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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
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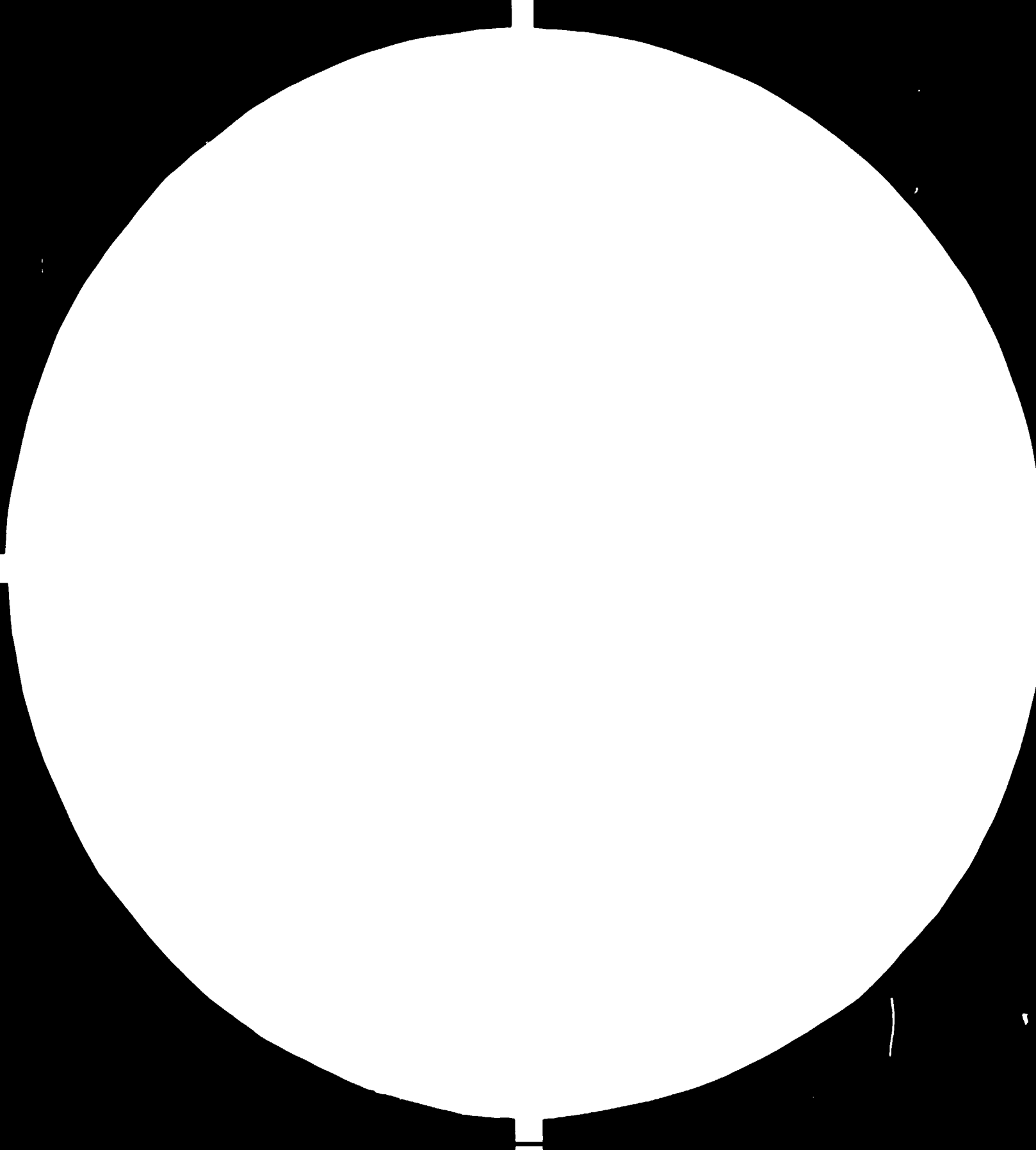
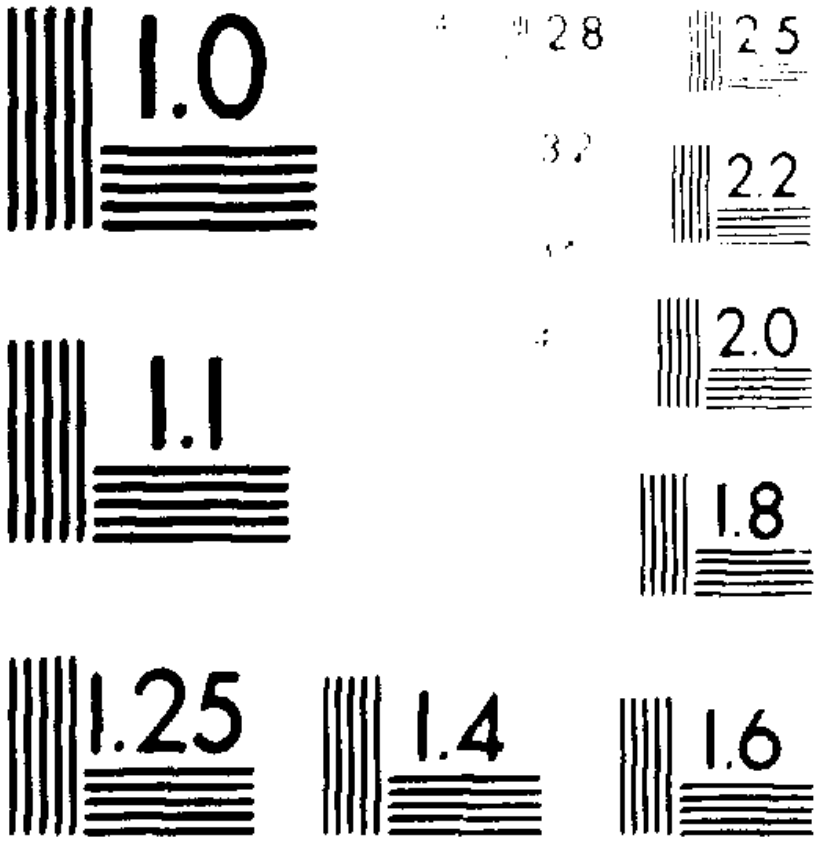
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org





Mozambique. 12997

INDUSTRIAL SCALE RUN OF THE TECHNOLOGY OF BOTTOM POURING TO PRODUCE PENCIL STEEL INGOTS AND TECHNO-ECONOMIC APPRAISAL OF EXPANSION AND MODERNIZATION OF THE FOUNDRY AND STEEL MAKING SHOP.

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* TERMINAL REPORT *

PREPARED FOR COMPANHIA INDUSTRIAL DE FUNDIÇÃO E LAMINAGEM S. A. R. L. (CIFEL)
PEOPLE'S REPUBLIC OF MOZAMBIQUE.

BY: I. D. SHERMANI UNIDO EXPERT

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

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1304

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	MEMBER OF NATIONAL COUNTER PART	
1.	Mr. Ussene Issufo Ibramidgy, Director Projects	
2.	Mr. Cugra Conrado, Official Project Department	
3.	Mr. Pandro Timane, Melting Section Chief	
4.	Eugenio Mabunda.	

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

The people's Republic of Mozambique has a steel complex in Maputo by the name of CIFEL. The main production capacities of this plant are :

One no. Electric Arc Furnace of 1.5/2 ton capacity, one no. 2 ton side blown acid lined converter two nos. cupolas of 3 ton capacity each, one 16" five stand three high open train type mill, one wirerod mill. The two mills have a capacity of approx. 50 ktpy rolled steel products.

The rolling capacity has not been achieved so far, mainly because the billets required for these mills had to be imported and funds were not always available.

To save the scarce foreign exchange the project of production of pencil Ingots by bottom pouring practice was conceived. In the first stage of the present UNIDO/UNDP Project, the technology of bottom pouring of pencil ingots was implanted by the author during March, June 1981. In the present assignment the Industrial scale demonstration run of this technology was to be carried out alongwith techno-economic appraisal of expansion modernization of foundry, steel melting shop and incorporation of CFM foundry for the production of steel billets for the full utilisation of Rolling Mills.

1 a) O B J E C T I V E

The objective of this project is to provide further technical assistance to secure the continuation of the industrial scale demonstration run of the newly introduced process of pencil Ingot Production, upgradation of the existing equipment in CIFEL, incorporation of neighbouring CFM foundry within the CIFEL project. More specifically the author is expected to :

a. Guide the bottom pouring practice of steel teeming to produce pencil ingots.

b. Establish optimum mould preparation including refractory lining of the runner channels to feed the molten metal.

c. Undertake requisite mould preparation and steel teeming practice based on bottom pouring technology.

d. Review and identify quality problem caused at the production of ingot moulds.

e. Assist in the preparation of the technical documentation on the expension of melting bay, up grading of the laboratory and chemical analysis.

f. Assist in the preparation of the programme of in corporation of the neighbouring CFM iron and steel foundry within the CIFEL project.

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2. DEMONSTRATION AND PRACTICE ESTABLISHMENT :

For full scale demonstration minimum of 6 nos. Bottom plates, 6 nos. of Trumpets and 48 Ingots Moulds were required However, CIFEL had only 2 nos. Bottom Plates, 2 nos. Trumpets which had been manufactured during the author's first assignment. Further only 16 Ingot Moulds were available out of which 15 were imported and one had been just manufactured at CIFEL. The author had no time to wait and whatever was available the demonstration was started.

2. a) BOTTOM POURING PRACTICE OF STEEL TO PRODUCE PENCIL INGOT AND BOTTOM PLATE REFRACTORY LAYING :

After placing both the bottom plates on the ground, these were levelled with the help of spirit level for uniform flow of liquid metal on either side of the trumpet.

Dry sand was placed into the bottom plate cavities. First, centre brick was placed in the centre cavity of the bottom plate. It was raised to the level of bottom plate top surface with the help of drysand underneath. There after two runner bricks were placed in the runner channels running from the centre brick to one end of the bottom plate. Fire Clay mortar was applied at the male female joint to get leak proof fit between the runner bricks and the centre bricks. These bricks were also raised upto bottom plate top surface by packing sand underneath. Laying of runner bricks was continued in this fashion. The standard runner bricks were followed by closed end runner. Brick bats and sand was filled in the remaining runner cavities of the bottom plate to keep the runner bricks secured in their position. Similar procedure was followed during laying of bricks on the other side of the bottom plate starting from the other end of centre brick.

contd.....4.....

The gap between the runner bricks and sides of the bottom plate channels was filled with sand and on the top, fire clay mortar was applied. Excess fire clay was removed with the help of scraper to get levelled surface. With the help of specially designed air pipe, air was blown in the brick hollows to remove, excess fire clay etc....which enter the runner bricks while laying. Non removal of loose sand etc. gives rise to refractory inclusions in the steel ingots.

After the laying of the runner bricks was completed, placement of trumpet sleeves was started. Joint of first sleeve was matched with the male joint of the centre brick by applying fire clay mortar in between. There after the trumpet sleeves were placed one above the other by applying fire clay paste at the joints. The two piece cast iron trumpet was placed on the bottom plate with the help of ECT crane.

After throwing some fire clay paste at the base the two halves of the trumpet were closed enclosing the trumpet sleeves. Steel ring was placed on the trumpet to secure it tight. Fire clay paste was applied at the trumpet joints.

After this refractory funnel was placed on top of the trumpet sleeves. Sand was filled around the sleeves in the gap between trumpet and sleeves tokkeep the refractory column of the trumpet secured in its position while teeming of liquid steel.

Fire clay mortar was applied between funnel brick and the top of the trumpet to avoid direct hitting of liquid metal on the trumpet in the case of funnel cracking while teeming. Once again the bottom plate top surface and refractory brick cavities were cleaned with compressed air. In this manner the bottom plate was made ready to receive ingot moulds.

2. b) MOULD PREPARATION AND PLACEMENT ON BOTTOM PLATE :

New C.I.Ingots moulds are susceptible to thermal stress and may crack during steel pouring if used in cold stage. Normally the new ingots mould should be slowly heated upto 300°C and soaked at that temperature for about 4 hours. During heating up the interior of the mould should be around 100°C ( ).

contd.....2.....

MOULD COATING :

Various kinds of mould coatings are employed to get smooth ingots surface, easy stripping and improved mould life.

Mould oils are extensively employed. For carbon Steel Furnace oil thinned with tarpentine or kerosene oil is quite effective.

The interior surface of the mould cavities were cleaned with brush and then heated oil was applied with the help of a cloth brush. Excessive oil was wiped off with the help of dry brush.

After the application of oil coating the touch hot moulds were lifted 4 at a time with the help of specially designed tackle and ECT crane and were placed on either side to form a cluster. The moulds were adjusted with the help of a crow bar and hammer so that the centres of mould cavities almost coincided with the centres of risers of B.P.refractory bricks. This is checked with the help of hand lamp or torch. This is important otherwise the mould misplacement may result in damaging the mould sides by metal scoring and leakage of plate.

After placement of moulds, clay paste was thrown around the moulds and trumpets to plug any possible minor cavity between the moulds and bottom plate.

2. c) STEEL TEEMING PRACTICE :

BASED ON BOTTOM POURING TECHNOLOGY :

The proper steel temperature is very important as too high temperature will give rise to mould stickers and may results in plate leakage whereas low temperature will increase the viscosity of the metal and flow of liquid metal becomes difficult resulting in short ingots and butts.

At the time of teeming metal temperature should be about 50°C above the solidus temperature.

At CIFEL liquid metal temperature of 1600°C in the furnace prior to tapping gave smooth teeming.

contd.....6....

The teeming ladle filled with liquid steel was sized over the trumpet funnel and teeming hole centre was brought at the centre of the funnel. Slowly the stopper was opened to watch the centre of the metal stream and then immediately full stopper was opened and teeming continued in normal fashion. Once the teeming is started the stopper should never be shut otherwise cold shut on the ingots will result and ingots may break in two parts while rolling. When the steel was about four inches below the required ingot length, the flow was reduced by slowly lowering the stopper and finally metal trickling was allowed to take care of the solidification shrinkage of the steel ingots. When the metal stopped rising in the mould, the funnel was filled and the ladle removed away.

2 d) MOULD STRIPPING AND RECYCLING :

The steel was allowed to solidify in the moulds and after 20 minutes from the time teeming was completed, stripping of ingots from the moulds was started. The moulds were lifted with the help of hook tackle suspended from the EOT crane.

Thus four moulds were stripped at a time. After completion of stripping the ingots were left for further cooling. When it was manageable to work near the ingots, these were removed with the help of crane, the runners from the bottom of ingots were removed by hammering and gas cutting and clean ingots were stacked for despatch to rolling mill for rollinginto desired shapes.

The moulds thus stripped were kept on, a plateform made by two rows of billets for natural cooling and avoiding their contact with sand and mud. After the moulds had cooled down to touch hot condition, these were cleaned, coated with oil and were placed on the bricked bottom plate for subsequent pouring.

The bottom plate from which the ingots were removed, was cleaned and new set of B.F.Refractories was placed as stated above before setting the moulds for subsequent pouring.

contd.....7.....

SUMMARY OF VARIOUS STEPS :

a. Clean bottom plate by removing broken pieces of refractory bricks, fire clay etc..... used in previous heat.

b. Inspect B. P. set refractories before laying. Discard damaged, cracked bricks. Clean the brick channels of blockade if any.

c. Lay runner bricks in the bottom plate, level these by packing sand underneath.

d. Apply fire clay paste at the male female joints while laying the bricks.

e. Fill the gaps between bricks and plate channels with sand and apply fire clay mortar on top.

f. Scrape excess fire clay.

g. Clean brick hollow channels by compressed air.

h. Place trumpet sleeves on the centre brick.

i. Close the iron trumpet around the trumpet sleeves column.

j. Fill sand in the gap between trumpet and refractory sleeves.

k. Clean & inspect the ingot moulds from major cracks.

l. Apply hot mould oil coating.

m. Set the ingot moulds on bottom plate with the help of EOT crane, crowbar and hammer.

n. Check the centres of ingot moulds.

contd.....8....

o. Apply clay paste around the ingot moulds to close possible minor gaps between bottom plate and moulds.

p. Size steel ladle over the trumpet and teem the liquid steel controlling the stopper during different stages of teeming.

q. Allow 15 to 20 minutes for solidification of steel.

r. Strip the ingot moulds and release stickers if any.

s. Remove ingots from the bottom plate when sufficiently cold.

t. Remover runners from the bottom of ingots. Dress the ingots if necessary prior to despatch to Rolling Mill for Rolling.

3. REVIEW AND IDENTIFICATION OF QUALITY PROBLEMS FOR INGOT MOULD PRODUCTION

The following major problems were faced while manufacturing the ingot moulds.

i) Proper chemical composition

ii) Proper sand mix for moulding

iii) Proper sand mix for core

iv) Core insert bar

v) Proper core paint

vi) Core baking

vii) Aluminium core box.

i) CHEMICAL COMPOSITION :

The following charge mix was used in cupola. This gave metal of about 4 % equivalent carbon and harness of 235 BHN. The chill test showed 1/4" chill.

Pig iron	100 kg.
M.S.Scrap	50 kg.
C.I.Scrap & foundry return	150 kg.
Lime Stone	16 kg.
Coke	45 kg.

1 kg. Fe-Mn & 1 kg. FeSi.

ii) SAND MIX FOR MOULDING :

Mr. N.G.Chakrabarty co-expert gave the following composition of mould sand which was found quite suitable.

White sand - 30 kg.
Red Sand - 20 kg.
Bentonile - 1.5 kg.
Bentocoal - 2 kg.
Water - 2 litres

contd.....10...

The properties obtained from the above mix were :

Moisture - 5 %
Permeability - 86 %
Green compression strength ..... 17.9 lbs/sq inch.

iii) CORE SAND MIX :

The following sand composition was employed washed
white sand (30 mush) .... 50 kg.
Red sand ..... 4 kg.
Bentonite ..... 2 kg.
Liquid Dexil (Foseco) ... 0.5 lit.
Coconut oil ..... 0.5 lit.
Molasses ..... 0.5 lit.
Water ..... 1 lit.
The properties were :
Moisture ..... 3.8 %
Permeability 90
Green compression strength - 5 lbs/sq. inch.

iv) CORE INSERT BAR :

At present perforated steel tube of 2" O. D. covered with hesin rope is being used. This many times results in core cracking during baking and subsequent metal pouring due to high expansion. To over come this problem a cast iron pipe is being cast and it will be used in subsequent cores.

v) CORE PAINT :

Mr. Chakrabarty gave the following composition for making the paint which was applied on the cores with the help of soft brush in the green stage.
Natural Graphite - 50 parts
Electro Graphite - 50 parts
Bentonite - 10/12 parts
Water - 30 parts
To get viscosity no - 45

contd.....11..

vi) CORE BAKING :

After applying the core paint and trowelling smooth the core surface, the cores were baked at about 250°C for 4 hrs. The cores withdrawn from the oven, were again painted and polished by trowelling graphite and were baked again for two hours. Natural graphite was not available, hence electro graphite was used.

vii) ALUMINIUM CORE BOX :

The major problem was the core box. CIFEL was advised during the author's last visit to prepare aluminium core box to get proper straight cores. The wooden core box does not retain its shape due to contact with moisture. Mr. Chakrabarty also emphasized the importance of metal core box, Mr. Chakrabarty has given core box and core carrier drawings to CIFEL to prepare aluminium core box.

The first ingot mould was cast on 6th December, 1982 and after machining it was brought to steel foundry on 23/12/1982. The first casting in this mould was done on 31/12/82. The mould behaved alright and stripping was smooth.

Further details of ingot mould manufacture will be given by Mr. N. G. Chakrabarty in his report.

4. EXPANSION AND MODIFICATION OF MELTING BAY :

During the last assignment of the author CIFEL was advised for the extension of melting bay towards Rolling Mill as this is the only possible way to get extra space for ingot manufacture with least cost. Only few columns and extension of crane gantry is required.

CIFEL has atlast prepared a drawing and bill of materials for this extension on 27th December, 1982 author alongwith Mr. N. G. Chakrabarty and Mr. Mota, Technical Director, CIFEL visited the steel stock yard of Maputo to explore the availability of required steel sections. All the sections were available and Mr. Mota promised that he will arrange to requisition these immediately and start the fabrication work.

CIFEL has been advised as how to utilise this additional space under the EOT crane.

A lay out of this area was prepared and explained to CIFEL. The sketch is enclosed.

Mr. Ussene Issufo Ibramiogy Director of Project planning informed that one additional crane will be installed in melting bay and new hoist assemblies are being procured for the existing cranes. One more crane is being procured for the second moulding bay and stores from one end of this bay will be shifted away to get extra space in this bay.

As suggested earlier, the sugar rolls should be shifted to CFM foundry as these cause considerable disclocation in CIFEL operations. CIFEL does not have big enough EOT cranes to tackle such heavy castings and road mobile crane is brought into the shop to tackle sugar rolls. The dislocation created by such activities would be felt more severely once

contd.....13.....

regular steel ingot production starts.

Once the sugar roll production is shifted away from CIFEL, the space thus available in melting bay could be effectively utilised by installing one more converter stand and connecting the same with the existing blower. Thus with least expenses daily operation of the converter would be possible and this will boost the production of steel.

The melting bay at CIFEL does not have plateform weigh bridge to accurately weigh the arc furnace scrap charge and the present spring balance gives erratic readings resulting in variation in weights of metal from Arc Furnace. A 5 ton plate form weigh bridge is a must.

5. UPGRADING OF LABORATORY FOR CHEMICAL ANALYSIS :

Chemical Laboratory is a big bottle neck at CIFEL for the quick and smooth production of steel. Many a time even carbon analysis takes more than half an hour to reach the melter and many times the Arc Furnace after melting is put off waiting for the analysis. Deter - mination of 'P' is not carried out for want of chemicals. Immediate remedial steps are necessary without which production of quality steel would be difficult and the productivity of the shop will suffer very badly.

A three pronged strategy should be followed depending upon the funds available and other constraints.

i) INTENSIVE TRAINING OF CIFEL LABORATORY STAFF :
At least four chemists should be trained to take care of the shifts. One chief chemist - cum - laboratory incharge should be trained to account for the work carried out by shift chemists and to look after the laboratory and the requirement of the consumable items.

ii) PROCUREMENT OF LAB. CHEMICALS, GLASS AND OTHER ACCESSORIES :
It is surprising to note that the analysis of Iron and Steel for 'P' is not carried out for last one year or so. There is no inventory planning and control. The result is, many a time vital chemicals are not available. Planning and procurement of chemicals needs no emphasis. It should be done straight away.

iii) PROCUREMENT OF SPARES AND ADDITIONAL EQUIPMENT :
One spare carbon and Sulphur analyser should be procured. One more chemical balance preferably single pantype would be required. Spare parts for the silicon analyser and one more silicon analyser would go a long way.

contd.....15.....

Leeds and North rup of England manufactures lot of metallurgical analysis devices. One such device for the quick determination of 'C' iniron and steel would immensely help the operation of cupola, converter and Arc Furnace. The temperature recorder at CIFEL does not function properly. A stand-by set would be beneficial.

An instant two point communication system between laboratory and melting bay should be established to avoid unnecessary delay in reporting the analysis.

5 a) METHOD OF CHEMICAL ANALYSIS OF PHOSPHORUS (VOLUME - -TRIC)

Determination of 'P' in iron, plain carbon steel and low chromium steel.

SOLUTION REQUIRED :

i) Ammonium Nitro Molybdate

Dissolve 100 gram Ammonium Molybdate in 200 CC water and add 200 CC NH_4OH. Mix 750 CC water and 500 CC HNO_3 in a bottle. Cool below 20°C when both solutions are cold add Amonical Molybdate to the HNO_3 solution a few CC at a time with continuous shaking to dissolve Molybdic acid, wait for 30 minutes, then add very little amount about 5 milligram of Ammonium Ortho Phosphate. Filter through ordinary filter paper and keep the solution in stoppered bottle.

ii) Potassium per Mangenet solution

5 % solution inhot water.

iii) Sodium Sulphite

Dissolve about 2.5 grams. Salt in 100 CC water ($NaNO_2$, KNO_2, $FeSO_3$, $FeSO_4$ can also be used).

iv) Dilute Nitric Acid

400 CC con. HNO_3 in 1000 ml. distilled water.

contd.....16.....

v) Ammonium Nitrate Solution

35 to 40 grams. salt in 100 CC water.

vi) Standard Sodium Hydroxide Solution

Dissolve 13.4 grams. NaOH in distilled water to make the volume of 2000 ml.
Standardise the same against potassium Hydrogen Pathalate. 0.7575 grams of Potassium Hydrogen Pathalate is equivalent to 25 ml. of N/6.74 NaOH.

vii) Hydrochloric Acid Standard Solution

Take 26 CC conc. HCL (analar grade make up the volume upto 2000 ml. in distilled water. Titrate against the standard solution of NaOH and adjust the actual normality by additionof distilled water if required.

viii) Potassium Nitrate

10 grams in 2 litres of water, to be used as wash solution.

ix) Phenolpthaline solution

1 % in Methyle Alcohal.

PROCEDURE :

Transfer 2 grams steel drillings in 500 ml. flask. Add 50 CC HNO_3, heat gently to dissolve, remove the Nitrous fumes. Heat to boiling, make drop wise addition of Potassium Permanganet wait till stable brown ppt. is formed. Boil gently for two minutes and clear the solution by the addition of few drops of Na_2NO_2 or Na_2SO_3. Continue boiling for two minutes. Remove from hot plate, cool near 75°C add 35 CC NH_4NO_3 and 35 CC of Ammonium Molybdate and 3 drops of Ammonia Solution, shake well allow to stand for a couple of minutes (about 30 minutes) filter through ordinary pulp, wash the ppt. with 0.5 % KNO_3 solution until washed 0.5 % KNO_3 solution becomes acid free. Acidity can be checked with one drop of N/6.74 NaOH solution and one or two drop of Phenolpthaline solution as indicator.

contd.....17.....

Transfer the ppt along with filter paper to the same conical flask add 50 ml of KNO_3 solution. Add measured excess of standard NaOH solution shaking to dissolve the yellow ppt. Add 3 drops Phenolphthaline indicator and Titrate with standard HCL solution.

% P = (ml. of NaOH used - ml. of HCL used) x .01.

For steels containing high Cr, dissolve the sample in 15 CC HNO_3 + 25 CC HCL. After disolution and 20 CC HCL and evaporate to fumes for 10 minutes. Cool and add 10 CC HNO_3 200 CC water when the salt is dissolved filter and complete the determination as above.

6. UTILISATION OF CFM FOUNDRY WITHIN THE PROJECT OF CIFEL :

This foundry has two nos. 5 M.T. each cupolas, one 2 M.T. cupola and one 1 1/2 M.T. acid lined side blown converter. This is a very old foundry and has an enormous pattern collection which indicates what a variety of castings was being made at one time. However, from the beginning foundry has never been used for mass production as that of CIFEL, inspite of bigger capacity cupolas. The acid lined side blown converter is lying idle for many years. The big cupolas are not run even once a week and when cupola operates, only few tonnes of castings are made which makes their operation very costly, especially in view of the imported coke.

To improve the productivity of this foundry the first step would be to install mechanised way of charging-bucket elevator system - for the cupolas similar to the one at CIFEL and create extra storage and handling of cast iron scrap, steel scrap and coke.

The main shed housing the foundry is divided in three parts with respect to the crane gantry. Only a one third portion of the shop at the centre is covered by EOT crane which operates on an independent gantry supported by a new set of columns. This gantry is too low. Thus the crane hoist is not much. The location of gantry needs a through review depending upon the use the shop is to be put to.

During the informal discussion the author had with Mr. LUIS GONSALEZ DIRECTOR Project Nation Commission of Planning it was mentioned that Mozambique needs a lot of pipes for its agriculture sector and at present some of the requirement is being met by making steels pipes by bending the imported steel plate welding it and galvanising it again with imported Zinc. In this respect author suggested that installation of centrifugal cast iron spun pipe machine should be studied. This type of machine can give a range of pipe sizes. Moreover the cast iron pipes have life more than four times

the life of steel pipes and lot of Mozambique scrap could be utilised.

Author suggested to Mr. Gonzalaz to look into this aspect and if further details are needed the author would be glad to assist in this regard.

Thus one way could be to install a centrifugal cast iron pipe casting machine at CFM to utilise this foundry for the manufacture of different sizes of pipes for agricultural needs.

The other way could be to convert this foundry into a steel melting shop for the production of steel ingots to feed the Rolling Mills at CIFEL.

Since already two cupolas of 5 ton capacity each are there, the matching twin stand side blown converter with required ancilliaries such as EOT cranes, steel ladles, transfer ladles, laboratory equipment, bottom plates, ingot moulds, and machenised charging system of cupolas could be installed, and steel production of 15,000 to 20,000 ton per annum could be achieved.

CONVERTER LINING :

At one time, it has been suggested to CIFEL to change the acid lining of the converter to basic lining to control sulphur and phosphorus in the steel so produced. The author after reviewing this aspect feels that the basic operation practice at CIFEL does not exis and basic lining is very costly as compared to acid lining. However, there is another alternative which could be easily employed by CIFEL with least cost and ease of operation. This consist of

1) Changing the cupola lining about one meter in length in the melting zone to basic.

ii) Making the basic slag in the cupola to control phosphorus.

iii) Instead of fire clay, lining the transfer ladles with basic lining and removing the

sulphur by addition of soda ash.

iv) Charging the low 'S' & 'P' iron into the existing acid lined converter to make the required low 'S' and 'P' steel.

The author is told by CIFEL that the coke at CIFEL is already low in 'S' & 'P'. This should help in making good steel and thus make it unnecessary to have basic lined converter. This aspect needs further study and experimentation but the results would surely be rewarding.

COMMENTS AND RECOMMENDATIONS

a) The demonstration of pencil steel ingot production was successfully carried out. The pencil ingots were not only produced but were also rolled in the CIFEL Rolling Mill. With some rearrangement and modification in the repeaters and guides it is possible to roll different sections desired by CIFEL. Presently 32 dia round was produced. A diagram showing the pass sequence for different sizes of rounds was prepared by autho., the copy is enclosed.

b) The shortage of trained man power very much exists. CIFEL should immediately recruit more hands, train them so that three shift operation of melting bay and ingot making could be resumed.

c) Planning for the vital raw materials is inadequate. During the author's assignment there were no graphite electrodes as the consignment had not yet arrived. However as per the author's suggestion the old broken electrodes were machined for nipples and sockets and were reused to operate the arc furnace and to produce pencil ingots.

d) Planning on the refractory front is also poor. No orders have been released for the procurement of E.P. Set refractories. There are no magnesite to reline the arc furnace. The author had emphasized in his last report regarding the proper planning of imported refractories considering the lead time.

e) Extension of melting bay crane gantry should be carried out without any further delay. The super roll casting pit should be replaced by another converter stand similar to the existing one and connected to the same blower.

f) A 5 ton plateform weigh bridge should be installed in melting bay to weigh the charging buckets.

cont'd...22.

g) Melting zone of one of the cupola to be converted to basic lining. One or two transfer ladles also to be given basic lining for controlling the S & P and blowing the low "S" & "P" metal in the acid lined existing converter to produce steel of desired grades.

h) Scrap collection and processing should be given due importance espccially in view of the new Mini Steel plant coming up in the country.

i) Laboratory should be provided the required chemicals and accessories for the analysis of C, Mn, Si, S, P, Cr. As these are very important to avoid the production of all-grades steel which would give trouble in subsequent processing of steel.

j) Author is glad that as per his suggestion the use of marble has been stopped and instead the salamanga lime stone has been started. This has reduced the cost of production.

k) Author is further glad to see that as per his suggestion the coke rate is cupola has been reduced from 1:6 to 1:7 thus a saving of 15% of coke cost has been achieved.

l) There are two alternatives for CFM.

Either to produce cast iron pipes by spun casting machine for agriculture use or converter it into steel melting shop and produce pencil ingots by installing a matching converter and its accessories to take care of the cupola output.

m) Mr. Cudra an official of Project Department informed author that as per his calculations there is saving of 76% in foreign exchange while producing the pencil steel ingots in place of import of steel billets. Present cost of billets is about US$300 per ton. If CIFEL produce 2000 ton of steel ingots the saving in foreign exchange would be

$$= \frac{300 \times 2000 \times 76}{100} = \text{US } \$\ 3,040,000.00$$

ACKNOWLEDGEMENT

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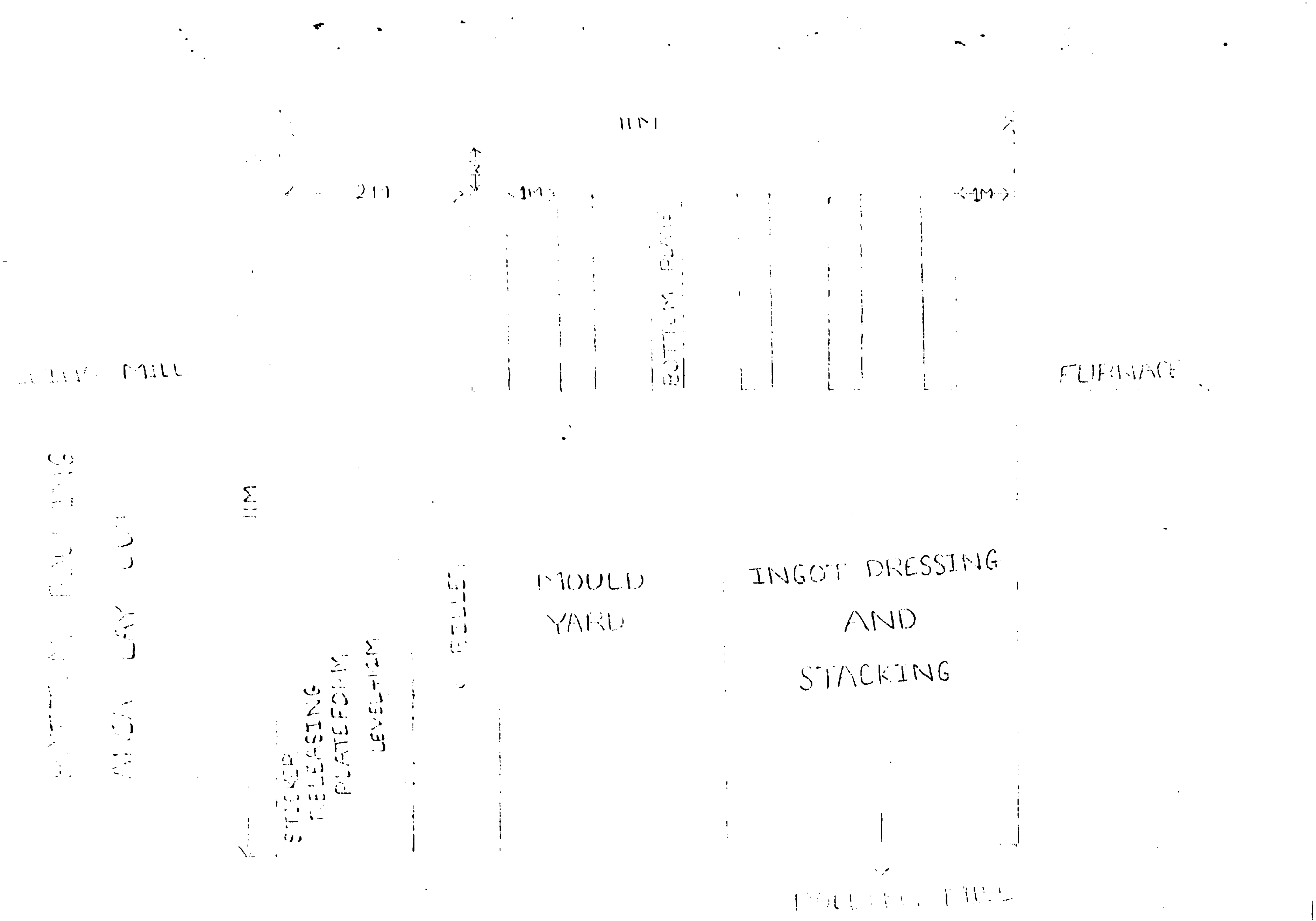
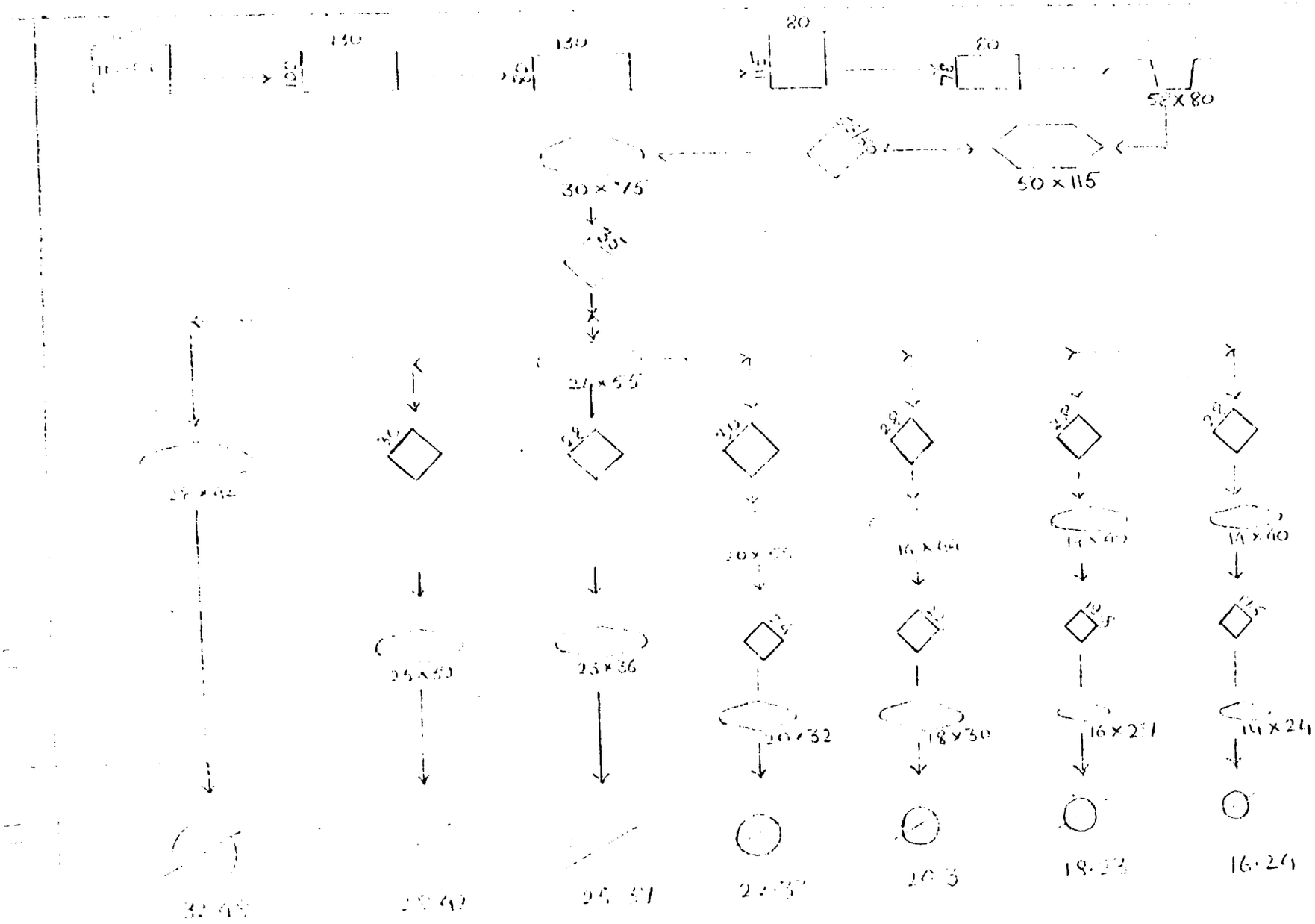


11M
2M
1M
1M
BOTTOM PLATE
MILL
FURNACE
11M
MOULD
YARD
INGOT DRESSING
AND
STACKING
BILLET
STICKER
RELEASING
PLATFORM
LEVEL-HEM

INGOT ROLLING



C I F E L

PIT SIDE REPORT

DATE..... HEAT NO..... QUALITY

TAP TIME.....TEEMING STARTED..... TEEMING OVER.....

TEEM DURATION.....METAL TEMPERATURE.....

	CLEAN SHUT	DRIBLING	RUNNING
	____	_____	_____
STOPPER CONDITION.....	____	_____	_____

FULL INGOTS CAST	Nos.	Av. Length	Av. Weight	Total Weight
	.....	.....	.....	.....
		.....	.....	.....
SHORT INGOTS AND BUTTS		.....	.....	.....
PIPED INGOTS	.....	.....	.....	.....

WEIGHT OF BONES ..... TOTAL LADLE NO.....

WEIGHT OF SKULL ..... LADLE LIFE .....

MOULDS USED (Nos) .....

.....

MOULDS DISCARED .....

.....

SIGNATURES PIT SIDE SUPERVISOR.