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D04699

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Distr.
LIMITED
ID/WG.146/5
7 February 1973
ORIGINAL: ENGLISH

Third Interregional Symposium
on the Iron and Steel Industry
Brasilia, Brazil, 14 - 21 October 1973

Agenda item 3

MINI MILLS FOR DEVELOPING COUNTRIES[1/]

by

C.W. Chua
South East Asia Iron and Steel Institute
(SEAISI)

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id. 73-753

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Corrigendum 1

<u>Cover</u> Correct authorship to read as above.

<u>Page 6</u> Delete Table II and replace with new Table II overleaf.

id.73-5701

TABLE II

GASEOUS PRE-REDUCTION PLANTS 1957-1972

At the United Nations Economic Commission for Europe Seminar on "Direct Reduction of Iron Ores" held in Rumania in September 1972, it became apparent that gaseous direct reduction plants were the more successful. These plants operating on a commercial scale using gas as the reductant are as tabulated.

Works	Nominal capacity (metric t/yr)	Start
HyL Process		
Hojolata y Lamina S.A. Monterrey, Mexico	66,000 Fe in product	1957
" " " " " "	165,000 Fe in product	1960
Tubos de Acero de Mexico S.A. Vera Cruz, Mexico	165,000 Fe in product	1967
Hojalata y Lamina S.A. Puebla, Mexico	165,000 Fe in product	1969
USIBA Bahia, Brazil	200,000 Fe in product	1972
Midrex Process		
Oregon Steel Co. Portland, Oregon	400,000 product+	1969
Georgetown Steel Co. Georgetown, S.C. USA	400,000 product	1971
Korf Industrie & Handel GmbH, Hamburg, W. Germany	400,000 product	1971
Sidbec, Contrecoeur, Quebec, Canada	400,000 product	1972
HIB (Hi-iron briquette) Process		
US Steel Corporation, Puerto Orde ., Venezuela	1,000,000 product	1972
Armco Process		
Armco, Houston, Texas, USA	320,000 product	1972

\+ The capacity of 400,000 t/yr for Midrex plants is quoted in both European and US literature and it is not always clear whether short tons or metric tons are referred to. Presumably the flexibility of the plant may cover the 10% difference.

INTRODUCTION

The South East Asia Iron and Steel Institute (SEAISI) held its first Symposium on "The Mini Mill" on 7-11 September 1971. During the period of 4½ days (with half a day for industrial visits) twenty technical papers were presented to the 89 delegates, with lively discussions. Over 100 sets of symposium papers have since been sold within the region.

This paper reviews the proceedings of the symposium, covering relevant papers on the possibilities and advantages of the mini mill for developing countries. It will also discuss the mini mills at present existing in the SEAISI region.

MINI MILLS AND THEIR ADVANTAGES

A mini mill can generally be defined as a plant producing steel from scrap, pig iron, and/or pre-reduced iron by the electric arc furnace and continuous casting processes and subsequently rolling into rods, small and medium bars, sections, and narrow strips at annual output rates between 80,000 and 400,000-500,000 tonnes. This type of steelworks has grown considerably during the last 25 years in highly industrialized as well as in developing countries. Not only has it survived, but it has also successfully competed with large-scale integrated steelworks which are based on the economies of scale.

Many of the papers detailed the reasons underlying the successful development of the mini mill and its characteristic advantages. These are listed as follows :

(1) Mini mills are usually located near a specific market. Being close to their customers, their transportation costs are lower than those of larger producers for wide areas.

(2) Their production facilities are designed to enable them to produce economically small batches to give quick deliveries and without having to keep large stocks.

(3) An efficiently built mini mill takes about 1½ years to construct compared with integrated plants, which may take up to 5 years. Returns on capital investments are therefore made much sooner.

(4) Considerable progress in electric furnace techniques, the development of continuous casting, and better rolling techniques have enabled the capital cost of mini mills to be low.

(5) A high degree of plant utilization and a high labour productivity is possible. Their simpler organization and consequently low overheads can overcome disadvantages stemming from their smaller size.

(6) Mini mills have a high degree of flexibility. Operations can be adjusted to varying market levels with far less economic disadvantages than larger works. With a compact layout, internal communication and transport is also reduced.

GENERAL CONSIDERATIONS

The modern mini mill concept offers developing countries an excellent chance to establish an indigenous steel industry adapted to suit local market requirements. An industrial age of steel can also be started off with a mini mill, even if it has to use imported scrap as the chief raw material. In fact, at the present time there appears to be no alternative in many of the developing countries such as those in South East Asia but to start with the mini mill, because steel demand is insufficient as yet to justify high-cost/high-capacity units which must be operated at near capacity output to be viable.

While it is possible to sell only semi-finished products (such as billets, ingots, and steel castings), it is not usual for mini plants to be able to do this economically. Quite a number, however, are rerollers. They possess only one or two re-rolling mills, buy in suitable scrap, and cut it to sizes appropriate for rolling mill feed, or buy in billets or ingots from outside suppliers. Some mini mills have also been moving into the field of further processing of their finished products so as to increase their profitability.

There are many possible layouts of mini mills. The basic layout, however, would depend upon the range of products to be rolled, as well as the proportions of such products required by the envisaged market and the type of feed available to the mill owner. A mini steel plant would therefore consist of all or some of the various units shown in Fig. 1.

The design and layout of each works has to take into account site considerations and other existing local conditions. It is essential that the layout should provide easy access to all sections of the works and that production materials should be stored as near as possible to their place of use. A direct-line production flow from the raw material to finished product stage is preferable whenever possible. Adequate cranes and other appropriate lifting equipment will help to reduce space requirements. Figures 2 and 3 are examples of two possible layouts. They are not meant to be blueprints for direct application to similar requirements but only serve to illustrate the general outline of aspects to be considered.

STEELMAKING

Layout

In the layout of the steelmaking section, it was stressed that the three activities - scrap handling, steelmaking, and continuous casting - should be considered as one unit. A proposed optimum layout is for the melting and casting shops to be parallel to each other under separate buildings and having separate cranes. The scrap bay, if it were to be built as a continuation of the melting shop, has disadvantages from the viewpoint of future expansion and interference of scrap movements. It is therefore proposed to have the scrap bay parallel to the furnace bay. Such a layout provides for efficient movement and operation of the three activities.

Improving arc furnace operations

The various methods of improving the productivity of the arc furnace have also been reviewed. The development of the ultra-high-powered (UHP) electric furnace, compacting and preheating of the scrap charge, and assisted melting by application of oxy-gas or oxy-fuel burners are essential features of present-day high-efficiency mini mills.

The UHP arc furnace results in increased productivity, better thermal efficiency, less capital investment for equivalent capacity, and less voltage flicker. Table I shows typical examples of transformer rating vs. meltdown times for a 50-60 ton furnace.

TABLE I : Transformer rating vs meltdown time for 50-60 ton furnace

Transformer rating		Meltdown time, h
kVA	kVA/ton	
18,000	327	2.0
28,000	510	1.5
36,000	655	1.0

This means that tap-to-tap times can be of the order of 2 h or less, enabling up to 12 heats to be cast from each furnace every day.

Oxygen techniques are also very effective in improving furnace productivity. Oxygen has been used in electric furnace practices for many years, and therefore the practices are well understood, and the effects of the various techniques can be readily assessed. There are three main applications : (a) decarburizing, (b) assisted melting with oxygen alone, and (c) assisted melting with fuel plus oxygen.

The use of oxygen for carbon removal has almost entirely superseded the earlier practice of using iron ore or mill scale. The advantages of this direct oxygen method are :

(i) No cold solid additions are necessary; the time required for them to pass through the slag and the heat absorbed in bringing them up to reaction temperature are inconsequential.

(ii) Some oxygen reacts directly with iron in the bath in the initial stages; whilst some of the oxygen and iron oxide reacts immediately with carbon, part of the iron oxide enters the slag in the molten state.

(iii) The passage of the oxygen into the bath and the immediate evolution of carbon monoxide combine to mix the iron oxide slag and metal, and consequently the reaction rates are accelerated, giving appreciable savings in operating time.

Several methods are available for introducing the oxygen, which should enter the bath as near as possible to the slag-metal interface. Submersible bare steel lances give an efficient carbon removal and lance life is economical provided that the correct size of lance is employed.

As for assisted melting with oxygen, two methods have been adopted successfully. In the first, oxygen alone is used to combust the hydrocarbon and carbon monoxide within the furnace and utilize the heat to assist melting. The combustible fumes arise from waste gas leaving the furnace during melting. Some countries suffering from a shortage of steel scrap may use a proportion of pig iron, which leads to an increase of carbon and silicon contents. These are oxidizable elements which, when combusted with oxygen, assist the melting, add to the speed of production, and give electric power savings.

In the assisted melting technique employing one or more oxy-fuel burners, these burners are brought into operation shortly after the commencement of melting. The burners are used to supplement the normal heat input from electrodes and their use is discontinued before a flat-melted bath is formed.

Possibility of direct reduction

A number of papers considered the possibility of using direct reduction processes to manufacture pre-reduced iron for electric furnace steelmaking. The uncertain scrap market and rising price compared to the stable price and abundance of iron ores for direct reduction have encouraged many mini mill operators to be highly interested in its possibilities. Some regard it as the future development of the mini steel industry.

Since pre-reduced iron, in contrast to scrap, is of uniform lump size it can be charged to the furnace continuously. Figure 4 shows an example of an engineering study of pre-reduced iron feeding system.

A major disadvantage of pre-reduced iron is its residual gangue content. This requires increased lime additions during steelmaking and therefore a higher amount of energy is required. It has also been found inadvisable to base production entirely on pre-reduced iron, and the most favourable mix is about 60% pre-reduced iron with 40% scrap. No doubt this ratio will vary with future improved practices. There are two fundamental methods for the production of pre-reduced iron : processes using solid reductants (such as anthracite, coal, and lignite) and those using gaseous reduction media. Commercial pre-reduction plants as at 1972 are shown in Table II.

There was some speculation about the time for the possible breakthrough of the direct reduction processes. A considerable amount of research and development was said to have been maintained and the funds required would only be possible from financially powerful integrated iron and steel companies or other institutions. Yet no integrated iron and steel group has yet been interested in tackling this process as at the moment it does not offer them technical or economic advantages. The institutions who could help achieve the breakthrough would either be iron-ore mining companies interested in expanding sales by processing ore into pre-reduced iron for mini mills or possibly mini mills in developed countries competeing with integrated works.

CONTINUOUS CASTING

Continuous casting has grown remarkably during the last few years. The practice has influenced steel production to the extent that it is gradually replacing conventional ingot casting. The papers presented have stressed that continuous casting plays an important role as the key factor governing the operational economy of mini mills.

Figure 5 shows a typical continuous casting machine for billets, suitable for mini mills. This curved-mould continuous casting machine is employed almost exclusively nowadays because of the low initial capital investment involved. Molten steel is transferred via the tundish to the oscillating mould, where it begins to solidify. In the secondary cooling zone, water sprays are used to remove the residual melt heat. The extracting force applied by the pinch and straightening rolls is initially transmitted into the dummy bar and direct into the actual strand. The arc-shaped strand is straightened, cut into finished lengths by torch cutting machines, and subsequently deposited on to cooling beds. These continuous billet casting machines are easy to operate and maintain.

The advantages of continuous casting are listed as follows :

(1) The cost of the equipment is lower than that of the corresponding conventional casting facilities, including the roughing mill.

(2) Continuous casting requires fewer production steps. The cast billets are ready for further processing to final products, whereas the stripping and transportation of conventional cast ingots need much more handling.

(3) Fewer operators per shift are required. Besides, work is carried out under more comfortable conditions than at conventional ingot casting pits. Fatigue and the possibility of accidents can be reduced.

(4) With continuous casting, the liquid steel - billet yield reaches 95-97% compared with about 87-91% for conventional casting. This means that the steel mill can increase its production without changing furnaces.

(5) Continuously cast billets exhibit greater homogeneity over the length of the cast, resulting in more uniform technological properties. The mechanical characteristics are improved in both resistance and resilience, and the surface of the finished product is better.

TABLE II : Commercial pre-reduction plants, 1972

Works	Nominal capacity (metric t/yr)	Start	Ref No.
HyL Process			
Hojolata y Lamina S.A. Monterrey, Mexico	66,000 Fe in product	1957	11
" " " " " "	165,000 Fe in product	1960	11
Tubos de Acero de Mexico S.A. Vera Cruz, Mexico	165,000 Fe in product	1967	11
Hojalata y Lamina S.A. Puebla, Mexico	165,000 Fe in product	1969	11
USIBA Bahia, Brazil	200,000 Fe in product	1972	11
SL-RN Process			
Highveld Steel & Vanadium Corp.Witbank,S.Africa	1,000,000 ore processed	1968	12
Inchon Ironworks, Seoul, S. Korea*	230,000 ore processed	1969	12,13
New Zealand Steel Ltd.Auckland,New Zealand.	190,000 ore processed	1969	12,14
Falconbridge Nickel Mines Ltd.Sudbury, Ontario	425,000 ore processed	1970	12
Midrex Process			
Oregon Steel Co.,Portland, Oregon	400,000 product +	1969	15
Georgetown Steel Co. Georgetown, S.C.,USA	400,000 product	1971	9
Korf Industrie & Handel GmbH,Hamburg,W.Germany	400,000 product	1971	16
Sidbec, Contrecoeur, Quebec, Canada	400,000 product	1972	17
HIB (Hi-iron briquette) Process			
US Steel Corporation, Puerto Ordaz, Venezuela	1,000,000 product	1972	§
Armco Process			
Armco, Houston, Texas, USA	320,000 product	1972	§

\+ The capacity of 400,000 t/yr for Midrex plants is quoted in both European and US literature and it is not always clear whether short tons or metric tons are referred to. Presumably the flexibility of the plant may cover the 10% difference.

§ information direct from company

* not operating at present time

(6) The productivity of a continuous casting machine can be further improved by sequence casting. This is the continuous casting of two or more consecutive charges and can be effected in four different ways :

(a) If an adequate number of cranes are available, no further auxiliaries are required. The first ladle is exchanged for a full one with the aid of two cranes while there is still sufficient molten steel left in the tundish.

(b) Instead of two cranes, a double crane with two parallel trolley runways can be used (Fig. 6).

(c) The same function can also be carried out with two ladle cars. The new ladle is brought up by the crane and inserted into the ladle car (Fig. 7).

(d) On the plant shown in Fig. 8, each full new ladle is placed on the free arm of the swivelling tower and then turned into the pouring position.

(7) Savings in rolling mills are due to a decrease in cropping bars and an increase in rolling utilization due to fewer cobbles, thereby lowering production costs.

In many cases, continuous casting machines have been installed to replace conventional ingot casting. Although some layout and installation compromises are required, the insertion of continuous casting machines did not pose a serious problem and production losses were negligible.

Continuous casting operations are not more difficult than those of pit casting but, being mechanized, they require a little more care. Even the steelmaking process does not change substantially. At the present time, direct coupling of the continuous casting installation with the rolling mill cannot be realised because the delivery speed of the strand is much lower than the entry speed of the material into the mill. Methods aimed at transferring part of the mill shaping work to the continuous caster also are unsuitable for mini mills. Moreover, any in-line reduction carried out in the pinch and straightening rolls has a negative effect on the quality of the material if the strands are not completely solidified.

It should also be noted that the high operational economy of the continuous casting machine cannot be fully utilized unless production is restricted to a minimum possible number of standard sections. This will cut out time-wasting conversion to other dimensions.

THE ROLLING MILL

Many papers gave priority to the optimum utilization of the rolling mill in the planning of the mini mill. The rolling capacity is the main factor governing the design of the steel shop and the continuous casting installation. The decision on the type of mill to be used depends primarily on the required shape, size, quality, and weight of finished product and the required output. The general requirements of the mini mill must also be considered, such as the possibility of producing economically small batches, the change of production following changes in market demand, to operate at low cost particularly with regard to labour and without engaging excessive capital expenditure.

For high-output mini mills with capacities up to 500,000 tonnes per annum, the modern continuous high-speed rolling mill was considered as undoubtedly an optimum solution with respect to many of the required conditions. Continuous rolling affords many advantages, enabling higher rates of production, heavier semi-finished products, as well as better dimensional accuracy and surface quality to be achieved. However, as the requirements of particular mini mills are frequently considerably smaller than the output potential of continuous mills, the installation of which would therefore constitute an excessive capital expenditure, the semi-continuous set-up was also recommended. Modern pass design, permitting variation of production with a minimum of roll changes, efficient handling equipment, pneumatic escape repeaters, roller guides, and various types of manipulators have made it possible to approach the efficiency of continuous mills.

For the mini mill with a very low output, some very simple rolling mills were also considered. A re-rolling mill using scrap as a feed and capable of producing up to 13,000 tonnes per annum of lightweight rounds, flats, and angles is shown in Fig. 9. This mill is quite common in South East Asia and the installation of repeaters in such a mill (Fig. 10) would reduce labour required but would give only a slight increase in productivity. By adding a separate breakdown stand (Fig. 11), larger cross-section feed could be used and production may well reach 19,000 tonnes per annum. Further expansion of this basic mill would appear to be unsound economically, as little gain in productivity could be obtained. A more sophisticated mill capable of using either scrap or billets as feed is shown in Fig. 12. In its basic form it would be capable of producing 20,000 tonnes per annum.

MINI MILLS IN SOUTH EAST ASIA

Steel consumption in South East Asia has been rising very rapidly. The main problems faced by the industry are :

(i) Lack of raw materials or poor-quality raw materials.

(ii) Small domestic market.

(iii) Shortage of foreign exchange and domestic capital.

(iv) Insufficient technical personnel and know-how.

(v) Lack of infrastructure.

These factors account for the abundance of mini steel plants in this region. The capital investment and running costs are low, thus permitting the setting up of such plants to meet local demand. They produce mainly reinforcing and merchant bar products, which play a key role in construction and in the initial industrialization of developing countries. Generally, mini mill plants in this region can be classified into three categories :

(i) Rerollers of scrap or billets.

(ii) Typical mini mills.

(iii) Mini integrated steel plants.

Rerollers

There are many small-scale rerollers in South East Asia. Most of their rolling mills are good only for cut-to-size ship plates as the feed material without the need for remelting. Their production comprises small-size merchant bar products. Owing to their low cost of production by direct rolling, they can afford to compete with larger steel plants.

There are, however, larger rerollers who use imported billets as feed. These plants operate on a more scientific basis. The large number of such rerollers in a country such as Indonesia has prompted several suggestions about establishing steelmaking centres to supply billets to these rerollers. This is to ensure a stable supply of the necessary feed and also help to upgrade the reroller industry. As they grow bigger many of these rerollers commence production of their own steel by installing arc furnaces.

Typical Mini Mills

These are plants whose steel is manufactured in electric arc furnaces to supply the rolling mills. Crude steel capacities may range from 50,000 to 150,000 tonnes per annum. Production covers the full range of merchant bar products. In some cases, small sections are also manufactured.

Scrap is obtained from local sources such as through ship breakage and detinning operations. A considerable amount is imported from overseas in countries such as Taiwan, Singapore, and Thailand to supplement their mini mills. Table III shows some of the import and export statistics of scrap for some of the member countries of SEAISI. Major problems faced by many of the steel plants are the reliability and quality of the scrap, fluctuations in scrap price, and quality control problems in steelmaking with scrap of unknown composition. As the larger industrialized countries extend the mini mill concept, scrap shortages are certain to develop. The possibility of using pre-reduced iron is therefore of considerable interest to arc-furnace steelmakers in this region.

Arc furnaces in the SEAISI region generally range from 5 ton units to 40 ton units. There are hardly any furnaces which can be classified as operating under ultra-high-power conditions. The power grids in many of these developing countries are relatively small, and even a modest-sized electric furnace consumes a substantial source of this power. The use of oxygen is, however, widely used to speed up the productivity.

Although conventional ingot casting is practised in most of the smaller mini mills, the larger plants have realised that continuous casting of billets is a definite advantage. Continuous casting machines have to date been installed within the SEAISI region at Siam Iron and Steel Company Limited (Thailand), Malayawata Steel Berhad (Malaysia), and Steel Casters of the Philippines. In the future, some other plants are also expected to install billet casting machines.

Mini Integrated Steel Plants

Two plants within the SEAISI region are not strictly within the concept of the typical mini steel mill as discussed because they have integrated operations. However, many of the features are under the same concept as mini mills and the reason for integrated operation is to make use of local raw materials available.

Malayawata Steel Berhad in Malaysia is an example of the mini integrated steel plant. The country has supplies of iron ore, charcoal, and limestone, although coal deposits are limited. It was found that charcoal produced from rubber-wood was metallurgically suitable for ironmaking. This provided a logical basis for the establishment of an integrated plant based on the charcoal blast furnace.

The layout of the steelmaking plant is shown in Fig. 13. Steel is produced at Malayawata in two 12 ton capacity LD converters. The expansion programme has provided for an electric arc furnace and a continuous casting machine. A horizontal continuous rolling mill is provided for merchant bar rolling and a wire rod mill is also incorporated into the merchant bar mill. Thus, under Malaysian conditions, where raw materials are comparatively low in price and stable in supply, the mini integrated steel plant with a present production capacity of about 120,000 tonnes per annum is undoubtedly a viable project.

TABLE III : Scrap imports and exports (metric tons)

Year		1965	1966	1967	1968	1969	1970	1971
Taiwan	Imports	449,687	217,820	218,540	223,382	241,720	210,409	525,023
	Exports	-	-	2,384	866	14 043	33,837	11,71[illegible]
Malaysia	Imports	1,856	832	151	816	1,185	93	n.a.
	Exports	36,328	20,964	30,305	27,525	25,641	18,484	n.a.
Philippines	Imports	n.a.	n.a.	n.a.	n.a.	n.a.	4,728	5,717
	Exports	n.a.	n.a.	n.a.	n.a.	n.a.	200	n.a.
Singapore	Imports	28,100	24,389	35,824	24,687	31,607	33,257	29,247
	Exports	11,558	8,591	3,591	602	1,123	4,909	340
Thailand	Imports	5,445	4,365	25,110	75,105	127,612	168,996	n.a.
	Exports	3,276	205	-	-	89	-	n.a.

Siam Iron and Steel in Thailand is a similar sort of mini integrated steel plant. The first two phases of its unusual four-phase approach to building the integrated steel plant is typical of any mini mill with electric arc furnaces, continuous casting facilities, and rolling mills. However, the third phase calls for integrated steel plant operations by the construction of charcoal blast furnaces and oxygen converters so as to make use of local deposits of iron ore and charcoal converted from wood.

BIBLIOGRAPHY

Whilst the complete set of papers from the Mini Mill Symposium have been used to prepare this review, the following papers were the chief sources :

1. "The use of oxygen in mini mill steelmaking" by J.L. Harrison (British Oxygen Company, UK)
2. "Continuous casting : the key to operational economy of small steel plants" by T. Onaka (Concast AG, Switzerland)
3. "Technical aspects of continuous casting used in small scale steel-making units" by M. Croce (Danieli & C. SpA, Italy)
4. "Review of mini mills and their developments" by J.C. O'Neill (BHP Limited, Australia)
5. "Optimum layout of mini mill - electric furnace and rolling mill" by L. Danieli (Danieli & C. SpA, Italy)
6. "Rolling mill for small steel plant" by S. Satomi (Ishikawajima-Harima Heavy Industries Co. Ltd, Japan)
7. "Small semi-integrated steel plants" by K. Tromel and P. von Campen-hausen (Schloemann AG, FRG)
8. "When is integration right ?" by F. Colautti (Danieli & C. SpA, Italy)
9. "How and when a semi-integrated steel plant should be converted to an integrated plant" by W.D. Roepke (Demag AG, FRG)
10. "Mini integrated steel mill in Malaysia" by K.S. Poh and H. Nakagawa (Malayawata Steel Berhad, Malaysia)
11. "The mini mill operation of United Malaysian Steel Mills Berhad" by T.S. Pao (United Malaysian Steel Mills Berhad, Malaysia)

In addition, information has also been taken from the following papers :

12. "Siam Iron and Steel Co. Ltd" by C. Ratanarat (SEAISI Quarterly, 1972, Jan., vol. 1, no. 1)
13. "A report on the iron and steel industry in Taiwan" by D.L. Wang (SEAISI Quarterly, 1972, April, vol. 1, no. 2)
14. "Development of the iron and steel industry in Indonesia" by E. Jogasara (SEAISI Quarterly, 1972, Oct., vol. 1, no. 4).

Copies of these publications may be obtained on application to the South East Asia Iron and Steel Institute, Killiney Road Post Office Box 189, Singapore.

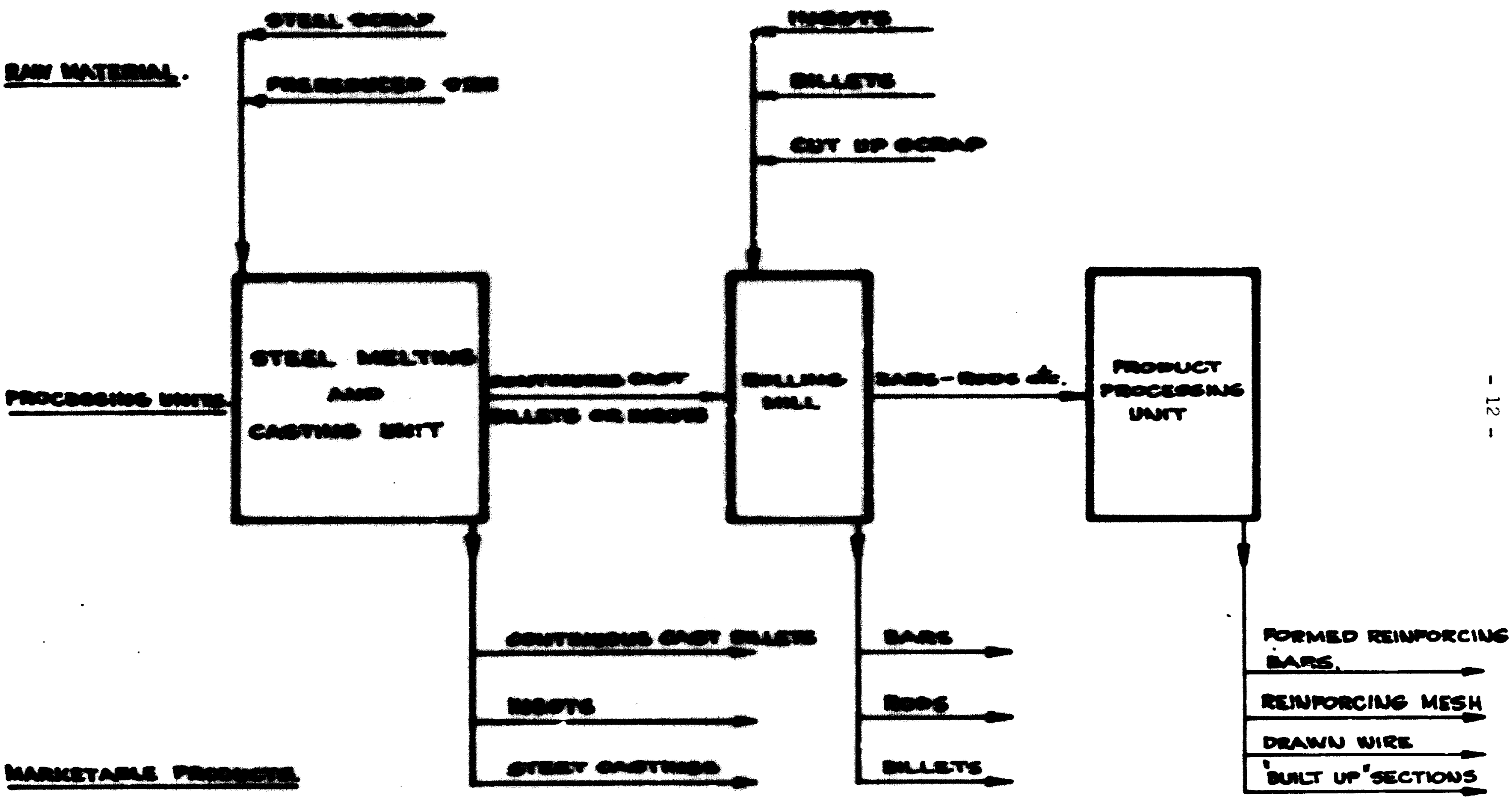
RAW MATERIAL.
STEEL SCRAP
INGOTS
BILLETS
CUT UP SCRAP
PROCESSING UNITS.
STEEL MELTING
AND
CASTING UNIT
ROLLING
MILL
BARS-RODS etc.
PRODUCT
PROCESSING
UNIT
INGOTS
STEEL CASTINGS
BARS
RODS
BILLETS
FORMED REINFORCING BARS.
REINFORCING MESH
DRAWN WIRE
'BUILT UP' SECTIONS
MARKETABLE PRODUCTS

Fig. 1

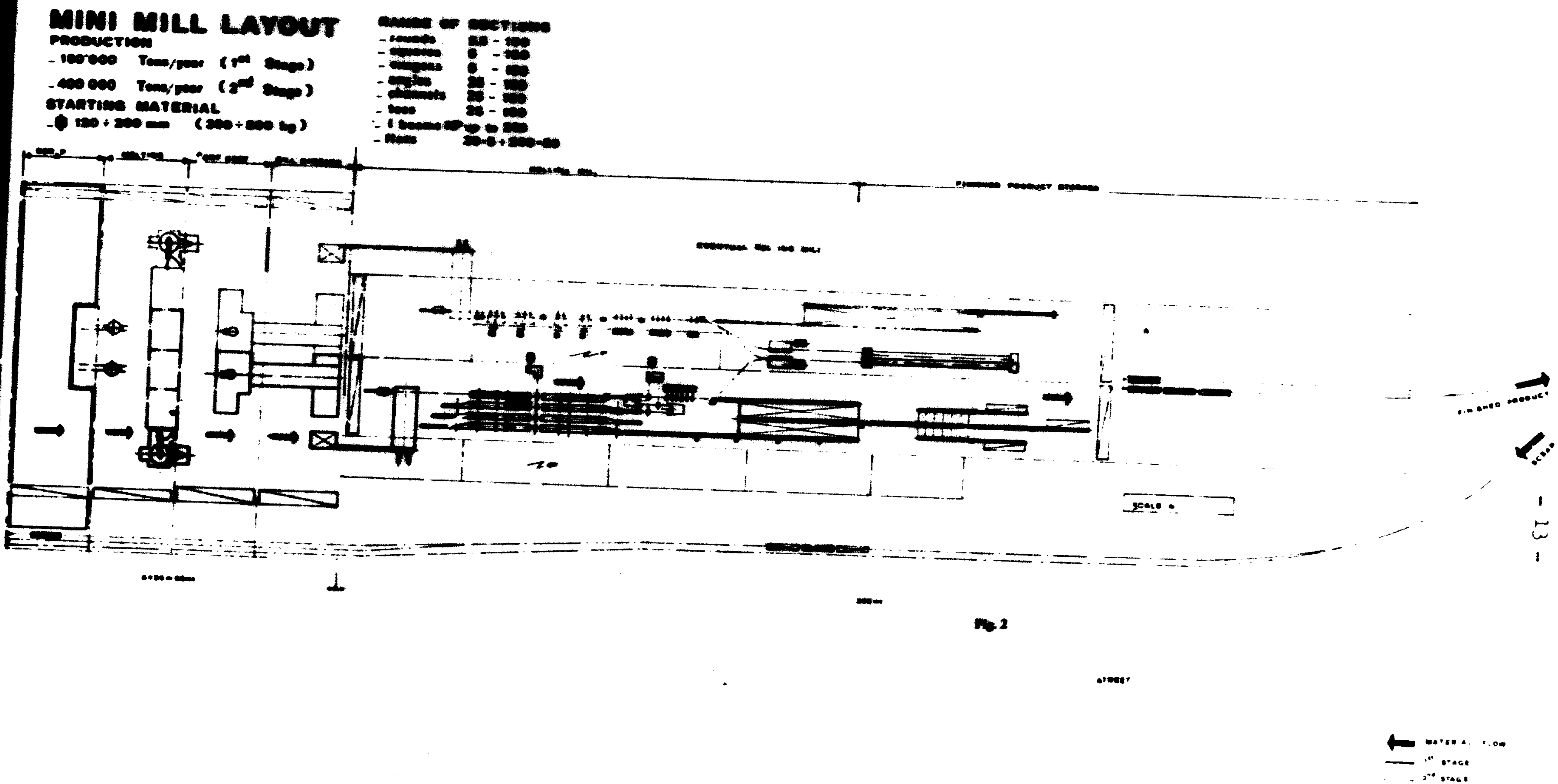
MINI MILL LAYOUT
PRODUCTION
- 100'000 Tons/year (1st Stage)
- 400 000 Tons/year (2nd Stage)
STARTING MATERIAL
120 ÷ 200 mm (300÷800 kg)
RANGE OF SECTIONS
FINISHED PRODUCT
SCALE
STREET
1st STAGE
2nd STAGE

Fig. 2

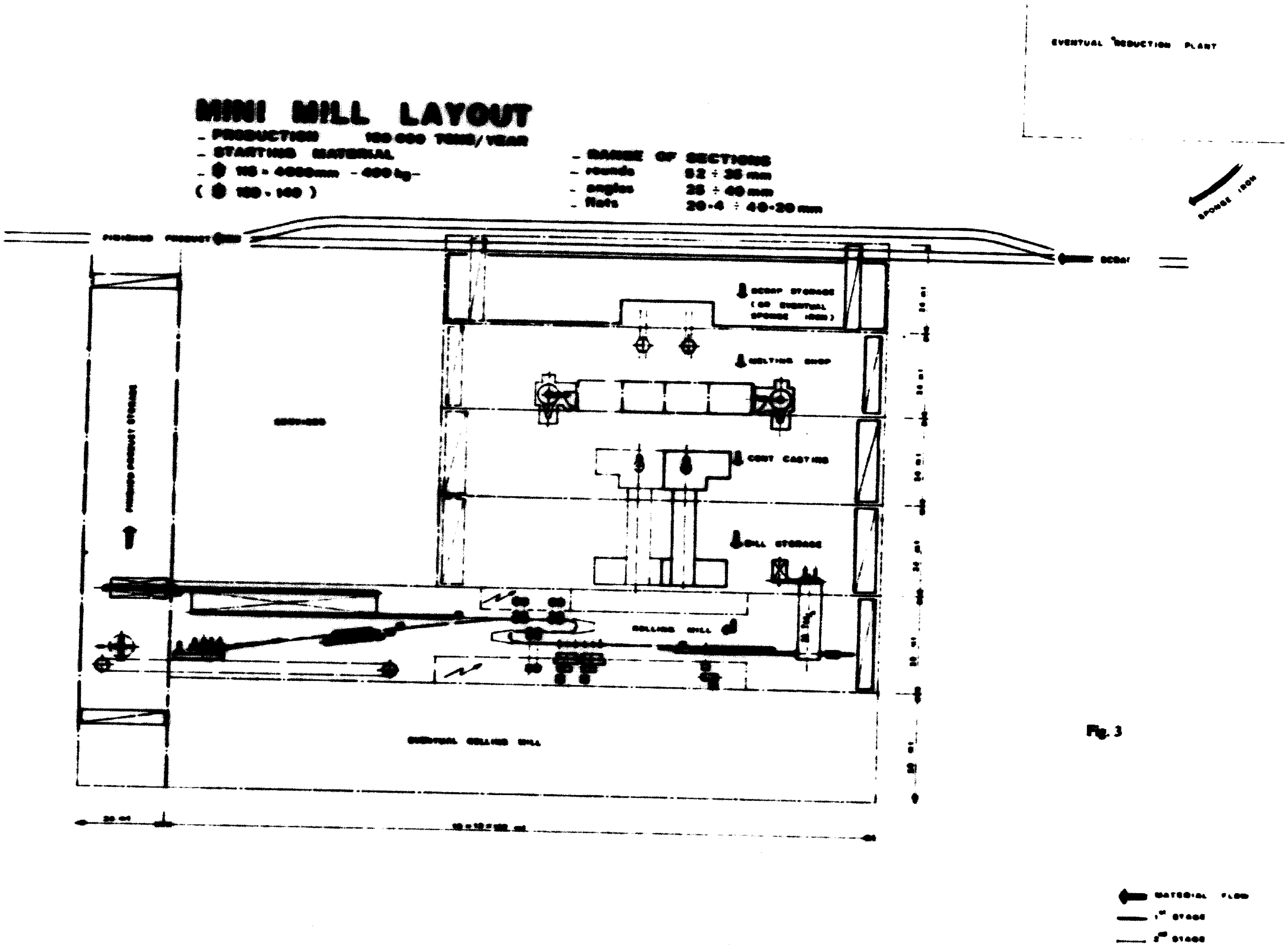
MINI MILL LAYOUT
PRODUCTION
STARTING MATERIAL
RANGE OF SECTIONS
EVENTUAL REDUCTION PLANT
SPONGE IRON
SCRAP
FINISHED PRODUCT
SCRAP STORAGE
MELTING SHOP
CONT CASTING
BILL STORAGE
ROLLING MILL
FINISHED PRODUCT STORAGE
EVENTUAL ROLLING MILL
MATERIAL FLOW
1st STAGE
2nd STAGE

Fig. 3

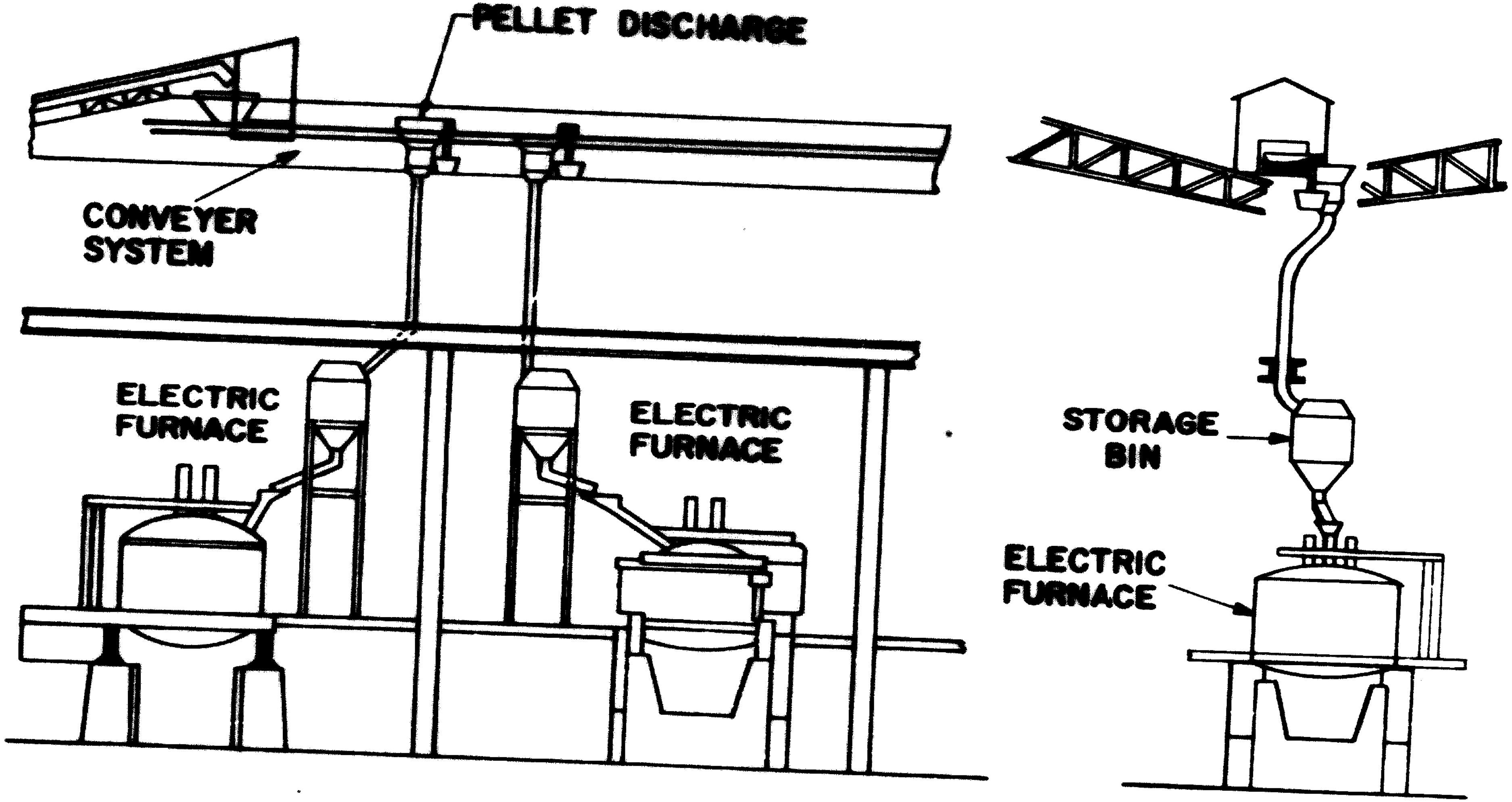

Fig. 4: Engineering Study of Prereduced Iron Feeding System at HYLSA's Monterey Melt Shop

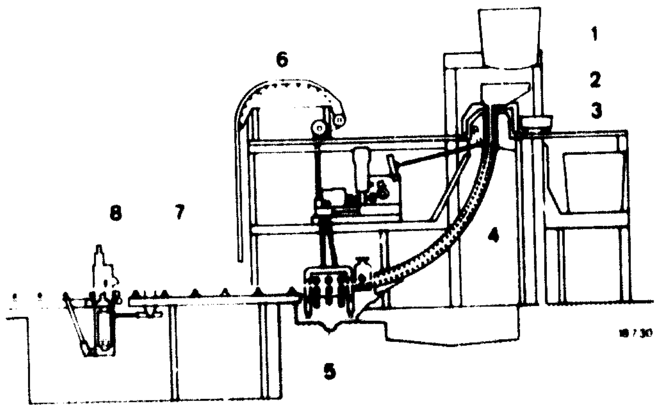

Fig.5: **Curved mould continuous casting installation for steel (CONCAST Model S)**

1 Ladle
2 Tundish
3 Curved mould
4 Secondary cooling zone
5 Pinch and straightening rolls
6 Dummy bar storage
7 Discharge roller table
8 Shear

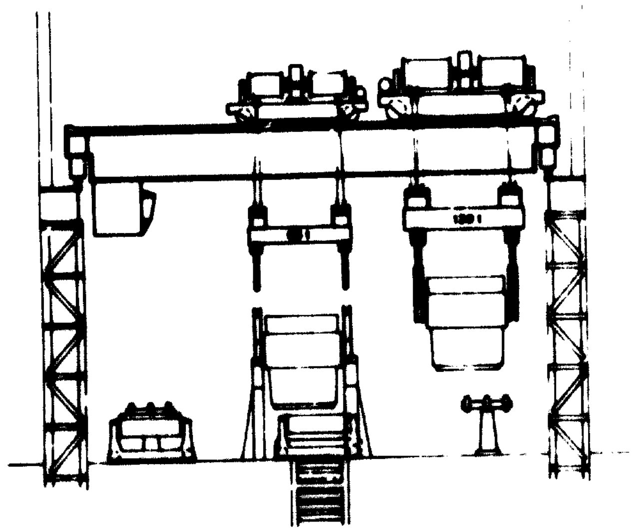

Fig.6: **Double crane**

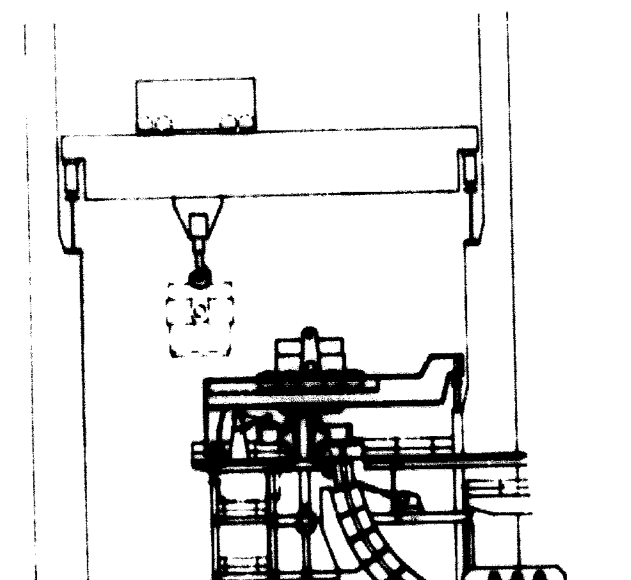

Fig.7: **Ladle car**

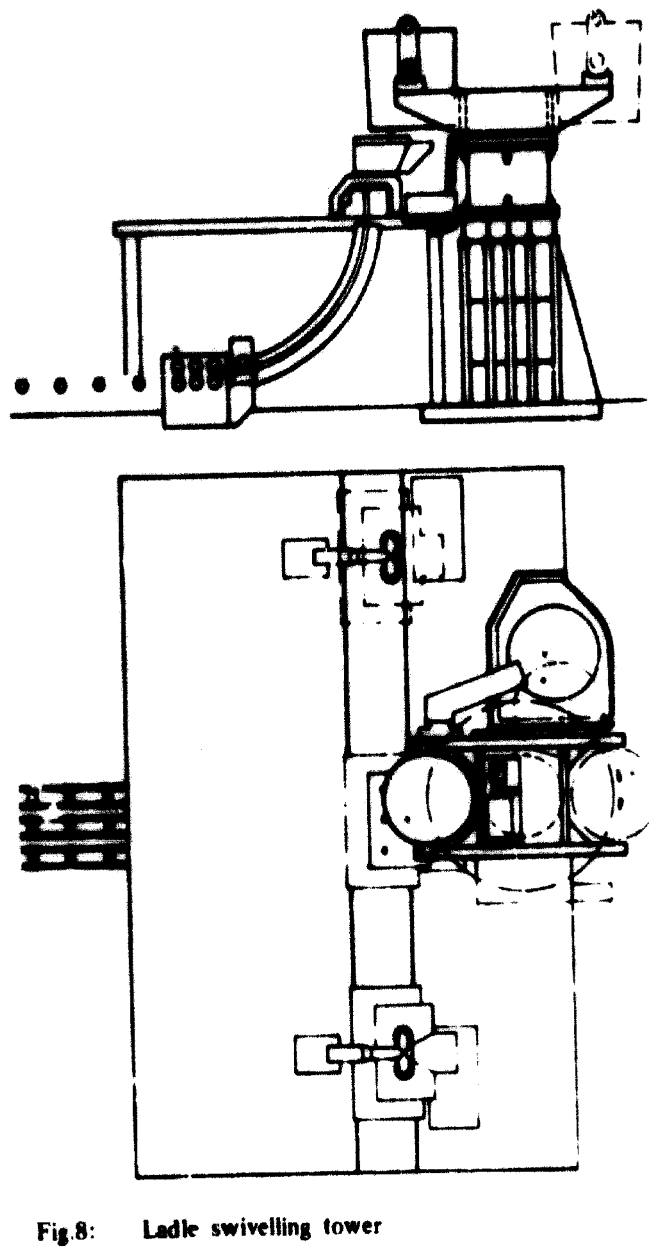

Fig.8: **Ladle swivelling tower**

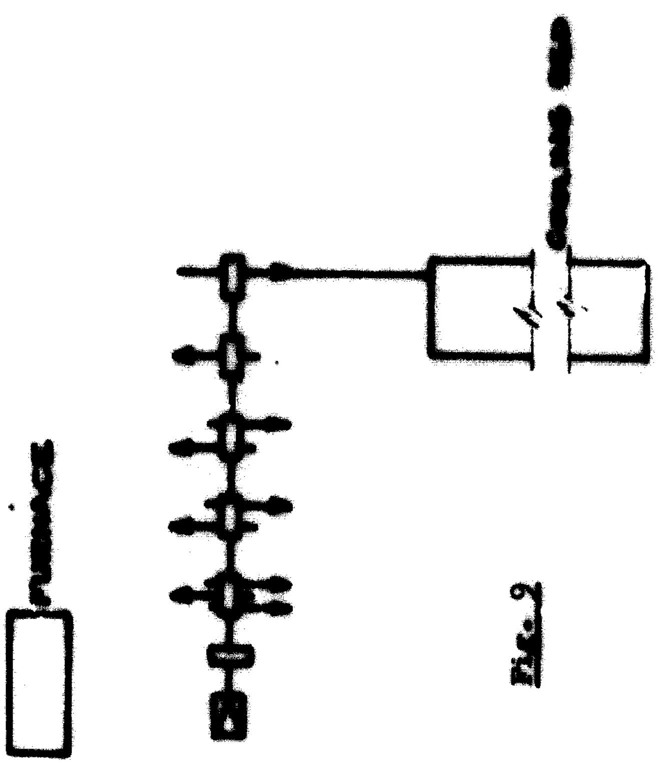

Fig. 9

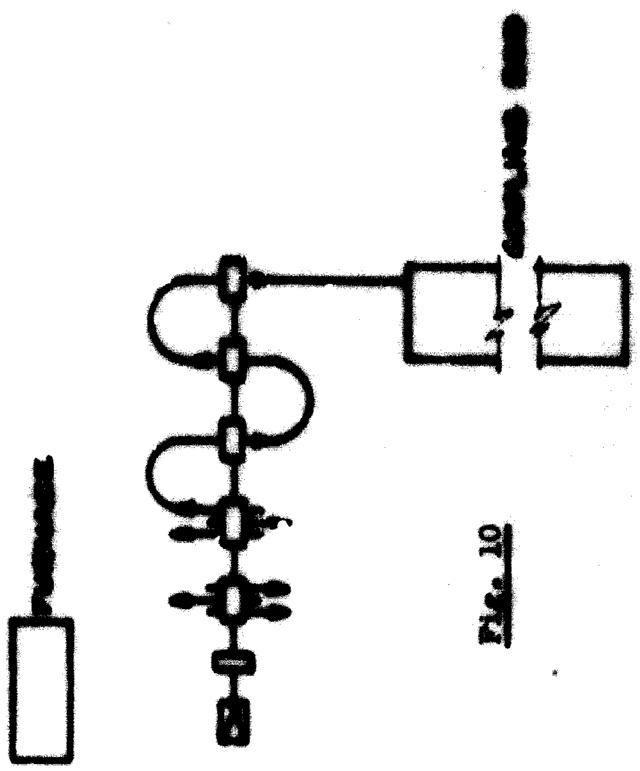

Fig. 10

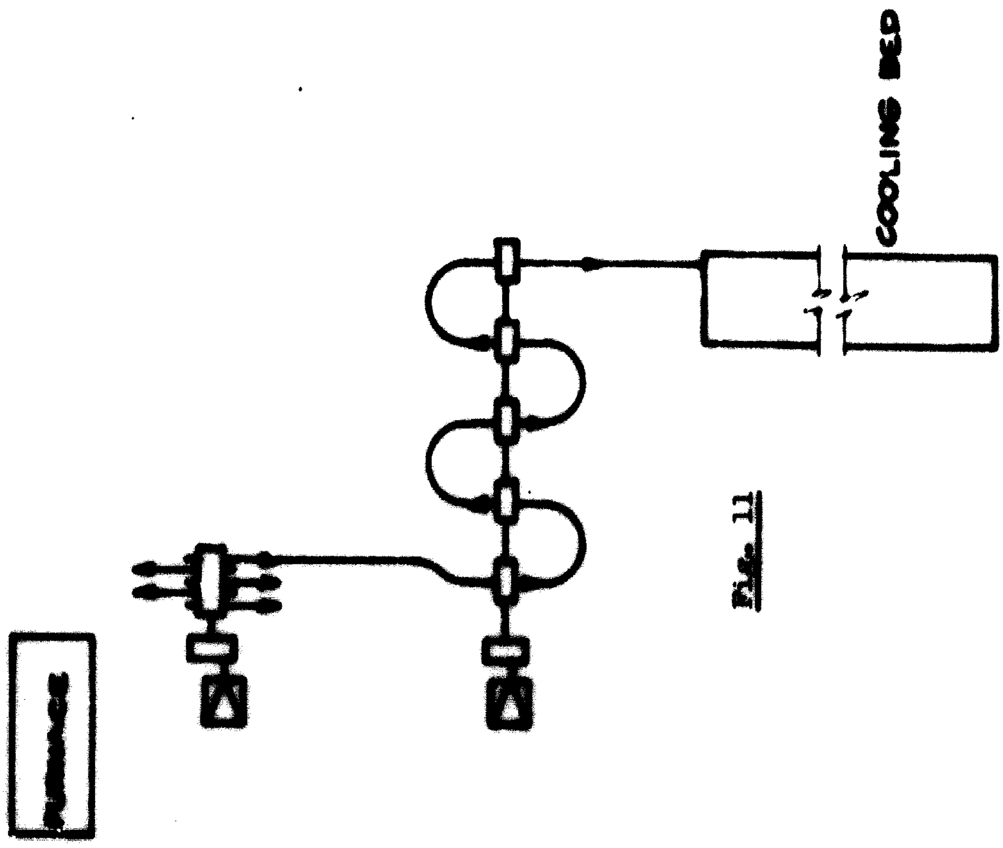

Fig. 11

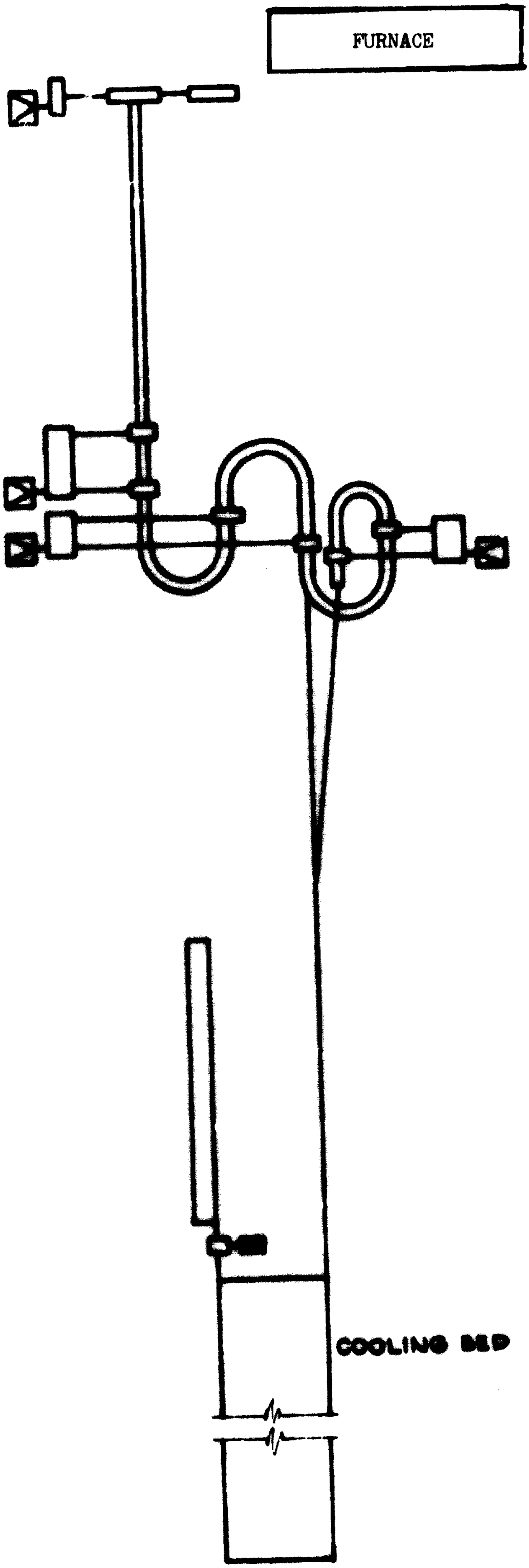

Fig. 12

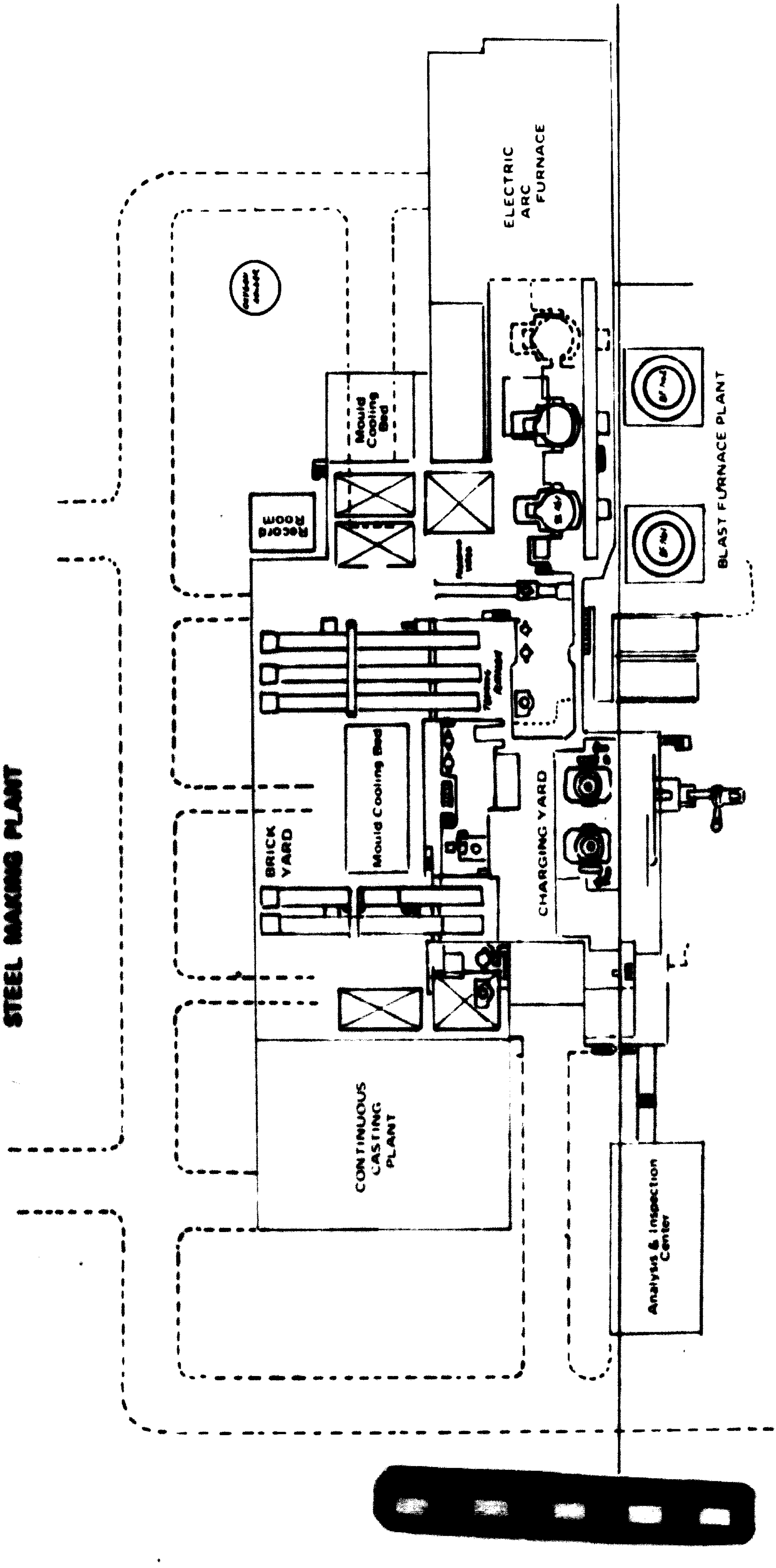
STEEL MAKING PLANT
ELECTRIC ARC FURNACE
Mould Cooling Bed
Record Room
BLAST FURNACE PLANT
Mould Cooling Bed
BRICK YARD
CHARGING YARD
CONTINUOUS CASTING PLANT
Analysis & Inspection Center

Fig. 13

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