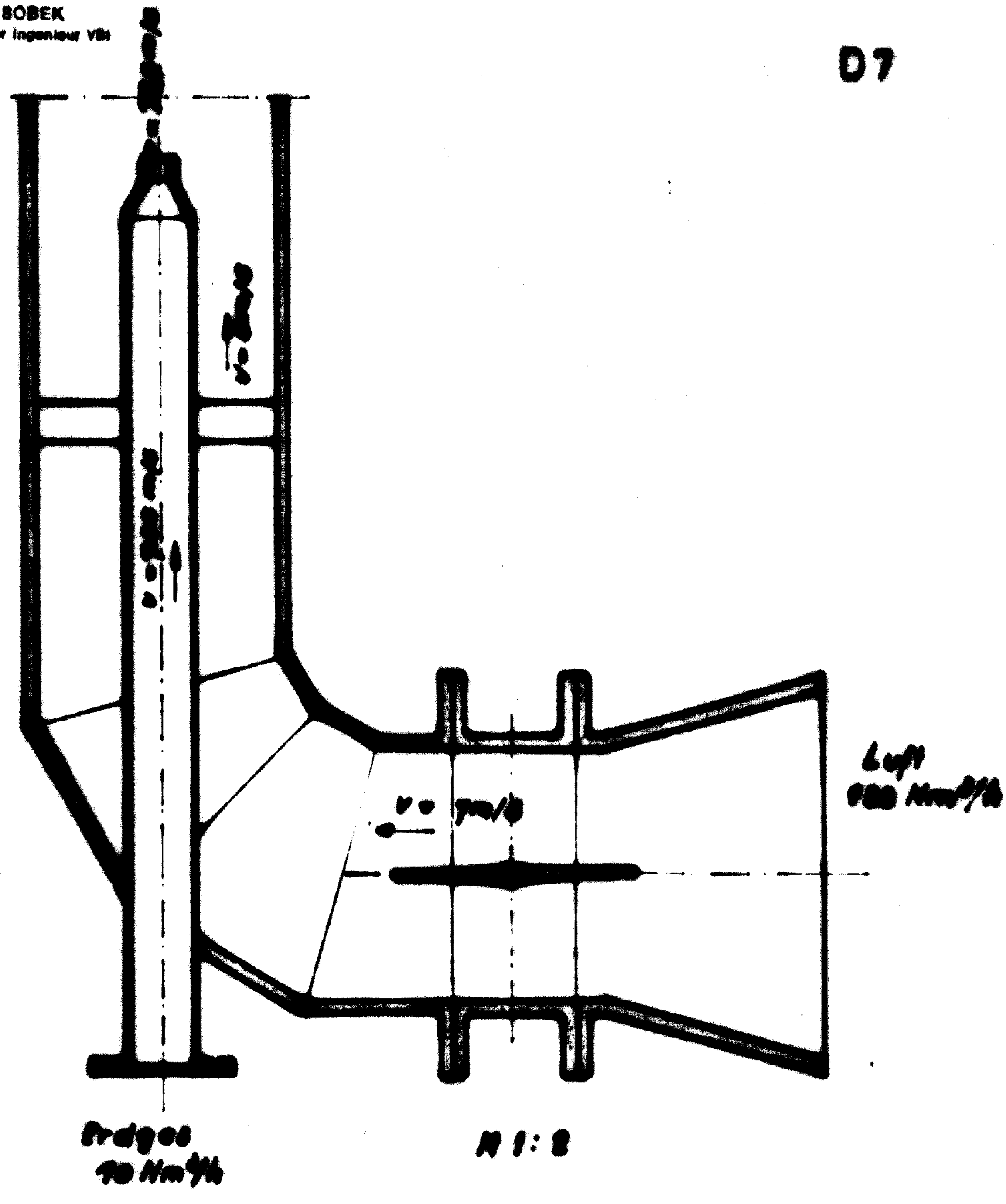

SECTION 3

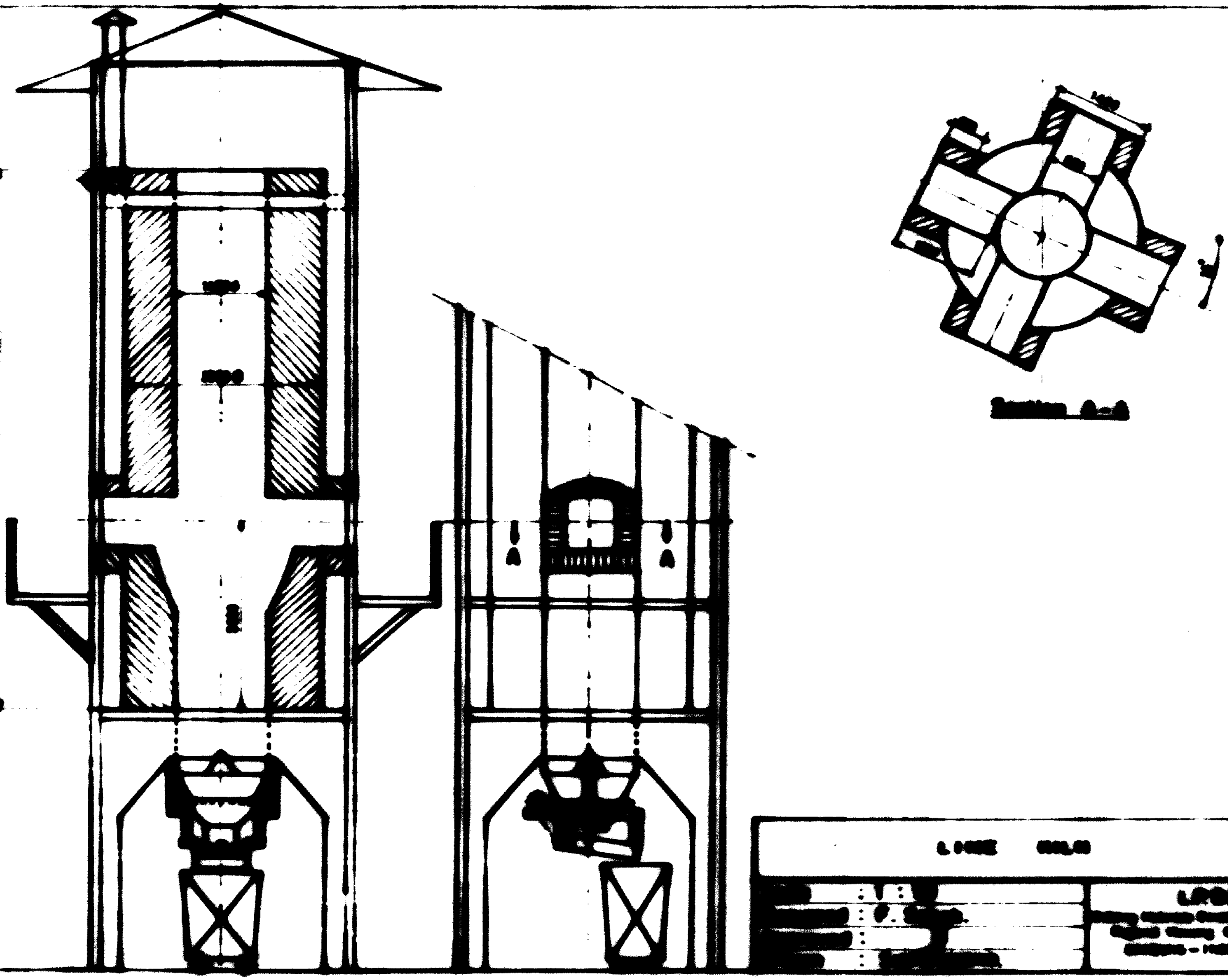
D6

| | | | |
|---|---|---|---|
| Belt Driven Speed Reduction Box For The Fuel Injecter (Speed ratio 47 : 1) | | | |
| Scale | : 1 : 2 | Date | L.P.B.B.<br>Building Materials Development Laboratory<br>Regional Housing Centre<br>BANDUNG . INDONESIA |
| Designed | : F. SOBEK | 18.10.1973 | |
| Approved | : | | |
| Drawn | : S. Kusumah. | | |

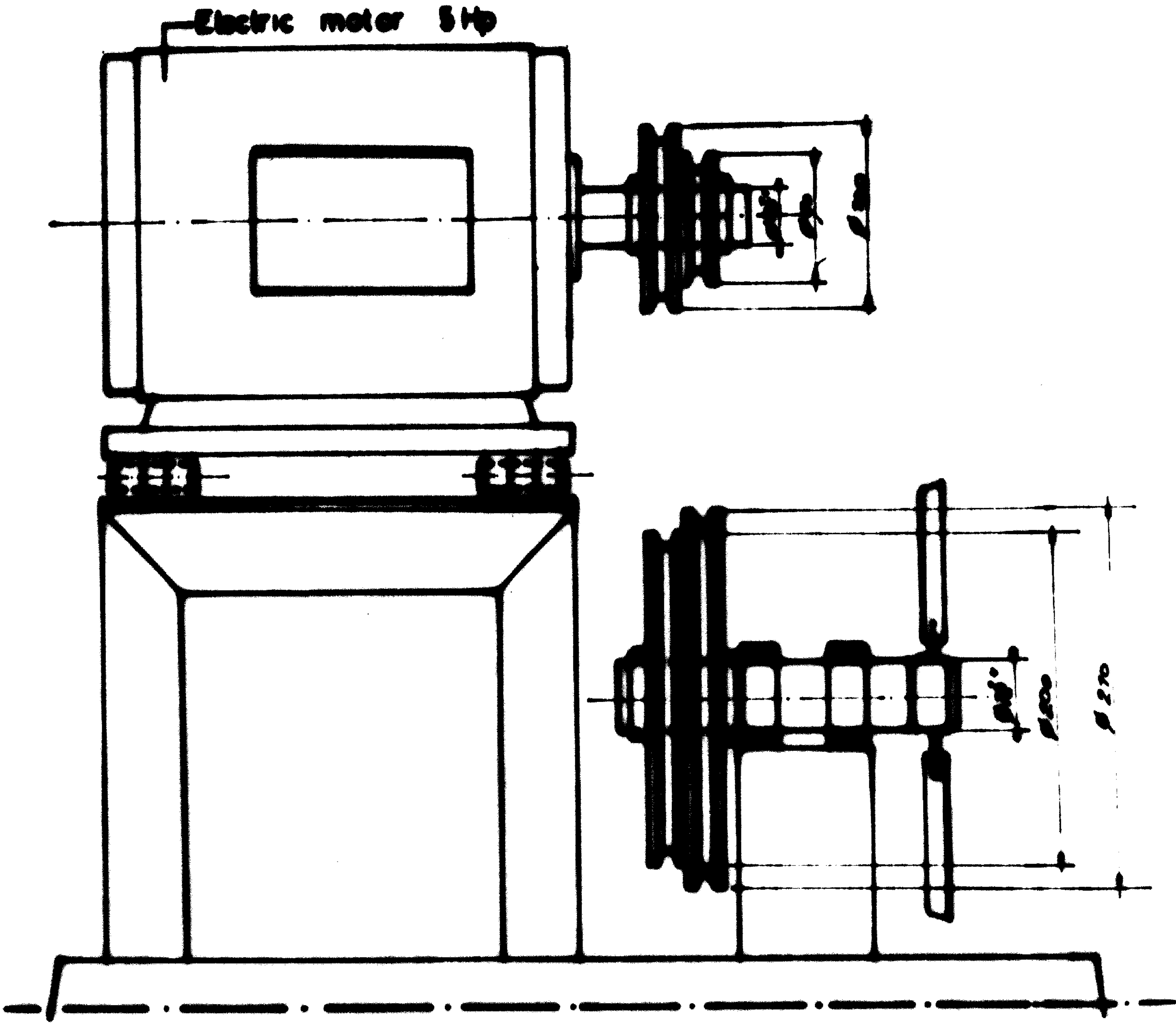
F. BOBEK
Beratender Ingenieur VBI

D7






LIME KILN




SECTION 1

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Designe

Approve

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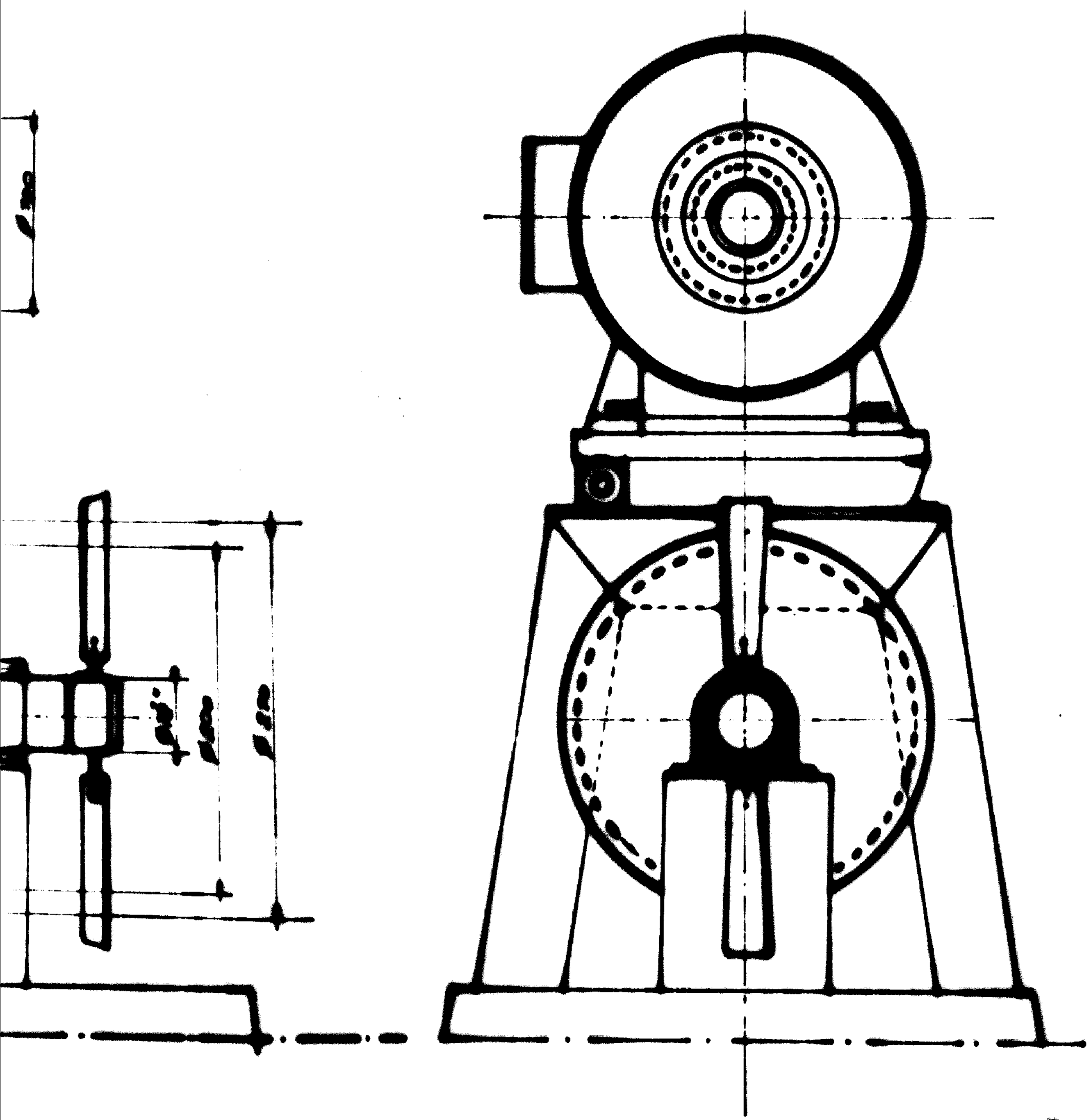

D9

**SECTION 2**

**Adjustable belt driven speed reduction system for the exhaust fan**
**( speed ratio 2 : 1 & 3 : 1 )**

| | | | |
|---|---|---|---|
| Scale : | | Date | **L P B B** |
| Designed : F. [illegible]. | | 19-10-[illegible] | (Building Materials Development Laboratory) |
| Approved : | | | Regional Housing Centre |
| Drawn : L. Sutarlie. | | | BANDUNG - INDONESIA |

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