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Moscow, USSR, 19 September – 9 October 1968

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EXPERIENCES AND ADVANTAGES IN EMPLOYING PREHEATED COLD CHARGE IN ELECTRIC FURNACES AND THEIR INFLUENCE ON NEW ELECTRIC STEEL PLANT LAY-OUT 1/

by

F. Grossi et al.
Italy

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SUMMARY

It is common knowledge that the operation of the electric steel-mill is economically affected by the amount and price of the electric power consumption and the cost of graphite electrodes as well as by the incidence of required operation personnel and the value of the employed investments.

Using the installations of two steel-mills of Latin America and adding to them some very simple equipment a pilot installation was set up based on the well-known method of pre-heating steel scrap charges by means of gas or liquid fuel before charging them into the electric furnace. This installation showed extremely interesting results especially from an economical point of view due to a substantial reduction of electric power and electrodes consumption although a certain increase in the fuel consumption was encountered.

* This is a summary of a paper issued under the same title as ID/WG.14/49

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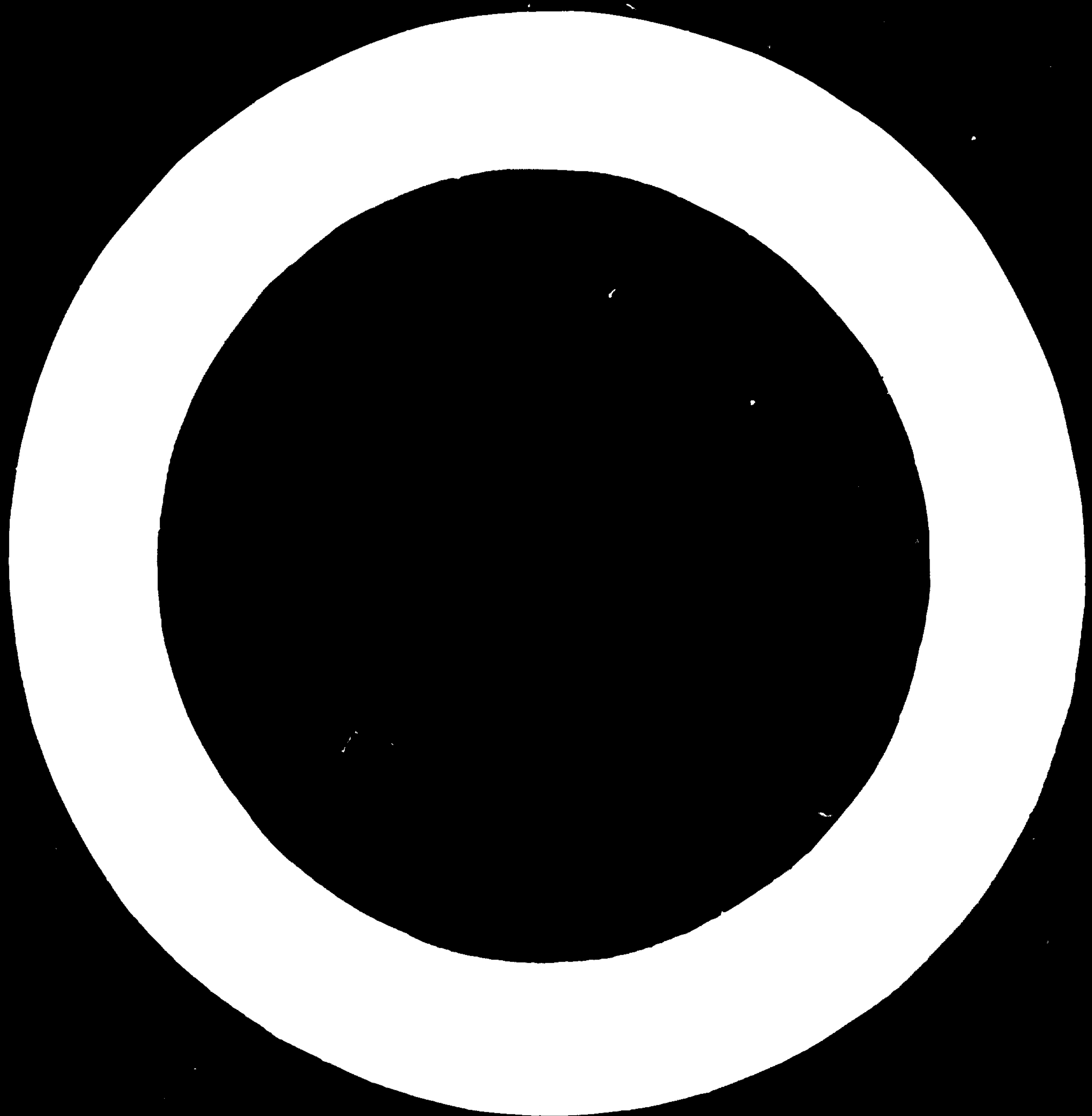

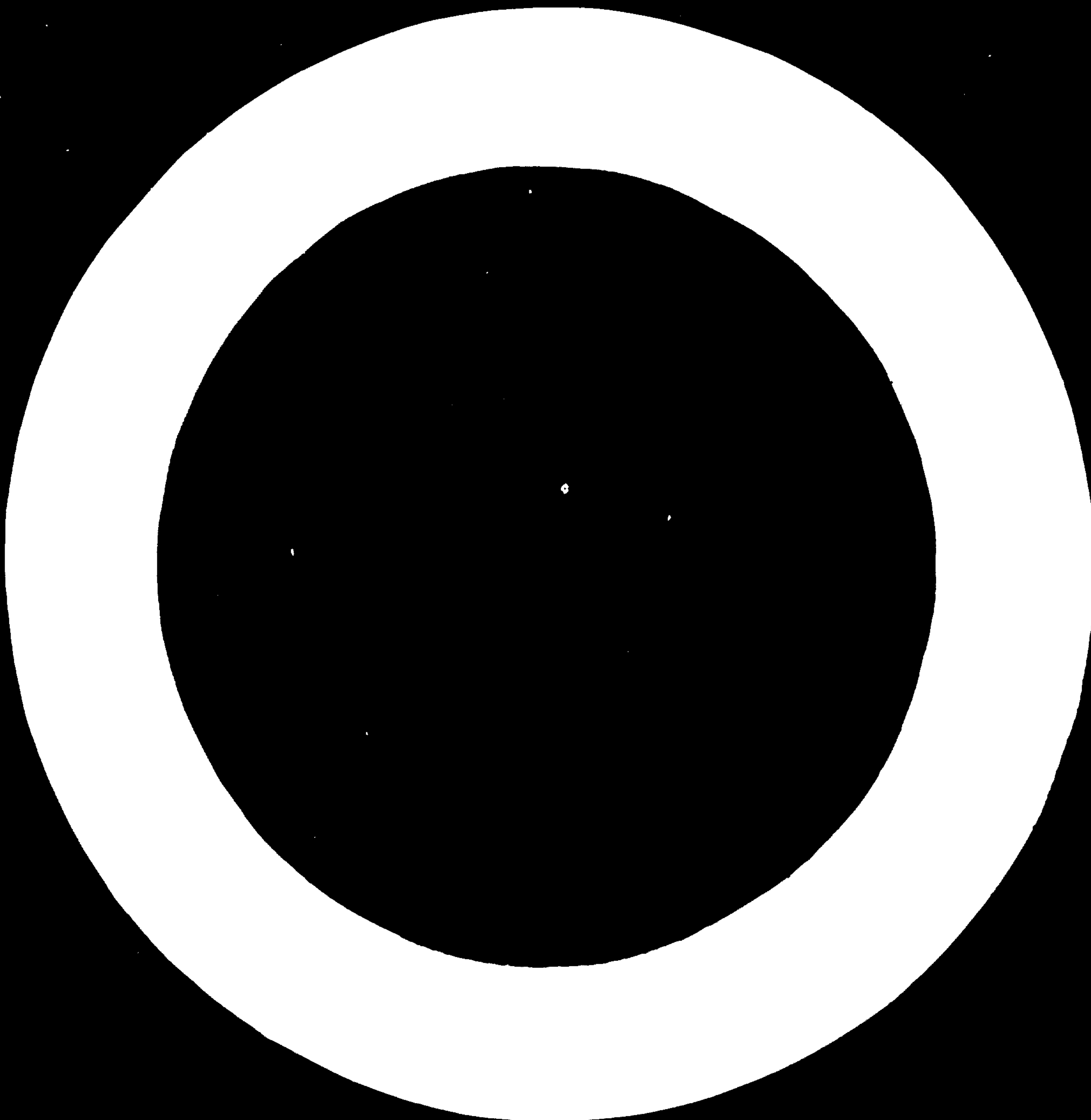

The economical balance mainly linked to the ratio of unit cost of electric power and electrodes to the cost of fuel resulted quite positive.

The operation of the new installation gave the hint to modify the conventional lay-out of the electric steel-mill in favour to the acquired and usual lay-out of both the plant and its material handling utilities.

This new type of steel-mill, which has not been yet implemented, offers substantial economical advantages and a larger flexibility during operation.

The drawback due to the novelty of this installation, which always bears some risks especially in the iron and steel field, can anyway be overcome by the possibility offered by the modern engineering techniques.

Using analytical techniques it is possible today to study all details of operation (Monte Carlo technique) and consequently foresee the yearly economical results of plant operation (by the use of computers).

This new way of plant design, while allowing substantial saving in the investment and operation, requires greater care during the design stage.

The estimated investment saving was evaluated around the 15-25 per cent. The increase in the design cost was evaluated of some percent of the value of the plant (above normal standard).

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1. INTRODUCTION AND SUMMARY OF THE CONCLUSIONS

It is common knowledge that the operation of the electric steel-mill is economically affected by the amount and price of the electric power consumption and the cost of graphite electrodes as well as by the incidence of required operation personnel and the value of the employed investments.

Using the installations of two steel-mills of Latin America and adding to them some very simple equipment a pilot installation was set up based on the well known method of pre-heating steel scrap charges by means of gas or liquid fuel before charging them into the electric furnace. This installation showed extremely interesting results especially from an economical point of view due to a substantial reduction of electric power and electrodes consumption although a certain increase in the fuel consumption was encountered.

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This new way of plant design, while allowing substantial saving in the investment and operation, requires greater care during the design stage.

The estimated investment saving was evaluated around the 15-25%. The increase in the design cost was evaluated of some percent of the value of the plant (above normal standards).

2. DESCRIPTION OF A STEEL WORKS OPERATING WITH PRE-HEATED SCRAP

The first steel-works in Latin America (Mexico) introducing the technique of pre-heating scrap, started up in 1961-1962.

The second one (Argentine) using this system in practical operation, began its tests in 1965.

This latter works has two electric arc furnaces, the main features of which are as follows :

Builders	Birlefco
Diameter of shell	15' (4572 mm)
Diameter of electrodes	18"
Transformer power	12,500 KVA
Nominal capacity	35 tons
Actual capacity	54 tons
Power available	230 KVA/ton of charge
Bottom and bank lining	Dolomite bloks 450 mm thick
Roof	Brickwork 60% Al_2O_3 350 mm thick

This plant which mainly produces steel for the production of seamless tubes by the Mannesmann-Calmes process, is supplied by a power station and connected to a network, the power supply of which is limited.

As the time allowed for refining had to remain unaltered in order to avoid prejudicing of the required steel characteristics, a supplementary supply of power was felt to be particularly necessary so that charging and melting times could be accelerated with only a small out-lay, and without resorting to heavy investments which, for example, would have needed to increase the output of the power station and to replace the fournace transformer with another and more powerful one.

The plant is laid out over a number of bays, as may be seen in Fig. 1, with plenty pouring space as required for the production of ingots for tube making.

3. THEORETICAL ADVANTAGES OF PRE-HEATING

It is well known that the theoretical amount of heat required for melting a ton of scrap, and for heating the bath, is 377.8 KWh, divided as follows :

87% for melting ,
13% for refining.

This means that, as the consumption at this particular steel wotks was 556 KWh/ton of molten steel, the same percentages give the following division :

490 KWh/ton for melting,
66 KWh/ton for refining.

It is clear that if a charge, which already possesses a part of the heat necessary for melting it, is introduced into the furnace, not only will there be some reduction in the consumption of electric power, but there will also be an appreciable increase in productivity, without altering the power of the transformer. If then the time it remains in the furnace is also reduced, it is to be expected that consumption of electrodes and linings will be reduced as well; on the other hand if the charge is pre-heated in the charge bucket these may be damaged to a certain extent.

4. DESCRIPTION OF THE PRE-HEATING SYSTEM

The experience gained from past work done (bibliography - see Ann. I) and the information to be found in technical literature on pre-heating scrap, mainly relate to the use of somewhat complex equipment which cannot alaways be installed in a traditional steel works; if often means too that these methods require the use of charging bucket which have been altered and suitably strengthened.

The very simple method adopted for use in the plants of Latin America is described in another paper (2) read at the IV Congresso Nacional de la Industria Siderurgica in 1965 (Mexico).

This method is essentially based on direct pre-heating of scrap in the valve charge bucket (diameter 3,470 mm, capacity 29 m3). Heating is done from the bottom through a hole in his middle, (Fig.2) to take the high pressure Venturi-type gas burner (about 160 Nm3/h to 23 kh/cm2).

The composition and properties of the gas used are as follows :

methane	84.1%
ethane	8.7%
propane	2.7%
butane	0.3%
CO_2	4.2%
net heat value	8762 Kcal.
gross heat value	9657 Kcal.

The pre-heating plant substantially consists of three stations placed parallel, each one merely consisting of a space with a vertical burner in it, fed by a pipe, with a flame controlled at a distance. There is no system of recovery or carrying away the fumes.

5. EXPERIENCES OF OPERATION WITH PRE-HEATING

Initial operational experiences in steel works aimed first of all at finding out the conditions and working difficulties which might arise by using the method described to exploit the pre-heating technique to the utmost.

Two similar working periods were examined, each lasting a month, an initial period without pre-heating and the second period with pre-heating in operation.

During the second period the four charge buckets normally loaned were heated for the following average periods :

Bucket 1,	17 tons of scrap,	pre-heating time 139'
Bucket 2,	18 tons of scrap,	pre-heating time 115'
Bucket 3,	11 tons of scrap,	pre-heating time 102'
Bucket 4,	8 tons of scrap,	pre-heating time 72'
	54	428'

A comparison is given in Table 1 of the results obtained in the two periods under consideration.

Table 1

	without pre-heating	with pre-heating	variations
Actual productivity in t/h	13.320	15.955	+2.635(19.78%)
Power consumption in KWh/t	556	455	-101 (18%)
Electrodes consumption Kg/t	5.56	4.24	-1.32 (23.7%)
Carbon steel %	67.72	50.61	-17.11
1.5 Mn Steel %	20.89	19.76	-1.13
Double slag steel %	11.39	29.63	+17.24
Consumption of gas in Nm3/t	-	22.253	
N° of tappings	163	195	+32
Tons produced	8300	99550	+1655
Working hours per month	624	624	
Tons per heat	51	51	

Thus, by pre-heating the scrap as described up to a tempetarure of about 500°C, an increase in productivity is achieved of 19.78%. This means that the steel works already able to produce 176,000 tons per year could reach an objective of 210,000 tons per year.

As there were no signs of operational trouble in the trial period(not even wear or deformation of the charge buckets) it was concluded that this method was worthwhile for the following reasons :

- the plant to be installed was decidedly simple and relatively cheap;
- the cost of the additional consumption of gas was greatly lower than the saving made from the reduction in consumption of power;
- the prospect of reducing working costs made it possible to foresee an appreciable rise in productivity.

6. EXPERIENCE OF ANNUAL OPERATION

After carrying out these trials, arrangements were made at both the electric steel works mentioned to install pre-heating plants for each of the electrical furnaces.

Following a charge in the type of scrap used, the number of charge buckets per heat was increased to five, but owing to the limited number of the existing buckets and to the restricted amount of space around the furnaces where the pre-heating plant was installed, heating times had to be reduced : thus only partially the advantages, which had been expected according to the results of the tests made when were exploited.

On the other hand, the fumes, coming from the buckets during the pre-heating stage, worsened considerably working conditions for the personnel in the furnace area; there was thus no incentive to increase the rate of exploitation of the pre-heating plant and to provide the extra charge buckets required for it.

Pre-heating could then only be carried out on an average of three buckets, and only for about 45' per bucket, consequently the average temperature of the pre-heating scrap did not exceed about 350°C.

Table 2 gives operational statistical data relating to the monthly averages for two typical months, one normal month without pre-heating and the other with reduced pre-heating.

Table 2

	without pre-heating	5 charge buckets with 3 pre heated ones	absolute difference	relative variations
Actual output in t/h	13.320	15.270	+ 1.950	(14.6%)
Power consumption in KWh/ton	556	460	- 96	(17%)
Electrodes consumption in Kg/ton	5.56	4.54	- 1.02	(18.3%)
Consumption of gas Nm3/ton	-	11.04		

7. FURTHER CONSIDERATIONS

7.1 Possible limitations to the pre-heating technique

An examination of the technique adopted, leads unfortunately to the conclusion that not all types of scrap are suitable to the pre-heating process. Turnings, forinstance, would melt if they came into direct contact with the burner flam so that, considering the large quantity of this type of scrap which is used in some countries, such as Italy for example, this technique of pre-heating in buckets may present some difficulties.

If an attempt is made to overcome the difficulty by reducing the size of the burner, pre-heating time is consequently increased making it necessary to increase as well the number of buckets charged, and this may often be awkward for a steel works for reasons of cost, space available and running.

In the case of light oiled sheeting, the danger of fusion may be avoided if a suitable treatment is given to it and if care is shown by the furnacement.

There is no doubt that the nature of the scrap may represent the most important limiting factor affecting the spread of the technique of pre-heating in buckets.

8. IDEAS FOR A PLANT DESIGNED TO OPERATE WITH FULL PRE-HEATING

From the experience gained by the plants in Latin America which today carry on regular work charging pre-heated scraps as described above, the following main characteristics of a plant for pre-heating the charge may be deduced :

1. fumes are created in the area where pre-heating is done;
2. the area to be assigned to pre-heatingis not negligible and must be sufficient to take 4 to 5 charge buckets;
3. the pre-heating area must have easy access to the furnaces so as to optimize the effect of pre-heating.

As regards point (3) it would clearly seem best to place the pre-heating plant in the furnace bay: the problem of creation of fumes could no doubt be dealt with by providing chimneys or fans.

There remains the objection to using this position as the furnace bay forms the most expensive part of the building; the area is strongly and heavily built and is therefore costly due to the presence of heavy service overhead cranes.

For this reason it would appear best to place the pre-heating plant out in the open air, or in a well ventilated position (without fume problems and on low cost space) in the neighbourhood of the furnaces.

An alternative solution might be that of placing the pre-heating plant in the scrap (yard) where the covered area costs less than the furnace space, and where fume problems would certainly be less serious than they would near the furnaces, on condition that a quick and easy access to the furnaces is assured.

Carrying forward the idea of installing the pre-heating plant in an outside, ventilated position and in order to provide easy access for it to the furnaces, a rough layout has been devised, as shown in figures 3 and 4, for a typical steel works, realizable in stages, with two 25 tons electric furnaces and with two continuous castings in two lines capable of an initial output of about 75,000 tons per year of square billets, and therefore of about 150,000 tons per year in the final stage.

The main principles which an attempt had been made to include in the plant shown in Fig.3, are :

- assembly within a restricted area and under one single bay of all operations requiring movement of heavymaterials, and at high levels, which must necessarily be done with bridge cranes;
- gradual investment in fixed and mobile plant thus reducing to the minimum the risks inherent in the launching of a new undertaking.

To solve the transport problem and reduce plant costs down to the minimum, consideration has been given to the extensive use of wheeled trucks, both at the scrap yard and at pouring bay, leaving the overhead cranes free for the very limited and highly specialized work for bucket loading and for tapping. This would give the following advantages :

1. the absence of overhead cranes (except in the small furnace area) would mean a reduction in the total investments in plant due to a saving of about 20% in the cost of the building;

2. the use of wheeled vehicles would mean great operational flexibility, with the possibility of temporally extending processes or stocks (scrap, for example) out in the open without any difficulty at all;

3. the use of wheeled vehicles would further mean that the pre-heating area could be placed towards the outskirts of the building, either under partially covered area or even quite out in the open air, but served by the little spare overhead cranes from the furnace area (charging and tapping services) which would ensure quick transport connections;

4. the use of wheeled vehicles is envisaged to secure a reduction in staff as compared with a similar, but more traditionally organised steel works.

9. TRASNPORTATION MEANS SPECIFICATION

As previously mentioned, for transport needs four essential types of special means are proposed to carry out four completely different types of services.

9.1. Wheeled (or crawler) jib cranes with lifting magnets fitted to the hook for executing two main functions :

- at the scrap yard (loading buckets and unloading trucks or railway waggons);
- general plant maintenance service (mainly at the furnaces and continuous castings, including the operations of replacing equipment and refractory material).

9.2. Motorized wheeled trucks able to self-load and unload large bins carrying out the following chief functions :

- moving empty buckets for scrap from the area behind the furnaces to the scrap yard for filling by wheeled cranes, for weighing and for returning when full to the preheating stations behind the electric furnaces;
- moving full slag pots from the area in front of the furnaces to be emptied at the slag yard and brought back in front of the furnaces;
- movement of the empty casting ladles from the area near to the continuous castings, to the various stations (change of the stop-

per rods, repairing refractories, preheating, etc. till they are once more in position in front of the tapping spout (empty and ready for the casting).

9.3. Fork lift trucks for carrying out the following main operations :

- movement of the continuous casting billets from the cooling platform to the inspection and conditioning stations, and to the stores, trucks or railway waggons for despatch;
- movement of all materials of consumption on pallets, such as refractories, electrodes, cases of loose goods, etc.

9.4. Overhead cranes for serving a very restricted area, and carrying out the following main duties:

- charging the furnaces with the buckets taken from the preheating stations and placed empty in the area behind the furnaces;
- at the steel tapping point taking the full ladles from underneath the spout, moving them to a continuous casting machine, emptying them of slag into the slag pot, putting them down on the ground in front of the furnaces and placing the ladle already prepared underneath the spout for the next tapping;
- acting as auxiliary to the wheeled jib cranes for the work of reparing the furnaces and the continuous casting machines;
- if necessary, pouring steel in the ladle into an emergency pit, adjacent to the continuous casting machines, if any accident should occur to them.

9.5. Wall bracket jib cranes with traveling hoist for the following special services :

- replacement of electrodes;
- replacement of nozzles on the pouring ladles.

A doubt which might arise when looking at the layout in Fig. 3, and thinking of the running of a steel works not divided into the traditional areas and above all served almost entirely by wheel based transport equipments, is that deriving from the novelty of the solution proposed, and thus from the risk that, in practical operation, the plant might not function properly due to lack of reliability, inadequacy or impossibility of operating this type of transport.

The first problem of reliability is therefore closely tied to the actual availability of wheeled transport vehicles which fulfil what is required of them.

The second problem of their proportionment or possibility or working in this plant depends on how good the studies and drawings of the project are; as previously mentioned, the analytic technique which it is proposed to follow in this connection - the designing of a steel works conceived so as to reduce the risk of error to the minimum - is based on the principle of making a prior experiment on how it actually works simulating running operations by the Monte Carlo technique using computers.

Only in this way, by minutely analysing each and every elementary activity of the component parts of the plant, we can know whether any of the means of transport envisaged would be unsuitable or inadequate (then taking steps to make suitable alterations to the plant during the design stage), whether the layout arrangements really are such as will ensure the required level of efficiency, and whether the used resources exploitation is close to the optimum.

The general programme for simulation of this type of plant on a computer is now being prepared and can be applied not only to the example suggested in the layout shown in Fig. 3 but (with suitable adaptions) to a very wide range of steel works of different sizes and types, as long as they are all based on the same principle.

10. EXPLANATION OF THE LAYOUT

In accordance with the specific working capacities and main functions of each of the various types of transport vehicle and equipment proposed, an attempt has been made to design the layout of the steel works so as to minimize the distances and the interference between one type of transport and another. For this reason the areas served by the same types of transport have been placed one near to the other.

10.1. The wheeled (or crawler) jib cranes have to serve the whole of the upper area shown by the plan in Fig. 3, and especially the scrap yard (where they will normally be located), now and again being taken as far as the centre of the plant when required for service at the furnaces and at the continuous casting machines.

10.2. The self loading trucks are to be used in the central area of the plant (moving ladles and slag pots) and at times in the upper area (scrap yard) for handling the charge buckets.

10.3. The fork lift trucks are for use in the lower area of the plant for moving billets, and also as far as the central area (furnaces and casting ladles) for transporting palletised raw materials.

10.4/5. The overhead cranes and jib hoists are for use in restricted areas and for extremely specialised work, without interfering with the other means of transport with which, however, they cooperate in moving buckets, ladles, slag pots and various materials.

This division into three working zones for the three types of the described wheeled transport vehicles also creates considerable operational flexibility due to interchangeability between the same vehicles (more than one) which carry out a particular type of operation, and also due to the ease with which the areas which may be required for the different work can be expanded; for example the scrap yard and the storage of billets can be extended to the open air with no limit imposed on them apart from the fencing round the land on which the steelworks stands.

11. PLANT PRODUCTIVITY RELATED TO CAPACITY OF THE MEANS OF TRANSPORTATION

Presuming for the steels which are to be produced a refining time of about 15' to 20' with a melting time of about 100' to 200' (with a transformer of about 10,000 kVA), with 3 or 4 scrap buckets, the time allowed for an average tap-to-tap cycle would be about 2,5 hours, or 150 minutes.

It follows that annual production per 25-ton furnace for 300 days a year would be :

$$\frac{24}{2,5} \cdot 300 \cdot 25 = 72,000 \text{ tons per year per furnace}$$

i.e., for two furnaces, 144,000 tons/year.

It is clear that, in order really to achieve a cycle of 2,5 hours per furnace, the means of transport employed would have to work fully efficiently throughout the whole period. We will therefore make a brief analysis of the work to be done by the overhead cranes at charging and tapping points.

During the initial stages of operating the plant, it is wise to assume that the overhead crane will remain above the casting ladle while continuous casting proceeds, so that it may be brought into action should any trouble occur.

On this assumption, and on the basis of a time analysis required for the actual tapping and pouring operations carried out by the overhead crane, we get the result of an average occupation of about 80% for one crane and one furnace.

For charging work at one furnace, a second crane would have an average occupation (intensity of work) of about 40%.

In a subsequent working stage at the plant, when for instance continuous casting operations will not be reason of possible accidents, it may be considered to leave the ladle above the continuous casting machine and thus reduce the intensity of work (for one furnace) to about 55%.

With only a single furnace in operation, it is therefore clearly essential to have two overhead cranes in operation mainly for security reasons, when the plant is starting up.

With two furnaces, however, and allowing for a total of only three cranes (one for each furnace for charging and one for the tapping), it would appear that the resulting intensity of work (0.55 x 2 = 1.1) would certainly involve long delays in castings due to chance interference occurring between the separate operations at each of the furnaces.

At any rate it may be noted that, as the three cranes working over the same running way are interchangeable, the two charging cranes could be given various types of auxiliary work to do in the casting areas (placed under the same route) so as to achieve the same intensity of work for the three overhead cranes serving two furnaces :

- 2 charging cranes : 60% (for each crane);
- 1 pouring crane (in the second stage of reduced occupation above the continuous casting) : 66%.

Using simpler considerations based on the queue theory, it can be forecasted that the production loss of the steelworks will be in the range of 2,5%; installing eventually a fourth overhead crane, it will be possible to recover this loss of productivity. (+)

In view of the limited and specialized nature of the work done by the overhead cranes, and in order to reduce the number of personnel working in the furnace areas, the possibility has been considered of not providing the cranes with an operator's cabin, but of working them from three panels at ground level (for each furnace) situated respectively as

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(+) Each crane has been considered as one station serving two clients (e.g. the pouring at the first and second furnace) presenting a chance law and frequency equivalent to the average interval between one pouring operation and the next. The average queuing result, calculated using the queue theory, has been halved to correct the effect of excessive variability envisaged by the queue theory formulae, then halved again to allow for the help which the charging cranes (temporally free) can give to the pouring crane.

follows : in the preheating area, in the furnace area and in the continuous casting area. From each of these panels, the operators can control the movements of any of the cranes in translation or in moving the hook.

As regards the wheeled vehicles, being highly flexible, their exact number can be decided in accordance with the particular requirements of any plant; an approximate estimate has therefore been made calling for two vehicles of each type for the first stage envisaging one furnace, with the addition of one of each type in the second stage with two furnaces.

However, as mentioned previously, in order to check the adequacy of all these means of transport, one connected with another, it is proposed to carry out Monte Carlo numerical simulations whereby a rational and economic choice can be made in accordance with the actual operation requirements of the entire productive unit.

As known, this practice, which uses calculations to check a system based on synthetic assumptions, foresees to characterize all component parts of the plant affecting the flow of materials (furnaces, trucks, cranes, continuous casting machines, ladles, etc.) with parameters, which are important mean for the evaluation of the required productivity rate and are considered statistically variable with known or assumed probability laws.

In this way, the actual operation of the steel works can be reconstructed minute by minute, estimating all the delays in castings causes by interference or by accidents (breakdowns, etc.)

For instance, with the simulations covering periods of a year or more, it is possible to know :

- what output can be achieved by the plant in that period (one year or more);
- which component acts as a bottleneck thus impeding flows;
- the evaluation of the advantages obtainable by increased output resulting from alterations to the system or from a better use of the resources available.

12. SAVINGS IN PLANT COSTS

Savings in the plant costs by the layout arrangement shown in Fig. 3, are mainly due to two kinds of considerations:

1. The cost of the building is considerably reduced because most of the area is not served by the overhead cranes, thus the structure is much lighter and cheaper.

2. The number of transport vehicles found necessary is greatly reduced to the the higher flexibility of the wheeled vehicles as compared with overhead cranes and cars running on rails. In this connection it may be emphasized that most of the conventional steelworks served by normal overhead cranes also employ an ever-increasing number of wheeled vehicles both to link up between the cranes placed in the various bays of the building, and for external use among the different buildings forming the whole plant.

Using as a basis price levels applicable to a country like the Argentina, the following investment costs have been estimated for two types of system (conventional and on wheels) of the sizes already described :

Steelworks with two 25 ton furnaces

	Conventional	On Wheels	Difference
Total cost - US$	2.630.000	2.200.000	--
Yearly production (20% of total cost) - US$	526.000	440.000	--
Tons per year	100.000	100.000	--
Cost per ton - US$	5.26	4.40	0.86
Difference of personnel : 21 persons x 3.000 US$/year	63.000	--	--
Cost per ton - US$	0.63	--	0.63
Total cost per ton - US$	5.89	4.40	1.49

It may thus be seen that the layout proposal shown in Fig. 3 can lead to a saving in plant costs of the order of 16,2%, as compared with those of a conventional steelworks with a similar output, size, type of furnace and covered area.

13. POSSIBLE VARIATIONS IN THE DIMENSIONS OF THE PLANT, AND GENERAL REMARKS

The plant, as contemplated, the output of which could be raised in two stages from 72.000 tons a year to 144.000, would appear to be close to the minimum in size capable of economic mass production of the common types of steel in countries in course of development with fairly low market requirements. It is clear however that the advantages of the plant layout and equipment proposed will still be valid, and probably even increase, if the furnaces are larger (more economic to run) and output rises to from 200.000 to 400.000 tons per year.

Today, a top limit to furnace dimensions would probably be set by the charging capacity of wheeled self charging trucks handling buckets and ladles, seeing that the weights to be lifted are rapidly increasing alongside the increase in the dimensions of the furnaces.

It would therefore seem that, today, maximum furnace dimension should be around 50 tons requiring trucks able to charge about 30 tons.

Emphasis should be laid on the fact that a plant as shown in Fig. 3, with 25 ton or larger furnaces, may easily be extended to take three or four furnaces in an almost exactly modular progression.

14. CONCLUSIONS

It seems clear from the above that the running of an electric steelworks with preheating of the scrap has a clear economic advantage from the power consumption point of view, where the ratio between the cost of a cubic metre of combustible gas (with p.c.i. = 8700 cal/m3), and the cost of a KWh is less than about 5 (in Italy, for example, the average ratio is about 1 to 2, so that it could generally be considered economical to use the preheating system in this country).

If we then add the advantages secured by a saving of electrodes and an increase in productivity, it is understandable how it is often worthwhile using the preheating system even when the ratio of the specific costs (calorie/KWh) exceeds the maximum limit of 5.

Use of preheating also improves the quality of the steel by removing humidity and reducing the content of harmful impurities such as tin, lead, etc.

However, its application to existing plants is often problematic for reasons of space, transport and the creation of fumes, as well as being conditioned by the type of scrap used that would have to be preheated.

Ideal for the most economic solution to the problem would appear to be the creation of a type of electric steelworks mainly served by adequate wheeled vehicles, which would lead to a reduction in plant costs of about 20%, while fully satisfying the requirements of the preheating system.

The novelty of the solution and the need to avoid risks (fundamental in a field as competitive as is the steel industry) make essential a prior and accurate study of the plant using the modern techniques of numerical simulation belonging to the new philosophy of plant designers.

It is clear that the increased amount of brain work shall be expensive; on the other hand, higher engineering costs may be more than justified as they will result in infinitely greater plant savings, as well as economy in running costs which can now be estimated in advance thanks to the computer simulation of operations over long periods.

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Figure 1

Dalmine Siderca Steel Mill Layout

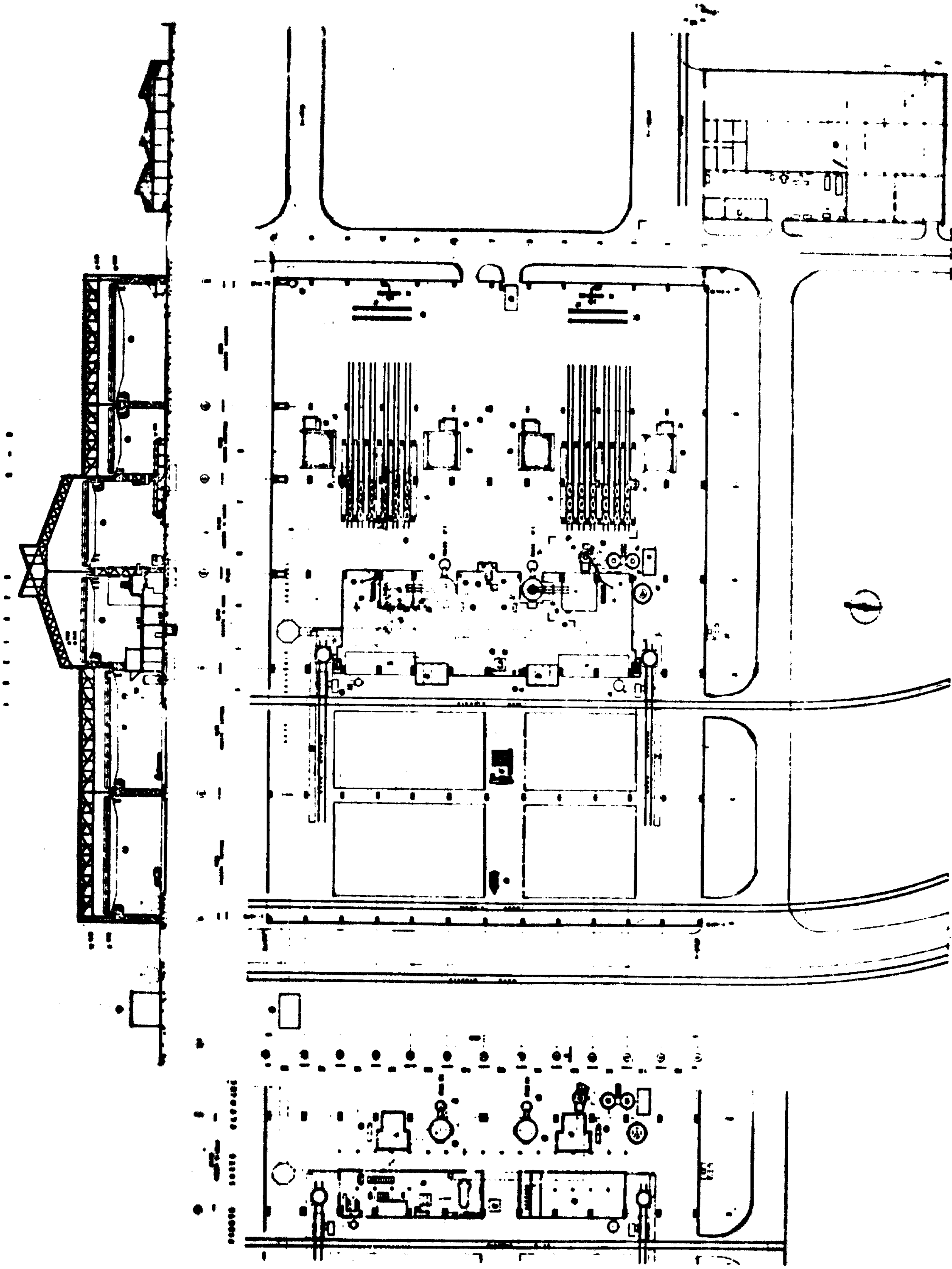


Figure 2

Valve Charge Bucket for Pre-heated Scrap

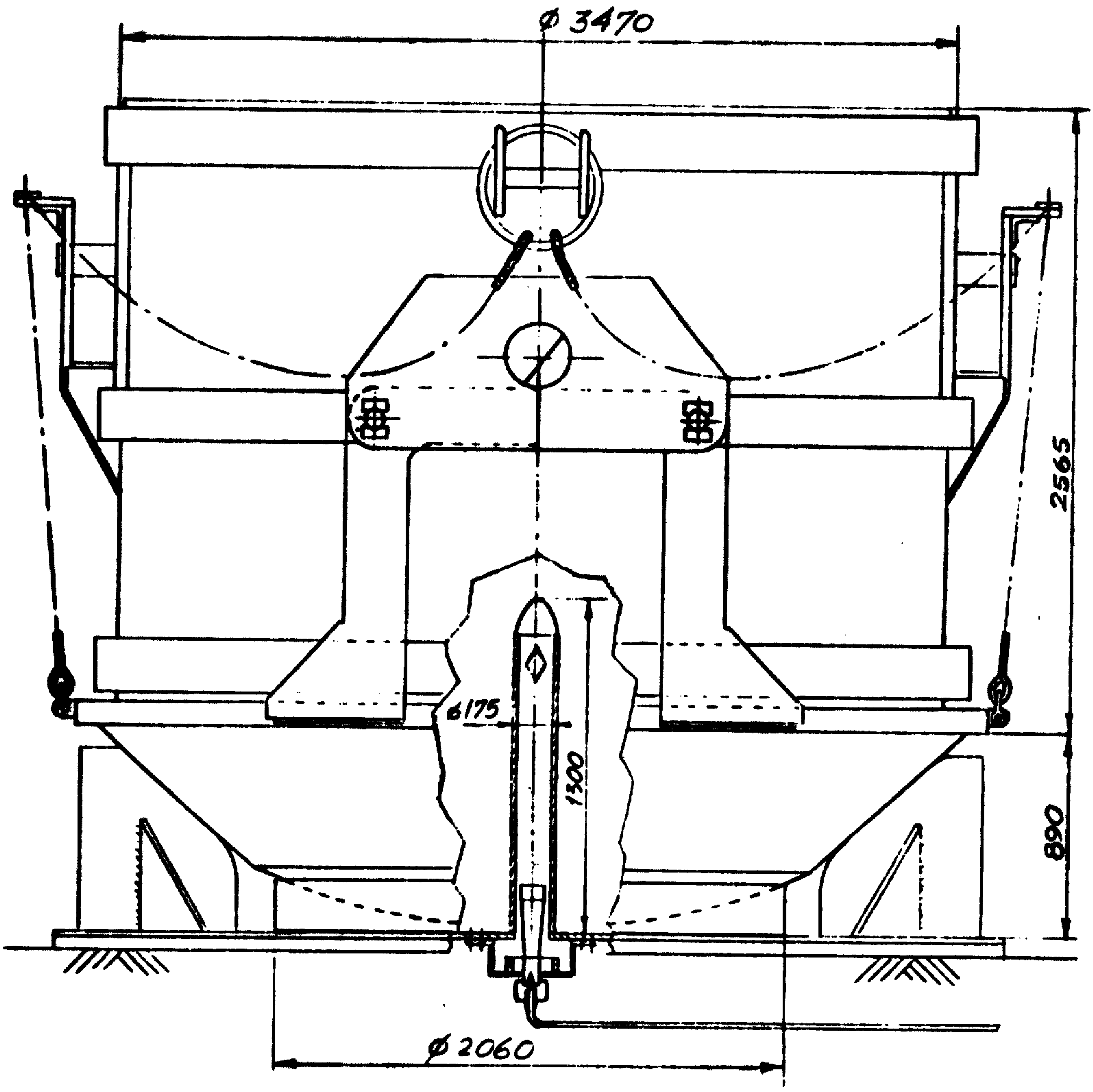


Figure 3

Wheele Vehicles Steel Mill Layout

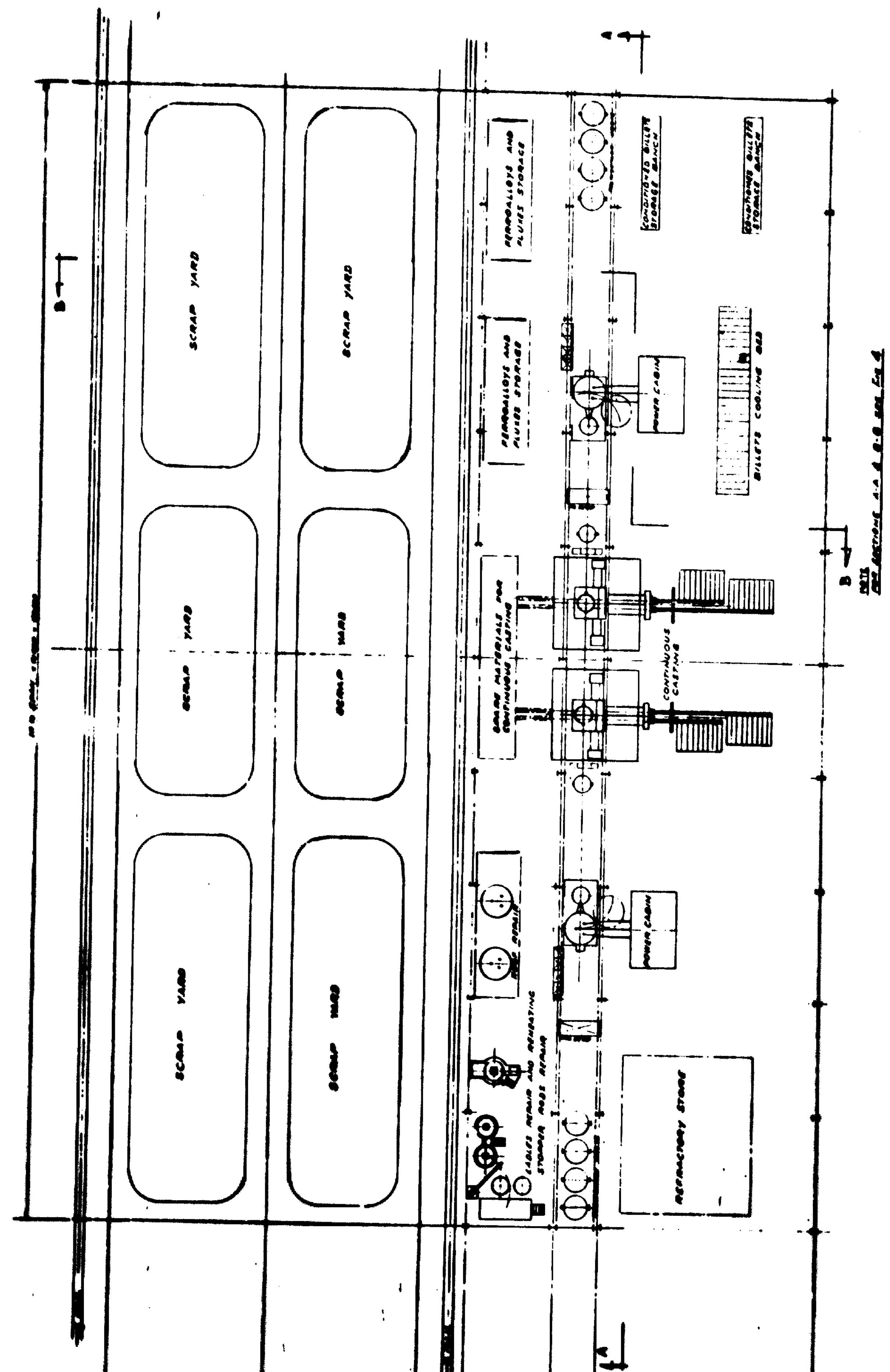
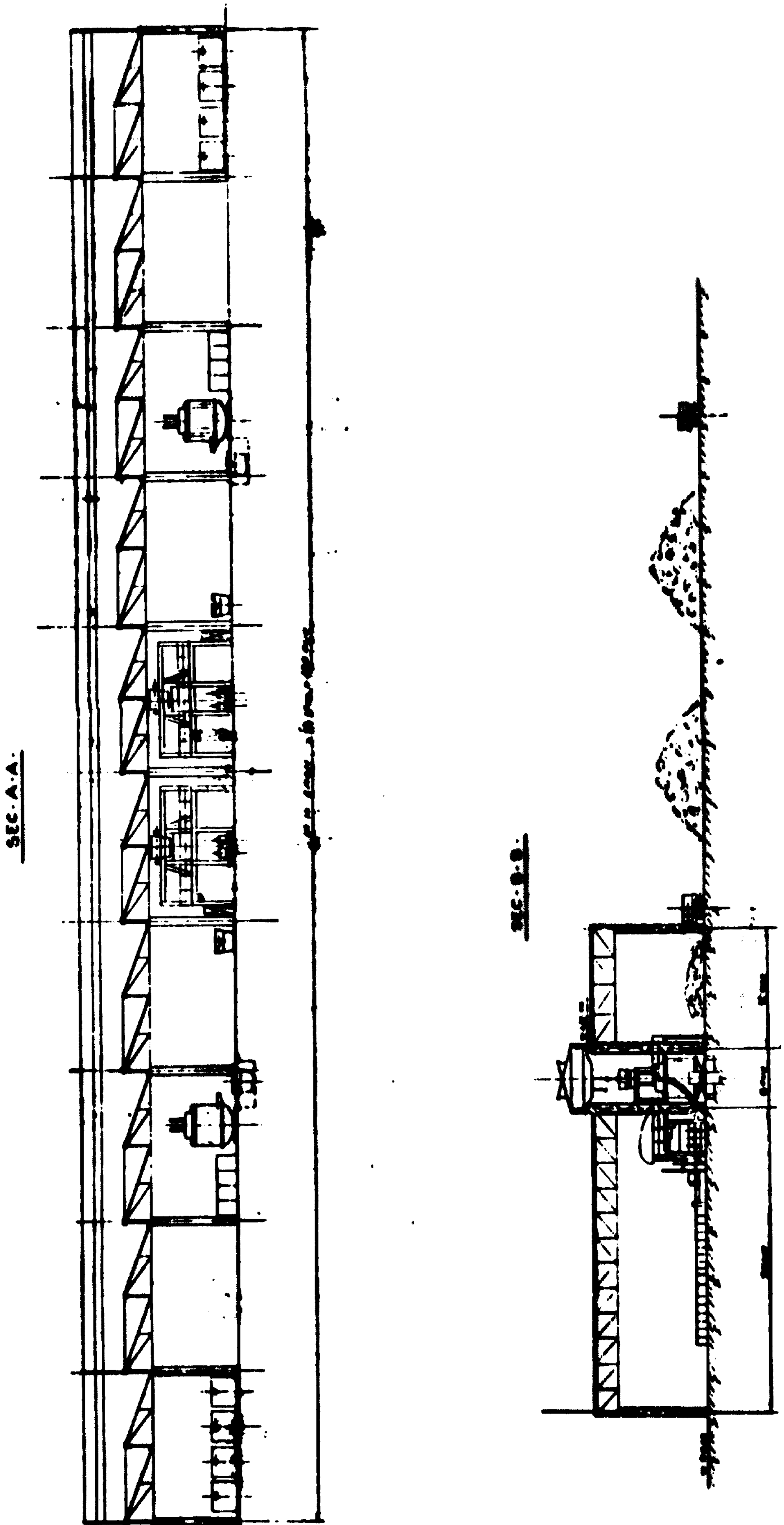


Figure 4

Wheel Vehicles Steel Mill Sections



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