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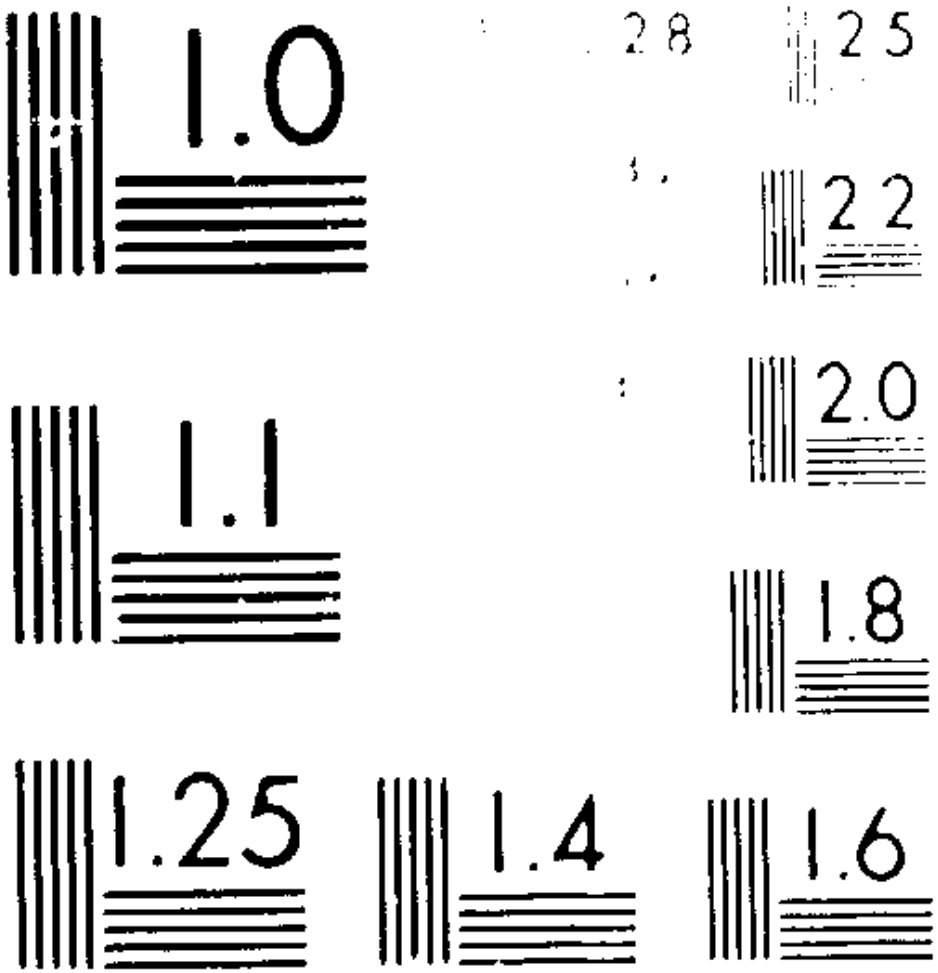
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UNITED NATIONS INDUSTRIAL
DEVELOPMENT ORGANIZATION

METAL PRODUCTION DEVELOPMENT UNITS *

Casting

by

Fiat Engineering SpA (Italy)

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I N D E X

METAL PRODUCTION
DEVELOPMENT
UNIT

FOUNDRY UNIT

METAL PRODUCTION
DEVELOPMENT
UNIT

C A S T I N G

PART I - OUTLINE OF THE FOUNDRY UNIT

PART II - ANNEXES

INTRODUCTION

General purposes of the foundry for A.C.P. developing countries.

The main targets of the present study are:

- singling out of present and expected market demands for iron and non-ferrous castings and for highly qualified services;
- development of professional capabilities in Administration Marketing, Engineering, Technology for locally born graduated people;
- training of workers not only for the production but also for highly specialized tasks as patternmaking , precision machining, maintenance, general installations control, etc.;
- production of capital good and spare parts through the output of quality machined castings.

In this way not only the unit will become selfsufficient and indipendent from overseas know-how, but it will be also possible to supply local existing industries with engineering and machine tools or patternmaking services obtaining, at the sametime, an additional income for the factory itself.

The unit should be, generally speaking, also profit and market oriented: this aspect is only a component of other broader and more important goals as social improvement and promotion of side activities.

A general survey referring to market opportunities for a Metal Production Development Unit in A.C.P. countries is reported in Annex VII.

FOREWORD

The foundry unit includes:

- a main cast iron foundry;
- a small non-ferrous foundry;
- a machine tool and maintenance department;
- a patternmaking shop.

The report consists of two parts:

- one with a short main report providing all the essential logics of information;
- one with the annexes, containing more detailed analysis and calculation about the different sections of the main report.

PART I

OUTLINE OF THE FOUNDRY UNIT

1. GENERAL DESCRIPTION OF TECHNOLOGY AND PLANT

1.1 Outline of casting technology

Sand castings production involves the following steps:

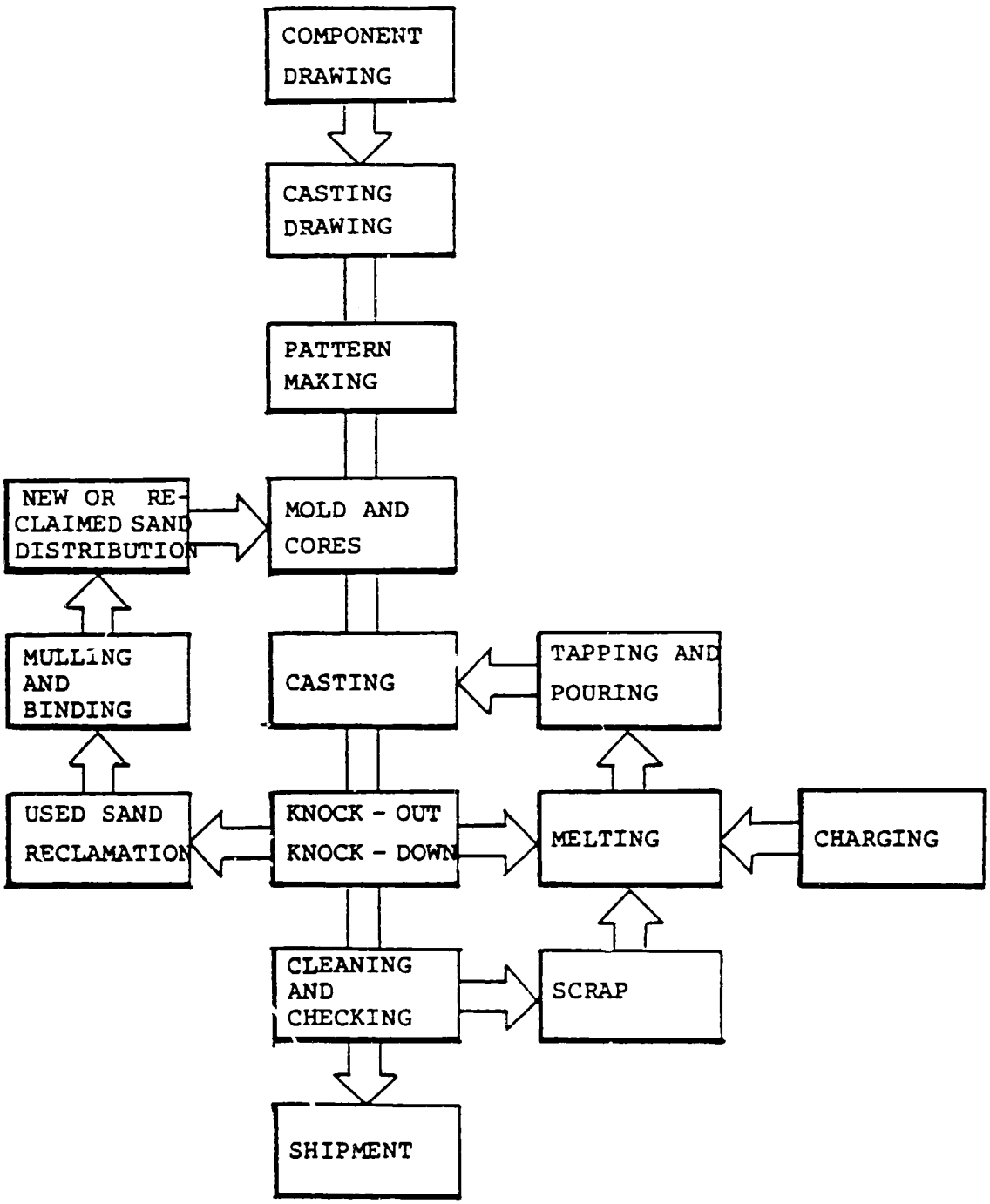
- production of pattern, that translates the idea of the designer, keeping into account the physical-chemical and metallurgical phenomena of the raw material, of refractory materials, and of the processes from which the mold is to be accomplished;
- production of mold, i.e. the cavity from which the external casting surface originates;
- preparation of sand and bonding elements forming the mold;
- preparation of cores required if the casting is hollow (containing voids that cannot be obtained with the pattern alone). The "pattern" shaping the core is called "core box";
- preparation of metal which is not only "melting", but also adjusting its composition and purifying it from harmful contents;
- assembling of cores and clamping of molds;
- pouring or passage of liquid metal into the mold;
- drawing of solidified casting from the sand (knock-out);
- final conditioning which includes removing supplementary parts, sandblasting, grinding, chipping and heat treatments (if any);
- checking to be carried out both "in line" and on the final product.

Sometimes, the mold can be of "metal" and "permanent" type (such as, for instance, die casting).

Table No. 1 shows the main steps of the process.

The foundry's final products are rough castings (normally followed by machining in other plants or at least in an other department).

Table I - Main steps of the foundry processes.



1.2 Types of products

The plant consists of a casting unit producing mainly grey and nodular iron parts with a small shop for non-ferrous castings.

The full production (about 80% of the capacity) is estimated to be reached in a period of 5 years, with production starting in the 2nd year of operation.

The capacity of the plant being 2000 t/y of "good" iron castings and 36 t/y of "good" non-ferrous castings, the "full" production is considered as follows (working days 225/year 8 hours/day):

rough grey iron castings	1360	tons/year
rough nodular iron castings	240	" "
rough non-ferrous iron castings	30	" "

Two shops will be built, adjoining to the casting facilities:

- a pattern shop for internal and market requirements;
- a machining department for rough castings (up to 50% of the foundry output) and for outside customers.

These two producing and training centers (that will provide in future highly skilled people) are regarded as integral parts of the basic lay-out.

1.3 Plant and equipment outline

3a) Unit size (see basic layouts and annex III)

The main features of the plant are:

fenced area	38,400	sq.m
total covered area	6,000	sq.m appr.

3b) Employement (see Annex V - pgs. 122-124)

At full saturation the unit will employ 170 workers and supervisors for the line and 24 employees for management and staff.

3c) Main processes and equipment (see Annex II - pgs.102-106)

As mentioned above four main sectors may be outlined in the plant:

1. a pattern shop;
2. an iron (grey and nodular) foundry with:
   a) melting department (two cupola shells and an induction coreless furnace)
   b) molding department (two jolt-squeeze machines, a continuous mixer, a pit-hand molding area) equipped with rolling conveyors;
   c) sand plant for green and special sand molding;
   d) cleaning room facilities;
3. a machining-maintenance shop;
4. a small non-ferrous foundry.

Details can be found in Annex II, where each equipment is more throughly described.

1.4 Justifications for the selection of equipment (Annex I)

For the transfer of technologies, A.C.P. countries' outstanding features have been considered: reference has been made to existing foundry equipment and processes.

Among these the ones seeming to be most suitable, very generally speaking, have been adapted and suggested.

Of course, at present this choice is only a guideline among a wide range of possibilities and, for the main processes, alternatives have been added: it is necessary to know more in detail the site where the unit has to be installed in order to propose a logic choice of equipment and materials.

We deem expedient to have a general picture of main foundry processes and to indicate, for each of them, which, based on the different characteristic, are adaptation opportunities in A.C.P. countries.

Annex I is completely devoted to this target.

2. ESTIMATED INVESTMENT FIGURES (see Annex III)

A detailed list of technological equipment and machinery, general installations, buildings, site development can be found in Annex III.

The list may be condensed as follows (000 $):

cast iron foundry facilities	1230
non-ferrous foundry facilities	140
utilities and material handling	640
inspection and lab testing	115
pattern shop	195
machine tool shop and maint.	780
building and site development	1000
ancillary equipment	150
Total	4250

Costs are inclusive of freight, foundations, erection and installation (as average value).

3. GENERAL TRAINING REQUIREMENTS

3.1 A look at training problems (Annex IV)

As specified above, one of the most important aims of the unit is training, in order to make the unit independent from overseas expertise and know-how, as far as possible.

When planning a training program, different possibilities must be kept in mind:

- overseas training (through direct contact with similar technologies);
- technical assistance program (through overseas experts integrated with counterpart trainers, accomplished during the first stages of unit production);
- in-plant training for any type of type of personnel.

Referring to different expertises we may make a distinction among:

- managers training;
- engineers and counterpart trainers training;
- precision workers training (machine tools, mechanics, etc.);
- patternmakers training;
- foundrymen training;
- staff personnel training;
- clerks / drivers : labourers training.

Annex IV_4 shows detailed figures for the above mentioned types of training.

3.2 Summary of training costs

From Annex IV we may anticipate the training costs in an approximate but reliable way.

Overseas Training Costs		
(Managers, Engineers, Counter-part trainers)		
Introductory in-plant group training	000 $	182
Professional improvement engineers and countp. trainers	"	208
Technical Assistance Program		
(for 5 years: 45 man/years)	"	3,765
Local Training Costs	"	600
Estimated amount of Total Training Costs	000 $	4,755

The costs are allocated over a period of one or more years according to the type of training: Annex IV shows a general scheme outlining the principles of precision worker training programmes suggested for M.P.D.U.S.

Training subsidies are expected to counterbalance training costs.

4. GUIDELINES FOR VIABILITY (details are shown in Annex VI)

(Some information about production, personnel, services, cost and revenue) (pgs. 125-128)

4.1 Production centers

Unit output is considered as resulting from different producing centers:

- rough castings;
- patterns shop services;
- workshop services;
- engineering services.

4.2 Estimated cost figures for materials

Any type of material for castings (raw, ancillary expendable maintenance) has been considered at prices 20% over European levels (see Annex VI/1).

4.3 Estimated prices for products

Local market prices have been considered as 30% higher than the actual European prices for each type of castings.

I.E. 1.2 $ / ton of grey iron castings
1.5 " of nodular iron castings
3.5 " of non-ferrous "

4.4 Production implementation (see Annex V)

Production, starting as above referred only in the 2nd year, will increase its casting output to reach practical saturation (80%) only in the 5th year.

The first two years will be considered devoted to in-plant training (Annex V/1): only some services - at very low rate of efficiency - are considered for the years 0 and 1st.

In the second year (the first year of castings production) manpower is considered working at a low level of efficiency with rejects percentage approaching 50% of the out-put.

This is normal not only for the poor level of skillness but also for the very frequent failures of new machinery.

So we will find in the 2nd year a number of workers equal to the working force of the third year with only 50% of production and a proportionally increased materials cost (scrap can be recovered through remelting).

Patternshop, machine tools and fitting shop will increase their efficiency level from 0.1 to 0.7 over a period of 5 years: the same applies to engineers and technicians (Annex VI).

4.5 Personnel, Wages, Salaries (see Annex V)

Line personnel is expected to reach the following figures at full production in the 5th year:

130 for the foundry;
16 " " patternshop;
10 " " machine tools and fitting shop.

Among them we find 30% of skilled workers, 35% of semi-skilled workers and 35% of common workers (see Annex V/2).

The number of surveyors and of foremen is considered to be 14 in 5th year (12 for castings and 2 for pattern and other workshops).

14 engineers will be working after 5 years in the plant; the work done by 12 of them is considered as a service for outside customers and will represent an added revenue (2 engineers will be employed in castings production in order to design foundry methods).

Staff (including management) will consist of 10 people: 9 for management of rough castings production and 1 for the sale of services.

Annex V shows more detailed figures for wages, salaries and personnel implementation.

4.6 Training costs (Annex IV)

Local training cost is included in manpower cost; as a counterbalance a training subsidy is considered to be paid by outside sources and is introduced as a revenue.

Technical overseas experts and fellowships training abroad are not, at the moment, taken into account assuming to be financed through EEC or bilateral funds.

4.7 Contingency

For rough castings a 10% of manufacturing cost has been considered as "contingency" to be added to obtain operating cost (15% in the 2nd year only).

For services, overheads (services sale and management) are considered in the figure of machine costs.

4.8 Depreciation (Annex VI - pgs. 125-128)

Depreciation of investments will be completed in:

- 25 years for site development and buildings (4%)
- 20 years for general installations (5%)
- 10 years for technological facilities (10%).

Ancillary equipment cost (equivalent to 150,000 $) is added to the investment for technological facilities.

Patterns, tool fixtures and different types of materials to start production are considered as working capital.

Depreciation incidence figures in different years are reported in Annex VI.

5. REVENUE FROM SERVICES (Annex VI)

5.1 Pattern and machining shop

Even if integrated in the unit, pattern and machining shop will supply products and services of quite different nature.

a) Patternshop will devote roughly 40% of its output to pattern repairs (figures are reported as maintenance materials in rough castings costs): 60% of working hours and means are devoted to the manufacturing of new patterns that are sold to outside customers (as a separate item or as a share on each casting).

b) In the machining shop a team of 10 workers will provide the machining of part of rough castings (nearly 50%).

c) Estimate of cost and revenue is carried out based on the following guideline:

Costs	Wage / man / year	from 1500 to 3000 $
	Machine cost / year	4000 $ / machine
	Overhead for sale and management	1000 $ / workstation/year

Revenue / man / machine / year (in U.S.$):
2 x wage + 5000 + (Profit = 2000)

Efficiency: increasing from 0.1 (1st year) to 0.7 (5th year)

5.2 Engineers and Technicians (figures/man/year)

Costs: salary + 10% (overhead for sale and management)

Revenue: 3 x cost + (Profit = 3000) in U.S.$

Efficiency: increasing from 0.1 to 0.7.

For detailed evaluation see Annex VI (pages 125-128)

6. M.P.D.U. Foundry Unit. Net Income and Cash Result

(Thousands of dollars)

	ITEMS	0-1st year	2nd year	3rd year	4th year	5th year
	INCOME 000 $					
1*	Sale of Products	-	696	1406	1812	2097
2	Sale of Services	13	69	176	331	409
3**	Training subsidy	225	149	66	72	88
A	TOTAL INCOME	238	914	1731	2215	2594
	COST 000 $					
4	Foundry operating costs	182	555	719	963	1114
5	Services costs	63	160	205	236	256
6	Depreciation and loan interests	258	300	335	583	583
B	TOTAL COST	503	1015	1259	1782	1953
	RESULTS					
C	Profit / Loss	(265)	(101)	389	433	641
D***	Cash result	26	157	682	774	982

1* Grey iron castings 1.2 $ / ton - Nodular iron c. 1.5 $ / ton Non-ferrous c. 3.5 $ / ton.

3** Including local training only.

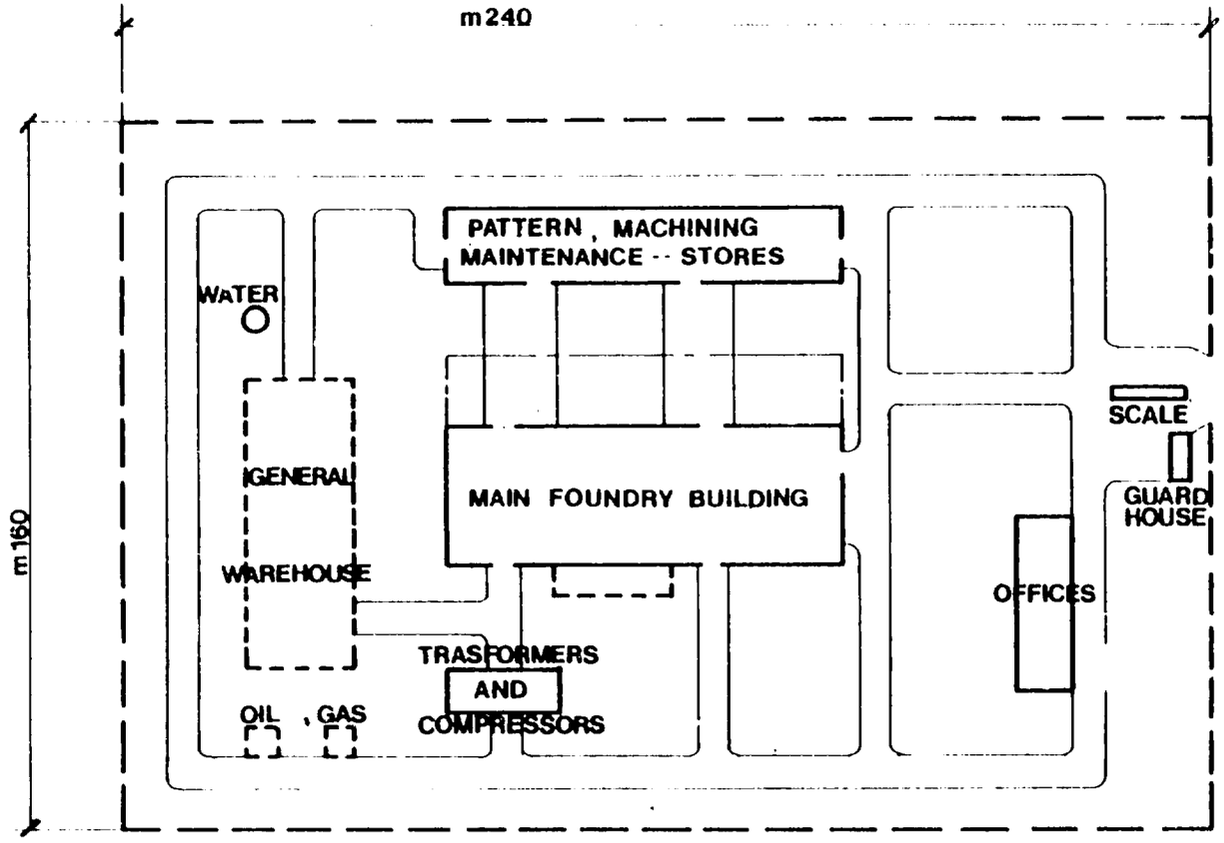
D*** Depreciation deduction only (see Investment x Depreciation)

7. CONCLUSIONS

A composed foundry unit has been studied, in its outstanding technological, economic and personnel training features, without entering in detailed analyses of the different figures.

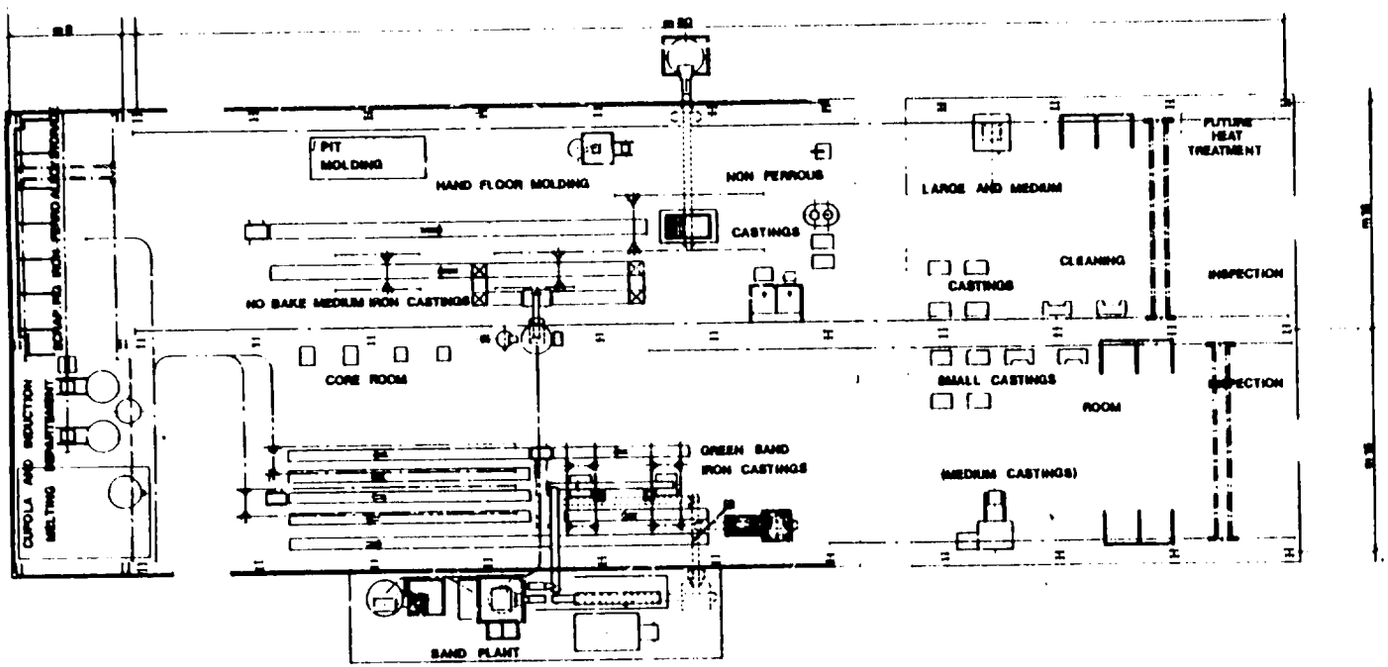
From this prefeasibility study the unit has proved to be viable, reaching break even point in the 3rd year (depreciation included).

The results are attained by summing up sales of iron and non-ferrous casting, and the income from workshops and engineering services: in this way, seltsufficiency in precision work and know-how is also assured.



METAL PRODUCTION DEVELOPMENT UNIT

GENERAL PLANIMETRY

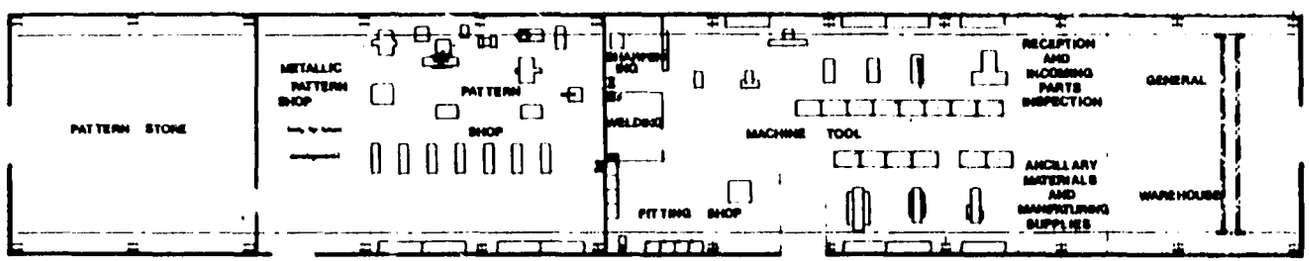


METAL PRODUCTION DEVELOPMENT UNIT

IRON FOUNDRY

MAIN BUILDING

BASIC LAYOUT



METAL PRODUCTION DEVELOPMENT UNIT

PATTERN – MACHINING

MAINTENANCE DEPARTMENT

METAL PRODUCTION
DEVELOPMENT
UNIT

PART II

A N N E X E S

METAL PRODUCTION
DEVELOPMENT
UNIT

A N N E X I

ADAPTATION OF INSTALLATIONS, MACHINERY, PROCESSES IN A FOUNDRY UNIT FOR A.C.P. COUNTRIES

FOREWORD

a) General

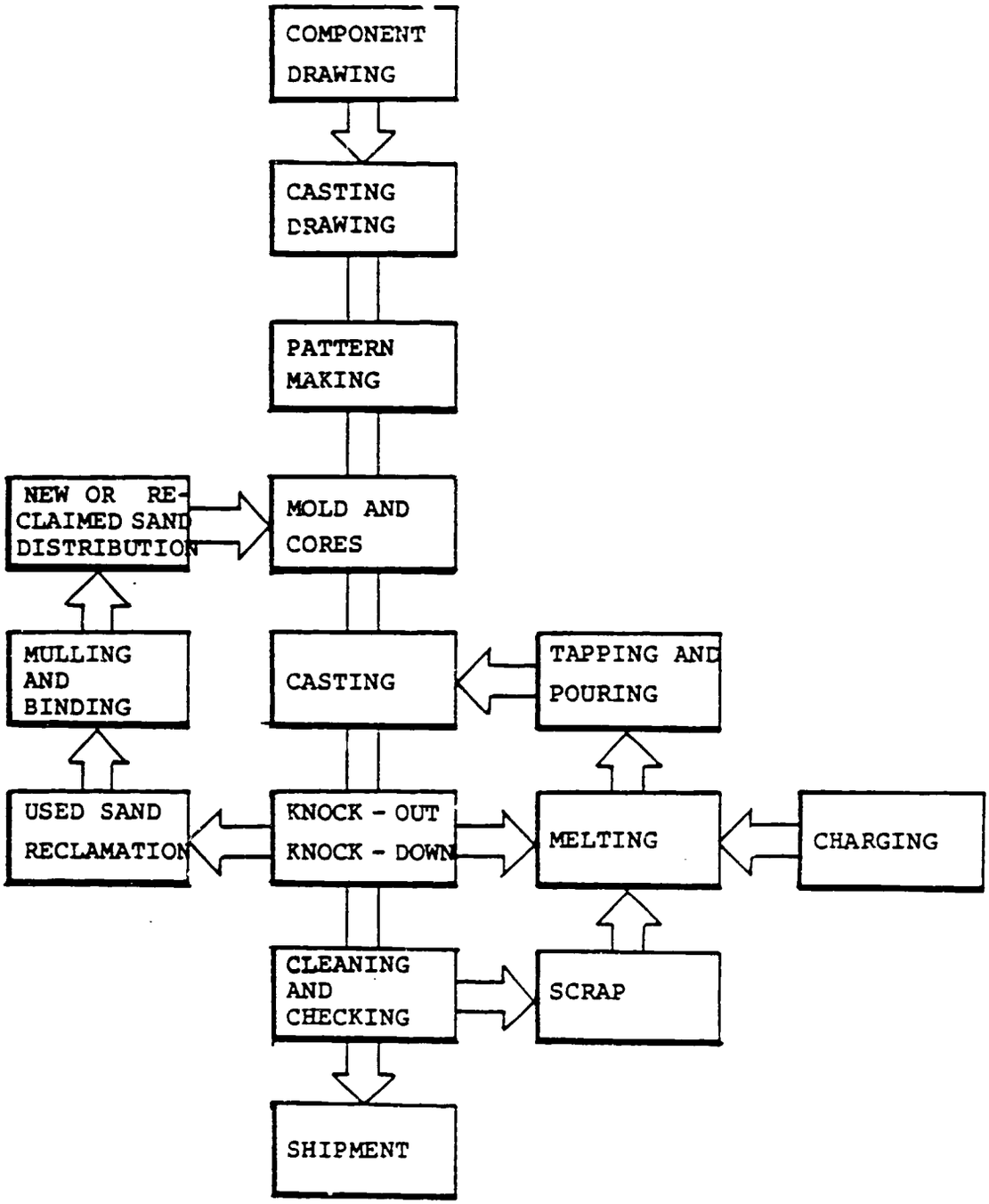
The design of the foundry covered by M.P.D.U. study for A.C.P. countries is based on general adaptation criteria of a wide range of technologies still in use in the industrialized countries.

It has been deemed expedient to make a preliminary schematic review of foundry processes and means together with general assessments of the main parameters (costs, productivity, quality results, performance problems, etc.). These opinions which must be regarded as an indication and are only of approximate value, are followed by some considerations justifying the choices and indicating in some instances possible alternatives.

Obviously, other alternatives could prove more expedient if the country concerned with the installation of a foundry could be defined and the local market, climate, industrial and agricultural infrastructure clearly outlined.

A set of illustrations of the different matters, partly taken from manufacturers' publications, technical literature or drawings prepared for this purpose is attached to the different sections hereof for a better understanding

Table I-b) Main steps of the foundry processes.



I - PRODUCTION PROGRAMME

The choice of the production means refers to machine features as well as to the aspects of the foundry production programme.

The choices resulting from general market investigations in the countries under development produced a guidance programme, the statistical aspects of which were the basis for the determination and adaptation of work means.

The essential production elements are shown in Table A.

Table A - Statistical data of Guidance programme for Cast Iron Foundry.

		Grey Cast Iron	Nodular Cast Iron	Total
Output	tons/year	1,360	240	1,600
Components	No.	76	30	106

Castings	10 kgs	177,000	No.comp.	74	medium	series	-	2400/year
"	10 to 100 kgs	25,400	" "	28	"	"	-	910/ "
"	100 kgs	600	" "	4	"	"	-	150/ "
Total		203,000		105				

Quantities must be increased by 10% to allow for rejects.

Working days are considered 225 in the year, and the daily work hours equivalent to one 8 hours shift.

II - ADAPTATION OF PATTERN MAKING TECHNOLOGIES

a) Main pattern making methods (Table II)

Table II shows the itemized diagram of pattern making methods with the relevant characteristics of use and cost for each of them.

The special methods such as investment casting are not included.

CAST IRON FOUNDRY

BASIC METHOD FOR PATTERN MAKING (SAVE SPECIAL PROCESSES SUCH AS INVESTMENT CASTING)

TABLE II

ADDITIVE NOTES

Classification / Characteristics	Full scale pattern					Special equipment pattern			Expendable pattern	
	LOOSE		ON PATTERN BOARD		FLASKLESS	SKELETON PATTERN	SWEEP PATTERN	TEMPLATE PATTERN	FIRST MOLD PROCESS	
	Single	Split	Matchplate	Cope and drag						
Type of material for pattern making	a) wood b) plastic --	a) wood b) plastic --	a) wood b) plastic c) metal	a) wood b) plastic c) metal	a) wood b) plastic c) metal	Wood	Wood	Wood	Polystyrene foam	
Number of producible moldings (ref. to material)	a) up to 40 b) up to 100 —	a) up to 40 b) up to 100 —	a) up to 300 b) 500-1000 c) 1000-5000	a) 150-300 b) 500-1000 c) + 5000	a) 50 - 100 b) 500-1000 c) + 5000	SOLE PARTS OR VERY SMALL SERIES			1 Not reputable	Reference is made to standard molding sands with good conduction
Molding method	By hand	By hand	By machine	By machine (by hand)	By hand By machine By mixer	By hand	By hand	By hand	By hand By mixer	
Skillness level of manpower required	3	2-3	1-2	1-2	3 - 4	3-5	3 - 5	3- 5	1 - 3	Indicative from 1 to 5
Cost - pattern incidence (comparison among types of moldings)	1	1 - 2	2 - 3	3 - 4	3 - 5	0.4	0.2	0.2	0.4	Figures, which are only indicative, start from 0.2 up to 5
Castings size	Not established		Up to a length of 2x1.5 m		Up to 1 x 1 m	Up to very large sizes for pit molding			large and medium sizes	Designations are referred to standard machines
Size precision on related castings	3	3	4	5	5	2	2	2	1	Precision range: from 1 to 5
Standard means or ancillary materials	Hand-operated tools (pneumatic rammers)		Precision flasks molding machines		Generally mixer or blowing machine	Hand-operated tools (pneumatic rammers) Contingently slinger machines for fillings			Not compressed, self-hardening materials required	Designations are only indicative
Special characteristics	Quite rare only, for very small quantities	Generally for first parts of a series	Controlled sizes castings required in repetitible series		different sizes. Good surface and precision	Generally large castings, small series should skilled manpower be available and pattern cost be high			For parts to be produced once only	Only the main ones are mentioned
Feasibility for foundries in developing countries	It is advisable only after a training period, for few simple parts		For most of parts metal is mainly excluded		Interesting if mixers or blowing machine molders are available	Very skilled molders are required; anyway it is advisable to provide a minimum level of machine molding			Technology to be applied in emergency cases	Reduction depends on areas and means

b) Choices for pattern department in A.C.P. foundry

The patternmaker department for the proposed M.P.D.U. foundry has been designed by adapting process and wooden and plastic pattern making machines.

In fact, the purchase, for the time being, of metal pattern machines (requiring an investment in excess of $ 500,000) appears to be out of proportion considering also the cost of the relevant patterns for series which only in exceptional cases are over 1000 parts per order.

For the same reason, the construction of combined patterns has been considered only in the very infrequent cases of bigger series.

The machines selected for wood molding are:

- Belt saw.
- Drilling machine.
- 2 Milling machines.
- Lathe.
- Surface sand papering machine.
- Honing machine.
- Buzz planer.
- Thicknessing machine.
- Carpenters benches.
- Marking-off benches.
- Copy-milling machine.
- Grinder.

The wood pattern by means of a simple duplicating method can produce more copies of resin (usually epoxy) patterns.

Among the chosen methodologies, some manufacturing methods proved to be more suitable to the type of production, infrastructure, and labour skill.

For the jolt molding machines, double match plates (top/bottom) have been chosen enabling a higher accuracy than opposed patterns, easier touch-up for half-molds finishing, easier handling.

Flaskless moldings are suggested for larger castings using the mixer as production mean (to prevent the use of heavy and expensive flasks).

The unfinished patterns (and to a minor extent loose patterns) require highly skilled labour: it is foreseen to train local craftsmen from the neighbouring villages for these types of hand molding. Consequently, sweep or skeleton patterns can be produced in several instances for single or very low series spare parts.

It is impossible at this stage to make a detailed study of resins types and suitability with respect to the different climates and temperatures, and bearing account of the different uses. It is however an important aspect for the possibilities of use to suit material stocking and machining methods to the climatic conditions of the selected country.

c) Diagrams and illustrations concerning pattern types

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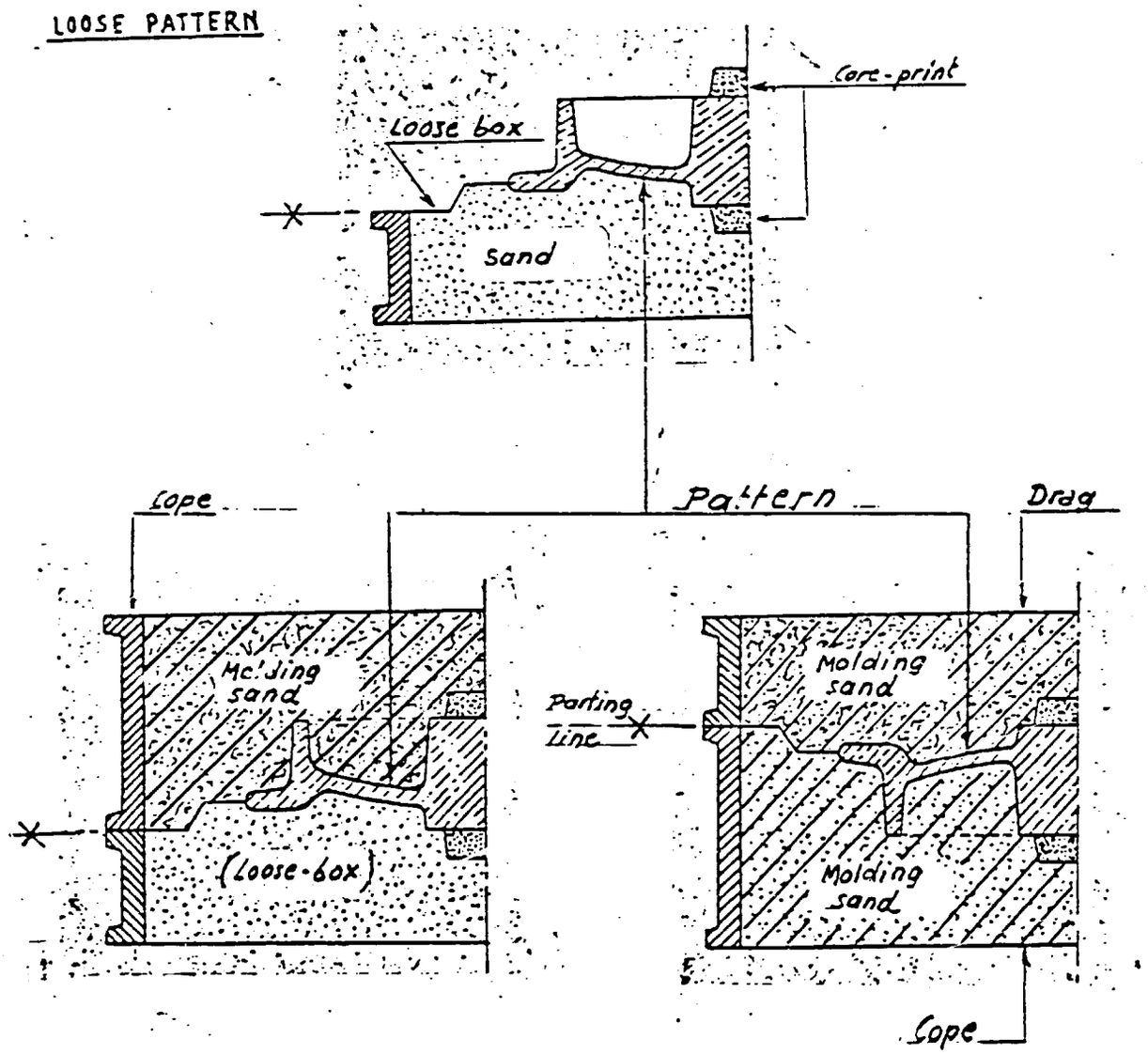
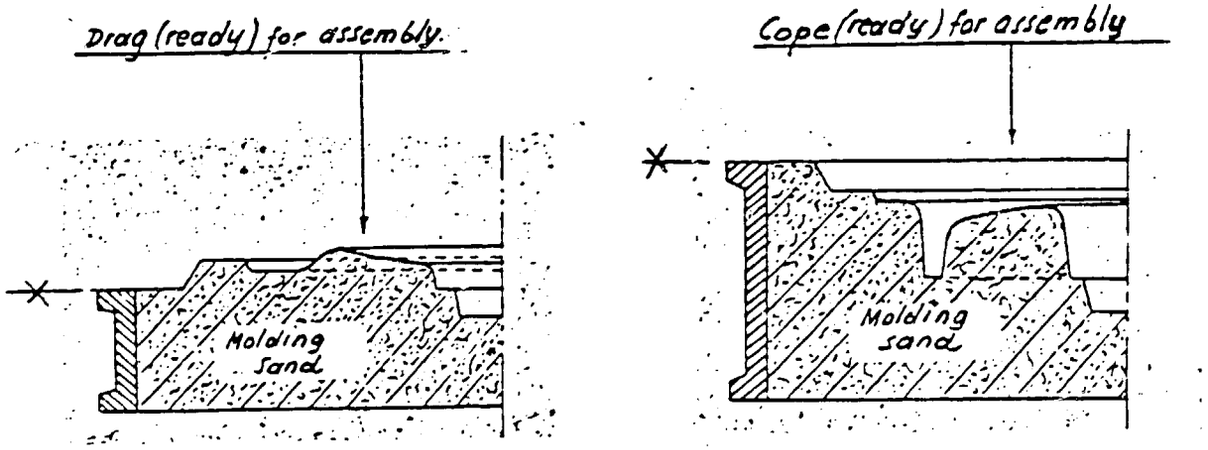
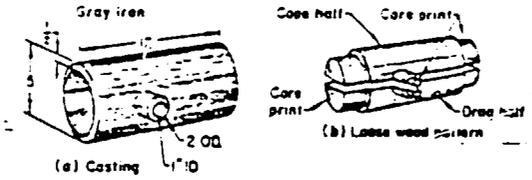
DIFFERENT TYPES OF PATTERN EQUIPMENT

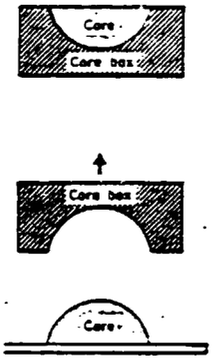
LOOSE PATTERN

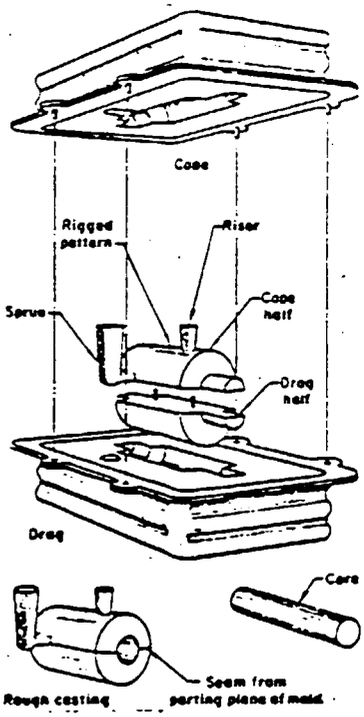


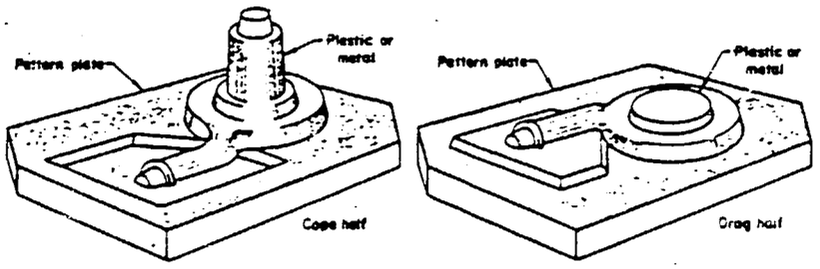


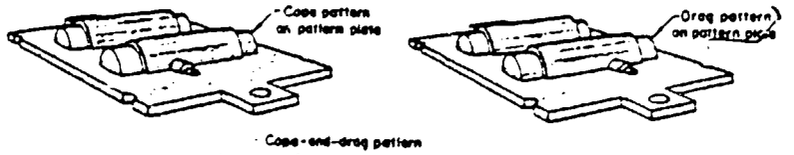
DIFFERENT TYPES OF PATTERN EQUIPMENT

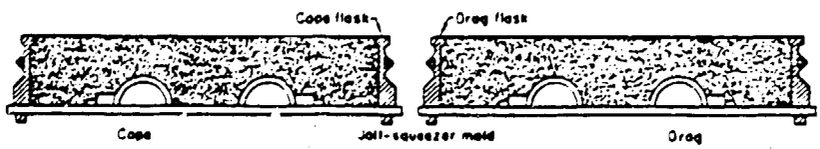






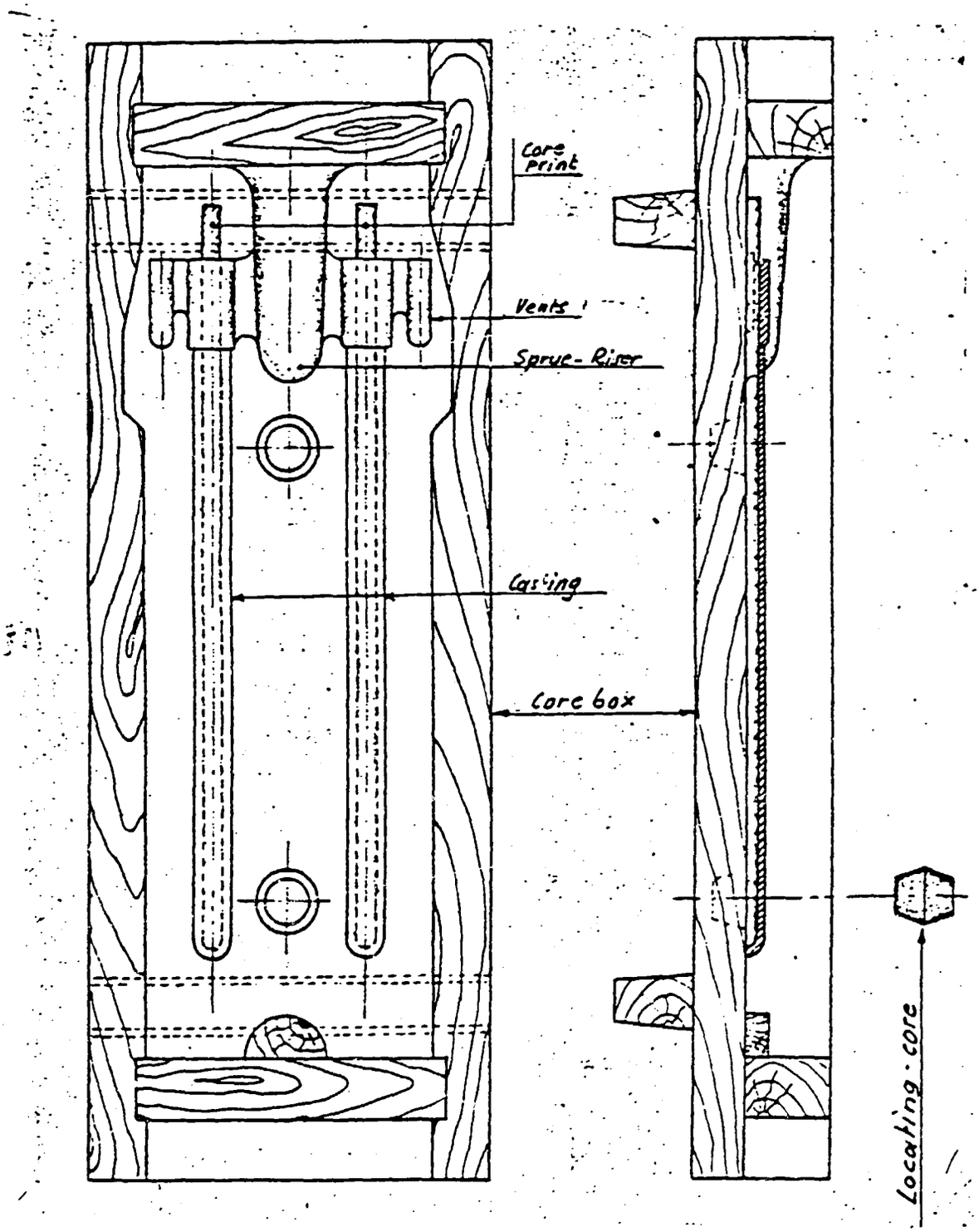






(From Metals Handbook, Vol V)

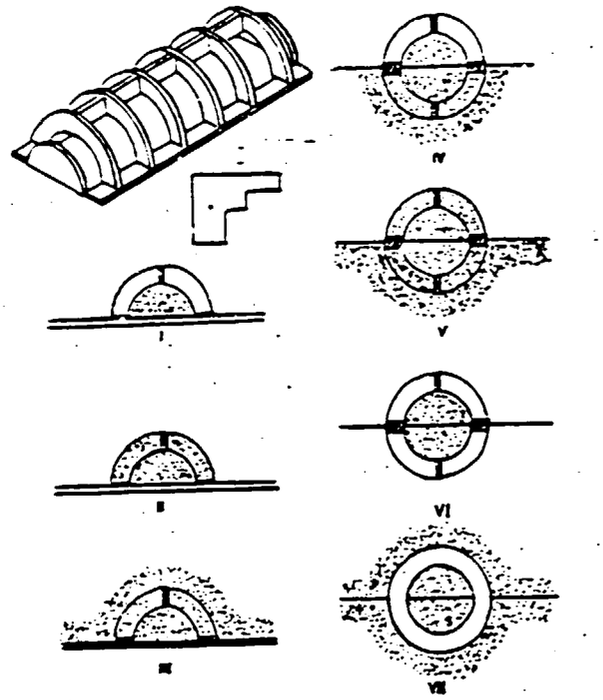
DIFFERENT METHODS OF PATTERN MAKING



- Wooden Corebox for flaskless hand molding -
(Pattern is located in a core box)

DIFFERENT TYPES OF PATTERN EQUIPMENT

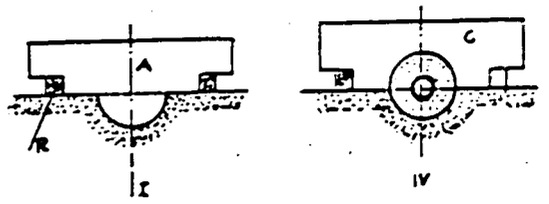
Special Pattern equipment for hand molding



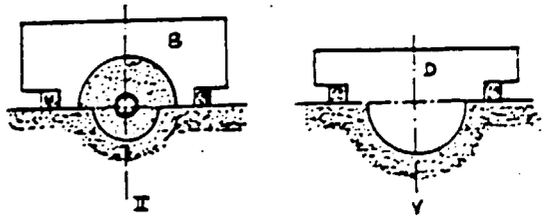
Hand molding with skeleton pattern

Process sequence

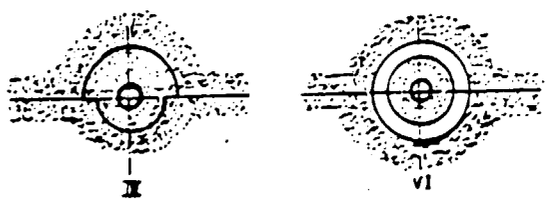
Mould making for a pipe



Different steps in template molding

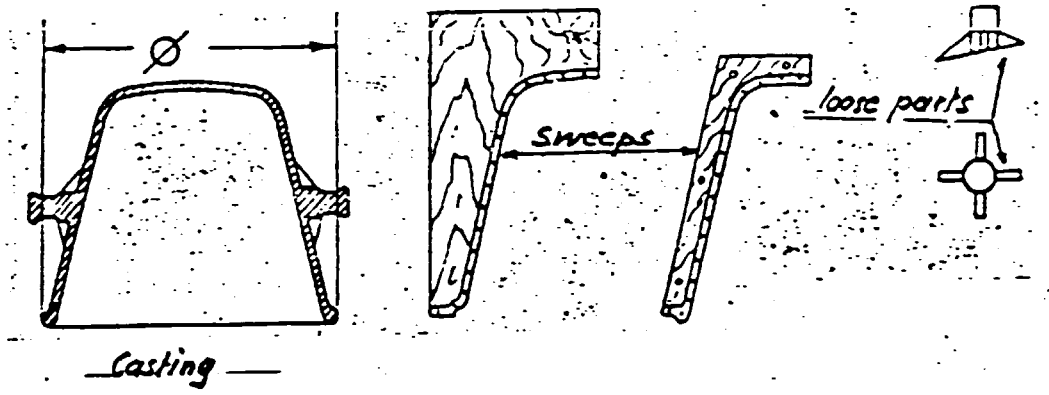


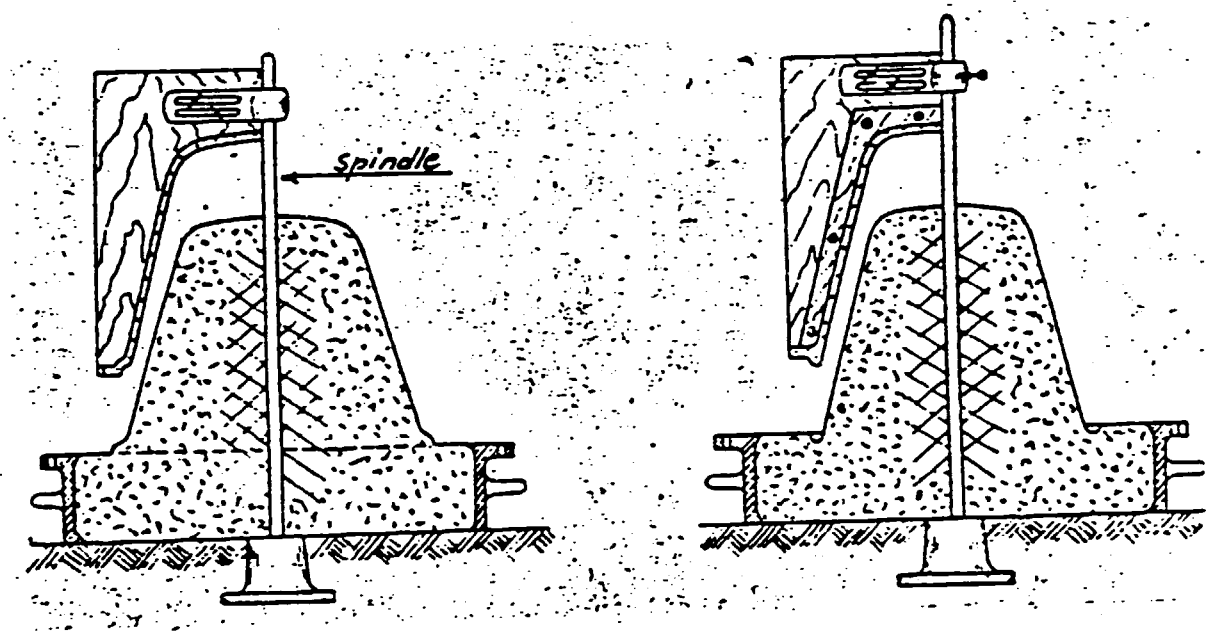
R = Slide
A = Template for internal shape
B = Template for the cope
C = Template for upper part of the core
D = Template for the drag

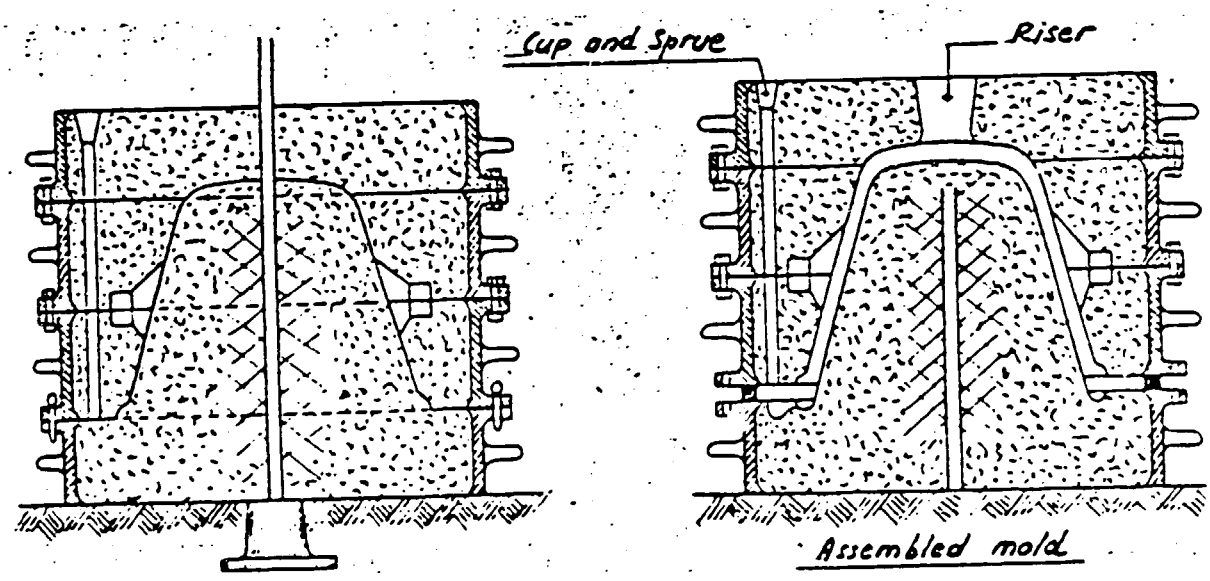


From: 'Format. Fond. Chisa' - ASSOFOND)

DIFFERENT TYPES OF PATTERN EQUIPMENT



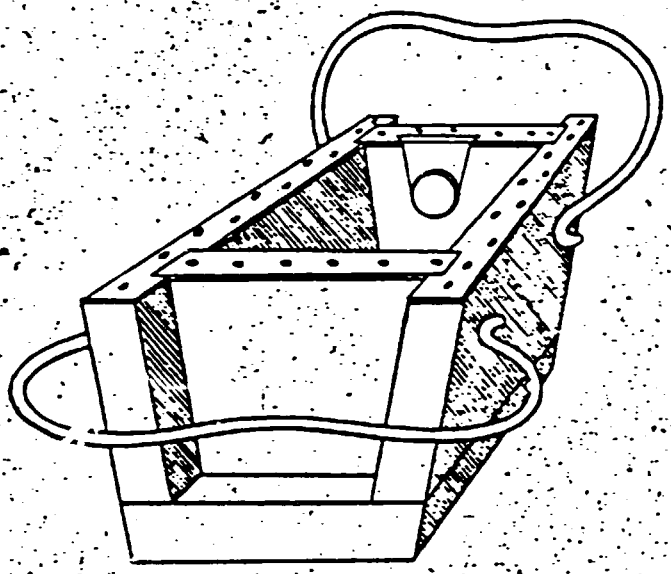




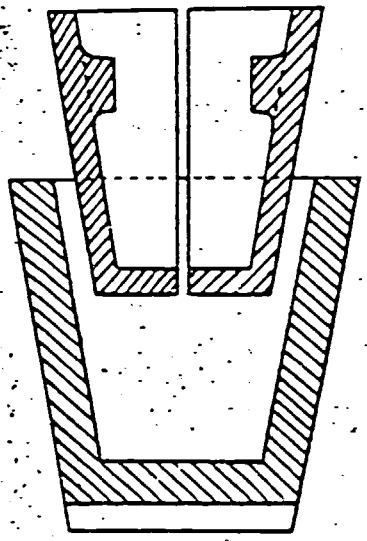
Sweep hand molding of a slag-Pot

DIFFERENT TYPES OF PATTERN EQUIPMENT

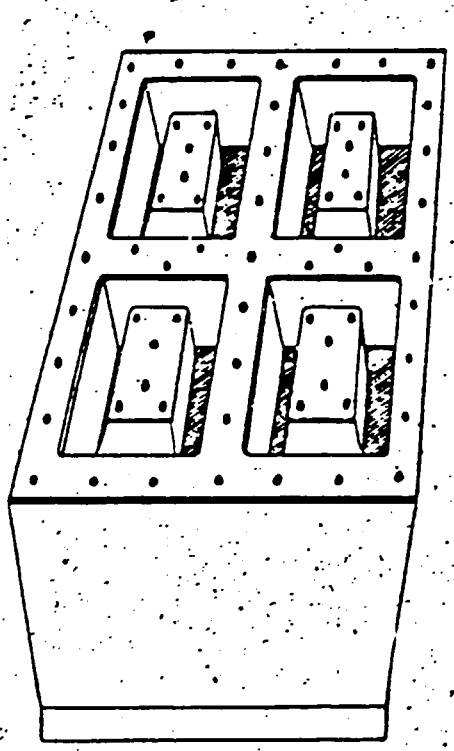
DIFFERENT TYPES OF CORE WOODEN BOXES FOR HAND COREMAKING



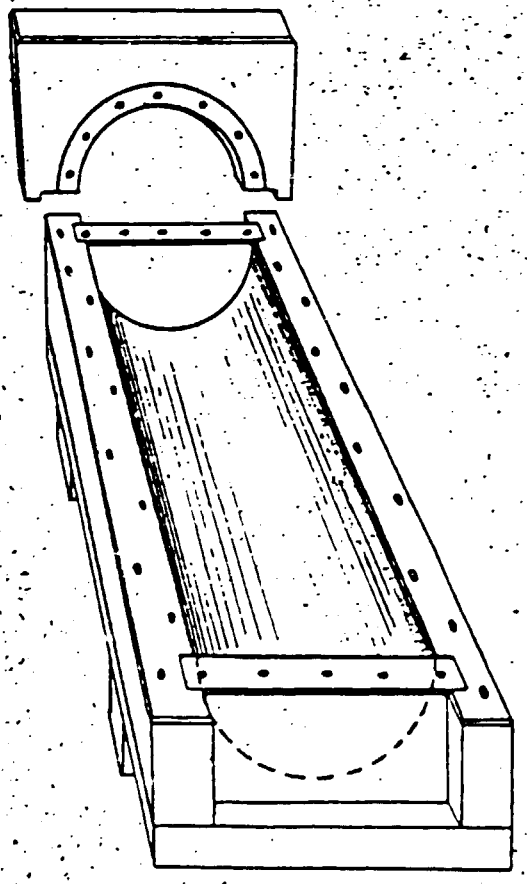
Disassemblable core box with clamps



Core Box with loose parts



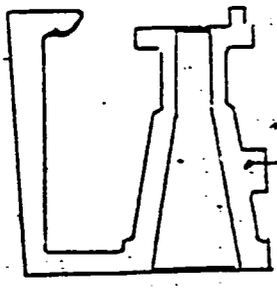
Multiple Core Box



Templaie Coremaking

DIFFERENT TYPES OF PATTERN EQUIPMENT

- FULL MOLD PROCESS -

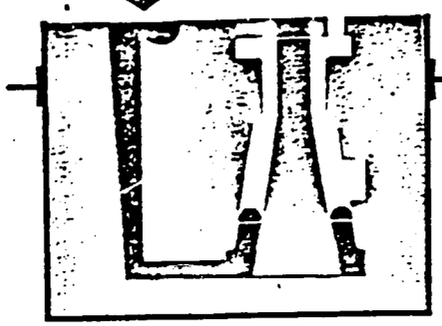


Polystyrene foam pattern

Molding with loose expendable pattern without cores

Flask (or Pit) molding sand (not rammed)

Pouring



Metal is Filling the mold while Pattern is burning

Finished Casting

(No flash or core print is left

III - ADAPTATION OF SAND MOLDS PRODUCTION EQUIPMENT

a) Main molding methods and relevant characteristics (Table III)

Table III lists the general characteristics of the main molding making methods for cast iron castings. Special machinery or of restricted use have not been considered.

Type	Characteristics	Main Variants	Application Fields	Product specificity level *	Required Skillness **	Equipment	Productivity (+)	Equipment Investment	Adaptability to A.C.C. conditions
Manual moulding	Bi-valve pattern	Presence of mechanical devices and/or boxes for locking the moulding boxes	Short run, generally, large simple patterns	1 - 2	1	Loose pattern or wood splitted pattern	1 - 2	1	Yes, for small foundries
	Bi-valve pattern with	Generally, halved cored bolt used	Short run and limited height castings	2	2	Loose pattern or wood splitted pattern	1	1	Only for small foundries
	Loose pattern	Separately from different types of patterns. Loose pieces are also assembled	Short run, large castings	1	3	Loose pattern, even reduced (profile, skeleton)	1	1	Yes, short run and large sizes castings
Machine moulding	Jolting	Compression plate, multiple fasteners etc.	Simple profiles, limited height plate patterns	3	1	Plastic or wood/board pattern	15	3	Valid only for thin castings
	Jolt	Different types of jolt	Plate patterns limited height, pronounced profiles	3-4	1-2	Plastic or wood plate pattern	10	3	Long run, with output of 30 moulds/h
	Jolt squeeze	Participating variants combined	Current castings having generally sizes smaller than 1500 m/m	3-4	1-2	Plastic or wood board pattern	15	4	Medium run with output of 30 moulds/h
	Pneumatic compression	Blowing or slo	Long run, having sizes smaller than 1000 m/m	4	1-2	In preference metal type	20	4	Good productivity, but pattern high cost
	Mechanized squeeze	Free unit mechanization up to mechanized sequences	Very long run, and sizes generally smaller than 2000 m/m	5	1-5	Metal type very precise and accurate	over 100	very high	Absolutely not suitable
Rotary carousel		Centrifugal with fixed or movable station	Very flexible production for different castings sequences	2-3	1 - 2	Plastic or metal type	10	5	Versatile but with high mechanical costs (patterns and modifiers)
Automatic moulding lines		Contemporary addition of liquid or pressurized sand with different modes	Flexible production for good sectional and precise casting.	3-4	2	Wood, plastic or metal type	8-10	5	Versatile, apt to supply good quality, rectilinear simple patterns
Shell moulding machines for hollow		Several processes (lost, shell welding, cold box etc.)	Precision and machining allowance castings. Long run	4-5	1	Metal type	over 100	4	Feasibility, to be checked according to each life
Flaskless moulding machines		Horizontal or vertical parting line	Simple, precise, possibly coreless, very long run castings	5	1-5	Very precise and accurate metal type	over 100	high	Absolutely not recommended

REMARKS

* 1 to 5 growing quality and precision
** 1 to 3 growing experience/capacity
*** 1 to 5 increasing cost

(+) PRODUCTIVITY - Indexes mean multiples as to basic selected productivity.

b) Choice of molds production methods for A.C.P. foundry

- Jolt squeeze machine represents an inexpensive and very versatile mean relieving the molder from a considerable part of physical fatigue and ensuring a satisfactory accuracy on the product with no requirement for metal patterns or long professional experience.

  Its productivity, though not included in mechanized lines, is fairly good and can exceed 30 molds/hr.

  Resort has been made to 600 x 800 unified flasks 250 mm high, which seem to be the most suitable for castings weighing up to 10 kilos.

  A machine of this kind can produce averagely 4 castings per flask and has therefore 90% saturation (bearing account of 10% reject).

- The most versatile machine for medium weight castings (10 to 100 kilos) is the continuous mixer which, with the possible aid of an adequate vibratory table, enables the settlement and hardening of mixes prepared by the mixer itself not requiring any baking. Reserves must be made about the type of mix to use taking into consideration temperature, humidity in the place of work as well as time of stocking.

  Only the study of well defined local conditions can lead to a choice.

  Such production mean, properly combined to sufficient labour, can produce with minor mechanization up to 10 molds/hr.

  Accuracy, surface finish, versatility, easy operation start-up are the main features of this type of machinery in addition to limited cost and no flasks.

Patterns are mostly of wood.

Considering the castings to be produced (with the usual 10% increase), the output rate (with an average of three castings per mold) saturates the mean for 50%. It is therefore suitable for the molding of small castings (if in excess of jolt-squeeze machine possibilities), as well as cores.

- An area has been reserved for pit molding where up to 2 tons castings can be produced with simplified patterns or where they may be assembled by parts (loose pieces and cores) produced in the mixer with "no bake" mix in case of larger series.

  Its availability for special molds and sizes is essential in countries where particular structures may be urgently required as spares of brokendown machinery parts.

  A small production has been foreseen for siderurgical and harbor industries, as basic requirement.

  There is however to underline that hand molding requires a multiyear experience of the personnel. Provisions have been made for some workers to be carefully selected and trained.

ALTERNATIVES

Cope and drag molding could be performed on the same machine using matchplates for castings up to 10 kilos and for a flask contents of up to 15 kilos approximately.

Moldings of 10 to 100 kilos (and over) castings could be made in flask using the manual application of facing sand and castings of baking sand. It is however necessary to have a machine with rotating impeller and a costly equipment also because of the spare parts.

c) Diagrams and illustrations concerning molding methods

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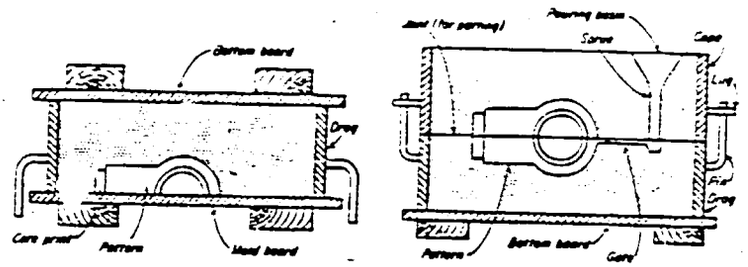
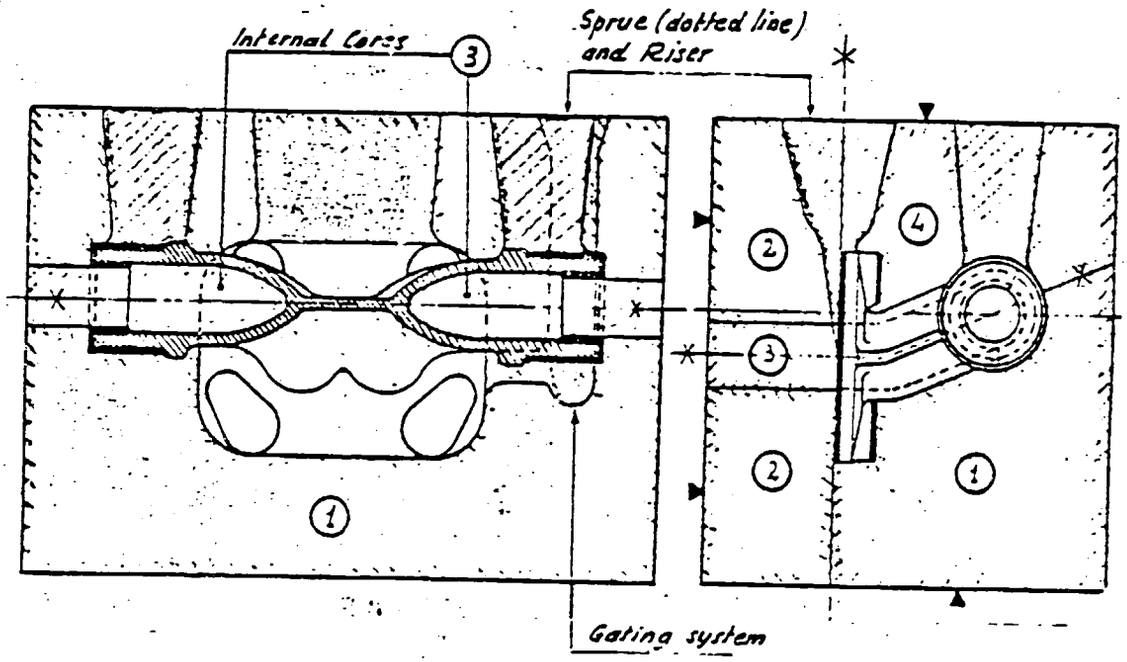
DIFFERENT TYPES OF HAND MOLDING



TRADITIONAL HAND MOLDING WITH SPLIT PATTERN

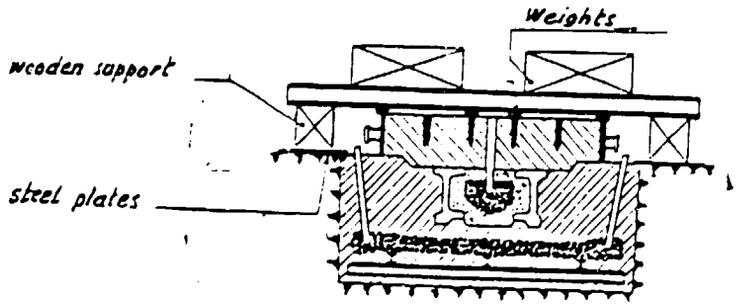
(Drag made by hand) (Cope made by hand directly on the Drag)

(from: "Principles Metal Casting" A.F.S.)



FLASKLESS HAND MOLDING WITH INTERNAL CORES

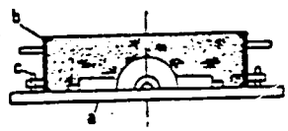
(1-2-4- are external cores acting as mold walls)



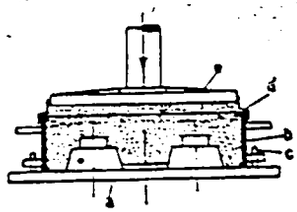
PIT MOLDING WITH COPE

(from: "Formatura" ASSOFOND)

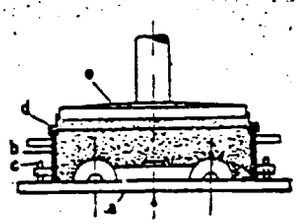
DIFFERENT TYPES OF MOLDING (RAMMING OF SAND)



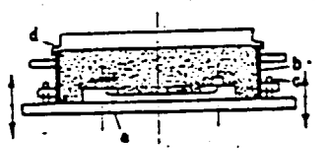
- Hand Molding



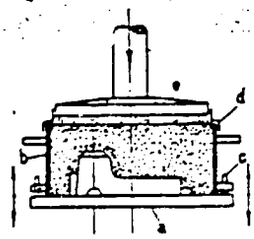
- Squeeze Machine Molding
(squeeze is done by top plate)
sand more compressed
in the upper part -



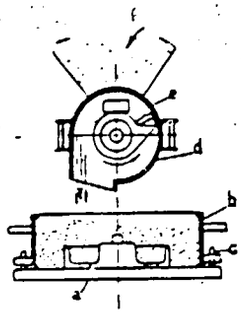
- Squeeze Machine Molding
(squeeze is done by follow board)
Sand more compressed
near the pattern -



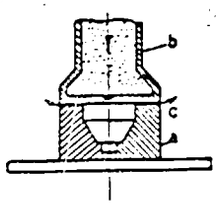
- Jolt (or vibrating) Machine



- Combined Action
of Pression and Jolt
Jolt squeeze machine

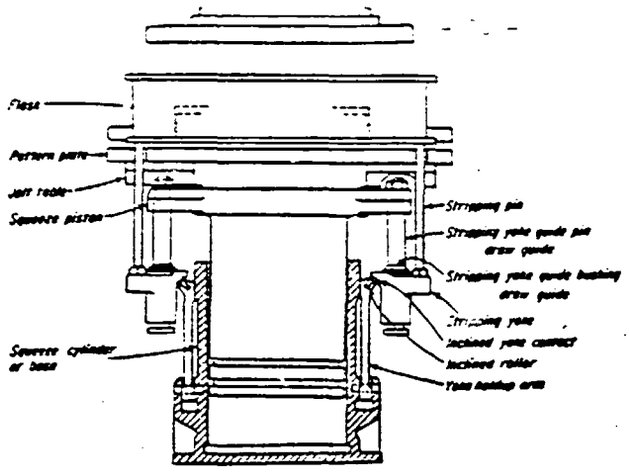


- Sand slinger Molding
(the sand is delivered into the mold by velocity from a rotating impeller)



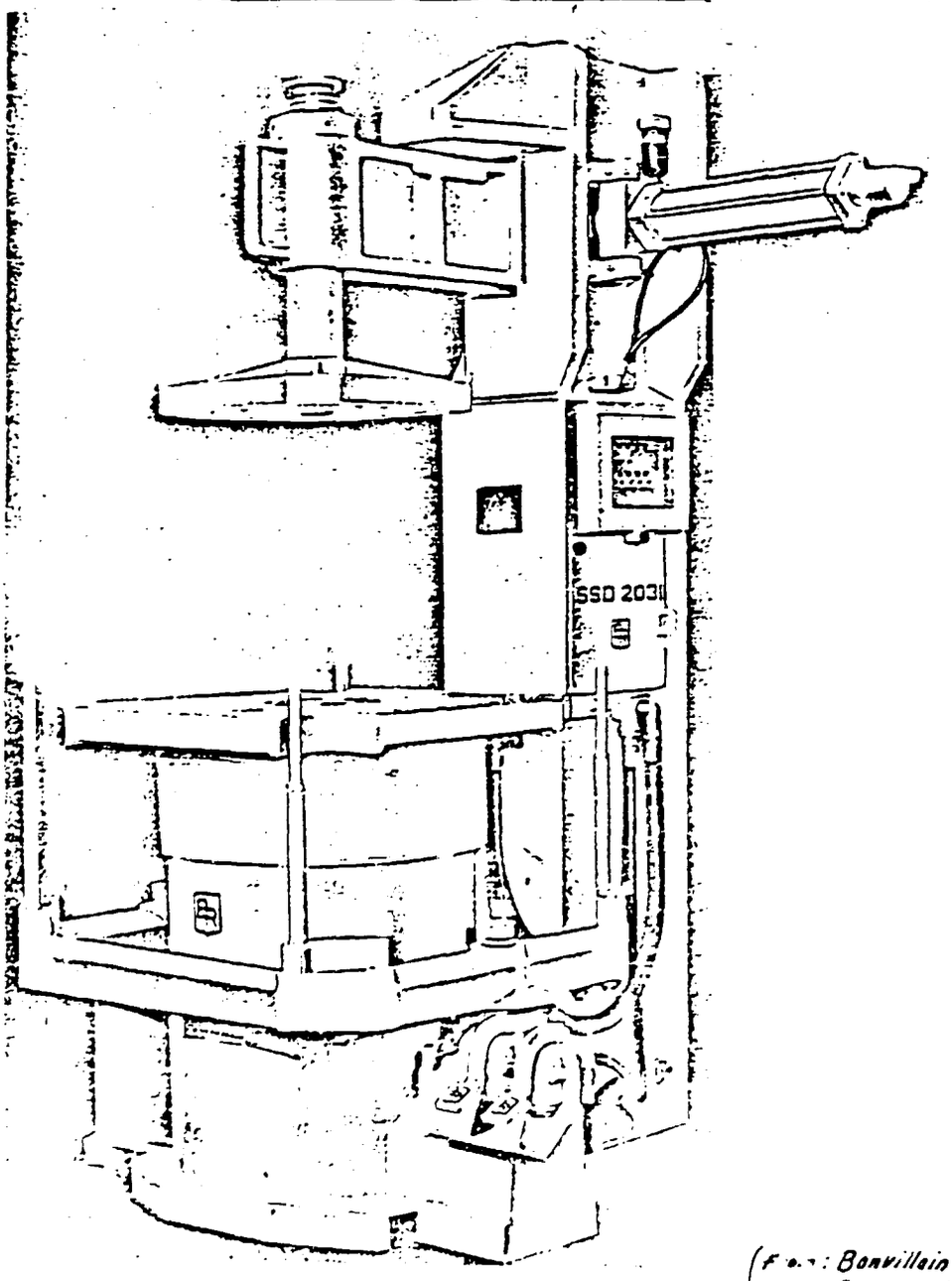
- Sand blowing machine

(From : "FONDERIA" by E. Capello -)



(From: "Principles of Metal Casting...")

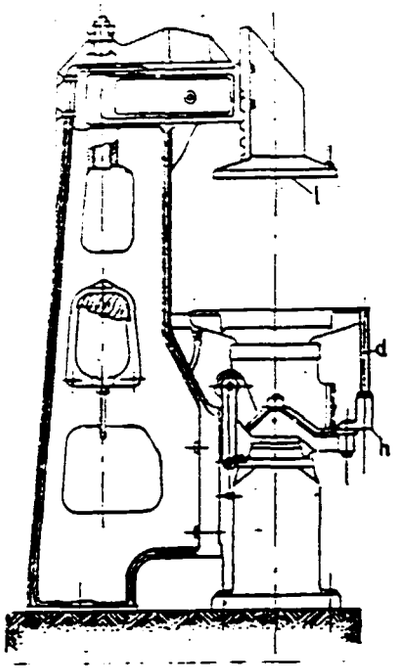
JOLT · SQUEEZING MACHINE



(from: Bonvillain & Ronceray Italiana)

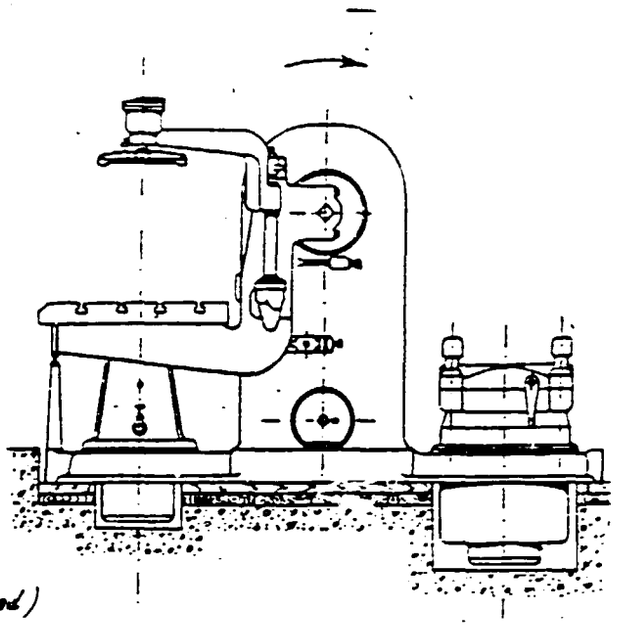
MECHANIZED MOLDIND ALANCED

TYPES OF MACHINE

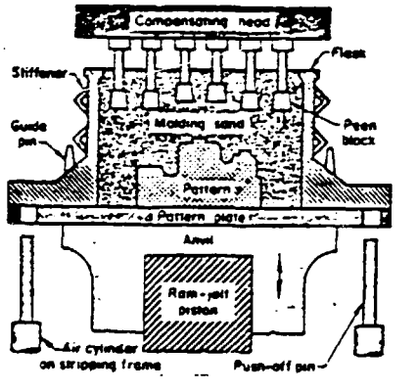


VIBRO-SQUEEZING MACHINE

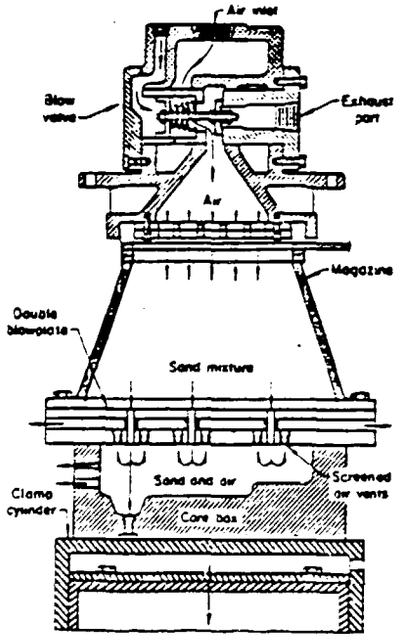
(From: "Fermatora" Astofond)



JOLT-SQUEEZE ROLLOVER MACHINE



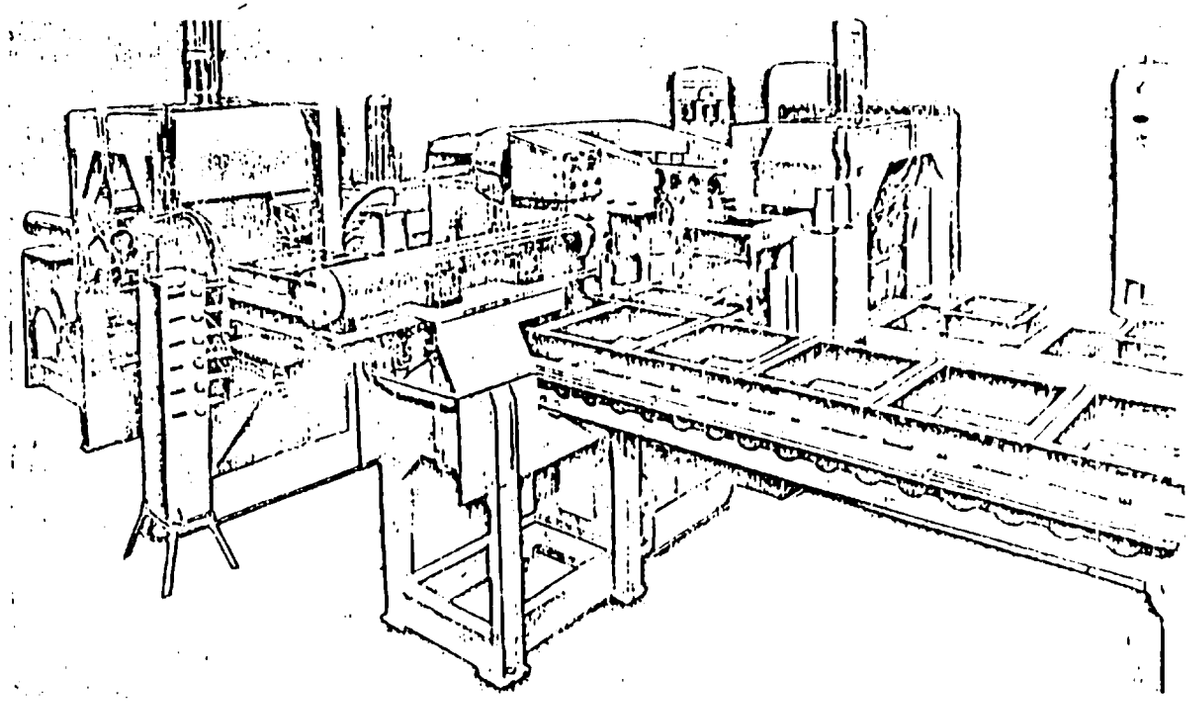
PRINCIPLES OF JOLT TYPE MOLDING MACHINE WITH COMPENSATED PRESSURE

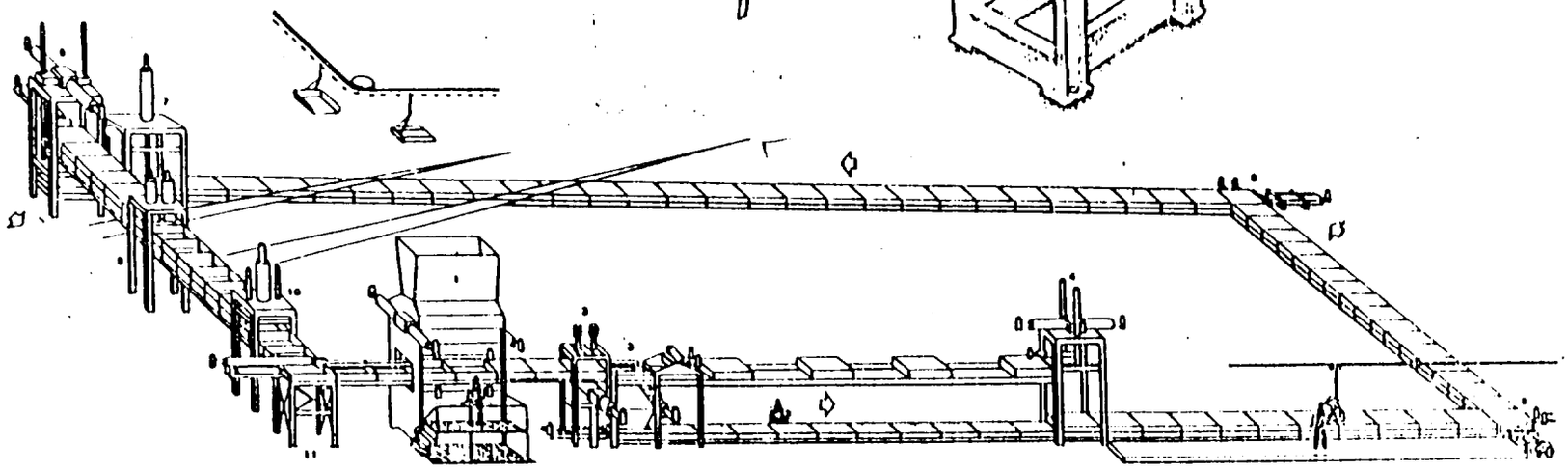


TYPICAL BLOWING SETUP

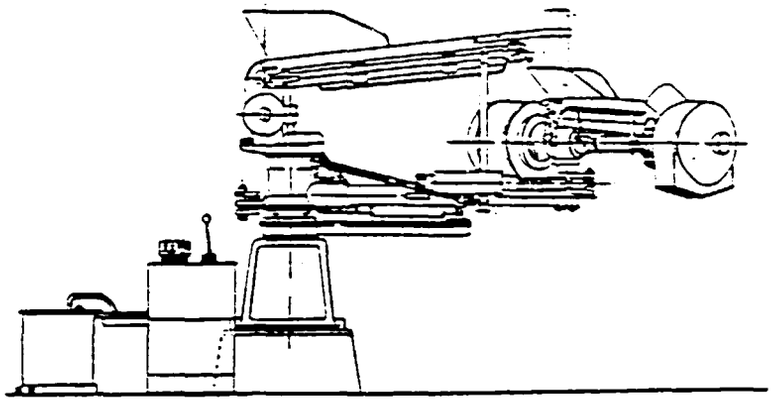
(From: Metals Handbook - Vol. V)

FULLY-AUTOMATIC MOULDING-LINES

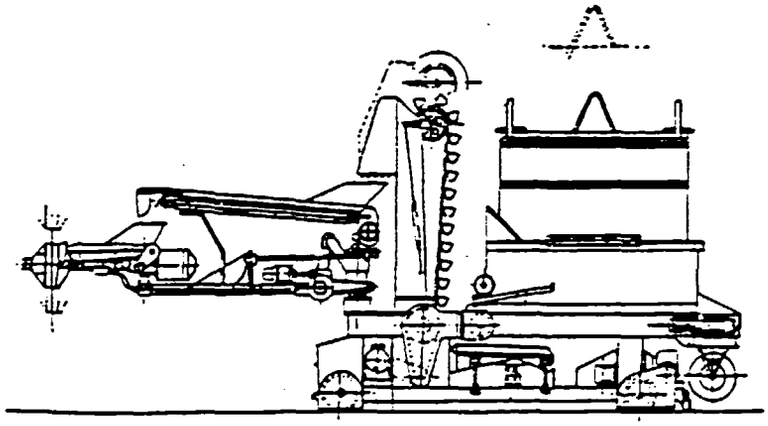




FILLING THE MOLD WITH ROTATING IMPELLERS

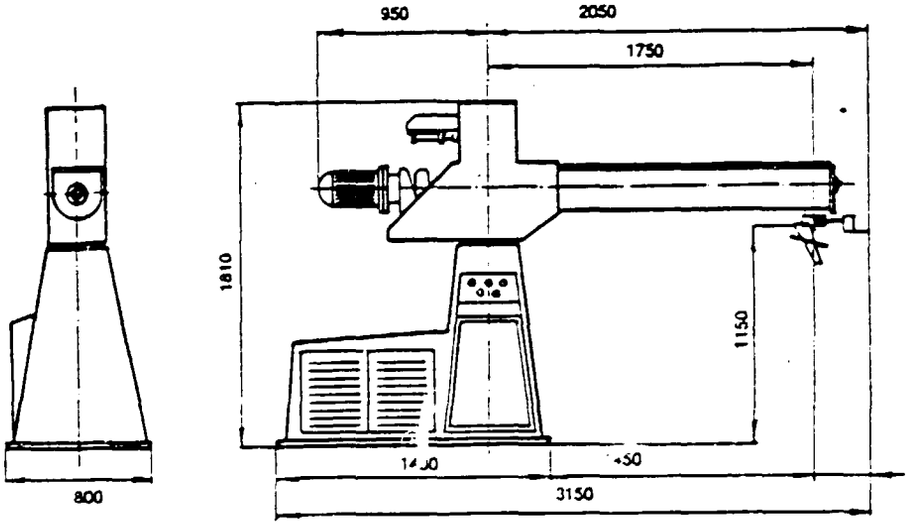


STATIONARY SANDSLINGER



MOTIVE SPEEDSLINGER (From "Formatura" BISOFON)

MOLDING WITH CHEMICAL BONDED SAND

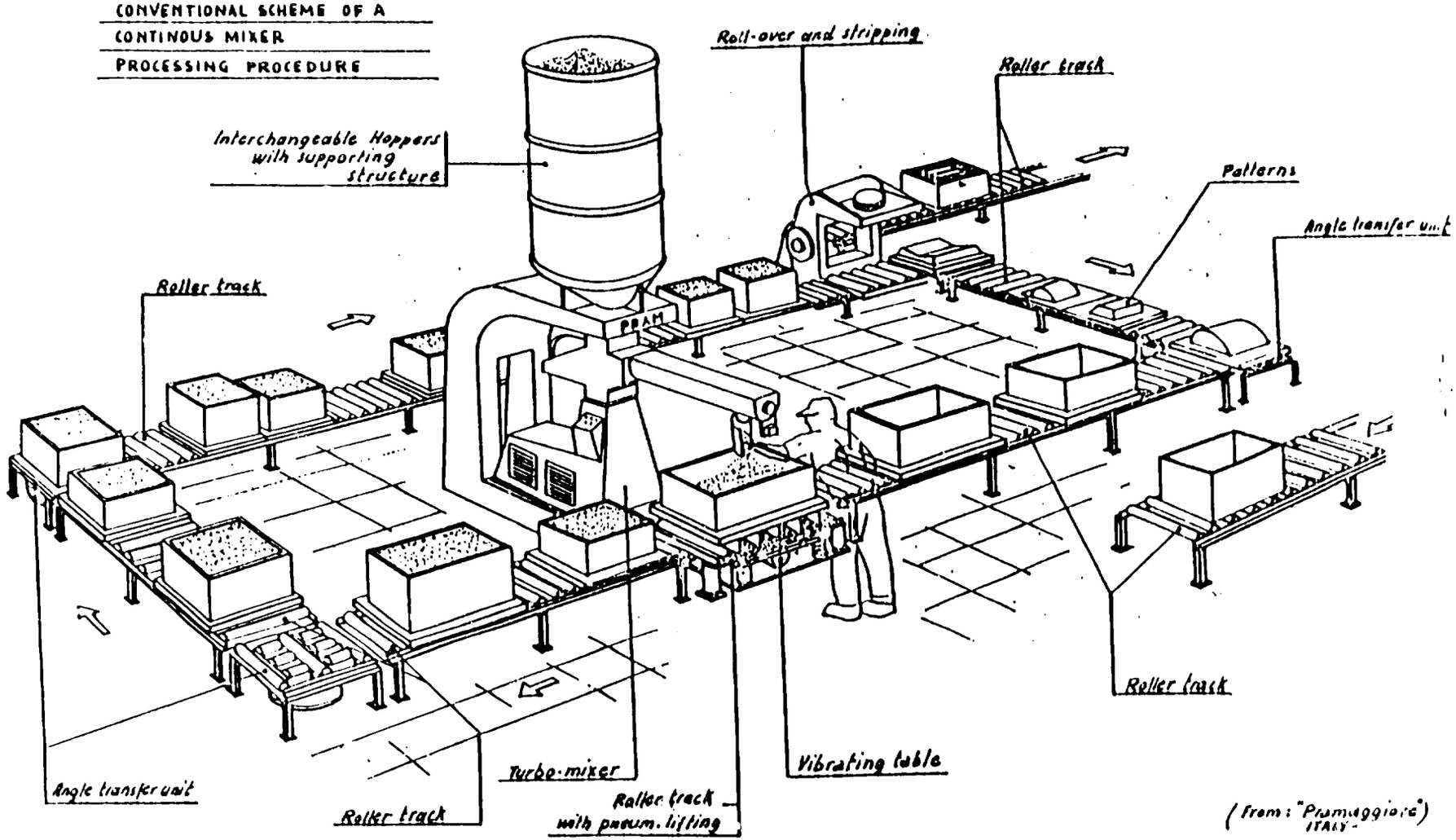


CONTINOUS MIXER

(from "Pramaggiore")

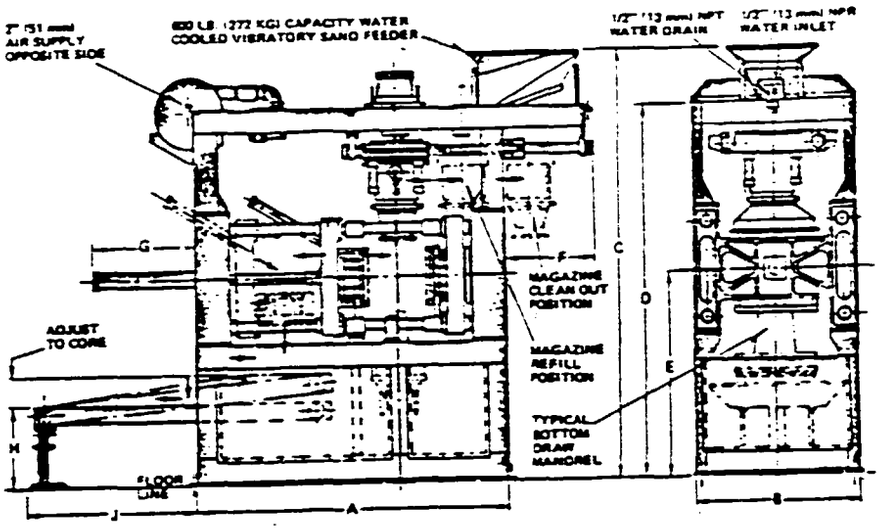
HANDLING SYSTEM FOR NO-BAKE MOULDING PROCESS

CONVENTIONAL SCHEME OF A
CONTINOUS MIXER
PROCESSING PROCEDURE



(from: "Promaggiore")
ITALY -

SHELL-MOLDING MACHINE



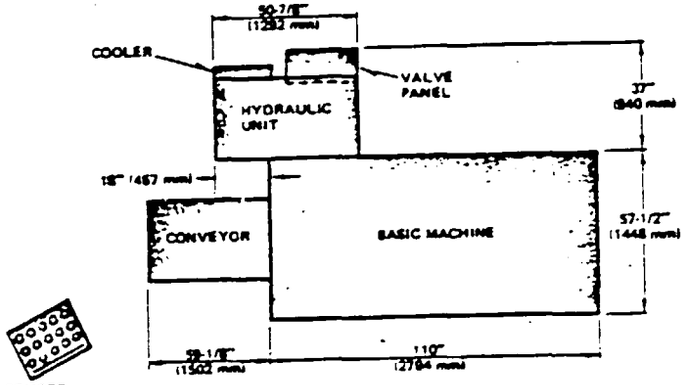
standard equipment:

- Automatic Controls
- Regulator for Control of Blow Pressure
- Filter and Lubricator for Air Syst
- Spray Gun
- Sand Magazine
- Movable and Stationary Core Bo Ejector System
- Installation and Operating Instructions

optional equipment:

- Loose Piece Controls
- Loose Piece Temperature Contr
- Indicating Type Temperature Controls
- Plug-in Receptacles for Loose Piece Heaters
- Bottom Draw Mandrel Attachme
- Heater Plate Extensions
- Dual Combustion System with 32" High x 30" Wide Heater Plat
- Automatic Indexing Core Conve
- Water-Cooled Blow Plate
- Vibratory Sand Feed Hopper
- Conical Sand Feed Hopper
- Core Box Handling Device
- Cold Process Mounting, Top Se and Controls
- Lower Mandrel Assembly — Hot Cold Process
- Duplex Receptacle for Loose Pi Heaters
- Gas Generating Unit — Cold Box Process
- Afterburner Unit — Cold Box Process
- CO_2 Valving and Controls
- Pendant-Type Control Station
- Dynatrol Probe-Sand Magazine Level Control
- Core Box Blow-Off and Spray

Typical Installation Floor Plan

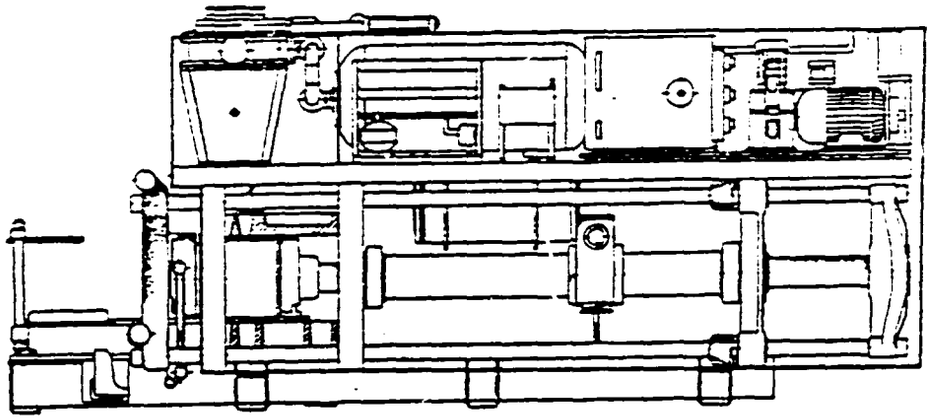


Required Space

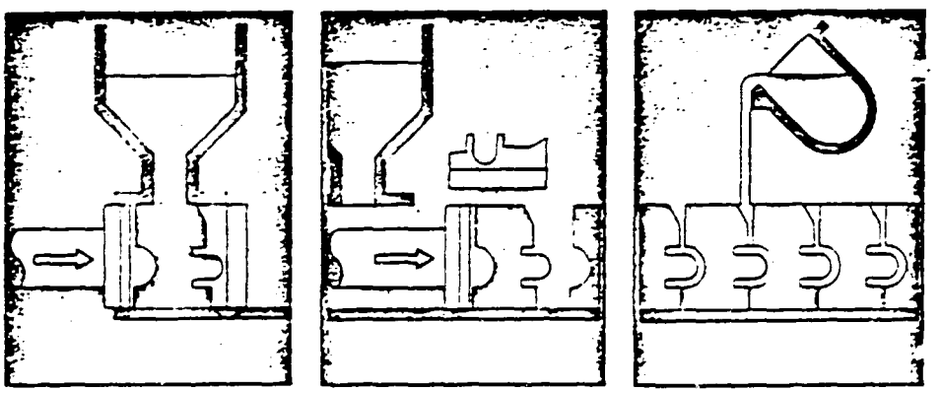
	L	W	H
Basic Machine	9'-2" (2794 mm)	5'-0" (1448 mm)	12'-6⅝" (3824 mm)
Electrical Control Cabinet	1'-0" (305 mm)	4' (1219 mm)	5'-0" (1448 mm)
Hydraulic Unit	4'-3" (1292 mm)	3'-0" (940 mm)	3'-0" (940 mm)

(From: "Shake").

TYPICAL MOLDING AUTOMATED FLASKLESS METHOD



THE "DISAMATIC" OPERATES AS AN AUTOMATIC MOLDING MACHINE. THE SAND-SHOT SYSTEM FILLS THE MOLDING CHAMBER WITH OUPUT CAPACITY OF 300 MOLDS PER HOUR.



The molds are flaskless. Using the Disamatic molding method, the sand is not rammed but squeezed in a chamber, resulting in a completely homogeneous block of sand fully capable of withstanding the pressure of the liquid iron.	Molds are vertically positioned. The advantage is evident: Whereas the horizontal arrangement calls for a drag and a cope to make up a mold ready for pouring, the DISAMATIC method simply lines up the molds, one after another.	Each mold carries two pattern impressions. The DISAMATIC molding method so to speak doubles the molding capacity in comparison with the conventional method as also the outside mold surfaces, otherwise plane and therefore useless, receive pattern impression.

(from "DISAMATIC Method")

IV - ADAPTATION OF SAND CORE PRODUCTION

a) Main sand molding methods of cores (Table IV)

The main and commonly used types of machines have been considered.

The type of materials used for the different machines represent only an indication being a more detailed investigation included in the subsequent table (Table V).

CAST PRODUCTS		CORE AND MOULDING MAIN METHODS			(TABLE IV)			
Characteristics / Method		Main variants	Moulding material	Characteristics	Equipment	Productivity, increasing with indexes	Ancillary operations and means	Feasibility for developing countries
BY HAND	Using moulding profiles	Sweep, template (single or multiple)	Natural, synthetic, oil sands, highly refractory, special sands	Large size and minimum series cores	Wood, very cheap	1	Many skilled artisans, baking	Processes requiring skilled manpower. At some extent applicability of this type of molding is recommended for art, rudimentary
	On lathe	Vertical or horizontal axis	Natural or synthetic sand	Small series, circular segment large cores	"	1	Handicraft, central supported spindle. Baking	
	Skeleton		Synthetic and oil sands or high, refractory mixtures	Minimum series, large cores	"	1	Many reinforcing stalks baking	
	In core box	The core box structure may have movable parts	Cement, silicate/CO_2, oil, no bake	Several dimensions, small series, with more restricted allowances	Wood, low cost	3	Oil molding only requires reinforcing stalks and baking	For very restricted series and oily dimensions
JOLT MACHINE		Core boxes rollover and handling are mechanized	Generally synthetic or natural sands	Cheap, small series production	Wood, plastic, exceptionally metal parts	10	Special reinforcing stalks Baking	Not very interesting
AIR IMPACT - EXPANSION	Single joint machine	Blowing type, in all types other than single joint machines operations are alternative or carried out by different machines	Oil, silicate/CO_2, hot box, cold box, no bake	Medium series production All operations in sequence	Exceptionally wood, generally metals	20	Generally stalk-free baking according to mixture	Recommended upper limit. Mixture characteristics are very important
	Double joint		Generally hot or cold hardening mixtures	Medium - large series. Alternative operations	Metal More complicated core boxes	35	No reinforcing stalks. Baking on machine, if required	Not advisable
	Multiple joints			Large - very large series. Distributed operations	Cast iron or steel Very sophisticated core boxes	More than 50	Ditto	Out of scale for AGP countries
AIR SQUEEZE		Ancillary equipment (rotatory table, rollover for continuous cycle).	Synthetic sand Oil	Flexible for medium series with core box rotation	Wood, plastic, metal (aluminium), average cost	10-15	Reinforcing bars, if required Baking	Versatile but subject to tools wearing and needing rotating impellers
CHEMICAL MIXER		Contemporary, timbers addition of pre-mixing	No bake mixtures (plastics, catalysts)	Surface precision, flexibility for small medium series cores	Wood, plastic, exceptionally metal. Good life of the equipment	15 - 10	Very small, no reinforcing (save for transport) and baking are required.	Many advantages; natural characteristics must be verified.

b) Choice of sand core production methods for A.C.P. foundry

Hand core molding requiring baking is intended for special cases of large castings, very small series, or urgent requirements. This due to the high professionality usually required, for the poor accuracy and low productivity.

Also sand-oil hand or machine molding of molds should be used in a limited way because of the core supports required before baking in order to prevent deformation.

It is suggested, for series cores (estimate approximately 2000/day), to use 2 core-blowers (capacity 30 cores/hr. ranging from few grams up to 10 kilos approximately) together with a blowing station for the mix being hardened by a gas flow.

Large cores can be produced with the continuous mixer , combined with flaskless moldings or using special sand and additives.

c) Diagrams and illustrations concerning sand core production

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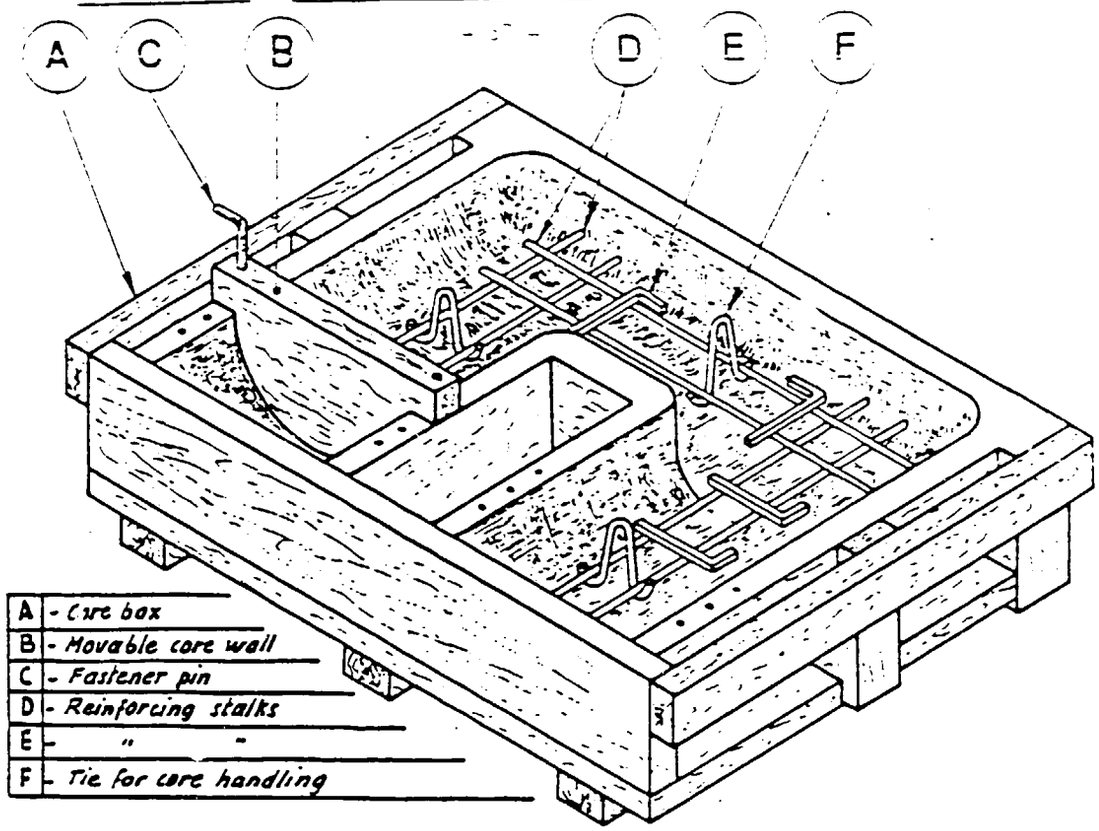
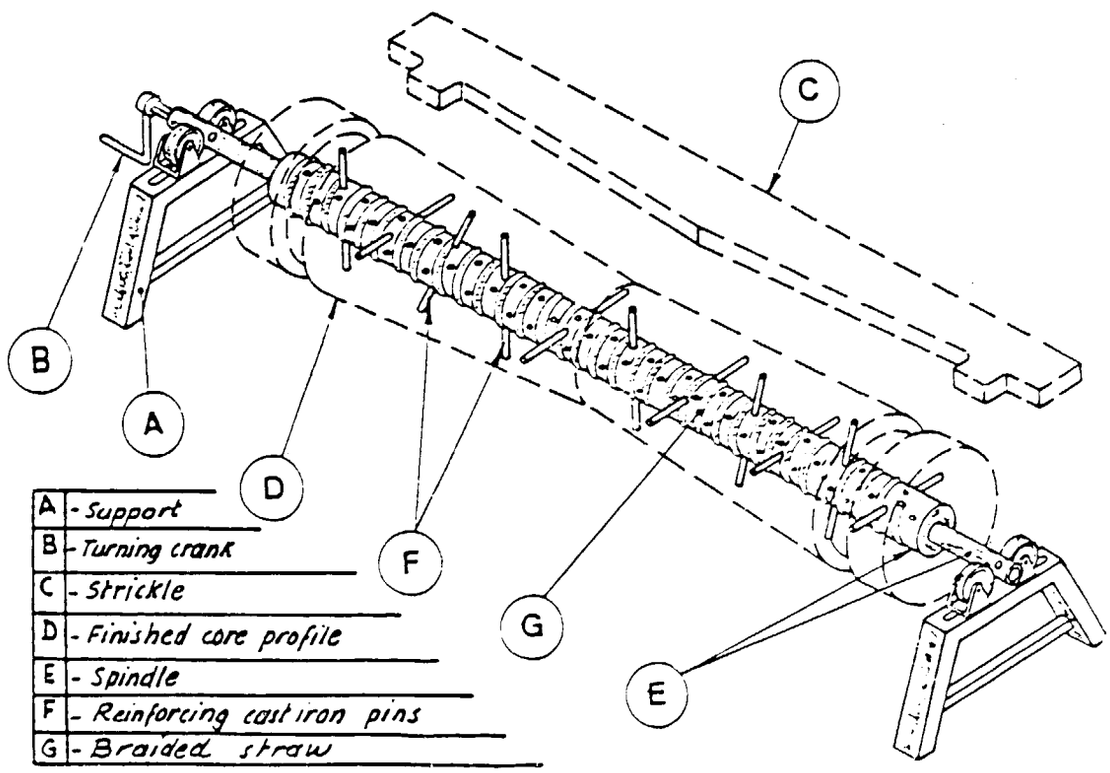
CORE BOX FOR PRODUCING LEFT AND RIGHT HAND CORE



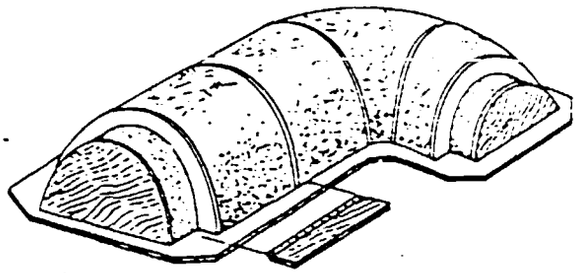
A	- Core box
B	- Movable core wall
C	- Fastener pin
D	- Reinforcing stalks
E	- " -
F	- Tie for core handling

LATHE TEMPLATE MOLDING



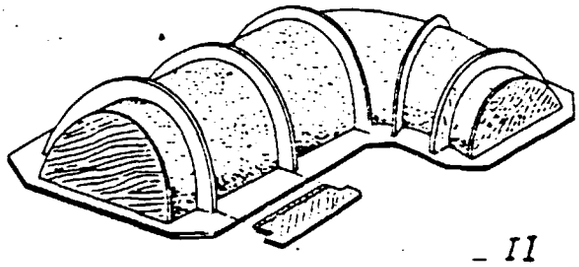
A	- Support
B	- Turning crank
C	- Strickle
D	- Finished core profile
E	- Spindle
F	- Reinforcing cast iron pins
G	- Braided straw

(From - "Formatura" ASSOCIAZIONE)



SKELETON MOLDING OF A CORE -

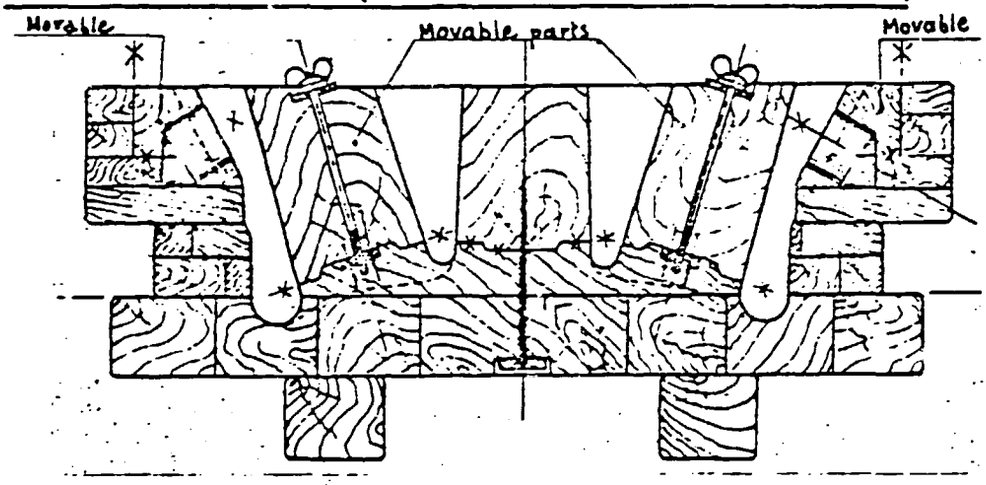
I

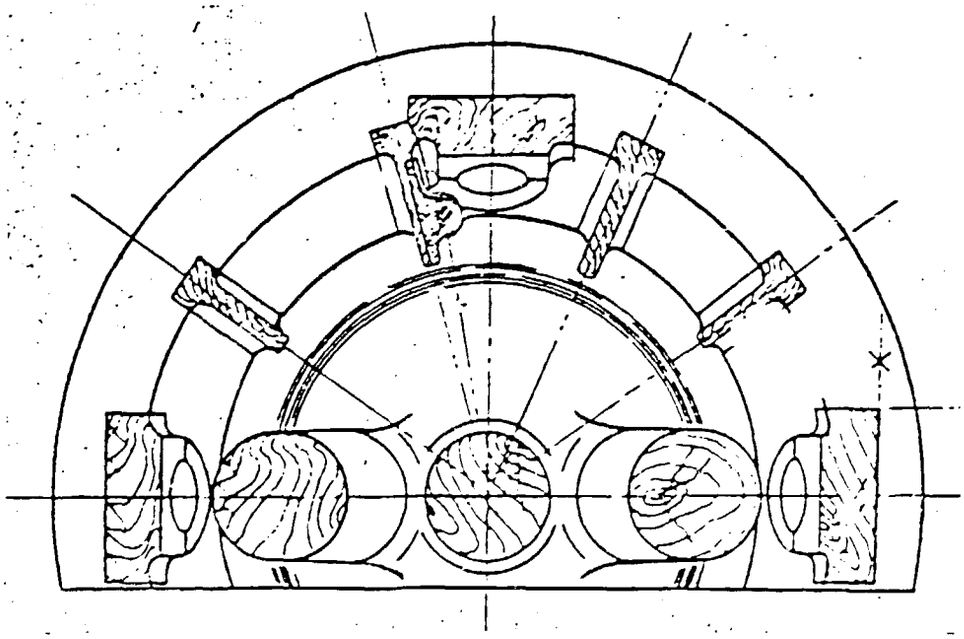


II

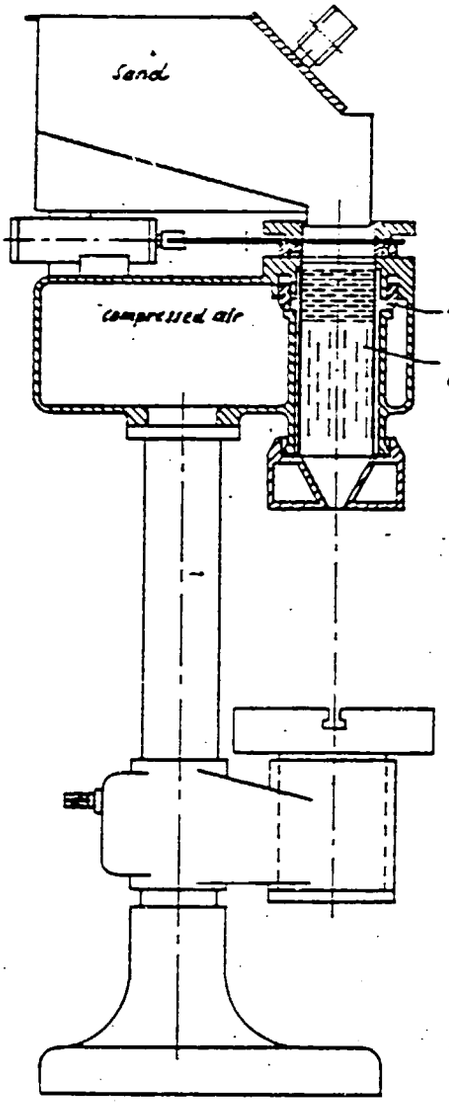
(From: "Le Anime - Fond. Ghisa" Assofond)

DECOMPOSABLE CORE BOX (BOAT DIESEL ENGINE CYLINDER HEAD)



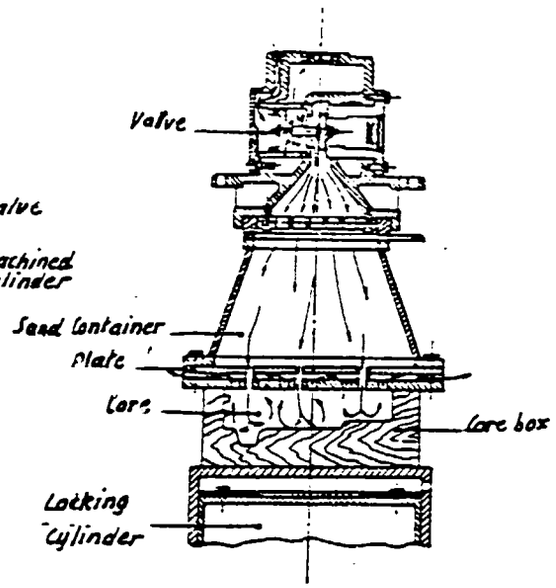


CORE BLOWING



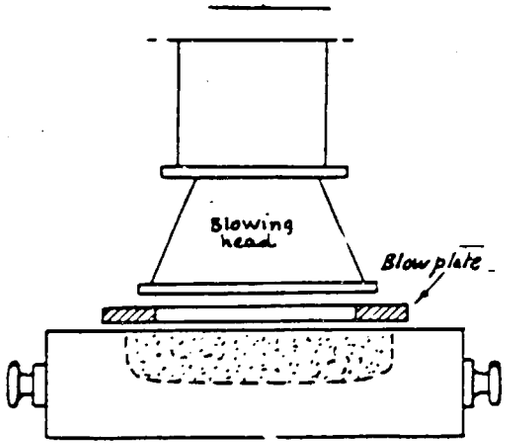
CORE SHOOTER

The compressed air acts pressing the sand suddenly at high speed as a shot

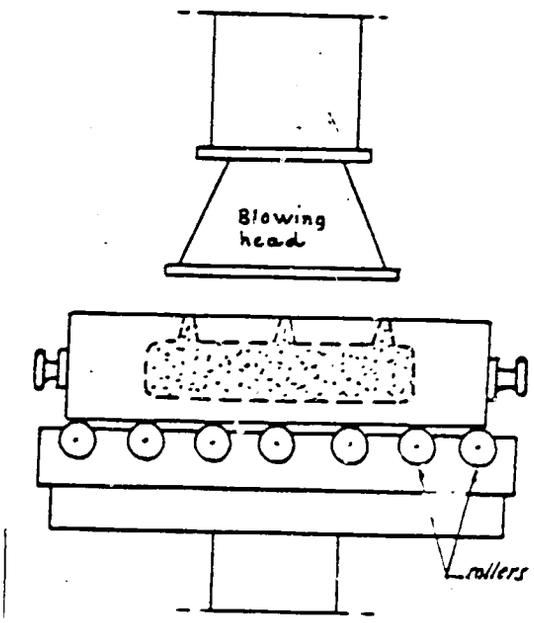


CORE BLOWER

The sand is entrained in the core box by the mixed air



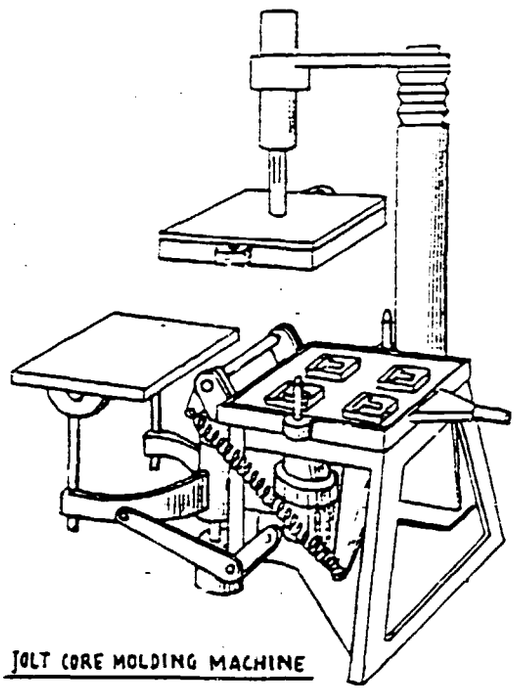
OPEN CORE BOX WITH LARGE UPPER SURFACE REQUIRE FRAME (BLOW PLATE)



CLOSED CORE BOX, WITHOUT INTERMEDIATE FRAME

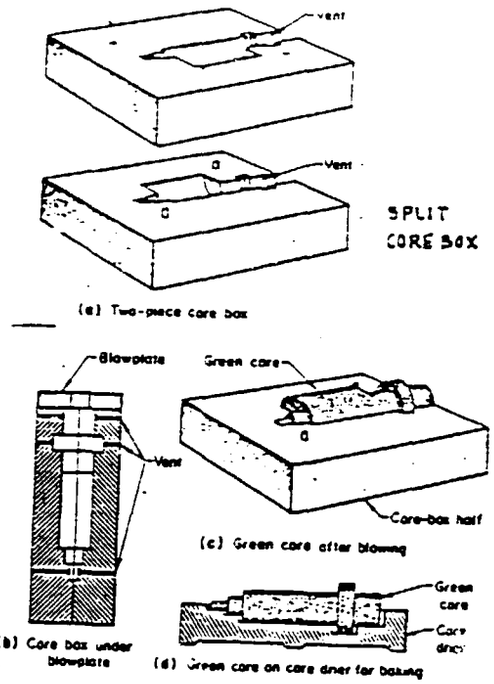
(From: "Le Anime Fond. Ghisa" A. SOFONO)

VARIOUS TYPES OF EQUIPMENT FOR CORE



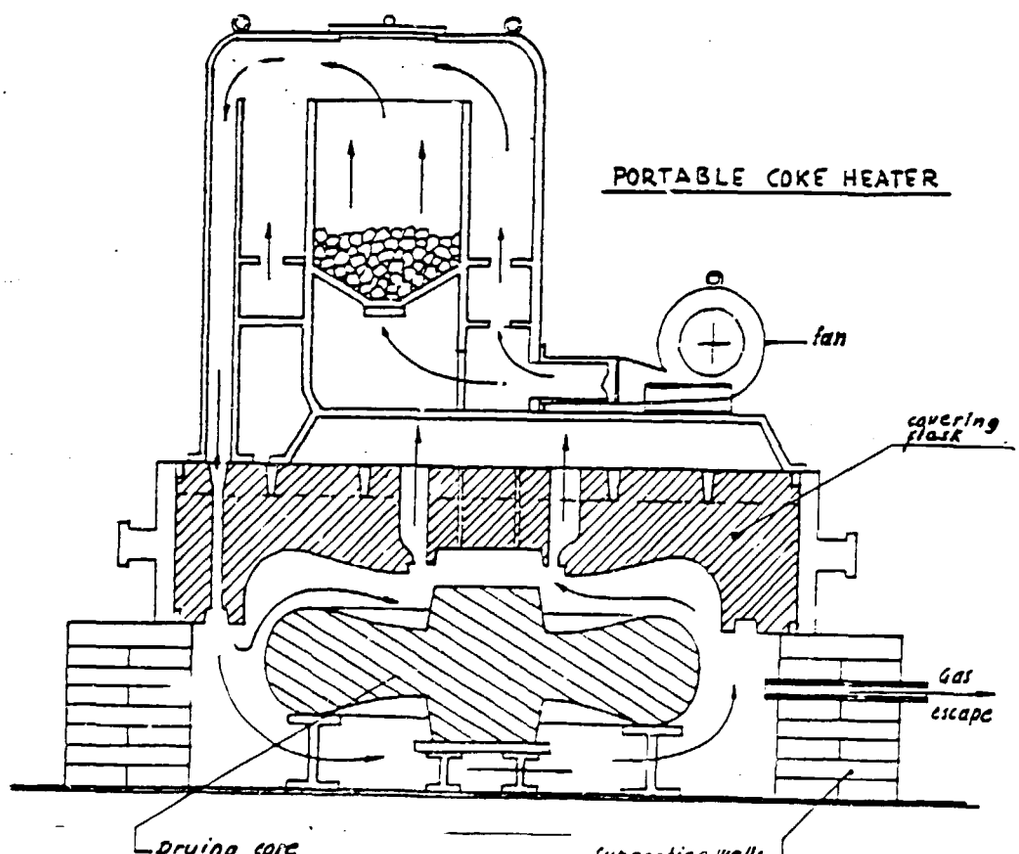
JOLT CORE MOLDING MACHINE

(From: "Le Anime - Fond. Ghisa" ASSOFOND)

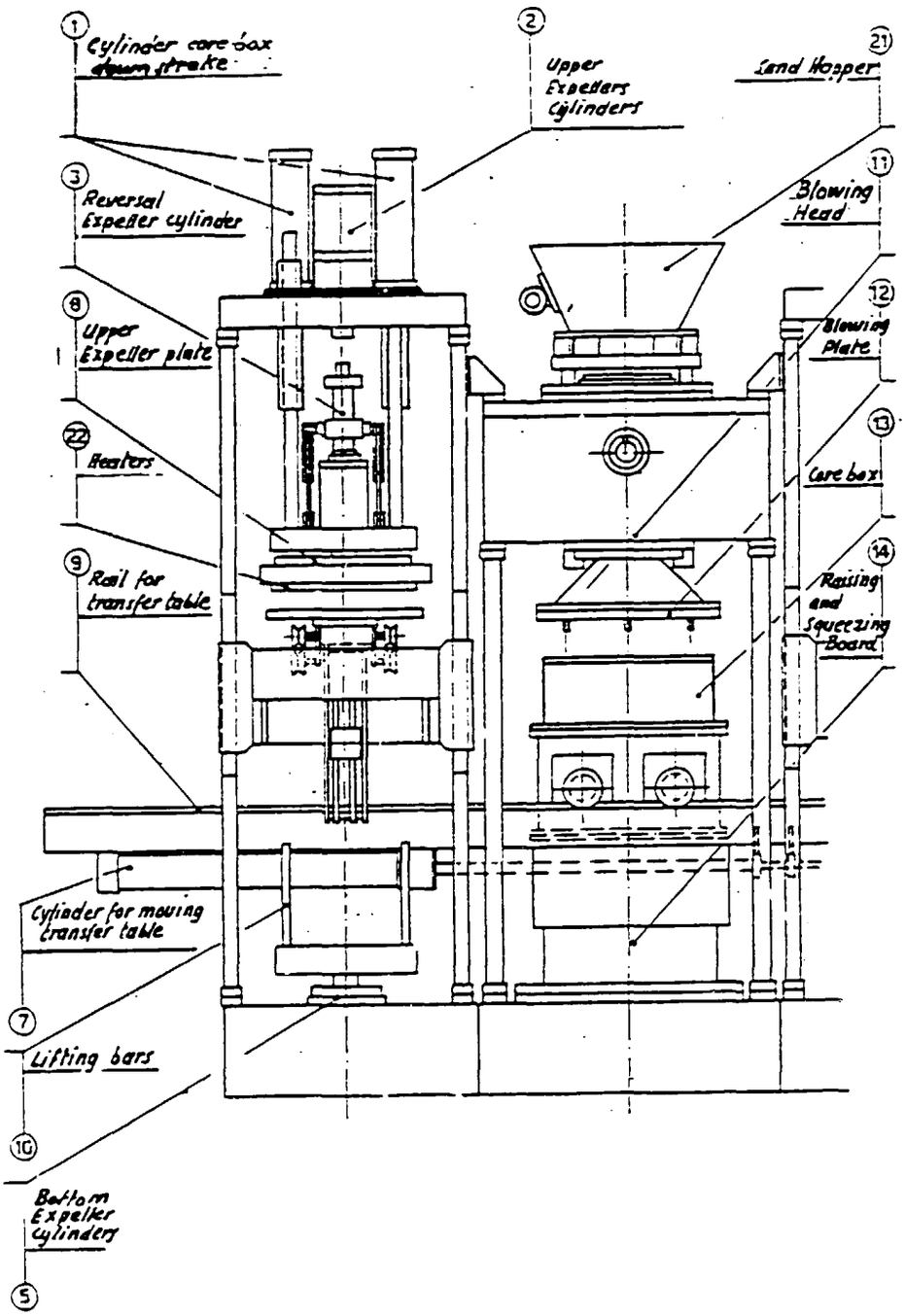


BLOWING SAND CORE IN A TWO PIECES CORE BOX

(from: "Metals Handbook")

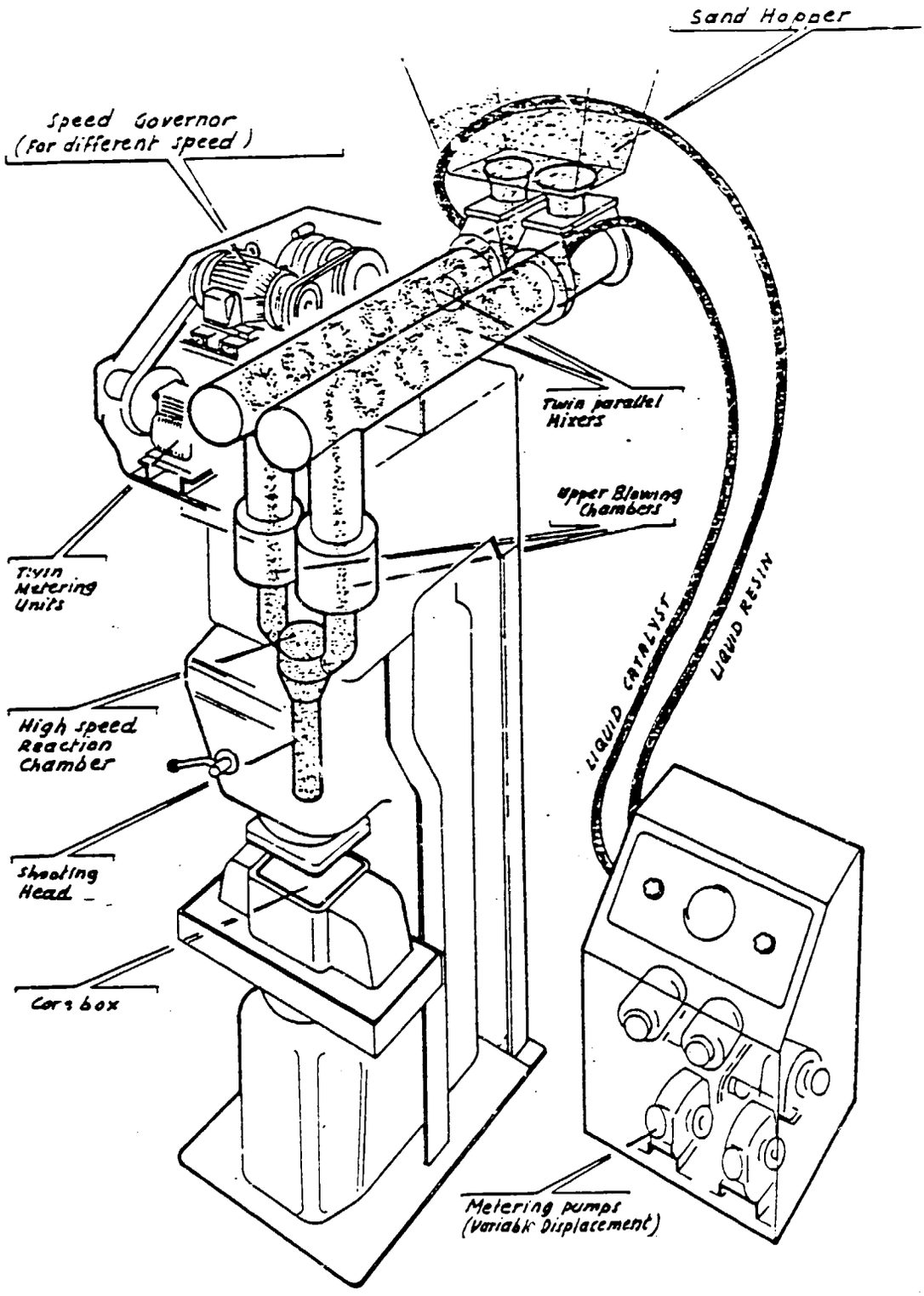


(From: "Le Anime Fond. Ghisa" - Assofond)



HALF PART OF A TWO STATIONS CORE BLOWING MACHINE

(From : Le anime - Fond. Ghisa - Assofond.)



SCHEME OF CORE MACHINE USING A PROPELLER AFTER SEPARATE PREMIXING OF CATALYST AND RESIN WITH SAND

(From: "La Anime - Fond. Ghisa" - Assofond)

V - TRENDS IN THE CHOICE OF MATERIALS AND PRODUCTION METHODS FOR MOLDS AND CORES

a) Main materials for sand molding (Table V)

Table V shows the itemized diagram of the main materials used for sand molds and cores and the indication of use and cost features for each of them.

Some types of materials have been grouped under a single denomination (e.g. Silicate process, Resin sand, etc.).

The less common methods have not been considered.

CAST IRON FOUNDRY — SAND MOLDING MAIN MATERIALS — (TABLE V)

Characteristics \ Mixture	Natural sand	Cement Sand	Synthetic sand	CO_2	Sand/Furan or phenolic resins	Sand/Resin with quick setting pre-mixing resin	Hot box	Cold box	Fluid sand	Sand Oil	Shell molding
Components (indicative)	Clay 30% Water 8–10%	Sand 100 Cement 7–12 Water 3,5–10	Sand 100 Benton. 10 Seacoal 5 Water 3–4	Sand 100 Silicate 3,5–7	Sand 100 Resin 2 Catalyst 0,5	Sand 100 Furan resin 2 Catalyst 1	Sand 100 Resin 2 Catalyst 0,5	Sand 100 Phenolic-acrylic resin 2 Hardener 0,2	Sand 100 Silicate 6–8 Surface act. 0,1 Bicalcic silicate 3 – 4	Sand 100 Oil 1,5–2,5 Added with alkyd resins	Sand 100 Phenolic resins 3–4
Standard application	Molds	Core/molds	Molds	Cores	Core/molds	Core/molds	Cores	Cores	Cores	Cores	Core/molds
Mold sizes (standard)	Not limited	Large	Not limited	Small–medium	Not limited	Small–medium	Small–medium	Small–medium	Generally large and medium	Small–medium	Small–medium
Type of required equipment	Simple, usually wood	Simple, usually wood	Wood or metal	Reinforced wood - metal for long runs	Wood Resin Metal	Wood Resin Metal	Metal (cast iron)	Wood Resin Metal	Wood Resin Metal	Wood Resin Metal	Metal
Mixture cost (indexes)	1	1,5	2	2,5	2,5	3	2,5	3,5	3	2	8
Expected productivity (indexes from 1 to 5)	1	1	2	2	4	5	4	5	6	1	5
Mixture reclaimation	10%	Limited	80–90%	Limited	Good	Good (special installations are required)	Good	Being studied	Being studied	90%	Being studied
Collapsibility (after knockout)	Average 80%	Bad 50%	Good 90%	Bad 50%	Good 90%	Good 90%	Good 90%	Good 90%	Average	Good 90%	Average-good 85%
Molding final characteristics: Compressive strength kg/cm2	15–25	10–20	0,9÷1,5	15÷70	40÷70	50–80	50–60	50–60	Reliable data not available	9–12	40–70
Molding final characteristics: Permeability	250	200	90–130	250	250	250	250	250	"	200–250	300
Molding final characteristics: Possible faults due to gas (from 1 to 5)	2	1	2	1	3	3	3	3	"	2	2
Castings precision (from 1 to 5)	1	2	2	3	3	3	3–4	3–4	2	2–3	5
Flowability	not good	optimum	not good	good	good	good	good	good	optimum	average	good
Adaptability for developing countries foundries	Subject to surveys and careful application	The process is slow and weather conditions must be taken into account	Results are positive with good based sands	It seems the most suitable for cores and flaskless molds	Resins and catalysts very good in European countries may be damaged during stockage due to weather conditions. It is necessary to select less critical mixtures and therefore with different setting periods				Some characteristics must be better established	Provisions must be taken to support cores before taking	Suitable for long runs due to the equipment and mixture costs

b) Considerations on possible choices and alternatives

For small-medium casting moldings, green sand (moisture 2.5 ÷ 4%), recoverable, is undoubtedly the most convenient one provided a good base sand and a proper dust exhaustion and cooling equipment are available.

In the foundry under consideration, green molding has been selected for jolt squeeze machines. By reducing the additives, it can be used also as backing sand where the methods of facing and backing sand in the same molding box are employed.

The latter method is obsolete in Europe for mass production (more expensive, slower, less uniform), but it is undoubtedly suitable for hand and pit molding where highly refractory special sands are used as facing sand.

As concerns continuous mixer molding suitable for production of flaskless moldings as well as of cores, sand can be agglomerated with many types of binders requiring no bake. In this case the set up must be done knowing the climatic conditions of the country for the adaptation of mixes characteristics (bench life, stocking possibility, etc.).

Generally speaking, it is suggested the use of sodium silicate mixes to be hardened in CO_2 flow or the use of the so called fluid sand the properties of which are reported indicatively (the use in Europe is not yet generalized).

VI - SMELTING PLANTS

a) Main fuel furnaces and relevant characteristics (Table VI/a)

b) Main electric furnaces and relevant characteristics (Table VI/b)

Table VI/a and VI/b show the characteristics of the different types of furnaces for smelting plants requiring diversified thermal sources and relevant suitability levels.

CAST IRON FOUNDRY — FUEL-FIRED MELTING FURNACES — (TABLE VI/a)

CHARACTERISTICS / TYPE	Main Characteristics: basic	Main Characteristics: variant	Heat source	Charge	Running	Lining and life	Remarks
CUPOLA	Cold wind	Traditional	Coke	Pig iron, foundry residues, scrap steel, coke, ferroalloys	Continuous from 1 ÷ 15 tons/h	Generally acid, exceptionally basic, daily relining	A receiver is required for overheating and as holding furnace
		Powered	coke with O_2 enriched wind				
		Poor fuel	with charcoal (experimental)	Charcoal instead of coke(+80÷100%)	Continuous 0.6 ÷ 0.8 ton/h	Acid lining, also sand	A forehearth furnace is deemed essential
	Hot wind with cooling	with or without recuperator; with or without lining	Coke	Cast iron pigs may be eliminated in most efficient types and carbon content for steel scraps may be obtained through coke	Continuous from 3–4 to 100 ton/h	Acid or carbon rammed lining is the most widely spread for hot lined types. Lining life can exceed one week. Basic lining running gives good results with long operation	A receiver is required, it may be an electrical channel or coreless furnace or a static or reverberatory furnace
	Hot wind water cooled	with O_2	Coke with O_2				
		with additional burners	Coke+natural gas, coke+fuel oil–coke+calcium carbide				
		with double rows of nozzle	coke				
	Gas	natural gas	natural gas	Added coke acts as burning material	4÷5 tons/h		
		propane/oil natural gas	gas or fuel oil				
CRUCIBLE	Fixed crucible Tilting crucible	Without air pre-heating Pre-heated air	coke gas fuel oil	Selected scraps and cast iron pigs with ferroalloys	up to 0.5÷1 ton (intermittent)	Crucible may be made of graphite or have lined and rammed metal frame	For small quantities of cast iron, even alloyed. System is in extinction.
STATIC REVERBERATORY FURNACE (hearth type)	Without air pre-heating With air pre-heating		cannel sea coal / gas / fuel oil	Selected scraps and cast iron pigs and liquid ferroalloys	up to 50 tons (intermittent)	Acid (siliceous or silico-aluminous)	Air pre-heating type is used to increase production and for larger sizes
REVERBERATORY ROTATING FURNACE	With or without recuperator Tilting or not		Fluid coal, gas, fuel oil, gas+fuel oil	High C content cast iron, scraps return ferroalloys. It may work in duplex with a cupola (liquid charge)	Intermittent with solid charge (up to 10 tons). Even continuous with liquid charge (up to 50 tons)	Generally acid, lining life:250–400 charges	Good deoxidizing and degassing. Valid also for malleable cast iron

Cast Iron Foundry	ELECTRIC MELTING FURNACES								Date: 9/61
Properties / Furnace type	Variants	Operation principles	Electrical characteristics	Capacity	Running	Linings	Installation critical points	Energy consumption	Merits, demerits and particulars
RESISTANCE FURNACE	Indirect arc Graphite resistor	Radiating heat from an arc between two horizontal electrodes Radiating heat from a graphite bar (ϕ 50÷90 cm)	Network troubles and low power factor Charge is constant and the factor near one 30 – 700 KVA 20 – 80 Volts	from 0-1 to 1,5 ton	Neutral, generally slags are not required considering the CO saturation of the furnace atmosphere	Normally, furnace is lined with high alumina cemented refractory and with corundum crust	2,5 – 4 kg/s tube electrodes consumption from 3-5 ml/s cooling water	From 520 to 700 kWh/ton	Useful for small foundries, especially with small capacity furnaces. Simple plant, cost not very expensive and easy handling.
CHANNEL FURNACE (OR INDUCTION FURNACE)	Vertical channel Lifting horizontal channel Opened channel	By means of an inductor, heat is generated in a secondary channel and then transferred to the charge by conduction and convection	For melting From 80 kw to 2000 kw and more For holding From 100kw to 2000 kw and more at 1.f. 1 or 2 inductors	from 0,5 to 10 tons from 2 to more than 100 tons	Acid, basic or neutral depending on lining nature	Crucible normally lined with corundum bricks and insulating bricks Zirconium, zircon, and magnesite linings are used for channel and inductor	Channel and inductor: the inductor replacement consists in furnace steps and could occur every 2-3 months Re-lining occurs after longer periods	For melting From 900 to 650 For holding 20 – 40 kwh/t For overheating 35 – 20 kw/t	Generally speaking holding furnaces are equipped with, and they become If coupled to a crucible furnace capacity to deliver the liquid production
LOW FREQUENCY CRUCIBLE FURNACE	Low frequency Thristor or rotating converter Intermediate frequency (for three-frequency)	An alternate current passes through a cooled coil surrounding the crucible where there is the charge in which an induced current producing heat is generated.	50-60 Hz 300kw –25000 kw 500-8000 Hz 150 – 300 Hz	0,4 60 tons 100 3000kgs 300 kgs	Generally is acid or neutral	Sand in very pure SiO2 bonded with formate sintered and roasted boric acid (linings in magnesium alumina or aluminium bricks are less used)	Coil cooling and good maintenance are very important 3÷15 m3/h cooling water (heat exchanger)	Low frequency for melting From 570 to 600 kwh/ton Medium frequency (melting) From 620 to 700 kwh/t	It is the most widely melting furnace of holding furnace of introduced on the Ghisoni, operations with cold, production or liquid charge. It is the most diffused furnace for all kind of iron (or steel)
(DIRECT) ARC INDUCTION FURNACE	The variants whose characteristics are listed is destined to the cast iron foundry in its different parameters	The arc between electrodes and charge and closing between charge and electrodes is the heat source	Max. tension 300V The ratio power/capacity (kVA/t) is important. Generally 400 KVA/ton. The power factor ranges between 0,85 and 0,7	from 4 to 5 up to more than 50 tons	Acid or basic	Roof: high alumina bricks Sides: refractory dolomite, magnesite or silica Hearth: generally basic lined	Electrodes control system and graphite consumption from 4 to 7 kg/t Graphite electrodes may break and may use stops	Approx. 1200 kh/t	It is the best suitable low furnace for the forming cast iron, charges, especially for the finest metal. High electrical power consumption

c) Choice of smelting equipment for the proposed type of foundry for A.C.P. countries

Choice elements

The definition of the proper smelting plant for a cast iron foundry in emerging countries depends on the many interdependent variables deriving from basic parameters, such as:

- metallurgy of the product;
- output rate of molds;
- casting dimension and complexity;
- available thermal sources and relevant regularity;
- materials availability (charge, refractories, spares);
- labour skill and cost;
- investment and operating costs.

After a first investigation of smelting means as a whole, the ones combining the most favourable factors for a non-industrialized country will be underlined, and the relevant adaptation to the general outline of the area involved and to the specific field of the foundry under consideration will be studied.

The available foundry means in the industrialized countries are reported in Table VI/a and VI/b.

Determination of most adaptable furnaces

In reviewing the characteristics of the furnaces reported in Table VI/a - VI/b, different adaptability levels are evinced.

Any type of hot wind cupola is an expensive and delicate equipment to be operated with extreme care and requiring refractories and possibly alternate sources of combustion supporters and fuels hardly available in a country where transportation is precarious and irregular, and imports restricted.

Natural gas cupola or with mixed heat sources are little tested experience-wise, while charcoal cupola have a limited application, low productivity and it may be expected (at least at present) that they produce low temperature and quality liquid cast iron unsuitable for the considered foundry programme.

Crucible furnaces are suitable for restricted specific productions of bonded cast iron, obsolete as conception and little versatile. Static reverberatory furnaces (which can be used as smelting or holding furnaces) are at present intended generally for large specific productions (rolling mills rollers), malleable cast iron, non-ferrous metals , but in general they are being replaced due to the low thermal efficiency (where the air is not pre-heated) and to low flexibility.

- Vertical channel furnaces have operation problems (non-uniformity of temperature) and life problems (breakage of bottom part of the refractory).
- Open channel furnaces have problems of heat exchange and side channel erosion thus the investigation is focused on tilt horizontal channel furnace.

For induction furnaces without channel the use of low frequency is the most suitable in cast iron casting for economical and metallurgical reasons (less power consumption, low purchase mixing and homogenizing action in the bath, easy operation, continuous running).

Generally, high tonnage of liquid cast iron can be best produced with low frequency furnaces. But medium frequency furnaces are suitable for small productions working in duplex with cupola (after the base cast iron has been properly treated) or starting from solid charge.

d) Detection of the more suitable alternatives (Table VI/c)

Further investigations will be carried out on the furnaces indicated as most adaptable to the emerging countries area.

When examining the types schematically summarized in the tables, and bearing account of the aforementioned considerations, it appears expedient to restrict the investigations for adaptation to the following smelting equipment:

1) Traditional cold wind cupola.
2) Reverberatory rotary furnace.
3) Electric resistor rotary furnace.
4) Horizontal tilt closed channel furnace.
5) Low and medium frequency crucible induction furnace.
6) Electric arc furnace.

The features of this equipment outline the smelting possibilities and the duplex operation where a forefurnace is required to keep, overheat and correct cast iron composition (Table VI/c).

References are made bearing account of the type of foundry, its capacity and the products to be supplied.

Adopted fournaces

Indicatively, a cold wind cupola plant with unheated forefurnace has been adopted for A.C.P. foundry. This equipment can be combined with a medium frequency induction furnace (for nodular cast iron casting).

CAST IRON FOUNDRIES — MELTING FURNACES – SINGLE FACTORS IN THE BEST ALTERNATIVE SYSTEM FOR A C.I.P. FOUNDRY — TABLE 1/1

Characteristics / Melting furnace	MELTING FURNACE CHARACTERISTICS				Cost/ton		HOLDING FURNACE		MELTING FURNACE APPROVAL	
	General characteristics	Temperature control	Composition control	Flexibility	Liquid cast iron	Investment	Type	Characteristics	Strong points	Weak points
COLD WIND CUPOLA Alternate duty production in 2 shells with re-lining after each working day. It is convenient to provide a forehearth furnace, not heated, for emergency.	PRODUCTION 2–3 tons/h CHARGE Cast iron pigs 25% CONSUMPTION Coke 10–15% SMOKE EMISSION Very high 1400 m3/ton	Acceptable for continuous and constant running. Overheating possibilities very limited	Quite precise if running is not constant. Good for constant running	Production variants are very limited (they are expensive). Composition variants request periods of transition and production loss	5° Charge high cost. High consumption of heat sources and refining)	2° (The equipment for the holding furnace has to be taken into account)	Reverberatory furnace	5 tons capacity Air pre-heating	Energy that units are economical, good, recovery. Good instrument for continuous continuous single testings	Not very suitable for modular cast iron, physical system, not very flexible Channel lining is expensive, thermal for cast iron not very suitable for cold start cast iron.
							Electric induction and channel furnace	5 tons capacity 250 KVA	More capacious but not flexible than the aforementioned. Good thermal efficiency, with overheating	
							Electric, induction, coreless furnace (low frequency)	Approx. 5 tons capacity 800 KVA	More flexible system, supplying very good quality of cast iron. Charge preheating etc. Increase production	High power absorptions, careful maintenance and cooling are required.
							Coreless induction furnace (medium frequency)	1 – 5 tons capacity 450 KVA	Expedient solution for small foundries allowing to melt partly in ingots and partly in cast.	Low stirring effect. Re-carburizer is not very well done to its reduced capacity
Mevertator, rotating furnace (fuel oil, gas, coal fired)	Capacity 2÷3 tons. Melting time 2.5 h, air pre-heating	Efficient up to 1550°	Good	Very good with two coupled furnaces	4°	1°	Heated forehearth furnace is not used. Provide for two coupled furnaces		Good cast-outs are excluded. Good quality cast iron, high temperature. Moderate investment	A strong disadvantage for its is represented for modular cast iron. The furnace is suitable for large, skilled foundries.
Mesistor, rotating electric furnace	Capacity 1.5 ton. 1000 KVA Electric charge Power fac. 1	Efficient also at high temperatures	Optimum	Acceptable	6°	3°	Heated forehearth furnace is not used. Provide for two coupled furnaces.		Good metallurgical behaviour, very good cast iron quality, flexibility with intermittence.	Power requirement is high but can be variable. (Single furnace) more special apparatus for comparatively.
Coreless induction electric furnace — for running low frequency	Capacity 5 tons – 1500 KVA	Optimum	Optimum	Optimum	2°	4°	Two coupled furnaces without heated forehearth furnace		The most suitable, with lots of selected scrap, to be available. It decreases costs and cast iron is always available.	High installation cost and notable overall costs.
Night running low frequency	Capacity 12 tons. 1500 KVA	Optimum	Optimum (with installations)	Limited	1°	5°	1 furnace together with a small melting furnace for modular cast iron			High installation cost, for the melting
Medium frequency	Capacity 3 tons. 1000 KVA (three frequency/thyristor)	Optimum	Good	Optimum	1° – 2°	6°	Heated forehearth furnace is not used. Provide for two coupled furnaces.		Quite good for different cast iron castings with relatively low costs.	High installation cost and [illegible] cost. Fine and more varied steel.
Arc furnace	Capacity 3–5 tons–3000 KVA–Castings length 1.5 h av.ton/h 2–3	Optimum	Optimum	Intermittent emission and consequently the forehearth furnace is required	3°	6°	Channel induction (I.F.)	10 tons capacity 250 KVA	Optimum as to temperature, productivity, reliability of charge, operation flexibility, metallurgical versatility	Peak periods, flexibility electric network. High noise during cast iron (90% of the normal) High power level. High installation cost
					1° low 2° high	Figures Figures	Coreless induction (I.F.)	10 tons capacity 1,000 KVA		

e) Diagrams and illustrations concerning types of smelting furnaces

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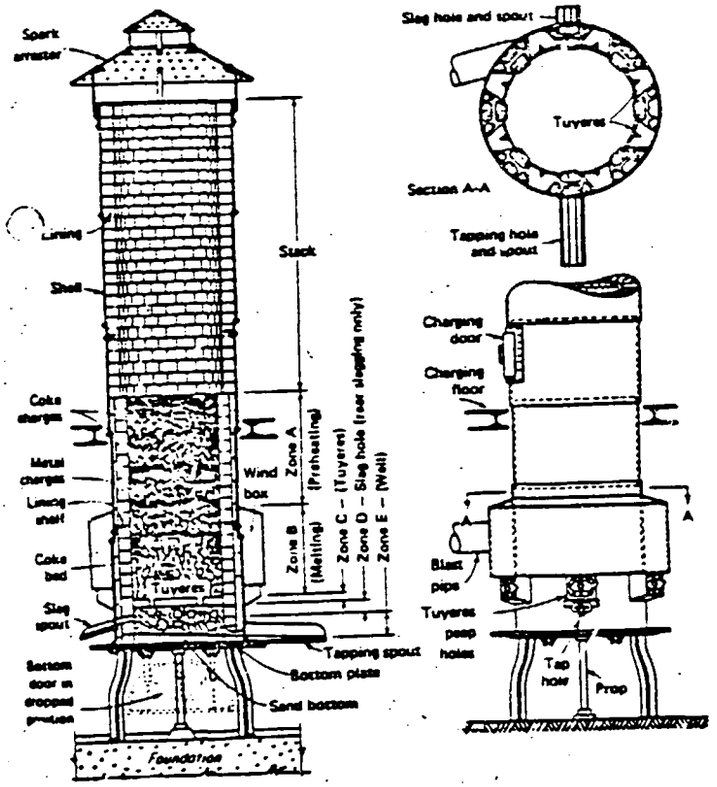
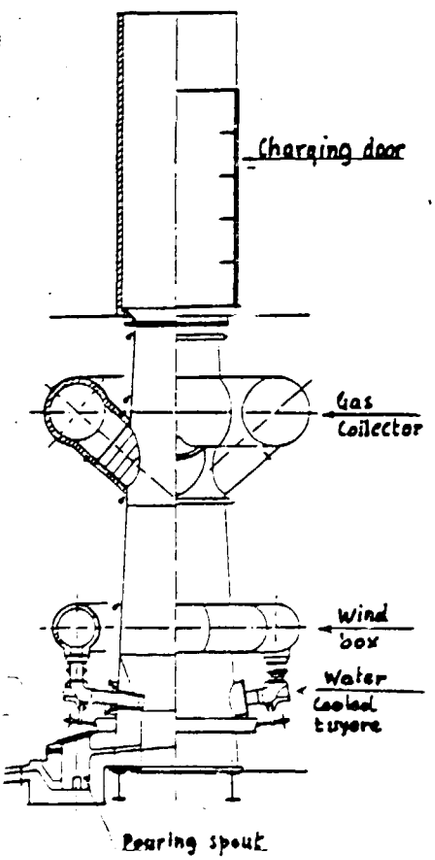
DIFFERENT CUPOLA INSTALLATIONS

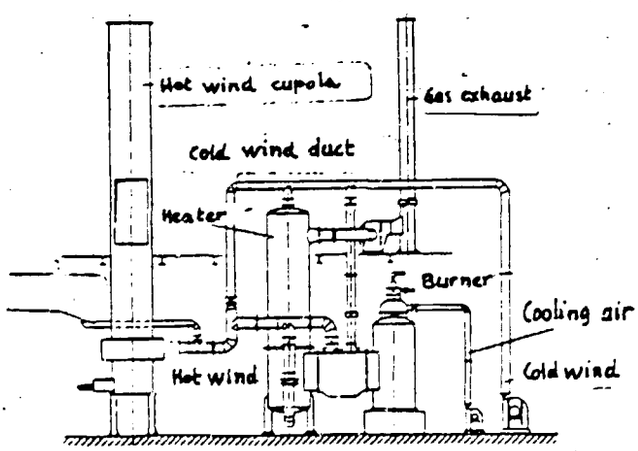


CONVENTIONAL COLD WIND CUPOLA

Hot wind water cooled lineless Cupola

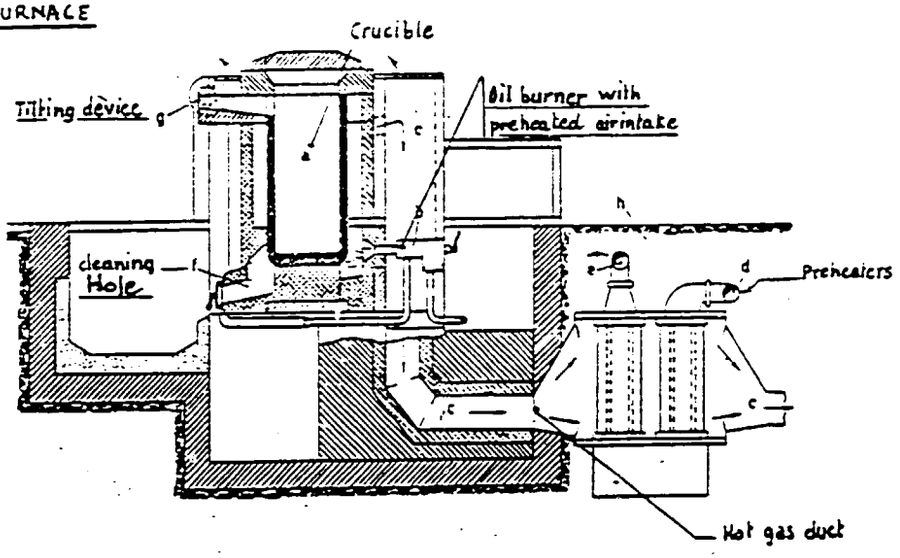


Hot wind Cupola installation (Indipendent heating)

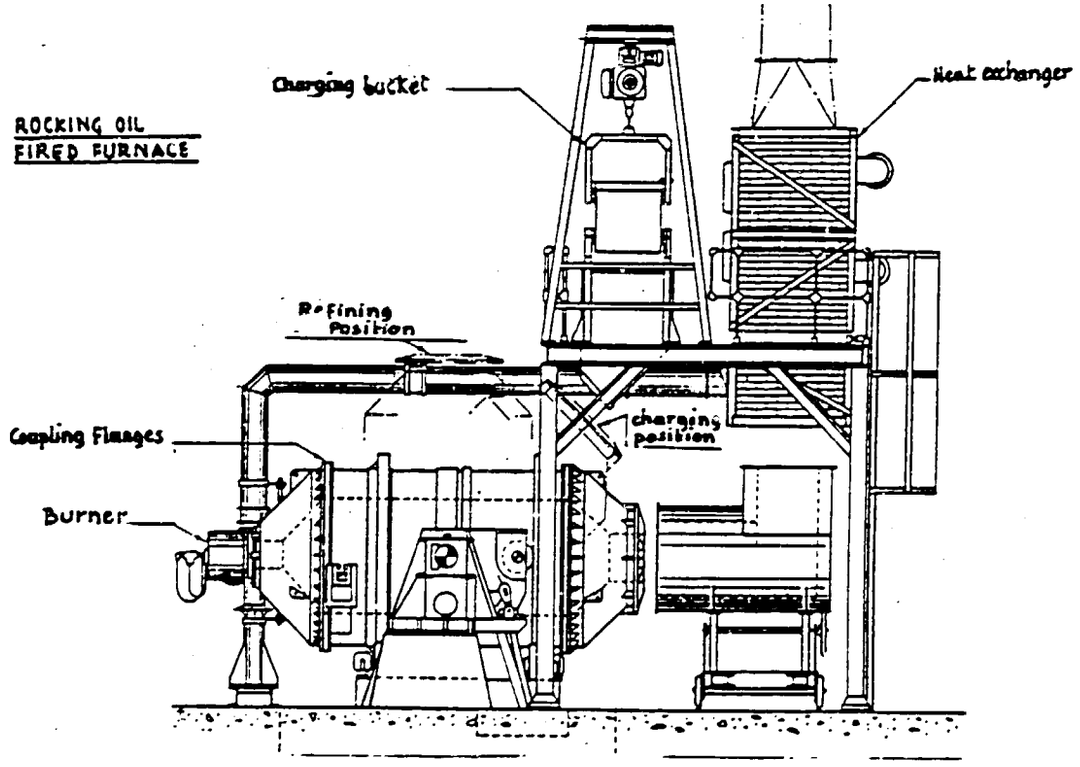


VARIOUS TYPE OF MELTING FURNACES

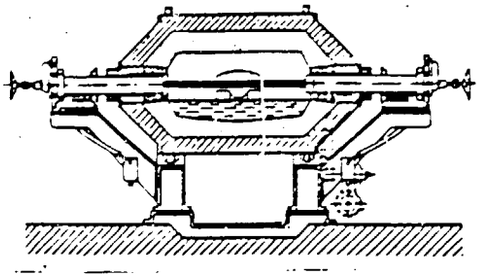
TILTING CRUCIBLE FURNACE
OIL FIRED WITH AIR PREHEATING



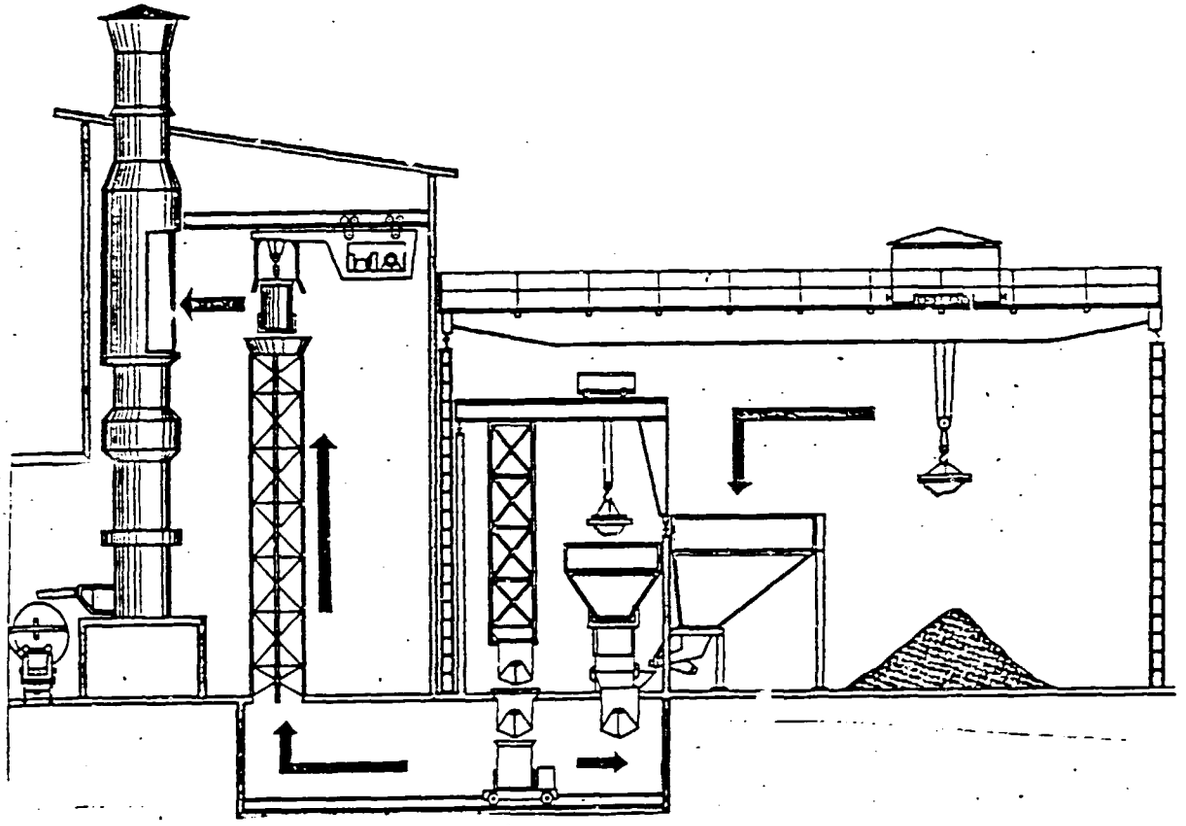
ROCKING OIL FIRED FURNACE



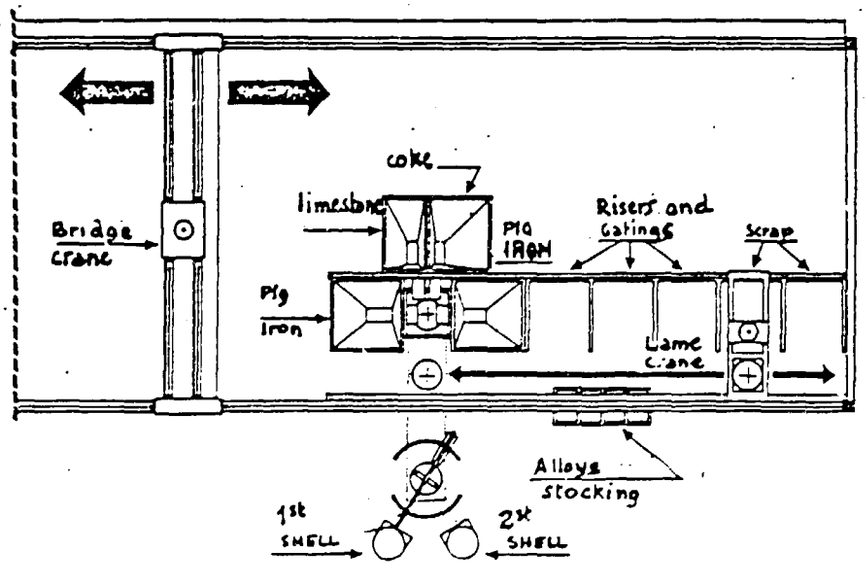
ROCKING RESISTOR ELECTRIC FURNACE



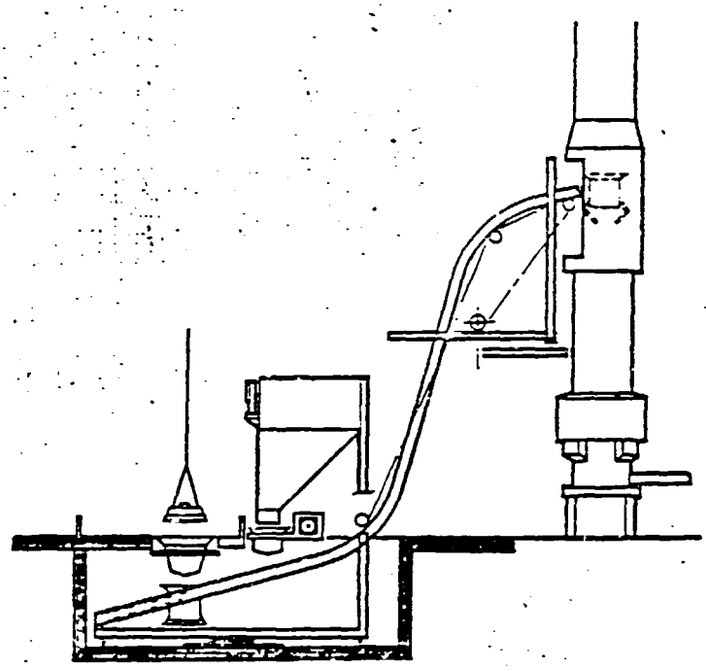
MECHANIZED CUPOLA CHARGING SYSTEM



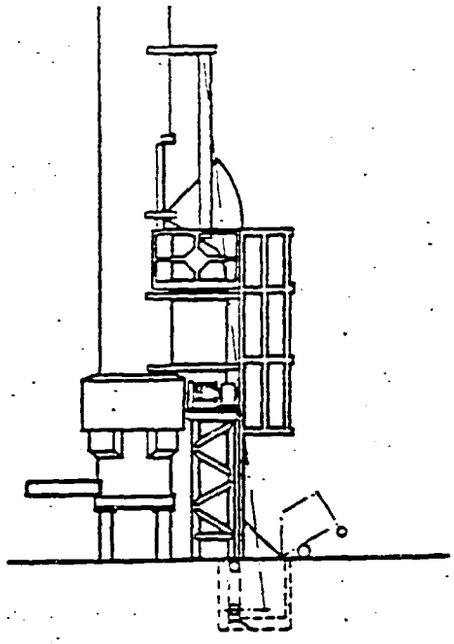
BINS FOR PROTECTED STORAGE OF CHARGE MATERIALS



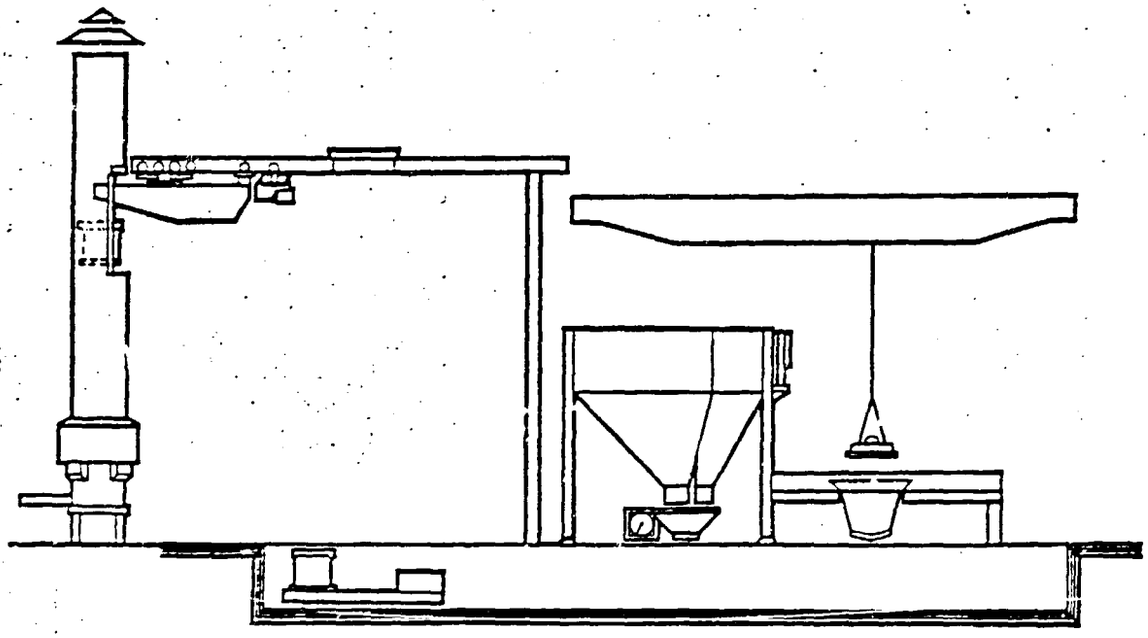
MECHANIZED CUPOLA CHARGING SYSTEMS



Sloping skip



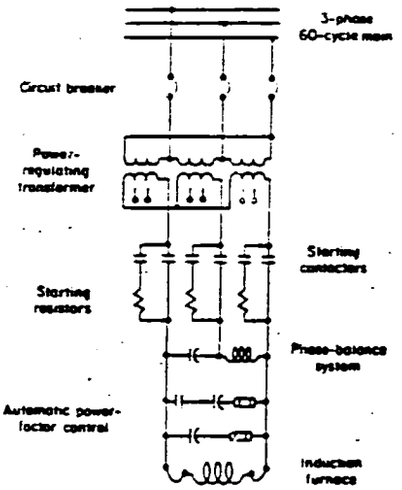
Vertical skip



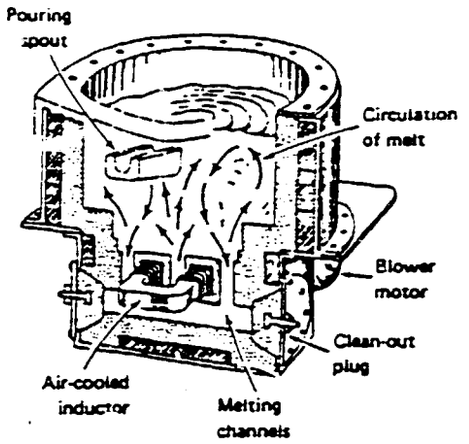
Monorail Travelling bucket

(From: "PRAMAGGIORE" Holz

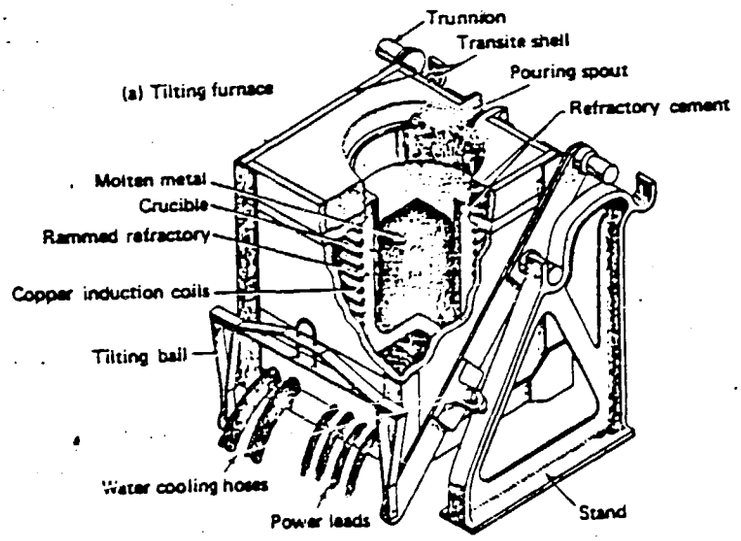
ELECTRIC INDUCTION FURNACES



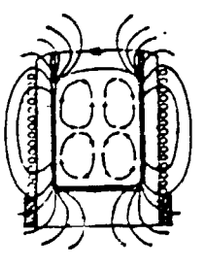
CIRCUIT DIAGRAM FOR AN INDUCTION MELTING FURNACE



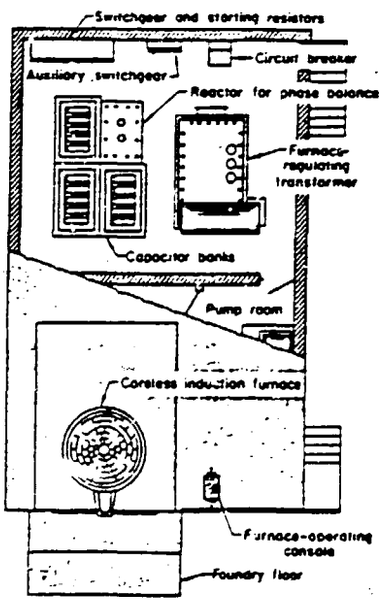
CHANNEL TYPE INDUCTION FURNACE



CORELESS INDUCTION FURNACE

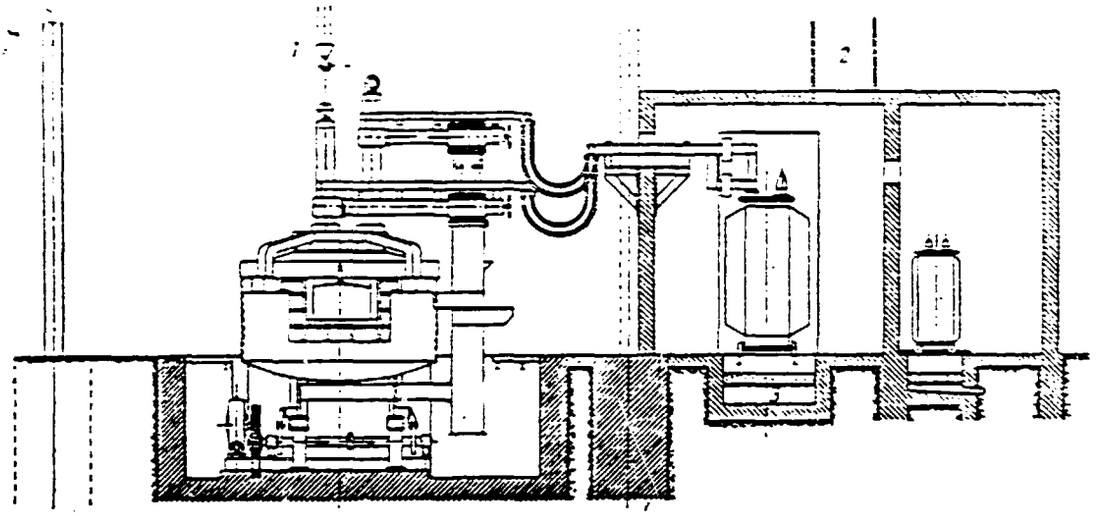


(b) Lines of magnetic force and stirring action on the molten metal bath.

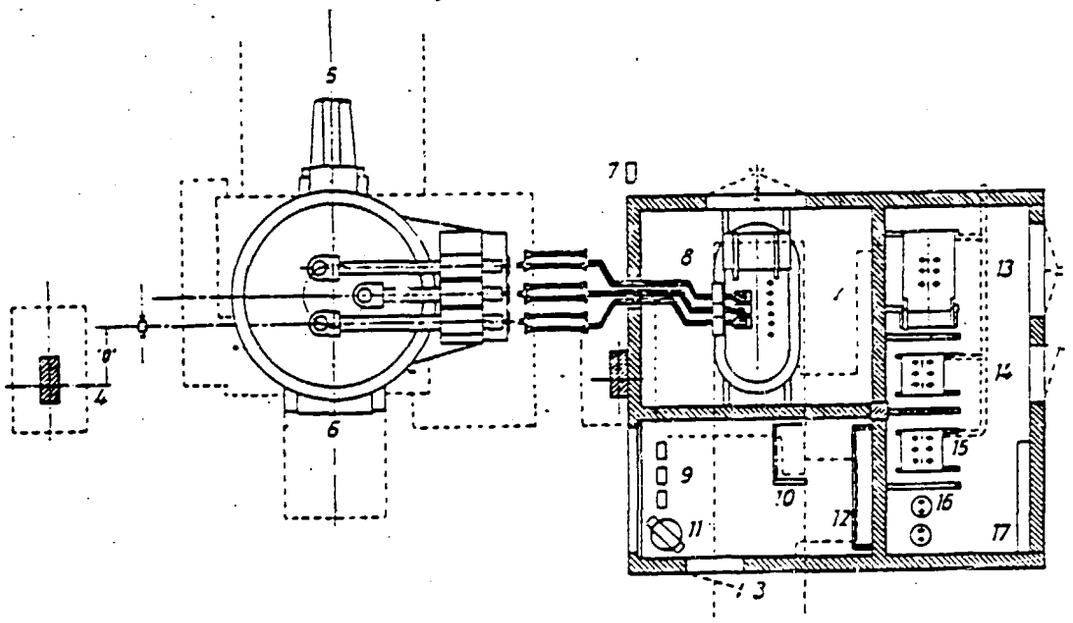


CORELESS INDUCTION FURNACE INSTALLATION

(From Metals Handbook · Vol. V · A.S.M and Principles of Production Metallurgy for ferrous castings · A.F.S



GENERAL WIEWS OF A TYPICAL DIRECT ARC FURNACE INSTALLATION



1.	Overhead bridge crane	10.	Control board
2.	Air exhaust duct	11.	Instruments panel
3.	Air intake duct	12.	Regulating system for electrodes
4.	Clearance of crane hook	13.	Impedance coil
5.	Tapping spout	14.	Oil impedance coil breaker
6.	Slagging duor	15.	Oil general circuit breaker
7	Tilting lever	16.	Underground passage for cables
8.	Transformer Room	17.	Panel board
9.	Electrodes manual control		

(From: La Metallurgia della Ghisa - ASSOFONDA)

VII - ADAPTATION OF A SAND PLANT FOR A.C.P. FOUNDRY

a) Sand recovery operation sequence (Table VII/a) and alternatives in the area of main machinery (Table VII/b)

Table VII/a shows green sand reclaiming operations.

Table VII/b shows a classification of the main machinery for sand plant and relevant alternatives.

One of the diagrams also shows a type of equipment for chemically bonded sand reclamation.

This equipment has not been taken into consideration for the time being, because of the low volume of sand involved, in order to prevent big investments.

b) Considerations on possible choices and alternatives

The specific characteristics of green sand recovery plant in the countries of the emerging area are:

- good selection of return sand;
- strong cooling;
- excellent depulverization;
- easy drawing from storage bins;
- safe and simple equipment;
- binders manual batching through volumetric containers;
- good aeration of prepared sand.

These requirements have been taken into consideration by adopting:

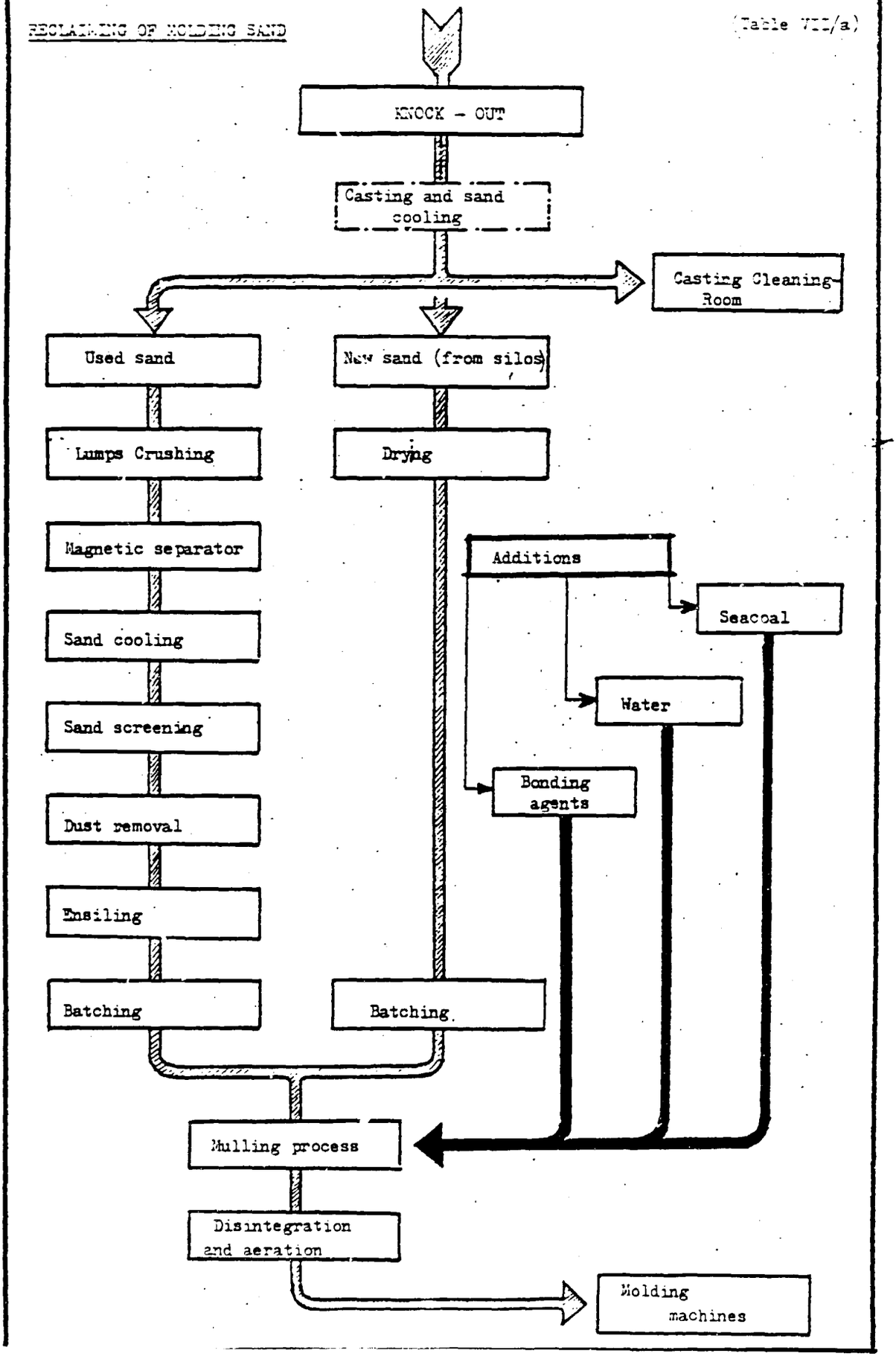
- shakeout on fixed screen for large castings and on vibratory screen for small-medium dimension plants;
- double separation of metal parts (pulley and magnetic belt);
- roller lump crusher (easier maintenance);
- additional cooling with elevator-cooler;
- properly exhausted disintegrating rotary sieve;
- fixed tank discontinuous cycle muller - Speedmuller type - capacity approx. 10 tons/hr;
- pan metering of new sand and additives by man controlled volumetric methods;
- aerator disintegrator on prepared sand (it can be adapted to conveyor belt);
- construction of small volume bins and hoppers, of proper shape, fitted with vibrator and extractor (to be designed for the specific project).

As concerns molding with continuous mixer, it has not been envisaged so far any recovery for shakedout sand (due to the low volume and the assumed availability of raw material).

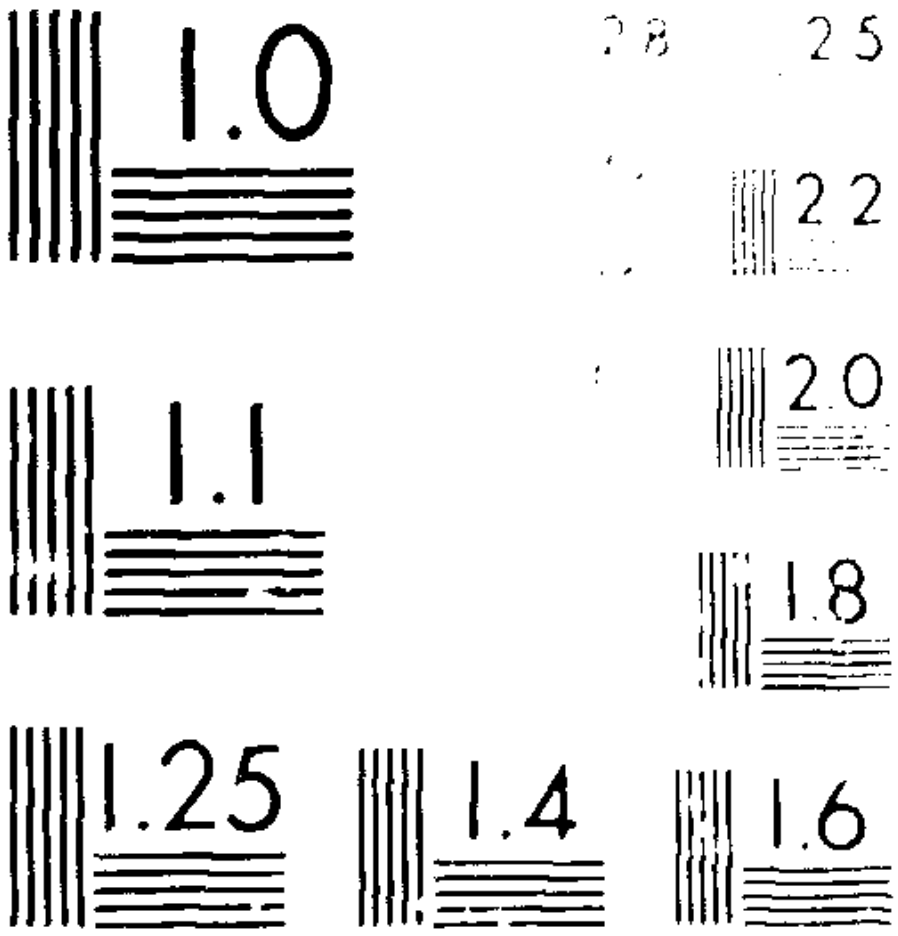
The illustrations however include an example of full recovery of chemically bonded sand, as it could be required in particular instances and production increase.

RECLAIMING OF MOLDING SAND

(Table VII/a)



CAST IRON FOUNDRY	GREEN SAND MOLDING PLANT - ALTERNATIVES IN MAIN MACHINERIES AREA	(TABLE VII/6)
OPERATIONS	MAIN TYPES OF MACHINERY	SURVEY OF CHARACTERISTICS OF DEVELOPING COUNTRIES DIRECTIVE
KNOCKING OUT	- by hand on fixed grate - by vibrating grate or shake-out grate (free or controlled)	Small and medium sizes castings: free shake-out grate large sizes castings: a fixed grate and hand knocking out are advisable to avoid exhorbitant investments
LUMP BREAKER	Elastic compression crushing rolls Hammer crusher Disintegrating crusher	Due to the green sand nature, a cylinder lump breaker is sufficient. It is less noisy and of easier maintenance The incident no lake sand crushing would require the use of disintegrator
MAGNETIC SEPARATION	- by magnetic pulley - by magnetic over belt separator	The combined use of band and pulley prevents metal inclusions in sand
COOLING	- Rotatory cooling drums (castings and sand together) - cooling elevator - water cooled chiller	- Homogeneous castings and installation under working flow are required - Lifting action associated with evaporation cooling - Quite useful for chemically bonded sand (consumption 5÷7 m3/h H2O)
SCREENING	- Disintegrating rotatory screens - Vibrating screens classifying meshes	The rotatory screen may also acts as lump breaker generally it is used for medium-large plants Jolting screens are suitable for smaller plants
DUST COLLECTION	- Carried out by suction, on screens, lump breakers, etc. - Additional use of instruments sucking dust and gradeating sand	A good suction where dust is splitted from the sand flow is sufficient for small plants.
LIFTING TRANSPORT and STORAGE	At local sand transfer may be carried out through re-vant belt conveyors, elevators, skips.Conveyors are the most widely spread means for the flat transfer of green sand; pneumatic systems are often used for chemically bonded sands. Storage is made in differently sized and aerated silos.	Elevator is the most suitable means for avoiding area waste. The skip tends to pack the sand. Pneumatic conveyor is suggested only for the feeding of new sand from the storage bins to continuous mixer hopper.
ADDITIONS AND PROPORTIONING	Binders and new sand proportioning occurs in a wide range of fully manual to fully automatic operation sequences.	The semi-manual method (binders and water proportioning per extra cycle volume) offers the most reliable operation and is sufficiently liable subject to personnel skillness
MIXER	1) fixed bowl continuous cycle (Simpson type) 2) rotator, bowl continuous cycle (Bonvillain type) 3) fixed bowl discontinuous cycle (Speedmuller type) 4) Rotatory, bowl discontinuous cycle (Clearfield type) 5) Intensive muller (type Eirich)	Many types are suitable: a fixed bowl discontinuous cycle muller for which the operation sequences length may be pre-selected, is advisable. The cycles length is very important in manual proportioning.
CONDITIONING AND AERATION	Several means can be used for sand aeration during transport. The most widely spread is the Pekay method.	Its use is advisable in small plants where cooling necessity and agglomeration danger are higher.
CONTROL	The sand stock arranged above the machine may be equipped with automatisms and signalers	At sight inspection, carried out by entrusted personnel, is recommended.


2.8
2.5
1.0
2.2
2.0
1.1
1.8
1.25
1.4
1.6

c) Diagrams and illustrations concerning sand plant equipment

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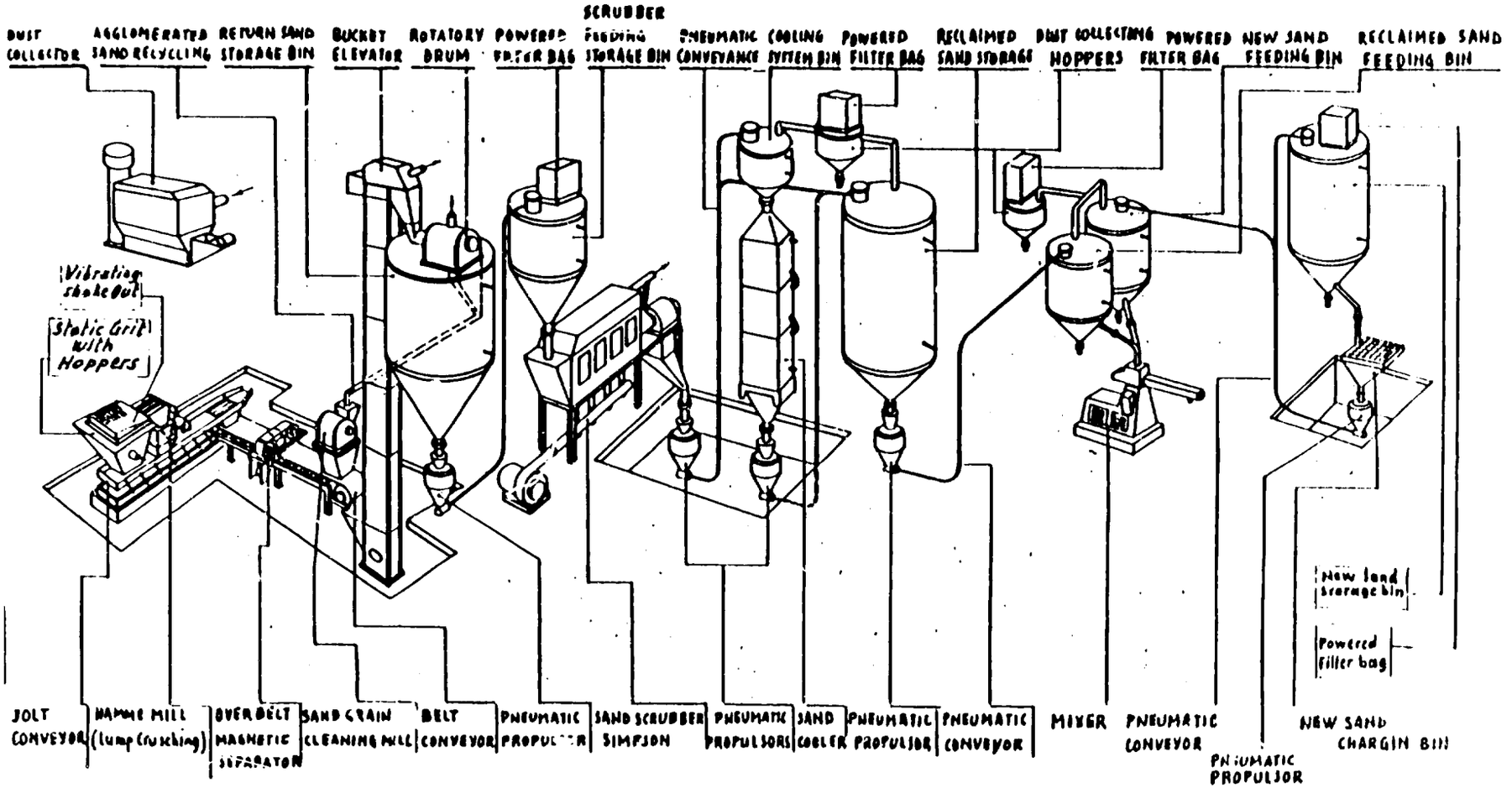
SAND RECLAMATION SYSTEM FOR CHEMICALLY BONDED SANDS

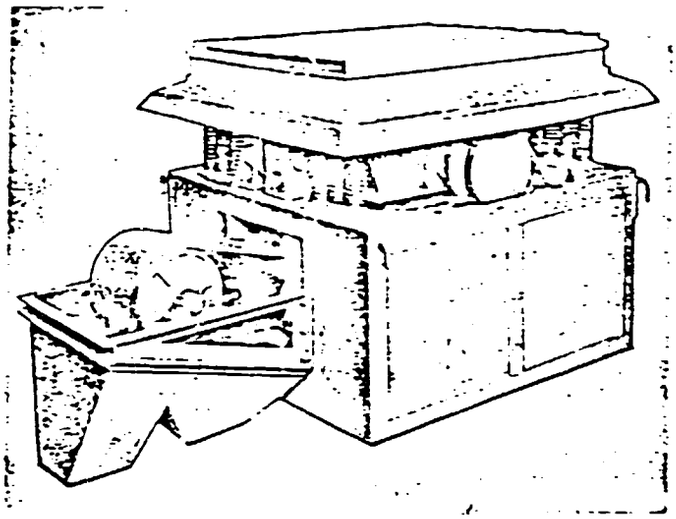
(FURANIC, PHENOLIC RESIN, SODIUM SILICATES) AND FOR BENTONITE GREEN MIXES



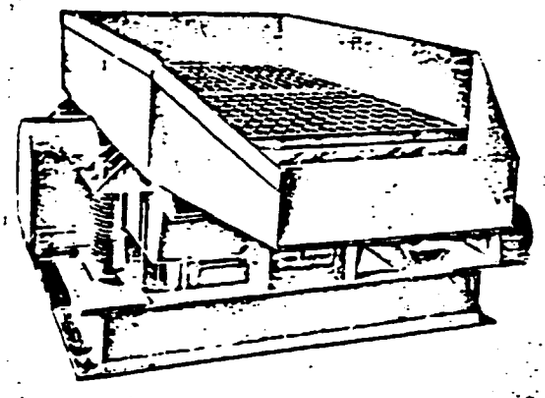
THIS SCHEME PRESENTS AN ADVANCED RECLAIMING UNIT TO BE INSTALLED WHERE NEW SAND IS USED IN LARGE QUANTITIES AND HIGH PRICE

– Adaptation –
(From: "FRAMAGGIORE" ITALY

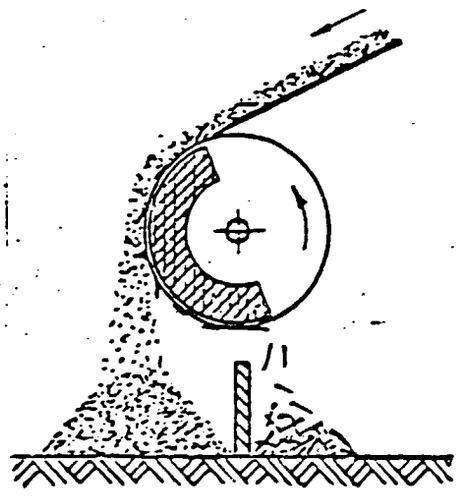
SAND RECOVERING EQUIPMENT AFTER POURING AND FREEZING OF CASTINGS



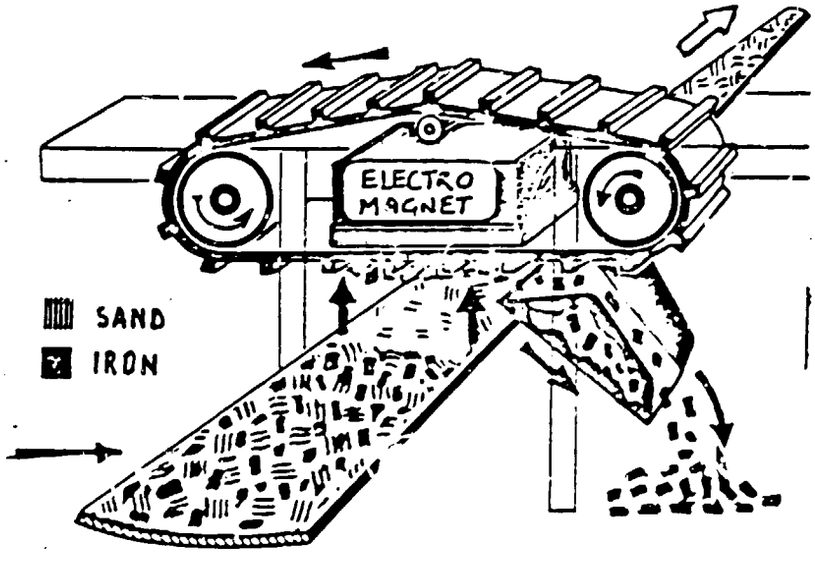
VIBRATING SCREENING SHAKE-OUT WITH ELECTROMAGNETIC SEPARATOR



VIBRATING MOULD SHAKE-OUT

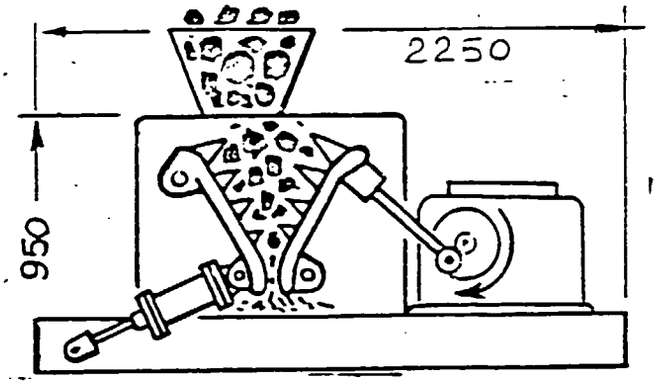


PULLEY MAGNETIC SEPARATOR

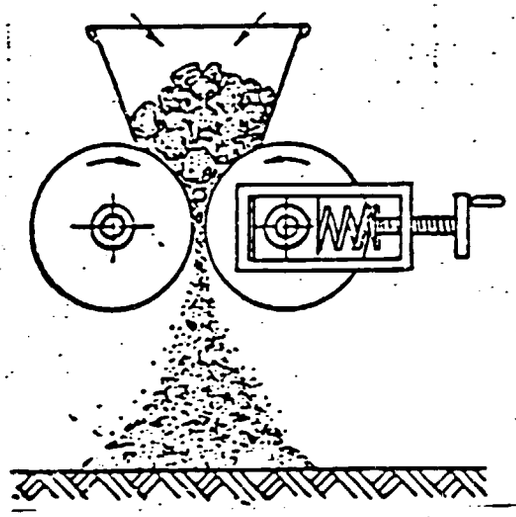


OVER BELT MAGNETIC SEPARATOR

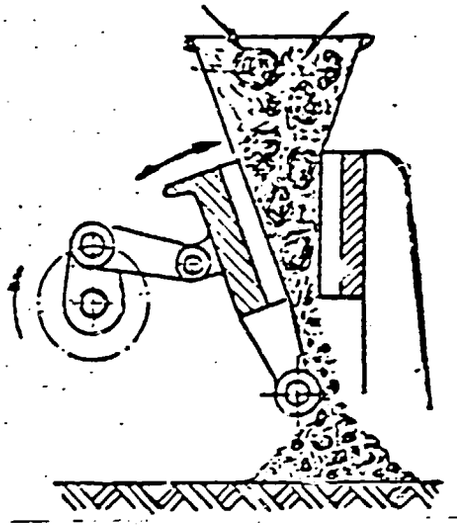
EQUIPMENT FOR SAND RECOVERY



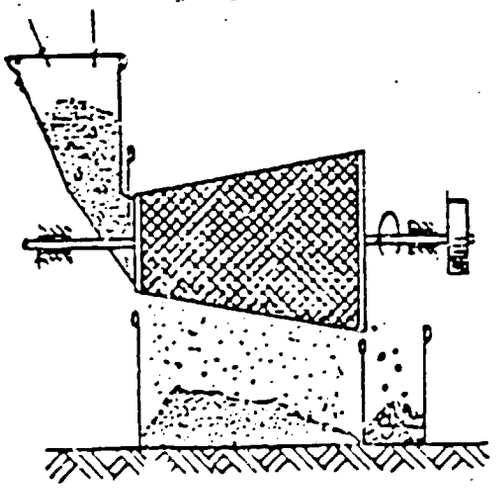
TYPE OF LUMP CRUSHER



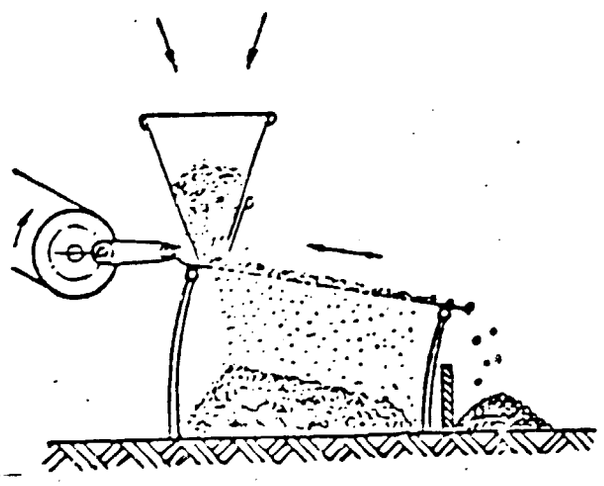
TYPE OF LUMP CRUSHER



HAMMER MILL

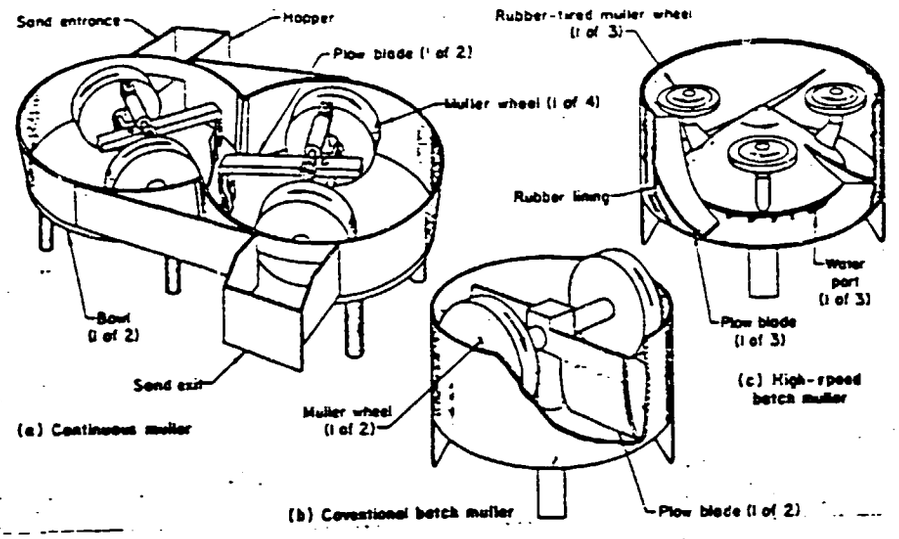


ROTARY DRUM



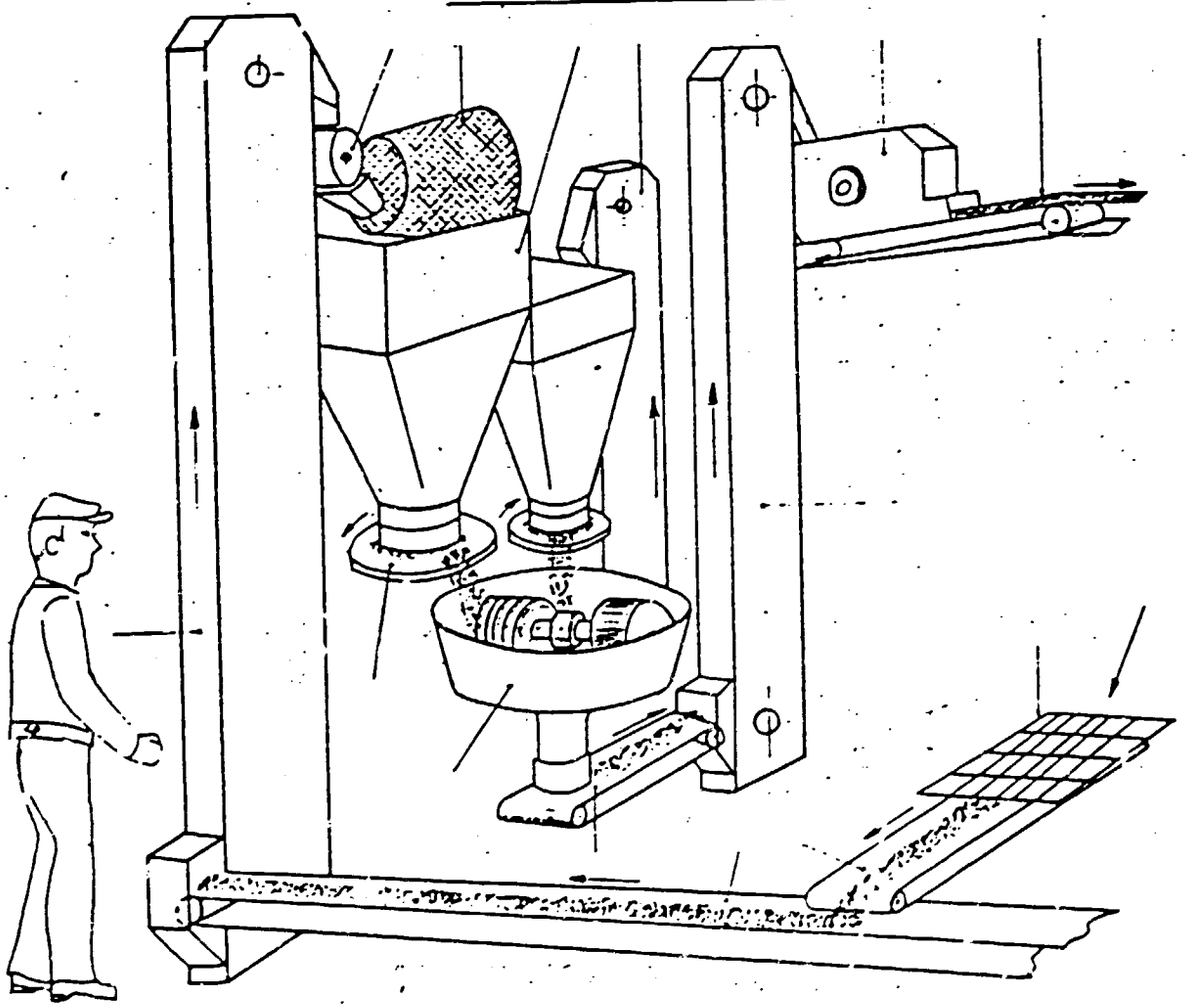
VIBRATING SAND SCREENING

GREEN MOLDING SAND PREPARATION

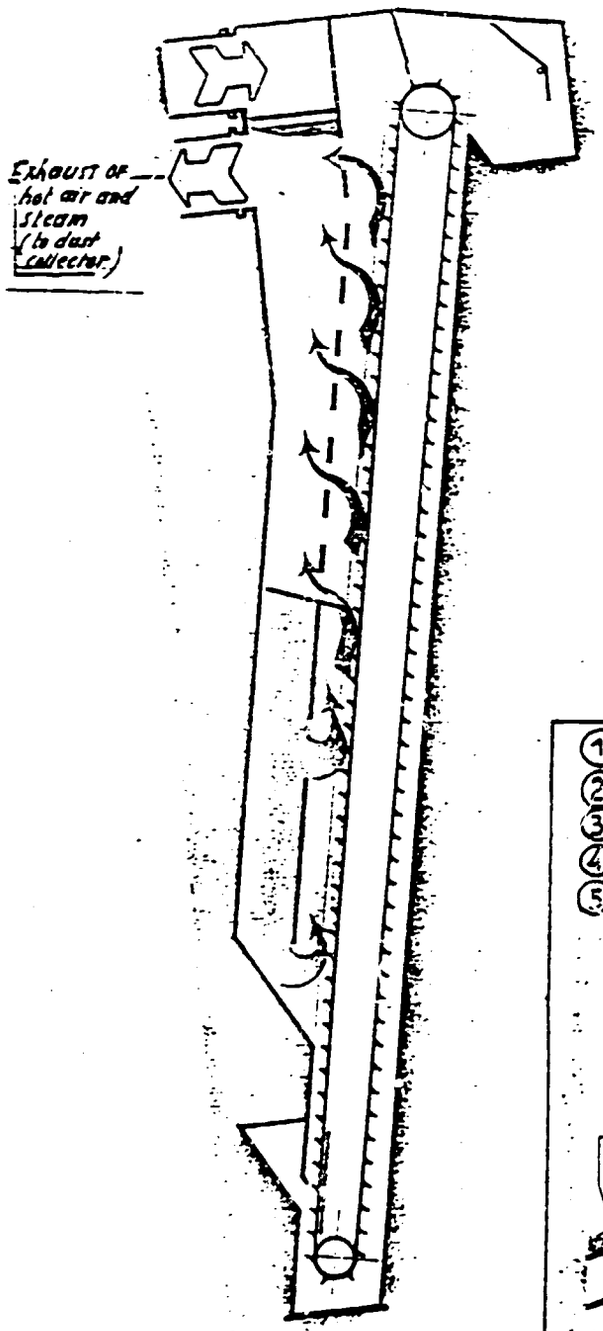


DIFFERENT TYPES OF SAND MULLERS (From: Metals Handbook)

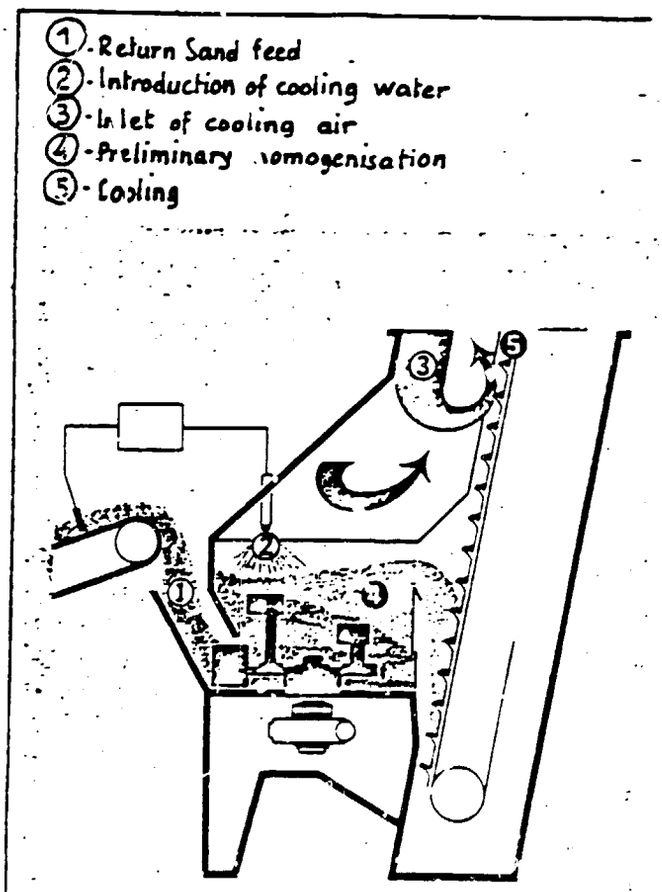
SCHEMATIC WIEW OF USED SAND RECOVERY, MIXING WITH NEW SAND MULLING AND DISTRIBUTING



SAND COOLING SYSTEMS (TOGETHER WITH ELEVATION)



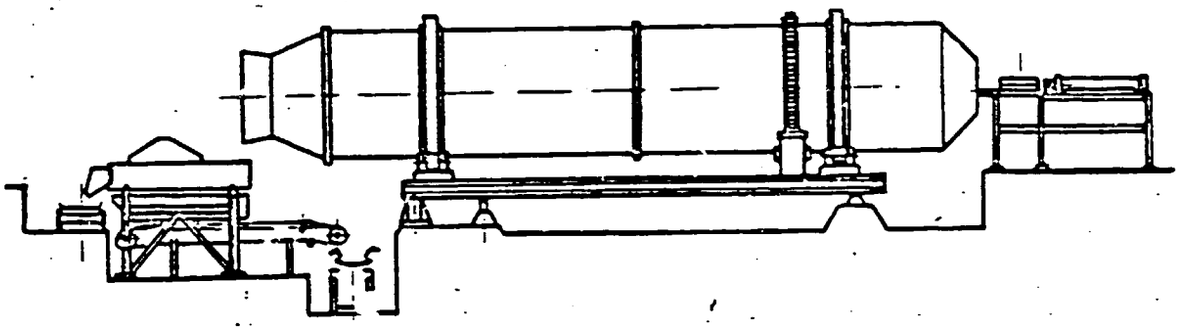
A PATENTED ELEVATOR, USING A DRAFT OF FRESH AIR EVAPORATION FOR COOLING HOT SAND DISTRIBUTED IN THE MOUNTING BUCKTES (SAND IS PARTIALLY RECYCLED)



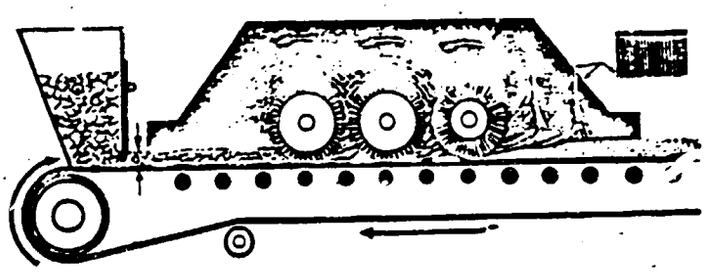
AN IMPROVED METHOD FOR COOLING RETURN SAND BEFORE ELEVATING

From: (British Ronceray Limited)

GREEN SAND CONDITIONING EQUIPMENT



TUMBLING AND COOLING OF SAND AND CASTINGS IN ROTARY COOLING DRUMS (AFTER KNOCK-OUT)



AERATOR, DISINTEGRATOR, COOLER FOR GREEN SAND MOLDING

VIII - SEQUENCE OF CLEANING OPERATIONS

a) Casting conditioning after shakeout - Table VIII

Table VIII must compulsorily be confined to the examination of the most common fettling operations because of the relatively simple equipment involved, without going into construction details.

Its purpose is to determine the most suitable means for A.C.P. countries and the type of planned foundry.

CAST IRON FOUNDRY	CASTING CONDITIONING AFTER KNOCKING OUT	(TABLE VIII)
OPERATIONS	MEANS AND THEIR OPERATION	PROSPECT OF ADAPTATION TO DEVELOPING COUNTRIES
KNOCKING DOWN	BY HAND (THROUGH SHOCKS WITH HAMMERS)	Correct notching on gates and risers allows easy breaking both during and after knocking out
	BY POWERED MEANS (disc saw, abrasive discs, presses, special equipment)	Save for specially fed castings, the use of abrasive discs by means of portable tools, could be advisable.
SANDBLASTING (particular care must be paid to dust and earth removal from abrasive steel shot)	In compressed air cabin	It is advisable for large-medium sizes castings being a cheap method and of low maintenance (generally > 50 Kg)
	Airless type (rotatory table or rotatory belt) With abrasive throwing impellers	The type fitted with small chamber seems to be the most suitable
	Airless type (suspended table or monorail belt) With abrasive throwing impellers	It is a good but expensive means for continuous productions
	In tumbling barrel (with castings intermixed with shades)	Suitable for tough castings: cheap, noisy and not very productive
FINISHING — CHIPPING	Hand operated pneumatic tool on bench or conveyors	Conventional means recommended: pneumatic tools on fixed bench for small castings or on floor for large-medium castings.
FINISHING — PRESS OPERATIONS	Machines are arranged to trim castings residues or to coin in the final stage: generally they are used for long run castings	Only exceptionally for nodular cast iron castings - coining (only a press is sufficient)
FINISHING — GRINDING	- Portable air grinder - Swing or supported fixed grinders - Special and multiple grinders	Portable grinders may be used for medium and large castings; swing or pedestal supported grinders are recommended for small castings
FINISHING — HEAT TREATMENT	- Single or double bogie hearth furnaces - Continuous furnaces - Standard or neutral atmosphere	A double bogie hearth furnace could be used for special and spheroidal graphite cast iron treatment: tightness could be assured by means of sand and lute
CHECKS — CASTING COMPOSITION ANALYSIS	Chemistry, spectrography, quantimetry, other means	A small quantimeter, additional instruments, chemical and dilatometric systems are recommended
CHECKS — VISUAL	By means of lights and magnifying lenses	Tight specifications must be prescribed
CHECKS — DIMENSIONAL	Gauges, inspection fixtures, marking off instruments	To be manufactured by the same production unit
CHECKS — SURFACE INTEGRITY	Penetrating fluids - Different systems to create magnetic field by means of detectors	The use penetrating fluids should be sufficient save for special cases. Should a careful inspection be required the use of magnetoscope is recommended
CHECKS — METALLURGIC STRUCTURE	Reflection microscope	A 1000 - 2000 magnifications microscope (optical)
CHECKS — INTERNAL INTEGRITY	Penetrating radiations means (X ray or ultrasonic testing)	If justified, an X-ray apparatus (300 kW) may be bought for big productions
CHECKS — MOULDING SAND	Instruments for checking hardness, humidity, strength, permeability, fineness grade etc.	They are necessary for a good checking of molding mixtures

b) Choice of essential finishing equipment

In the case under consideration, knockdown must be manual supported however by pouring techniques to aid the shake-out of sprues and risers.

The large castings should be sandblasted by means of compressed air. To prevent the exposure of the workers to the danger of silicosis (or the use of heavy protection suits) the controls of the sandblasting tuyeres should be arranged outside the cabin where the part is located so that the sand action is directed to the desired positions.

A manually charged endless apron sandblaster (or alternatively, a rotary table sandblaster) seems to be the most suitable for the foundry and for the area where the same is located. Stand grinders for small castings and portable or hanging grinders for large castings can complete the fettling operation together with pneumatic hammers.

Welding operations for small defects have not been considered yet. This may be envisaged at a later date when the delicacy of the operation on cast iron and workability and integrity risks involved in the components are clear. (This applies also for the European countries where weldings must be approved by customers' inspections).

Heat treatment shall perhaps be introduced when there will be a diversified nodular cast iron production and it will be necessary to add other types to the types sold as cast.

c) Inspection

In addition to dimensional control equipment, control means for chemical composition (quantimeter), integrity of main components (magnetoscope), nodularity (metallographic microscope), sand (humidity, cohesion, finess, permeability, refractoriness) appear to be necessary.

d) Diagrams and illustrations concerning finishing equipment

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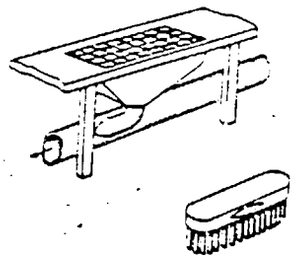
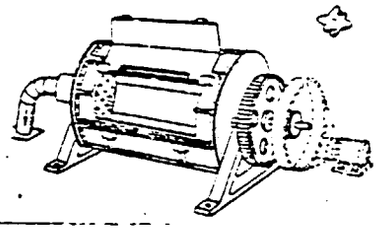
CLEANING OF CASTINGS



BENCH FOR MANUAL SAND REMOVING FROM CASTINGS

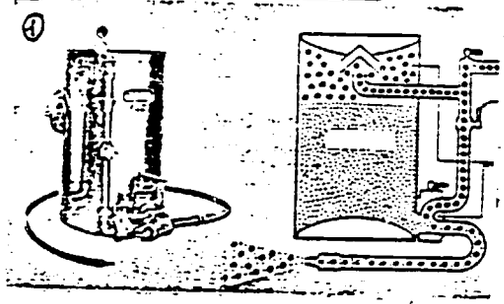


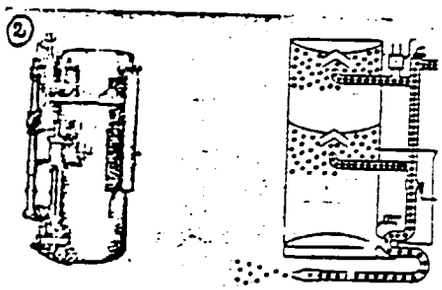
TUMBLING BARREL

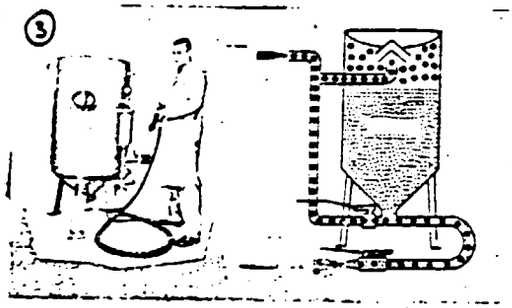
(From : FONDERIA - by Capello)

COMPRESSED AIR SHOT BLASTING

① For intermittent operation
② For continuous operation
③ For small stations

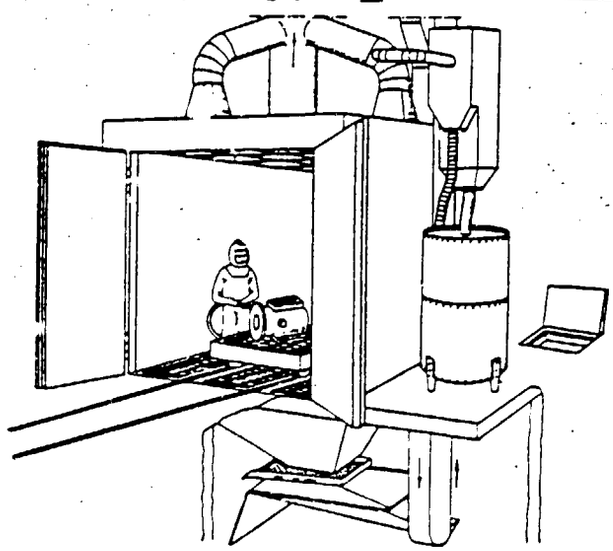




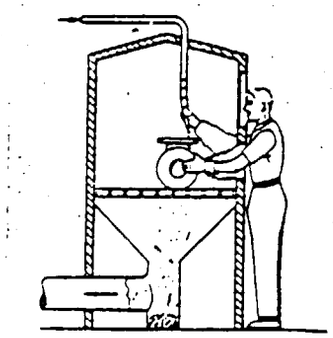


(From : "Pangborn Corporation")

WITH INTERMEDIATE CONTROLS ALL THESE INSTALLATIONS CAN BE HANDLED BY WORKERS FROM OUTSIDE BLASTING CABS



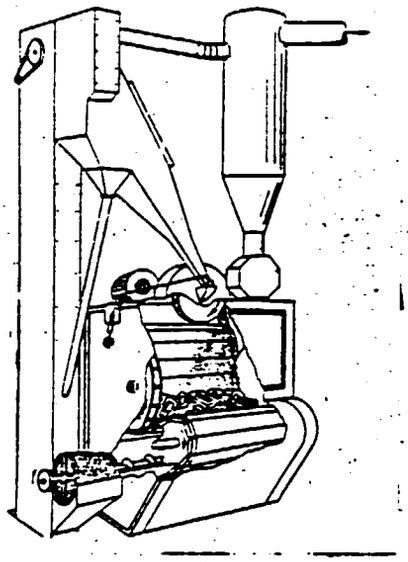
INSTALLATIONS FOR BIG CASTINGS



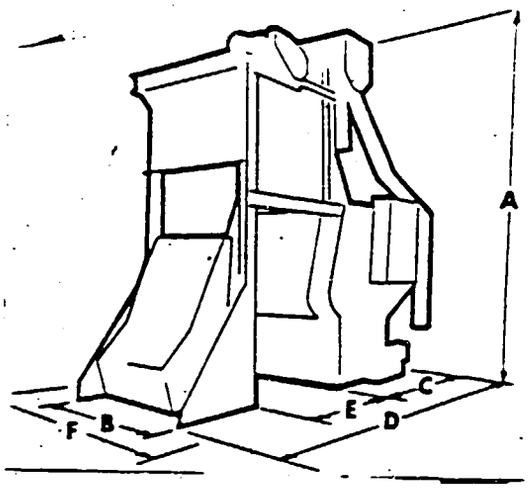
SMALL CAB HANDLED MANUALLY BY A WORKER STANDING OUTSIDE

From : (FONDERIA by E. Canello)

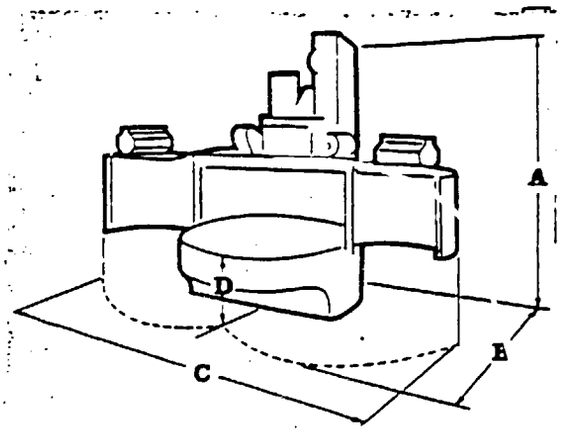
MECHANIZED CLEANING OF CASTINGS



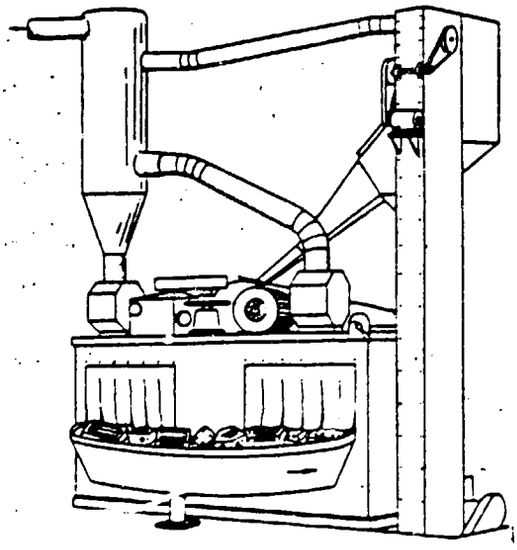
SAND BLASTING MACHINE WITH ABRASIVE THROWING IMPELLERS AND ENDLESS APRON CONVEYOR COMPOSED OF ABRASION RESISTANT FLIGHTS.



SCHEME AN AIRLESS ENDLESS APRON CONVEYOR MACHINE EQUIPPED WITH [illegible] LOADER



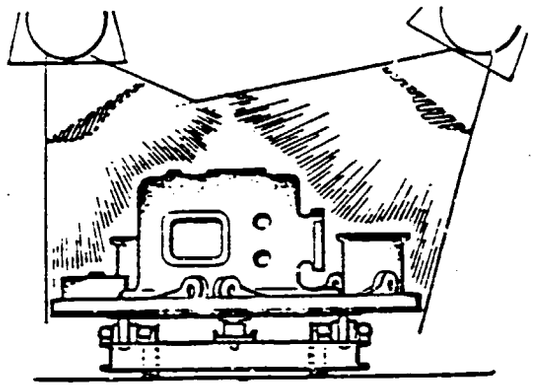
SCHEME OF AN INTERMITTENT TURNING TABLE SHOT BLASTING MACHINE



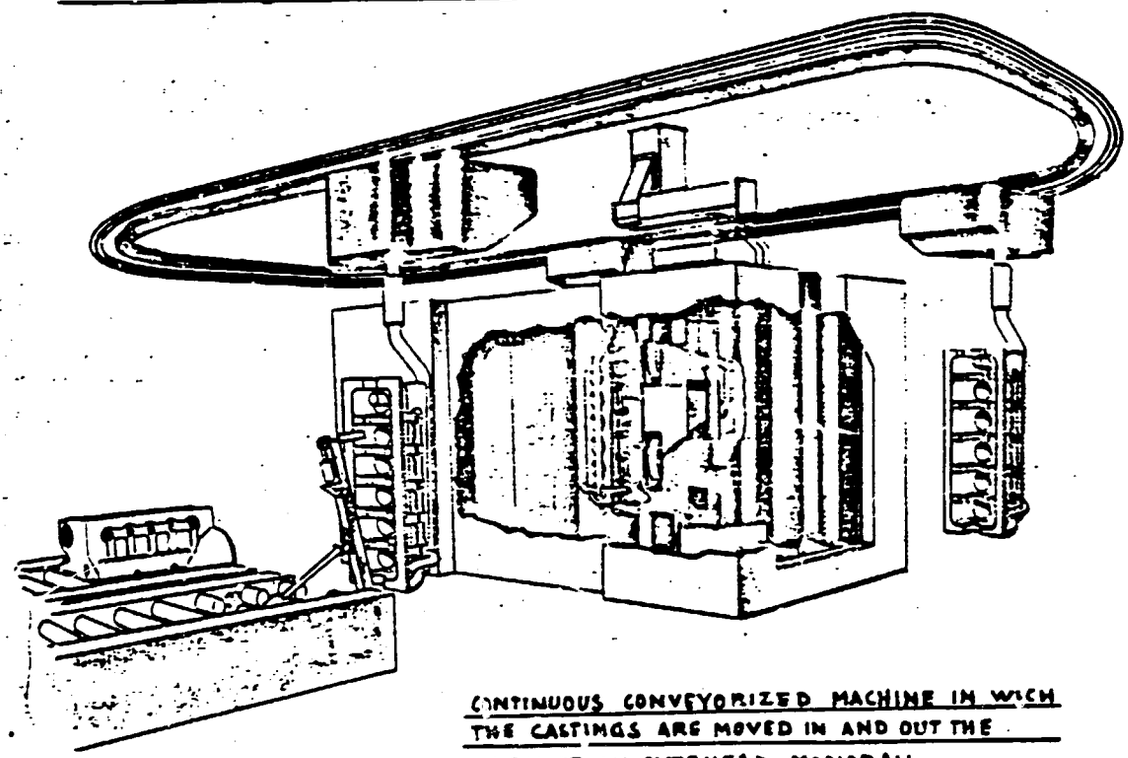
TURNING TABLE SAND BLASTING WITH DUST COLLECTOR (CONTINUOUS OPERATION)

(from: [illegible])

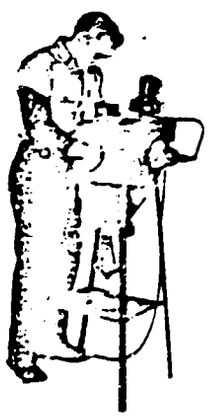
(from: [illegible])



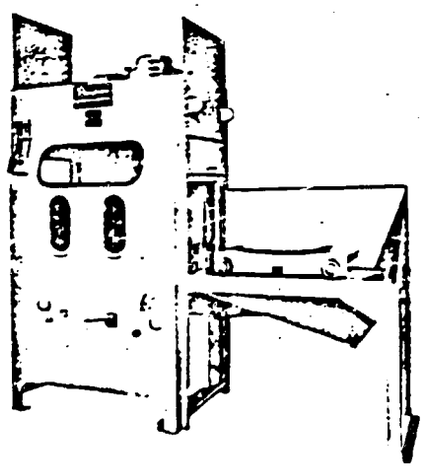
A CABINET FOR BIG CASTINGS EQUIPPED WITH TWO ABRASIVE THROWING ROTATING IMPELLERS AND A POWERED TURNABLE



CONTINUOUS CONVEYORIZED MACHINE IN WICH THE CASTINGS ARE MOVED IN AND OUT THE CABINET ON OVERHEAD MONORAIL



PORTABLE HYDROFINISHING MACHINE FOR SPECIAL PARTS

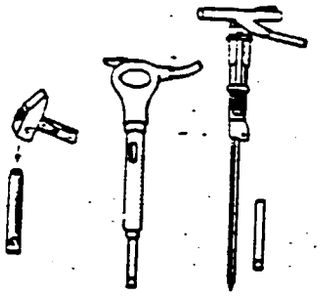


HYDROFINISHING MACHINE WI[T] AIR MIXED TANK

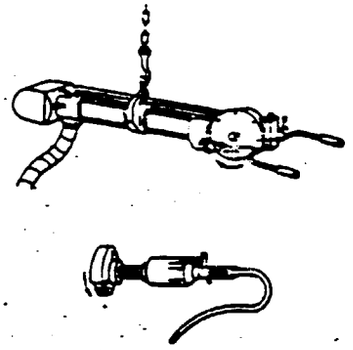
(From: PANBORN Corporation)

FETTLING AND HEAT TREATMENT OF CASTINGS

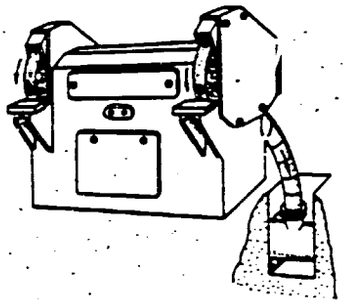
- ::: -



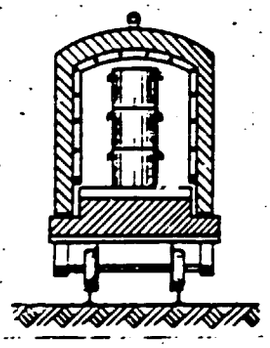
EQUIPMENT FOR MANUAL FETTLING OF CASTINGS

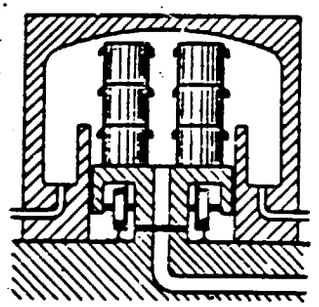


HAND OPERATED GRINDERS

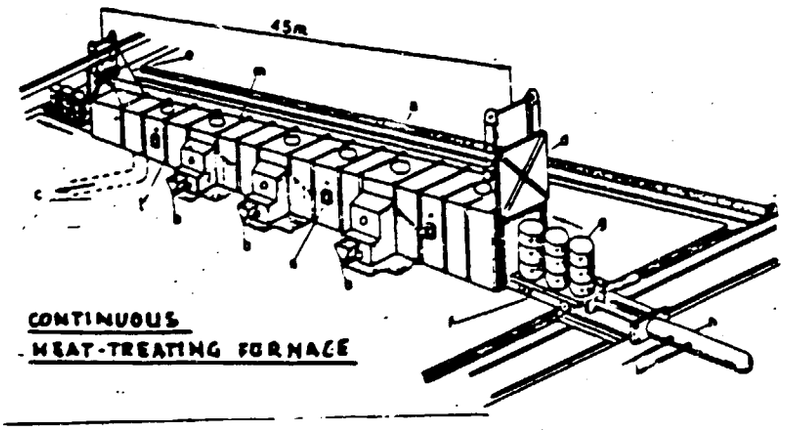


DOUBLE-ENDED STAND GRINDER - MACHINE WITH DUST COLLECTOR





DIFFERENT TYPES OF HEAT-TREATING FURNACES



CONTINUOUS HEAT-TREATING FURNACE

(from: "FONDERIA" by Cocchi)

IX - NOTES ABOUT THE CHOICES FOR NON FERROUS FOUNDRY

The purpose of introducing a small department for non-ferrous material is to give an auxiliary mean to the unit for the production of small sand and chill castings:

- manual molding for lightweight castings on bench with generally divided patterns, on wood plates or flasks operated by a single worker;
- molding of larger castings with the use of flasks on single-jolt machine and ramming with pneumatic rammer;
- for series moldings (valves, pistons, domestic and trade tools) two small benches where the chills are closed, poured, open in the standard way;
- for cores, a 5 liter coreblower and manual molding. For large cores, the cast iron foundry continuous mixer can be of aid;
- a 135 liter diesel oil furnace with double crucible can supply sufficient metal of adequate quality;
- the most important machine in fettling is a belt saw.

METAL PRODUCTION
DEVELOPMENT
UNIT

A N N E X I I

PROCESS PLAN DESCRIPTION

(reference to basic foundry lay-out)

II/1

FACILITIES AND OPERATIONAL STAGES ESSENTIAL IN THE IRON FOUNDRY

Production stages		Main Equipment	Notes
PATTERNS (the same as aluminium)		Wood machines (1 lathe, 1 thicknessing machine, 1 honing machine, 2 marking-off benches, 2 milling machines, 1 copy milling machine, 1 buzz planer, 1 surface sand papering m., 1 belt saw, 1 drilling machine, 1 grinder, 7 carpenter's benches.	In addition to repairs of used patterns, construction of new wood patterns has been foreseen, as well as the possibility of plastic duplication; application of metal parts and finally preparation of metalpatterns may be also accomplished in a subsequent stage.
MOLDS	TYPES OF STAMPING	In flask (600 x 800) on 2 jolting and pressure machines (30 molds/h)	For castings up to 10 kgs. In general 20/30 kgs weight of castings may be produced in each mold.
		Production of flaskless molds with cold self-hardening sands (continuous mixer) (8 ÷ 10 molds/h)	In general, castings between 10 and 100 kg are produced at a rate of 3-4 casting/mold. Handling is carried out manually.
		Manual production in pit or on ground.	Experimental castings of special or very large size (assembly of preformed parts).

SAND	Sand reclaiming unit for green sand has been designed, supplying the 2 jolt/squeeze machines with nearly 8 tons/h of prepared sand. Other sources of used sand are, at present, of no interest (owing to their low volume), for regeneration. Pneumatic conveyance is used to transfer the new sand to the continuous mixer.	Utmost importance is given to cooling of used sand to be regenerated (owing both to climate and shortness of runs): the job is carried out by special devices. The continuous mixer is completely separated, and at this stage of saturation only new sand is foreseen to be used.
CORES	Cores are requested in a figure of 2500 kgs/day. Two 100 kgs batch capacity core sand mullers with rubber tired wheels will be available.	Large size cores can be manufactured by continuous mixer; medium small size cores by the core blowers or on core benches.
LIQUID METAL	1 cold wind cupola installation (2 tons/h) with two shells and a fore hearth is planned; an induction coreless furnace medium frequency (1,5 tons - 450 kW) will work for melting nodular iron and also, if necessary, for duplexing iron melted in the cupola.	When nodular cast iron is produced, after melting directly into electrical furnace a desulphurizing treatment in ladle can be provided for.

ASSEMBLY POURING CASTING DRAWING OUT	Cores assembly and mold closing is carried out on roll tracks or on ground. Casting is drawn out on a shaker or by means of cranes. Manual pouring is accomplished using an overhead crane or other hoisting devices.	The assembly lines are fitted with continuous rolls for higher productivity: cores and flask less molds handling for medium size casting is accomplished through several manual operations. In case of manual stamping, each movement is carried out by the worker (whether assisted or not by a crane) by means of pneumatic tools.
CASTING CONDITIONING	Knock-down apron. Sandblasting machines, grinders. Diesel trolleys for production handling. Heat treatment may be also carried out, if necessary, with additional facilities.	All operations are performed by workers operating or controlling machines. No automation (except for safety stops).
INSPECTION	A magnetoscope, optical pyrometers and gauges have been foreseen for size cheking, and sand checking equipment. Small microscope, 10-channel quantity meter.	For nodular cast iron.

II/4

FACILITIES AND OPERATIONAL STAGES ESSENTIAL IN THE NON-FERROUS METALS DEPARTMENT

Production sequence		Main Equipment	Notes
PATTERNS		The laboratory is in common with cast iron foundry.	
MOLDS	TYPES OF STAMPING	Bench for manual molding (3-4 molds/h)	Castings up to 2 kg (various types of flasks)
		Jolt machine rammed with pneumatic tools (10 mold/h)	Castings heavier than 2 kg
		No. 2 small benches for gravity casting.	In general for aluminium pistons and brass cocks.
SAND		It is not expected for the time being to reclaim used sand (only 10 tons of sand/day is used)	Ventilation of sand is essential after mixing with binders.
CORES		Benches for hand stamping of self hardening (no bake) sand have been foreseen.	By selecting various types of sand in the iron foundry it is possible to use core blowers both for cast iron and aluminium. The iron foundry mixer can produce large size cores for aluminium.
LIQUID METAL		No. 1 double crucible liquid fuel furnace (135 litres) is used (t° 1000°).	After proper preparation, the furnace can melt both brass and aluminium.

POURING	Molds assembly and pouring are performed on floor: castings are drawn out and knock-out is carried out by means of simple manual tools. Gravity diecastings are also hand operated.
GRINDING	Knock-down is carried out by means of band saws: other operations are manually carried out by means of grinding wheels or chiesels.
INSPECTION	The laboratory checking sand can employ the same equipment used in the cast iron foundry: for safety parts, a radiographic equipment has been foreseen. The laboratory is equipped with normal means to check compositions, mechanical and dimensional characteristics of different types of castings.

MACHINE TOOLS DEPARTMENT

The shop is equipped with means for maintenance and for machining rough castings: approximatively fifty % of foundry output may be machined.
In the Annex III, pg. 114 equipment for machining and maintenance (only for indicative purposes) is listed.

GENERAL INSTALLATION

Compressed air and water supply systems together with electrical equipment for 1500 kVA installed power will be available.
In the annex III, pg. 115 some general features and detailed items are shown.

METAL PRODUCTION
DEVELOPMENT
UNIT

A N N E X I I I

LIST of EQUIPMENT and INVESTMENTS

III/O

Condensed list of equipment, general installations and civil works for cast iron foundry, non-ferrous department, patterns and machining shop.

INVESTMENT COSTS

DEPARTMENT OR UTILITIES	COSTS (1000 $)		TOTAL COST
	Equipment	Freigts + Installations	
Melting + emission control	235	127	362
Sand plant	324	130	454
Molding	215	32	247
Core room	35	10	45
Fettling-cleaning department	90	34	122
Non-ferrous shop	106	32	140
Hoverhead bridge cranes	90	25	115
Inspection and lab.testing	100	15	115
Pattern making	170	25	195
Machining and maintenance	691	89	780
Utilities: Materials handling	125	10	135
Utilities: Exhaust and dust collection system	120	40	160
Utilities: Energies and fluids	190	40	230
Buildings	870	30	900
Site development	90	10	100
GENERAL AMOUNT	3,451	649	4,100

IRON FOUNDRY TECHNOLOGICAL INSTALLATIONS

Department	Utilities	Cost 1000 $
MELTING and POURING	Cold blast cupola (2 shells) 2 t/h Weighing and charging devices. Not neated forehearth. Blowers - Blowed air control equipment. Molten iron tapping and weighing means. Emission control. Pouring monorail.	
	Total cupola plant	86
	Medium frequency induction melting furnace (crucible capacity 1.5 tonn.) Hourly production 0.6 t. Max elettr. power demand 450 kW. Coil water cooling in closed circuit (with heat-exchanger). Power transformers, protection, capacitors and control equipment in a power cubicle. One crucible installated (and another foreseen) with hydraulic tilting devices.	
	Total induction furn.	140
	Ladle heating station Scrap and alloy bins Pouring ladles and various equipment	9
TOTAL MELTING AND POURING		235

IRON FOUNDRY TECHNOLOGICAL INSTALLATIONS

SAND PLANT	Utilities	Cost 1000 $
New sand	Floor grit, bins, elevator for feeding store silo with new sand 1 silo (65 m^3) Pneumatic conveyance	
	Total new sand	33
Green sand (8 tons/h) and special sands for hand molding	Vibrating shake-out unit. Belts for conveying used sand Electromagnetic separators. Elevators. Rotating breaker screens. Silos for used sand. Sand cooling devices. Reclaimed sand hoppers with volumetric dosing. Screw feeders for binders. Sand muller (8 t/h). Special sands mixer. Aerators Prepared sand distributing to bind for jolt/squeeze machines. Grits and belts for spill sand. Carrying network structures.	
	Total green sand and special sands for hand molding	276
No bake sand	Vibrating shake out. Belt for used sand. Elevator and hopper for used sand removing.	
	Total no bake sand	18
	TOTAL SAND PLANT	324

III/3

IRON FOUNDRY TECHNOLOGICAL INSTALLATIONS

MOLDING	Utilities	Cost 1000 $
Green sand molding (normally small castings)	2 jolt squeezing machines: max squeezing pressure (static) 8000 kg (6 atm.) max flask size 700 x 850. Hoisting devices. Not powered rollers conveyor mt. Rollers transfer tables. 80 x 2 600 x 800 x 200 + 200 moulding boxes	
	Total green sand molding	150
No bake molding (continuous mixer) for medium castings	New sand silo. No. 1 continuous mixer (3 ÷ 4 tons/h). No. 1 new sand storage bin. Vibrating table. Roller conveyors mt. 90. Transfer tables. Hoisting device for mold handling.	
	Total no bake molding	60
Pit molding	Hand tools. Pit with movable panels. Pneumatic hammer.	
	Total pit molding	5
TOTAL MOLDING		215

III/4

IRON FOUNDRY TECHNOLOGICAL INSTALLATIONS

Various Department	Utilities	Cost 1000 $
CORE ROOM	2 core sand mullers. 1 manually operated self hardening sand core machine (gas automatically controlled) (2.5 lt) 1 bench core blower (5 lt.). 1 core blower 12 lt. with mechanised core drawing devices. 4 core benches with sand hoppers. 1 core oven with heater unit (two compartments). Core racks for oven baking. Manual low bed lift truck for oven charging.	
	TOTAL CORE ROOM	35
FETTLING and CLEANING ROOM	Endless apron shot blast machine. Air blast cabinet. Pedestal grinders. Abrasive cut-off machine (Nod Iron). Benches for deburring. Swing-frame grinder. Snag grinders (portable). Arc welding. (to be used only later) Other portable tools.	
	TOTAL FETTLING AND CLEANING ROOM	90
OVERHEAD BRIDGE CRANES	1 bridge crane (14.5 mt. 5/1 ton) (controlled by the floor) warehouse. 2 overhead bridge cranes for the two bays (14.5 mt. span - 3/1 tons) (controlled by the floor). 1 overhead bridge crane for furnaces bay (4.5 mt. 10/3 tons).	
	TOTAL OVERHEAD BRIDGE CRANES	90

III/5

NON-FERROUS FOUNDRY SHOP TECHNOLOGICAL INSTALLATIONS

Installations	Utilities	Cost 1000 $
For melting	1 fuel oil crucible furnace (135 lt) with control equipment. 3 ladles and heating station. Linings and refractory maintenance.	
For molding	1 molding jolt machine for sand castings. Hoppers, mixer, elevators, areators for sand molding. 1 bench for hand molding. 2 gravity die castings benches with manual operating sequences. Flasks and related equipment.	
For cores making	Cores room. Mixer, hopper, core benches for 2 work station with no bake process. Ancillary equipment.	
For cleaning	Fettling shop. 1 belt saw, knock out and fettling benches. 2 grinders - shop fixture and equipment.	
For inspecting	Sand and castings inspection lab. equipment.	
Hoist devices	2 service hoisting eq. for tapping and pouring.	
	TOTAL NON-FERROUS CASTING	106

III/6

ANCILLARY FACILITIES AND PATTERN SHOP

Department	Equipment	Cost 1000 $
INSPECTION and LABORATORY TESTING	No. 1 marking off bench. No. 1 magnetoscope. No. 1 equipped marking - off bench. Microscope and micrographic equipment. Quantometer. Laboratory equipment for analysis and sand control. Inspection equipment.	
	TOTAL INSPECTION AND LAB. TESTING	100
PATTERN MAKING (wooden or resin patterns)	2 milling machines. 1 copy milling machine. 1 buzz planer. 1 surface sand papering machine. 1 honing machine. 1 belt saw. 1 lathe. 1 thick dressing machine. 1 drilling machine. 1 grinder. 2 marking off benches. 7 carpenter's benches.	
	TOTAL PATTERN MAKING	170

III/7

WORKSHOP ANNEXED TO FOUNDRY

Department	Equipment	Cost 1000 $
MACHINES TOOLS and MAINTENANCE SHOP (machine list is only for indication purpose)	1 center lathe (center gap 2000/250 mm) 1 universal milling machine table (1300/300 mm). 1 front surface grinder (250/1000 mm). 1 radial drilling machine (1000 mm range). 2 column drilling machine (Ø 35 and 50 mm). 1 bench sensitive drilling mach. (Ø 15 mm). 1 back sawing machine (Ø 150 mm). 1 double grinding machine (Ø 250 mm). 2 horizontal turret lathes (Ø 100 and 250 mm). 1 15 ton press. 1 universal sharpening machine	
	Total	281
	1 arc welding machine 7 kW. 1 portable oxyacetylene welding station. 1 set of portable drilling and lapping machine. 1 equipped reference table (1500x1500) 8 benches for fitter with vice. 5 sets of wrenches of every type, files, miscellaneous equipment. 3 sets of tools and electrical instrument for maintenance	
	Total	42
	Tools and fixtures	176
	Gauges	35
	Shelvings, containers, supporting frames, etc.	157
	TOTAL MACHINES TOOLS and MAINTENANCE SHOP	691

III/8

UTILITIES AND GENERAL INSTALLATIONS

Purpose	List of Main Items	Cost 1000 $
MATERIALS HANDLING (any sort of materials sand included)	3 fork and lifting truck. 3 batteries charging station. 2 trucks. 2 passenger cars. 1 power shovel. 1 dumper.	
	TOTAL MATERIALS HANDLING	125
EXHAUST and DUST COLLECTION SYSTEM	Furnaces' emission control (included in melting department's costs) Sand plant: wet dust collector - 1000 m^3/min. (with complete equipment). Shake outs: wet dust collector (sludge tank). Shot blast dry-bag system (150 m/min.) Grinders dry-bag system (200 m/min.) Other foundry areas.	-
	TOTAL EXHAUST AND DUST COLLECTION SYSTEM	120
ENERGIES and FLUIDS	2 air compressors 3000 m^3/min with air dryer and refrigeration unit. Electric equipment: 2 + 1 transformers 500 kVA (medium and low voltage boards) Stand by generating set 100 kW other electric facilities. Service water systems (tank 1000 m). Hydraulic-sanitary water system. Gas oil fuel stocking and distribution.	
	TOTAL ENERGIES AND FLUIDS	190

III/9

MPDU - FOUNDRY - BUILDING and SITE Development

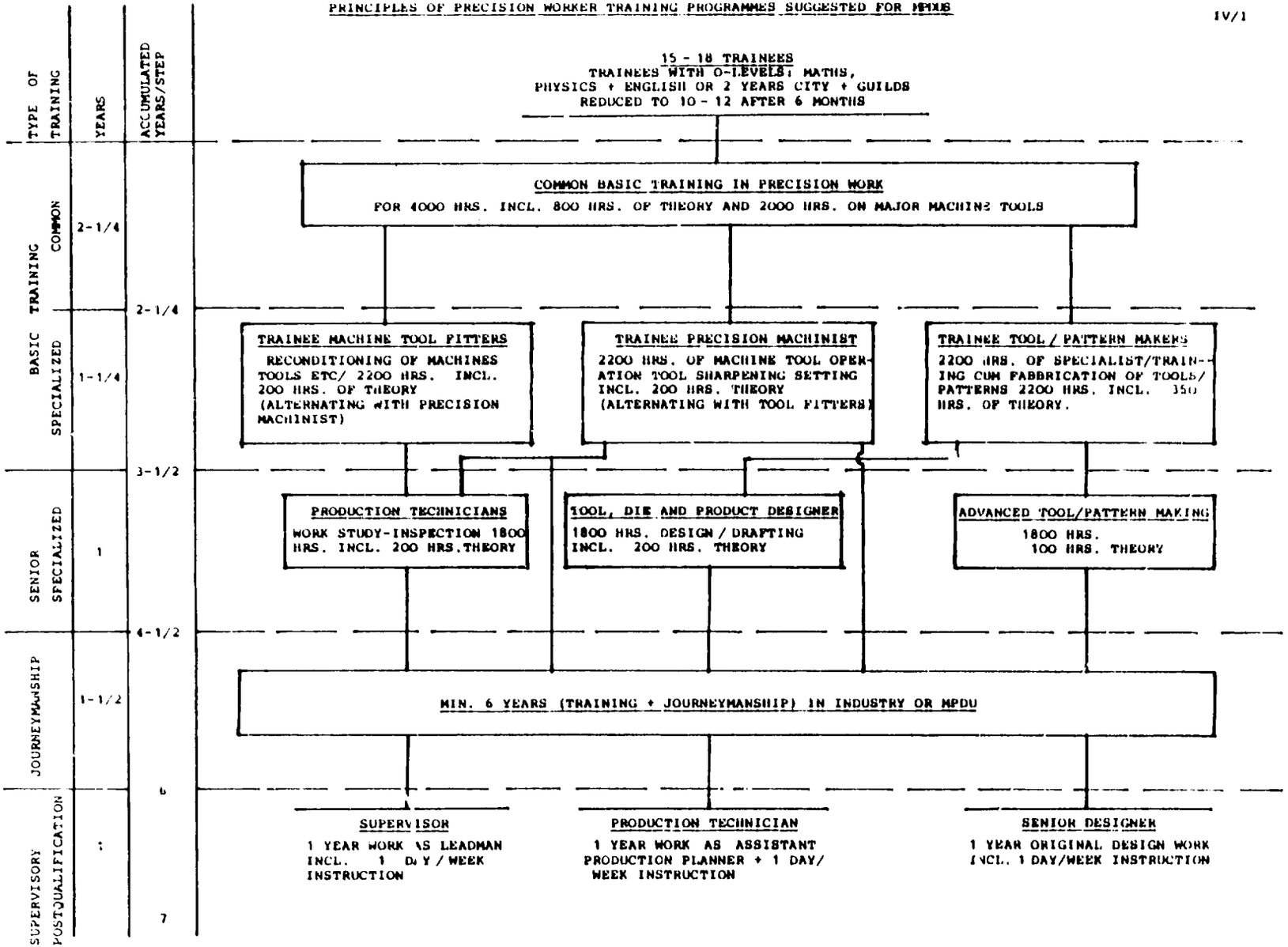
	Utilities	Cost 1000 $
BUILDINGS	Main foundry buildings: bay melting (16 mt. high) foundry bays (12 mt. ") cleaning room (9 mt. ") side shed (sand plant).	400
	Pattern making - machining maintenance - general store (88 x 16) H = 9 mt	140
	Offices buildings 500 m x 2 floors x 300 $	300
	Cabins for transformers - compressors and integrating works	30
	TOTAL BUILDINGS	870
SITE DEVELOPMENT	Roads and area arrangements (included scrap yards)	50
	Fence	25
	Sewers and drainage	15
	TOTAL SITE DEVELOPMENT	90

METAL PRODUCTION
DEVELOPMENT
UNIT

A N N E X I V

GENERAL TRAINING REQUIREMENTS

PRINCIPLES OF PRECISION WORKER TRAINING PROGRAMMES SUGGESTED FOR MPDU



IV/2

OVERSEAS TRAINING COSTS

a) Introductory in plant group training for

1	General manager (designate)	Total 14 people for 4 months
1	Deputy " "	
6	Engineers	
6	Counterpart trainers	

Costs (for the full period)

Travel	3,000 x 14	=	42,000 $
per Diem	4,000 x 14	=	56,000 $
Training	6,000 x 14	=	84,000 $
Total cost of overseas (introductory group training)			182,000 $

b) Professional improving of Engineers and Counterpart Trainers

with overseas in plant training for 8 Trainers and 8 Engineers 4 months each over a 5 years period

Total cost of overseas upgrading 208,000 $

TECHNICAL ASSISTANCE PROGRAM - M.P.D.U. (FOUNDRY)

Expertise Required	Duration	Application in year (costs thousands $)					Approx Total cost 000 $
		1	2	3	4	5	
Project Manager - 3 first years acting General Manager	5 years	80	90	90	100	100	460
Foundry shop Manager/Trainer	4 years	40	80	80	90	45	335
Moulding Trainer	3 years	35	70	80	40		225
Melt and Casting Trainer	3 years	35	70	80	40		225
Machine Tool Operator Trainer	3 years	35	70	80	40		225
Machine Tool Mechanic Trainer	4 years		70	80	80	80	310
Pattern Maker Trainer	5 years	70	80	80	80	80	390
Foundry Plant Engineer Expert	3 years	70	80	80			230
Cast Iron Design Engineer	4 years		80	80	90	90	340
Industrial Engineer / economist	3 years	35	80	80	40		235
Metallurgist	2 years		80	80			160
Marketing Engineer	2 years	70	80				150
Short term (4 - 6 months each) Specialist Engineering Experts - e.g. Brassware, Special Product Design and Plant Design, etc.	4 man years		20	80	80	150	330
Preparatory Project in Year O (Equipment purchasing - local building activity - recruitment, etc.)							150
TOTAL TECHNICAL MANPOWER ASSISTANCE	45 man years	470	950	970	680	545	3,765

If a tool making capability is to be developed alongside the above it would require another 8 years of workshop experts and 8 years Engineering experts.

LOCAL TRAINING - MANPOWER PLAN - M.P.D.U. (FOUNDRY)

000 $ US

	Year 0		Year 1		Year 2		Year 3		Year 4		Year 5		REMARKS
	No.	Cost	No.	Cost	No.	Cost	No.	Cost	No.	Cost	No.	Cost	
General Manager Designate/ Deputy	2	16											Start at 8000/year
Secretary / Accountant	1	6											
Counterpart Trainers / Foremen (Moulding, Pattern, Machine tools)	8x½ 2x1	18	12	40	12	42	14	56	14	62	14	68	(2 for each expert) Start wages 3000 $/year
Counterpart Engineer / Technicians	6x½	15	6	30	2	10	2	10	2	10	2	10	1 Engineer + 1 Technician for each expert an average start salary 5000 $/year
Trainees Patternmakers	10	10	18	20	15	20							
Trainees / Workers Foundry	18x½	9	20	22	20	30							Start at 1000 $ / year
Trainees/Machine Tools - Mechanics and other skilled W.	20x½	10	20	22	30	45							
Assist.Accountants / Secretaries	2	5											Start at 2500 $ / year
Clerks/Drivers/Labourers	4	4											Start at 1000 $ / year
Total m 000 $		93		132		149		66		72		88	Total amount 1 to 5 years 600

SUMMING UP TOTAL COST TRAINING PER YEAR

	0-1st year	2nd year	3rd year	4th year	5th year	TOTAL
Overseas introductory in plant group training	182	-	-	-	-	390
Overseas professional improvement of Engineers and C.P.trainers		52	52	52	52	
Technical assistance program	150 470	950	970	680	545	3,765
Local training	225	149	66	72	88	600
TOTAL TRAINING COST	1,027	1,151	1,088	804	685	4,755

Local training cost is considered as operating cost, and local training subsidy as counterbalance revenue (from Government funds).

Overseas training and technical assistance program are assumed to be financed by outside sources.

METAL PRODUCTION
DEVELOPMENT
UNIT

A N N E X V

PRODUCTION and PERSONNEL

WAGES and SALARIES

V/1

ROUGH CASTINGS PRODUCTION and PERSONNEL IMPLEMENTATION

TONS OF "GOOD" ROUGH CASTINGS	0 - 1 year	2nd year	3rd year	4th year	5th year
1. Grey Iron	only training	500	1000	1250	1360
2. Nodular Iron		50	100	150	240
3. Non-ferrous		6	16	25	30
A. TOTAL	-	556	1116	1425	1630

No. OF PERSONNELS INVOLVED in the Production of Castings	0 - 1 year	2nd year	3rd year	4th year	5th year
1. Skilled workers	only training is forecast	20	20	24	30
2. Semiskilled workers		37	37	45	48
3. Unskilled workers		45	45	52	52
4. Foremen and Supervisors		10	10	12	12
5. Management-Staff-Engineers		10	10	11	12
B. TOTAL		122	122	144	154

V/2

FOUNDRY PERSONNEL

ESTIMATED PERSONNEL FOR THE FULL PRODUCTION

STAFF AND SUPERVISORS

General management	2	Marketing	2
Secretarial staff	2	Production manager	1
Accounting and Adm.	3	Superveyors or foremen	
Engineers	14	(c. trainers)	14

OPERATING WORKERS

JOB	TOTAL	PERSONNEL TYPE			JOB CLASSIFIC.	
		Skilled	Semisk.	Unskill.	Direct	Indirect
Molding	30	5	15	10	25	5
Melting	13	3	7	3	8	5
Pouring	8		4	4	5	3
Shake out	6		1	5	4	2
Sand plant	7	2	3	2	3	4
Coremaking	8	3	3	2	6	2
Cleaning	26	2	6	18	20	6
Maintenance	8	8				8
Store	5	1	2	2		5
Shot blast	4		2	2	3	1
Lab/inspection	8	3	4	1		8
General duties	7	3	1	3		7
TOTAL FOUNDRY	130	30	48	52	74	56
PATTERN SHOP	16	10	5	1		16
MACHINING SHOP	10	6	4		10	
TOTAL UNIT (percentages)	156	30%	35%	35%	53%	57%

V/3

WAGES and SALARIES

COST / MAN / YEAR	0 - 1 year	2nd year	3rd year	4th year	5th year
1. Skilled worker	1500	2000	2500	2800	3000
2. Semiskilled worker	1000	1200	1500	1800	2000
3. Unskilled worker	1000	1100	1400	1600	1800
4. Supervisor	3000	3500	4000	4500	5000
5. Engineer	5000	5500	6000	6500	7000
6. Average Management and staff	5500	6000	7000	7500	8000

WAGES and SALARIES (ONLY FOR ROUGH CASTINGS)

TOTAL COST OF PERSONNEL/YEAR (Local training included)	0 - 1 year	2nd year	3rd year	4th year	5th year
1. Skilled worker	only for training	40000	50000	67200	90000
2. Semiskilled worker		44400	55500	81000	96000
3. Unskilled worker		49500	63000	83200	93600
4. Foremen and Supervisors		35000	40000	54000	60000
5. Engineers		11000	12000	13000	21000
6. Staff and Management		55000	56000	67500	72000
A TOTAL / YEAR	165000	234900	276000	365900	432000

METAL PRODUCTION
DEVELOPMENT
UNIT

A N N E X VI

COSTS and REVENUE FIGURES
(Depreciation included)

VI/1

COSTS OF MATERIALS/TON GOOD CASTINGS

General Figure / Components	$/ton of Rough Castings		
	Grey i.	Nodular i.	N.Ferrous
Raw Material			
Purchased Ferrous scrap pig-iron, carburizing agents, Nodulizing Agents, Ferrous and non-ferrous alloys, Metals (Shop returns are not considered as added cost)	195	235	1750
Auxiliary Materials			
Sands, Binders, Chills Fluxing Materials, Mold and Core Washes, Abrasive and grinding wheels, etc.	70	95	150
Energy for melting and molten metal refining, for core or hand mold drying	110	165	120
Coke for cupola			
Expendable Materials			
Gas, Fuel, Energies (general installations, Cooling, Dust collecting, Lighting, etc.) Energetic fluids Water, Oil, Various	117	147	120
Maintenance Materials			
Refractories, Lining, Pattern repair, spare parts	140	150	150
Direct Materials	195	235	1750
Indirect materials	437	557	540

Figure, as told above, results from current W. Europe prices + 20%.

VI/2

ROUGH CASTINGS - Annual estimated operating costs

(Thousands of Dollars)

Cost components	0 - 1 year	2nd* year	3rd year	4th year	5th year
1. Raw and ancillary materials	-	160	247	329	396
2. Expendable and maintenance materials	-	90	134	185	245
3. Wages and salaries	165	235	276	366	432
4. Contingency (10% of manufacturing costs)	17	70	62	83	101
Total annual estimated OPERATING COSTS 000 $	182	555	719	963	1174

* For the second year (when production starts running) 50% of man power efficiency and 50% of rejects has been considered: a 15% figure for contingency has been estimated.

In the subsequent years increasing efficiency and 10% of rejects have been taken into consideration.

	0 - 1 year	2nd year	3rd year	4th year	5th year
Production: tons	-	556	1116	1425	1630
Divided into:					
Grey iron	-	90%	89 5/8%	87 7/8%	83 5/8%
Nodular iron	-	9%	9%	10 5/8%	1 7/8%
Non-ferrous	-	1%	1 5/8%	1 8/8%	1 8/8%

WORKSHOPS AND ENGINEERING SERVICES

A) PERSONNEL and MACHINES COST FIGURES		0 - 1 year	2nd year	3rd year	4th year	5th year
1. Patternshop						
No. of workers		4	8	8	10	10
Total Wages	000 $	6	16	20	28	30
2. Machine Tools and Fitting Shop						
No. of workers		4	8	10	10	10
Total Wages	000 $	6	16	25	28	30
3. Engineering						
No. of engineers techn.		2	8	10	12	12
Total salaries + Overhead	000 $	11	48	70	90	96
4. Cost of Machines (Overhead included) 5000 $/year per machine	000 $	40	80	90	100	100
TOTAL SERVICES COST	000 $	63	160	205	236	256

B) ANNUAL ESTIMATED REVENUE		0 - 1 year	2nd year	3rd year	4th year	5th year
Workshop						
Efficiency		0.1	0.2	0.4	0.6	0.7
Revenue	000 $	9	35	86	151	182
Engineering						
Efficiency		0.1	0.2	0.4	0.6	0.7
Revenue	000 $	4	34	90	180	227
TOTAL SERVICES REVENUE	000 $	13	69	176	331	409

VI/4

INVESTMENTS and DEPRECIATION

INVESTMENTS 000 $	0 - 1 year	2nd year	3rd year	4th year	5th year
BUILDINGS and SITE DEVELOPMENT (25 years depreciation) TOTAL INVESTMENT : 1,000 (000 $)					
1. Investments	1000				
2. Depreciation	40	40	40	40	40
GENERAL and ECOLOGICAL INSTALLATIONS (20 years deprec.) TOTAL INVESTMENT : 525 (000 $)					
3. Investments	525				
4. Depreciation	26	26	26	26	26
TECHNOLOGICAL EQUIPMENT (10 years depreciation) TOTAL INVESTMENT : 2,575 (000 $)					
5. Investments	1500	420	350	305	
6. Depreciation	150	192	227	275	275
7. TOTAL DEPRECIATION	216	258	293	341	341

METAL PRODUCTION
DEVELOPMENT
UNIT

A N N E X V I I

GENERAL MARKET SURVEY

FOREWORD

Metal production development units must meet specific features deriving from the actual needs of the market: productive programs were thus formulated on detailed components s.c. defined by outline, weight and general dimension.

Indication of the main market areas to be supplied with new plant's products

The general indication of the multiannual plans, associated with the remarks and information gathered during the two investigations, suggest to address the M.P.D.U. production towards specific market fields, namely:

1 - Agriculture.
2 - Off-road transportation.
3 - Parts for power means.
4 - Metal working and mining industries.
5 - Food and miscellaneous industries.
6 - Building and town planning.
7 - Home and sanitary uses.
8 - Conveyance of industrial utilities.
9 - Electrification and telephone lines.

The "product families" and the "sample components" have been detected in the above fields and they are intended to serve as a pattern in the formulation of conceptual projects.

Condensed Products' lists

The detailed list of items proposed to supply the market may be summarized taking into account the type of technology and the field where the end products are used.

1 - AGRICULTURE

Though bearing in mind the remarkable incentive towards motorization noticed in the different countries, lack of manual work and equipment for animal traction has been remarked. The dimensioning of the demand in the agricultural field has been made, lacking market researches, taking a yearly supply of implements on statical basis as reliable: production scheduling has been avoided for items that can be locally produced in appreciable quantities.

a) Manual agriculture

This equipment requires surface hardness, toughness and high elasticity limit, or elementary implements for transportation means, normally using welding at some extent.

The basic material is steel, the main technology is forging with possible adaptations of shaped plate properly sharpened and treated.

Production of the following has been considered:

- miscellaneous implements (not locally produced) mainly forged;
- material handling means (shaped and assembled sheets);
- parts for drums and brackets for pails.

b) Animal traction equipment

The equipment can be generally identified as tool-carrying structure on wheels to be fitted with blades to cut into the ground.

Again, the material is steel: main technology is assembling of section iron and plate for the supporting structure (with possible introduction of nodular cast iron castings).

Forging is always essential in the farm equipment field but there is also room for some cast iron castings especially nodular cast iron.

The amount of the demand has been proportioned yearly around 0.5% of the house hold groups considered as productive average in the agriculture in each country.

The productive lot consists of:

- traditional plow (forged - structural steel work)
- rotary blade harrow (forged - castings - structural steel work);
- rings rollers (forged-structural steel work-castings);
- zig-zag harrows (forged - structural steel work);
- seeder with dispenser (shaped plate - cast iron castings);
- bearing and other parts for animal-drawn carts;
- carts - animal drawn for farms and general transport.

c) Equipment for power traction cultivators

After chosing some very popular equipment (harrows, seeders, graders, clod smashers, sawing machines, etc.) containing cast as well as forged and cold machined parts with subsequent welding, the production has been set up assuming to supply 0.2% of the active household groups.

The production includes:

- spare parts for power cultivators (mainly forged);
- tractor implements:
  . sawing machine (cast or forged parts);
  . ground graders (mainly assembled plate);

. cold smasher roller (mainly assembled plate);
. seeder harrow & cultivator (stamped plate, castings, structural steel work);

- components for sprayers (aluminium castings).

The number of the required components has been correlated to the expected average number of tractors for an A.C.P. country. A considerable role is played by the spare parts for implements.

d) Irrigation

The production of a sufficient number of separate parts for centrifugal pumps, connections and bends has been foreseen to supply about one hundred units.

More complex technologies are involved in this field, among which the casting of non-ferrous metals and special cast iron, which shall be integrated by mechanical machining and outside purchases.

Typical products in this area are:

- components for centrifugal pumps on trolley (all technologies under study are involved);
- connections and bends (mainly aluminium and no ferrous alloy, in general);
- components for hand pumps;
- components for sprayers;
- panels for water reservoirs/roof tanks.

2 - OFF-ROAD COLLECTIVE TRANSPORTATION
(Railroad and navigation)

The volume of the components to be manufactured takes into consideration the surveys made during the visits to the maintenance plants.

About thirty components have been selected among the most significant ones and representing the imported spare parts share available for local production.

Among these, brake shoes for railway cars are of major importance for the considerable wear affecting the great number of shoes fitted on each car.

For naval spare parts only some components have been considered.

Without dwelling in a detailed description, these can be summarized as follows:

- parts of railway wagons, new and reconditioning;
- components for railroad (forgings or cast iron castings);
- miscellaneous external components in the railcar (assembled and welded shaped plate);
- bushings and covers (nodular cast iron castings);
- traction components (forged or shaped metal work);
- brake components (cast iron cast);
- boat propellers (non-ferrous alloys);
- mooring bitts (nodular cast iron);
- hooks, turnbuckles, clamps, etc. (mainly forged).

3 - PARTS FOR POWER EQUIPMENT

Putting together the spare parts for motor-cars, trucks, tractors, earth moving machines and industrial conveying - hoisting equipment, the wear components have been selected for production referring to the estimate that the visits to governement storehouses enabled to make.

To these vehicle components subject to easy breakdown (pulley system, fans, traction hook and miscellaneous plate optionals) have been added.

The figures refer to the consumptions based on the vehicles in circulation as concerns drums, brake disks, pistons, etc., while other figures do not exceed one thousand set each.

The following has been selected as representative items:

- brake disks and drums (pig iron);
- oil tight covers, oil sumps, pistons (aluminium alloys);
- fans (aluminium alloys and stamped plate);
- lights and tool kits (aluminium alloy and stamped plate);
- trolley roof (stamped plate and structural steel work)
- hubs for tractor and trolley front and rear wheels (cast iron);
- trailer traction components, articulated joints, etc. (mainly forged and of nodular cast iron with plate components);
- track links (forged).

4 - METAL WORKING AND MINING INDUSTRIES

The components of metal containers, conveyors, gears, specific tools and fixtures, supplies for tracks and Decauville cars, pulleys, electric motor casings, etc. have been chosen as guide production.

Typical products are:

- plate bins (shaped plate);
- components for rolling conveyors (plate or cast iron castings);
- components for overhead conveyors (forgings);
- pulleys and gears (cast iron castings - forgings);
- equipment for ingot mold pit (cast iron castings);
- blacksmith or melter equipment (all technologies);
- miscellaneous tools (mostly forged).

5 - FOOD AND MISCELLANEOUS INDUSTRIES

Due to the different technological stages of the processes in different countries and from plant to plant in the same country, generic products (crusher components, stainless plate containers) have been chosen, which the definition of the country and the details may suggest to replace with specific manufactured articles, according to the progress stage and the technologies of the local industry.

Among the chosen types:

- components for cereal crushers (mainly plate);
- components for seed oil presses (only cast iron cast parts);
- containers for food liquids (normally stainless steel stamped parts);

- dies for glass (cast iron special alloys);
- stainless steel vats, tables, containers, etc., for food processing plants;
- wire products (baskets, shelves, dish drainers, etc.);
- metal hanging panels (incl. filler);
- cookers, water heaters, solar heaters.

6 - BUILDING AND URBAN INFRASTRUCTURES

Considering the large expenditure margin the many Government plans allocate to these facilities of which many construction details can be detected, a considerable part of the basic list has been devoted to these productions: they often consist of simple castings imported in whole or in part from abroad. Also the building yard machines and tools have been found to be essential means where the domestic production could replace imports.

Consideration was given, to mention only the main groups, to the following:

- building yard equipment (for rod shaping) (mostly forged);
- scaffolding material (mostly casted);
- mason tools (mostly forged);
- components for building yard machines (cast parts are considered);
- implements for rolling shutters or window screening (shaped plate);
- components for door framing (cast or stamped in plate);
- indoor and road reflectors (cast in aluminium or stamped in plate);

- drain covers, grates, road drain wells (cast iron castings);
- piping, elbows and unions for drains (cast iron castings);
- components for valves, gate valves, unions, etc. for drinkable and service water (cast iron castings);
- street and road signs, road fencing;
- fire hydrants.

7 - PRODUCTION FOR HOUSEHOLD USE

The present utilization already covered in part by the domestic handicraft market, has been integrated with the scheduled inclusion of elementary components which shall be replaced, as soon as the market allows it, by a more sophisticated product capable of supplying the assembly of equipment in the same field so far imported, thus avoiding damages to the small local manufacture through an illogical competition.

The component considered refer to:

- bath tubs, showers and sanitary equipment (mostly cast iron cast);
- taps (non-ferrous alloy cast);
- miscellaneous household fixtures and equipment (cast iron and aluminium castings shaped sheet);
- brassware e.g. sanitary fittings, stop-cocks, water taps, etc.

8 - INDUSTRIAL UTILITIES CONVEYANCE
(valves for liquids or gas)

The purpose of the small production scheduled for the first three years is the training and the approach to the problems that the specific field involves.

Productions are almost exclusively in nodular cast iron and concern the components of gate valves and unions of methane pipeline and oil pipelines. These can also include the components of small rotary compressors and radial fans which however employ mostly shaped plate castings.

Cast iron pipes, centrifugally or statically cast, must also be taken into account.

9 - ELECTRIFICATION AND TELEPHONE LINES

Under different aspects, more than the plans disclose, the countries are on the threshold of expansion in the demand of power.

Main consideration has been given to forged and cast components for connection and supply equipment.

As concerns the telephone lines, some components for supply equipment have been selected.

We mention here the following items as illustration:

- connection, support and mooring clamps for power lines (cast iron and aluminium castings);
- accessory for overhead line supports (aluminium castings and forgings);
- cable junction boxes (cast iron and aluminium castings);
- waterproof feeder boxes (cast iron and aluminium castings).