PLANT REQUIREMENTS
TO SET UP AND OPERATE
A SMALL STEEL MELTING PLANT

TECHNICAL AIDS BRANCH
INTERNATIONAL COOPERATION ADMINISTRATION
Washington, D. C.

FOREWORD

This brochure is one of a series of reports resulting from overseas technical inquiries on factory or commercial establishments, operation, management, and engineering. The report is designed to provide only a general picture of the factors that must be considered in establishing and operating a factory of this type. In most cases, plans for actual installations will require expert engineering and financial advice in order to meet specific local conditions.

Mention of the name of any firm, product, or process in this report is not to be considered a recommendation or an endorsement by the International Cooperation Administration, but merely a citation that is typical in its field.

Industrial reports prepared for ICA under special contract are customarily reviewed and edited before publication. This report, however, like other technical inquiry replies, has not been reviewed; it is the sole responsibility of the firm that prepared the report.

This brochure was prepared in September 1957 by the George H. Andrews Engineering Associates, Inc., Washington, D. C.

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For further information and assistance, contact should be made with the local Productivity Center, Industrial Institute, Servicio, or United States Operations Mission.

Code Number
60

ACKNOWLEDGMENTS

The author gratefully acknowledges the cooperation of the following companies in providing technical information for use in this brochure:

* Albert Curry & Company, Incorporated,
941 Oliver Building,
Pittsburgh 22, Pennsylvania.

Electromelt Furnace Division,
McGraw-Edison Company,
P. O. Box 1257,
Pittsburgh 30, Pennsylvania.

Southern Electric Steel Company,
2301 Huntsville Road,
Birmingham, Alabama.

* Will furnish either new or used equipment.

Examination of this brochure was provided by Thomas B. Hudson, Jr., Vice President of Albert Curry & Company, Incorporated. His suggestions are greatly appreciated and have been incorporated.

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A SMALL STEEL MELTING PLANT

INTRODUCTION

The small steel melting plant described in this brochure is intended to manufacture ingots or billets from scrap metal where the demand for such products exists and where such a local operation would be practicable. The product of this plant is intended for use in a small steel rolling mill to produce concrete reinforcing bars and merchant shapes. Either ingots or billets can be produced in this plant. However, for the purpose of simplification, only ingots will be discussed in this brochure.

GENERAL ASSUMPTIONS

In order to make realistic estimates, certain assumptions must be made. These are:

1. All costs, such as those for building, equipment, materials and supplies, are based on prices in the United States.

2. The operating costs, including labor used, are taken from the actual operating experience of a small scrap melting plant in the United States.

3. Adequate power and water are available at the plant site.

4. Adequate transportation facilities are available at the plant site.

5. All estimates are based on one 8 hour work shift per day, 5 days per week, or 40 hours per week.

6. Several more workers than are shown in the estimate will be required during the training period and peak production is not likely to be attained until

the whole organization is thoroughly trained. It is estimated that this training will require from 6 weeks to 3 months.

7. The scrap and part of the supplies will be available locally.

8. A market analysis has proved that annual sales of at least 11,000 tons of ingots are possible.

9. The following items cannot be estimated realistically:

   A. Land value
   B. Freight in and out,
   C. Distribution and sales cost,
   D. Taxes, interest and insurance.

While general assumptions will be made for each of these items, for the purpose of completing cost estimates, adjustments should be made in accordance with actual local costs.

In fact, all costs contained in this brochure should be adjusted to conform to actual local conditions.

PRODUCT SPECIFICATIONS

The principal product of this small melting plant is ingots produced from locally purchased scrap metal.

The ingots are intended for the production of hot rolled reinforcing bars and merchant shapes in a steel rolling mill. The ingots will be about 57 inches long and tapered, 5 inches square at the top and 4 inches square at the bottom, with rounded corners. Each ingot will weigh approximately 264 pounds.

The quality of the ingots produced will be equal to a low carbon commercial or merchant quality steel, usually designated SAE 1010 to SAE 1020.

MANUFACTURING OPERATIONS

Scrap is received at the plant by railroad and by truck. It is unloaded by the bridge crane, using a magnet, and placed in the scrap yard.

The scrap is loaded into a charging bucket by the bridge crane, using a magnet. The bottom of the charging bucket is hinged, usually in 8 sections. These sections are secured in the center of the bucket at the bottom with manila rope.

When the bucket is fully loaded, the bridge crane carries the bucket into the melt shop and places it in position for charging.

When the furnace is ready for charging, the roof of the furnace is raised and swung clear. The bridge crane then picks up the loaded charging bucket and places it into the furnace. The heat from the furnace consumes the manila rope holding the hinged section, releasing the charge of scrap into the melting furnace. The bucket is then removed and the furnace roof is swung back into place and securely locked.

At this point, additions of lime and mill scale are made through charging doors so that the slag which forms will have a deoxidizing effect on the molten metal. The electric power is then turned on and the electrodes are lowered until contact with the scrap is made, completing an arc. As the scrap is melted, the electrodes are lowered, so as to maintain a constant arc with the receeding metal. When the original charge is sufficiently melted, one or more charges are added until the total charge equals the required weight.

On completion of the melting, chemical analyses are made and the required additions of materials necessary to produce SAE 1010 to SAE 1020 are made.

The molten steel is retained in the furnace and analyzed frequently until the effects of the deoxidizing slag and the additions have produced the proper chemical conditions.

After the melting is completed, a ladle is positioned by the overhead traveling crane to receive the metal from the furnace. The furnace is tilted so that the molten metal flows through the pouring spout into the ladle. The loaded ladle is moved by the bridge crane to the pouring floor, where the molds have been arranged in rows and a hook made from 3/4 inch scrap reinforcing bars has been placed in the top of each mold, forming a loop, for the purpose of removing the ingot from the mold.

The ladle is passed from mold to mold and the correct amount of molten metal is discharged from a hole in the bottom of the ladle into each mold.

As soon as all of the molten metal has been removed from the furnace, it is immediately recharged, and the melting cycle is repeated. The melting cycle requires approximately 2 hours.

The molds are allowed to cool from 4 to 6 hours before the ingots are removed. The ingots are removed from the molds by the bridge crane, 5 at a time, as shown in one of the illustrations, and placed in ingot storage, ready for use in the rolling mill.

There will be considerable maintenance and repair work to the plant equipment due to the nature of the operations. Ladles will have to be repaired and relined; the molds will have to be repaired; the furnace will require repairing and relining.

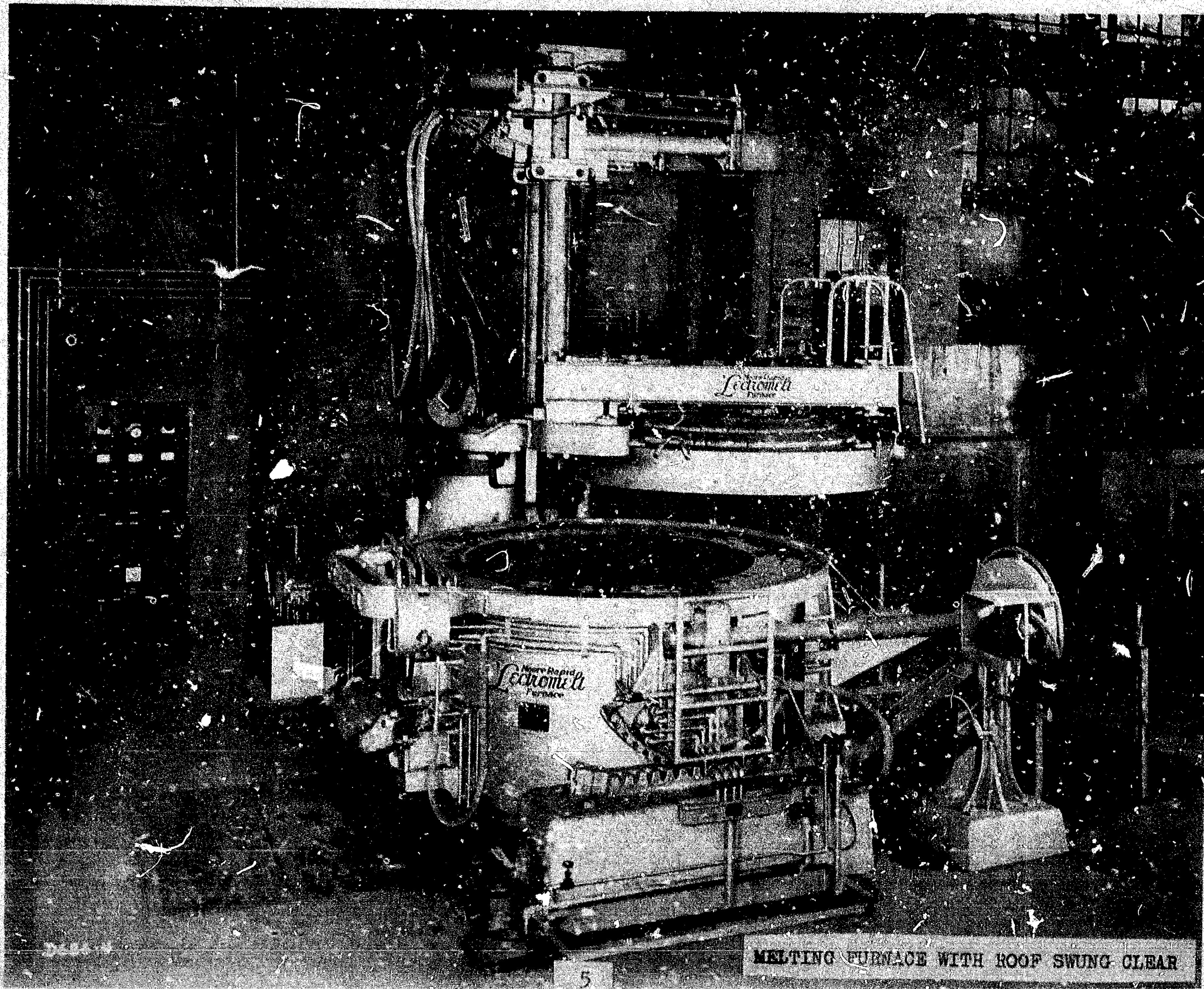
In the average factory, a maintenance crew is employed to do all repair work. This work may require only 1 or 2 men in a small plant and might require several men in a large plant.

In the average industry, repair work can be done with very little, if any, delay in the production schedule.

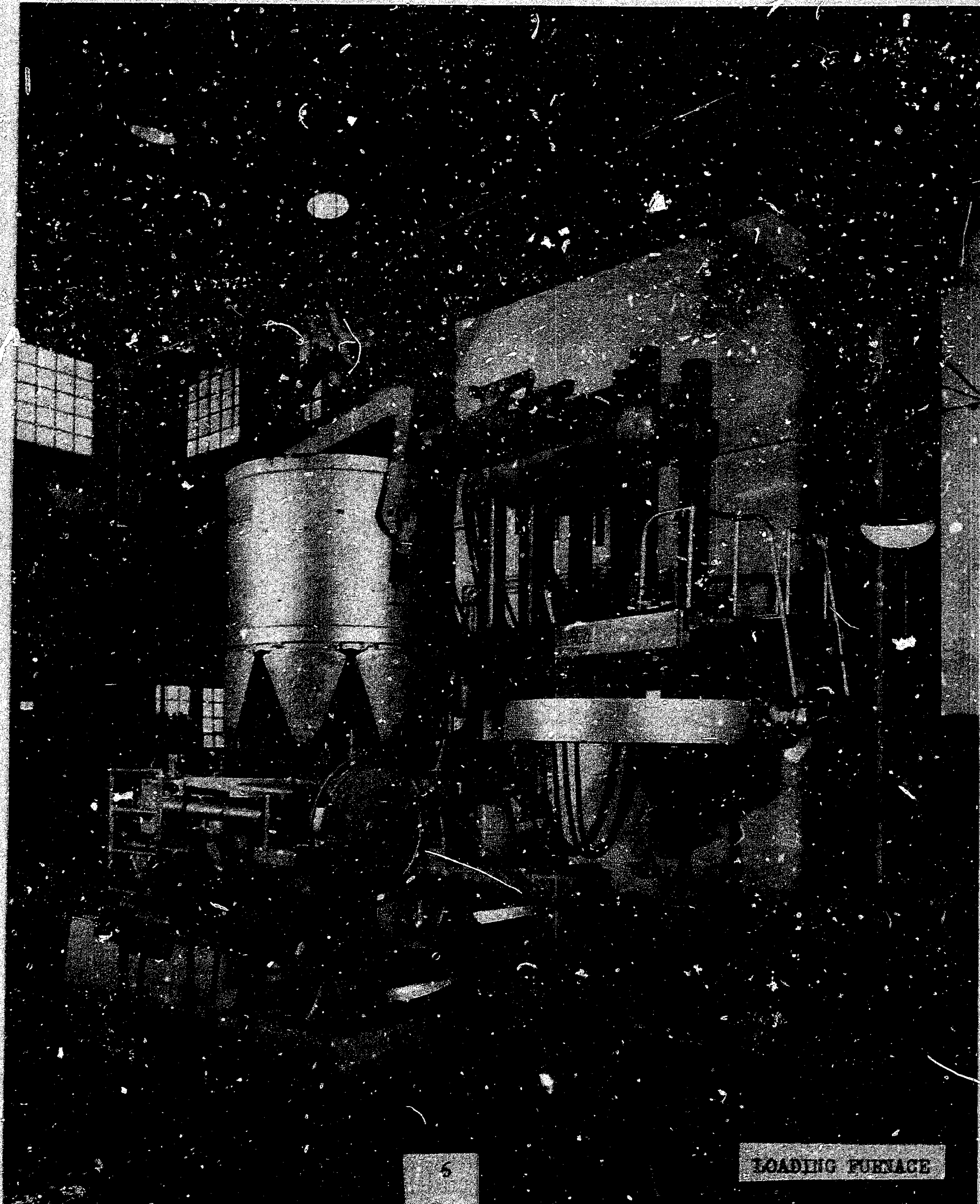
However, in a steel melting plant, the ladles and the molds, and especially the furnace, control the production. Production is always halted while the furnace is being relined. This repair, or relining, may be required at any time. Therefore, while one maintenance man will be employed for general maintenance work, all maintenance work required for the major equipment will be done by the regular operating crews.

PRODUCTION CAPACITY

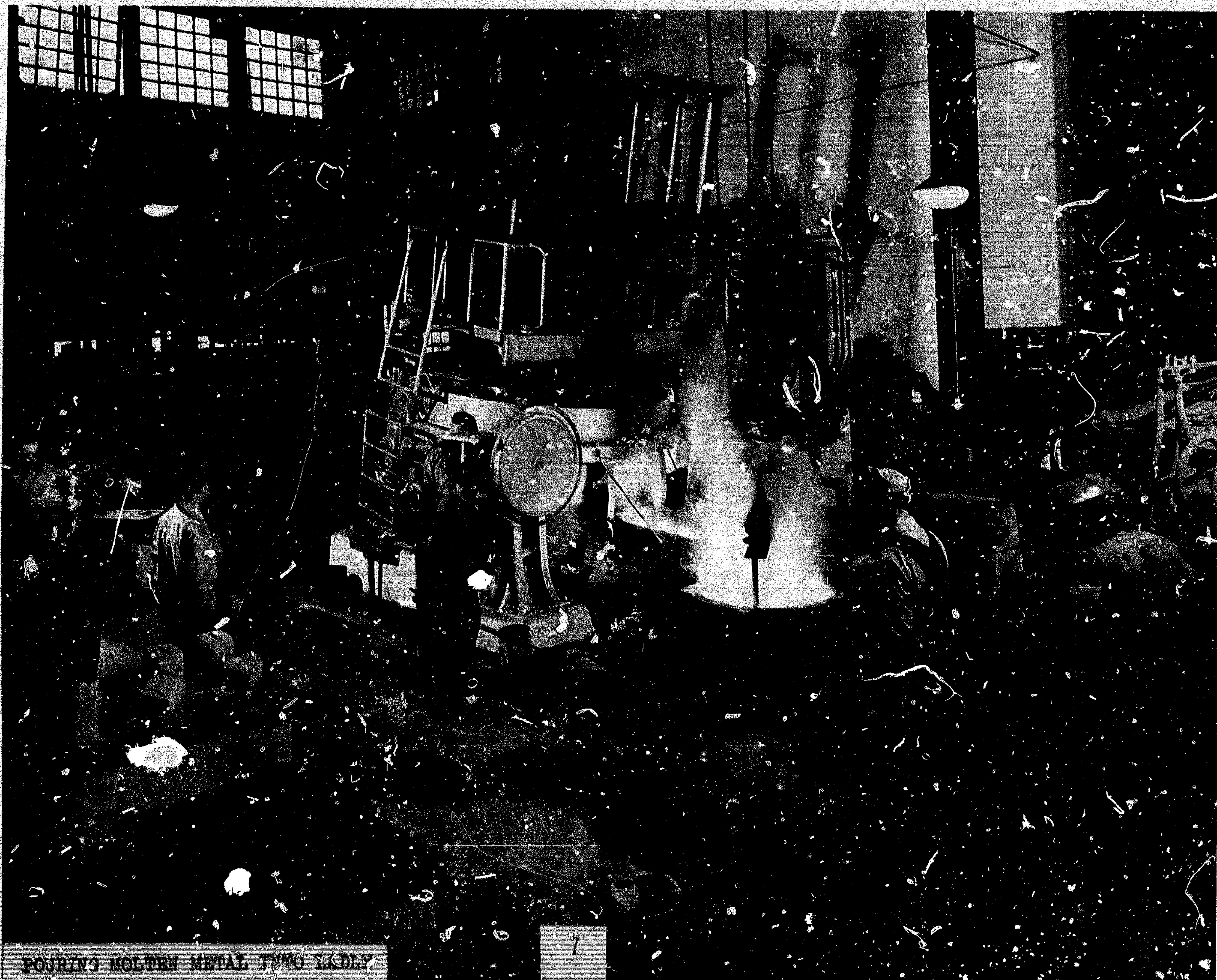
The capacity of a melting plant is governed by the size of the furnace. The furnace shown in this brochure is rated at 3 tons per hour. Based on operating experience in the United States, about 4 hours per day are required for repairs and maintenance. Therefore, the furnace will operate an average of 20 hours per day 7 days per week, or 140 hours per week. Based on this furnace rating and plant experience, the production capacity of the plant is about 400 tons of ingots per week, or 20,000 tons per year. Should a larger production be required, initially, a larger furnace would be needed. If eventual expansion is required, an additional furnace with adequately rated capacity to meet the production demand should be installed.



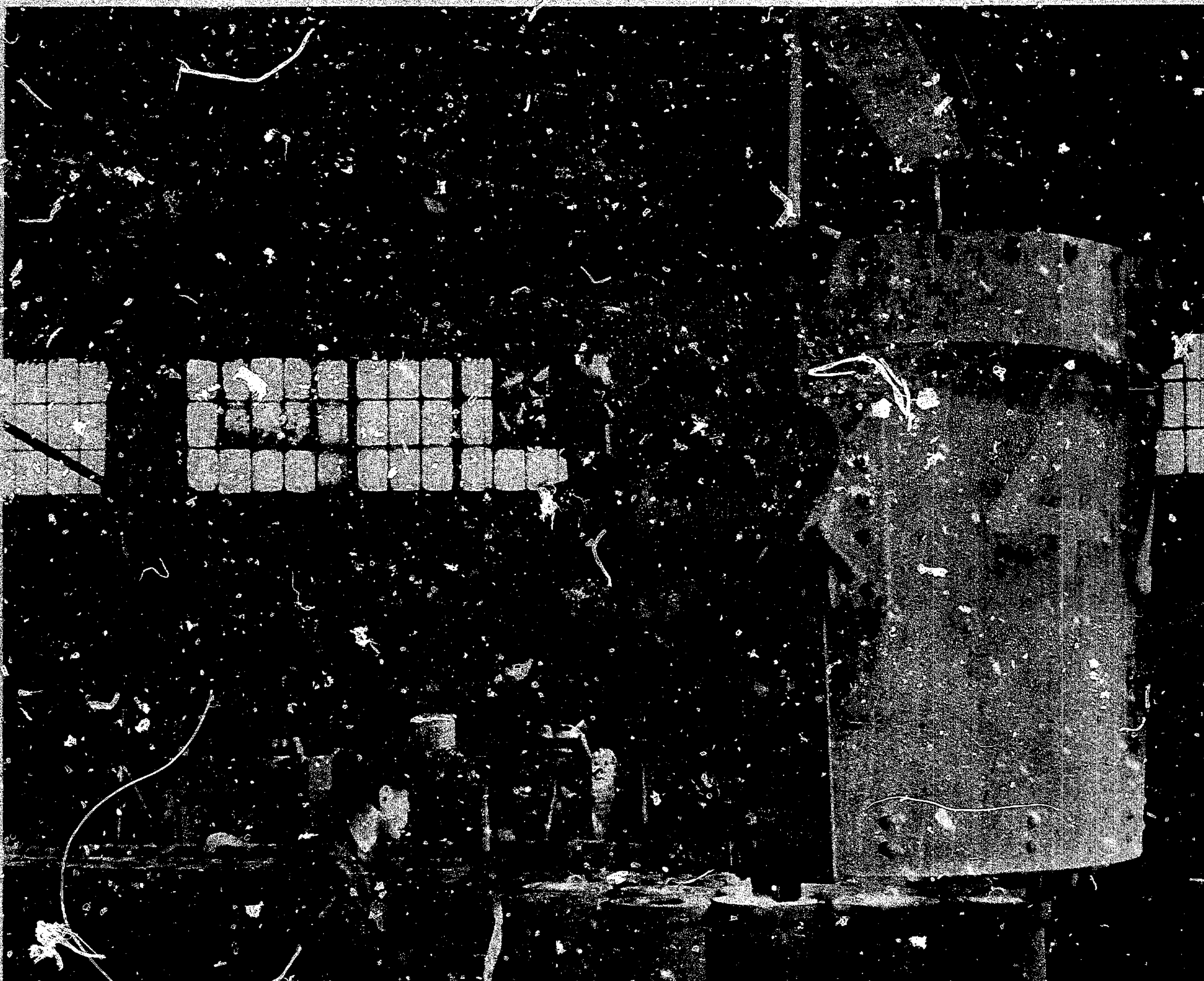
MELTING FURNACE WITH ROOF SWUNG CLEAR



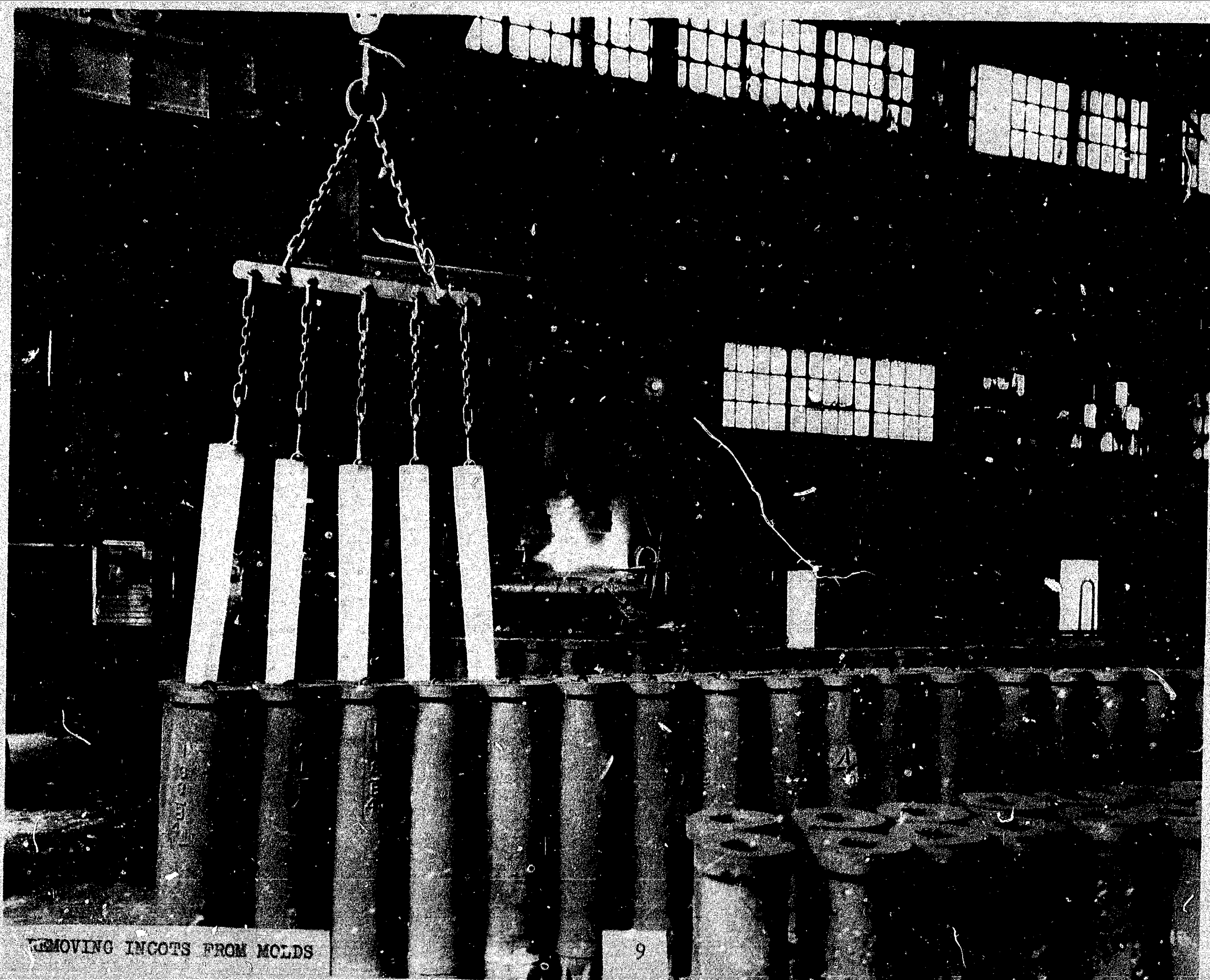
LOADING FURNACE



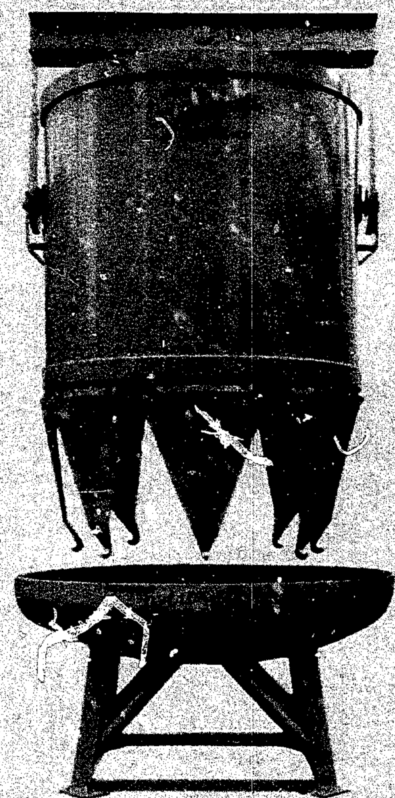
POURING MOLTEN METAL INTO LADLE



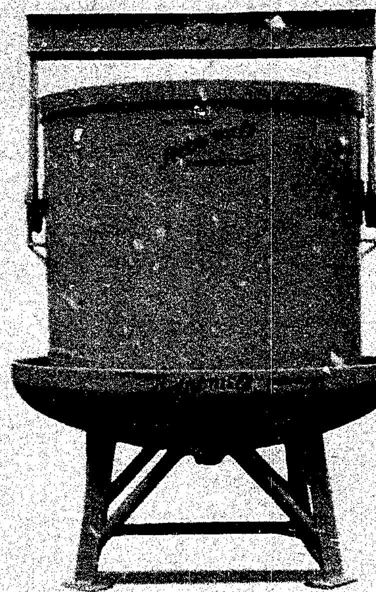
POURING MOLTEN METAL INTO MOLDS



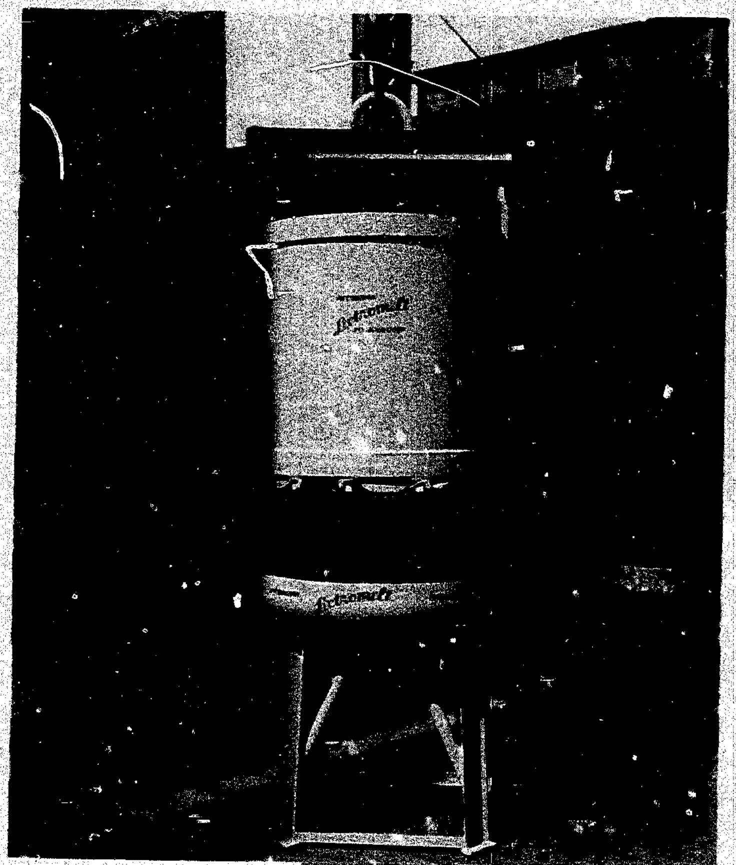
REMOVING INGOTS FROM MOLDS



EMPTY CHARGING BUCKET

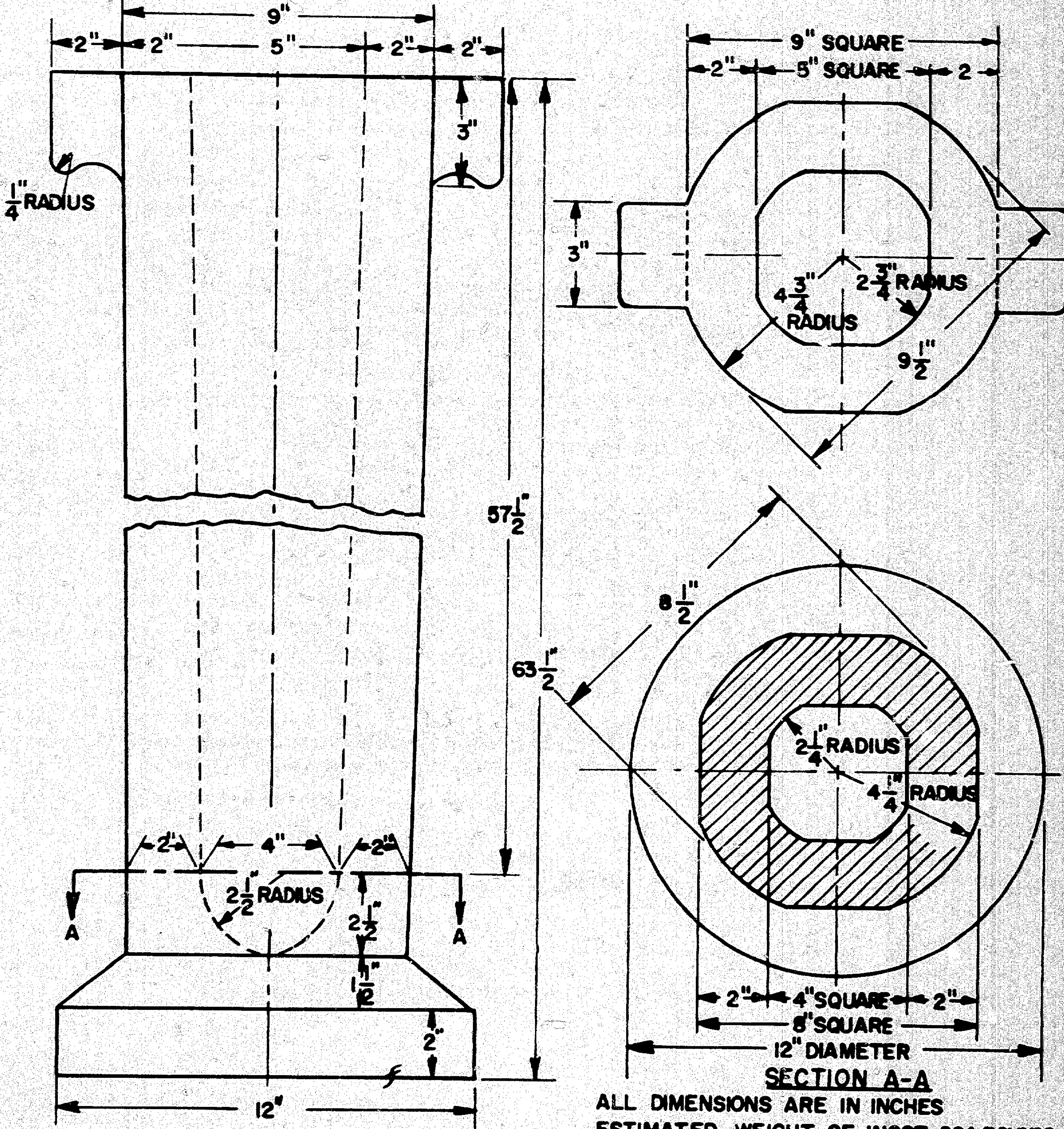


FILLED CHARGING BUCKET



PASSING CHARGING BUCKET TO FURNACE

INGOT MOLD



SECTION A-A

ALL DIMENSIONS ARE IN INCHES

ESTIMATED WEIGHT OF INGOT 264 POUNDS

ESTIMATED WEIGHT OF MOLD 773 POUNDS

PLANT SITE

To provide for eventual expansion, 10 acres of level, well-drained land is required. The site should be as advantageously located as possible with respect to transportation facilities, power, water, fuel, sources of labor and markets. The estimated cost of the plant site is $1,000.

BUILDINGS

The building frame should be 350 feet long, 60 feet wide and about 35 feet high to permit the installation and operation of a bridge crane across the 60 foot span, with adequate clearance below the crane. The building frame should be of steel.

One half, or 175 feet of the frame construction, where the actual melting and pouring takes place, should be provided with a roof and sides as shown in the plant layout. The roof and sides should be covered with 16 gauge galvanized sheets. The galvanized sheets should not have direct contact with the ground. The ends should not be covered, but left open. Since the other half of the frame construction will be used for scrap storage only, it will not require any covering. The floor of the covered half of the building should be of heavy concrete. No floor is required in the open half. A well constructed, dust-proof building 16 feet by 20 feet, should be constructed to house the transformers and other electrical equipment. The estimated cost of the above 2 buildings, including the cranes, is $100,000.

A one story office building of approximately 1,000 square feet will be required to provide for a chemical laboratory and quarters for the superintendent and a clerk. The estimated cost of this building is $6,600.

POWER

It is assumed that a dependable supply of electric power will be available from public power service lines. The total power required to operate the plant is approximately 500 KWH. The estimated annual cost of power is $80,000.

FUEL

Very little fuel will be required. Heat will be needed for the office and in the plant when the furnace is not operating in cold weather. It is estimated that the annual cost of fuel will not exceed $500.

WATER

The factory will not use large amounts of water. The office will use some water, but no large amounts will be consumed. It is estimated that the annual cost of water requirements will not exceed $500.

BRIDGE CRANES

Two overhead 5 ton bridge cranes, cab operated and equipped with both magnetic and hook lifts, will be required. The cost of the cranes complete is included in the building cost.

TRUCK

Since the overhead bridge cranes will handle all materials and ingots, the only truck required will be a one-ton pick-up truck estimated to cost $2,400. The annual cost of operating the truck is estimated at $500. The cost of the driver is shown in the indirect payroll.

REPAIRS

Estimated annual cost of miscellaneous repairs for:

General plant	$1,200
Buildings	1,200
Electrical equipment	1,600
ESTIMATED ANNUAL REPAIRS	$4,000

This does not include repairs to major equipment. It does include materials that the maintenance man will use for minor repairs to the building and utilities of all kinds.

EQUIPMENT REQUIREMENTS

6 ton furnace, complete with spare roof ring, transformers, switch gear and hydraulic equipment	$146,500
250 molds for casting ingots	28,500
2 10-ton ladles	9,000
Charging equipment, including magnet, charging buckets and closing stands	10,000
Tools and chemical analysis equipment	4,500
Furniture and fixtures	1,500
TOTAL COST OF PLANT EQUIPMENT	$200,000

DEPRECIATION ON FIXED ASSETS

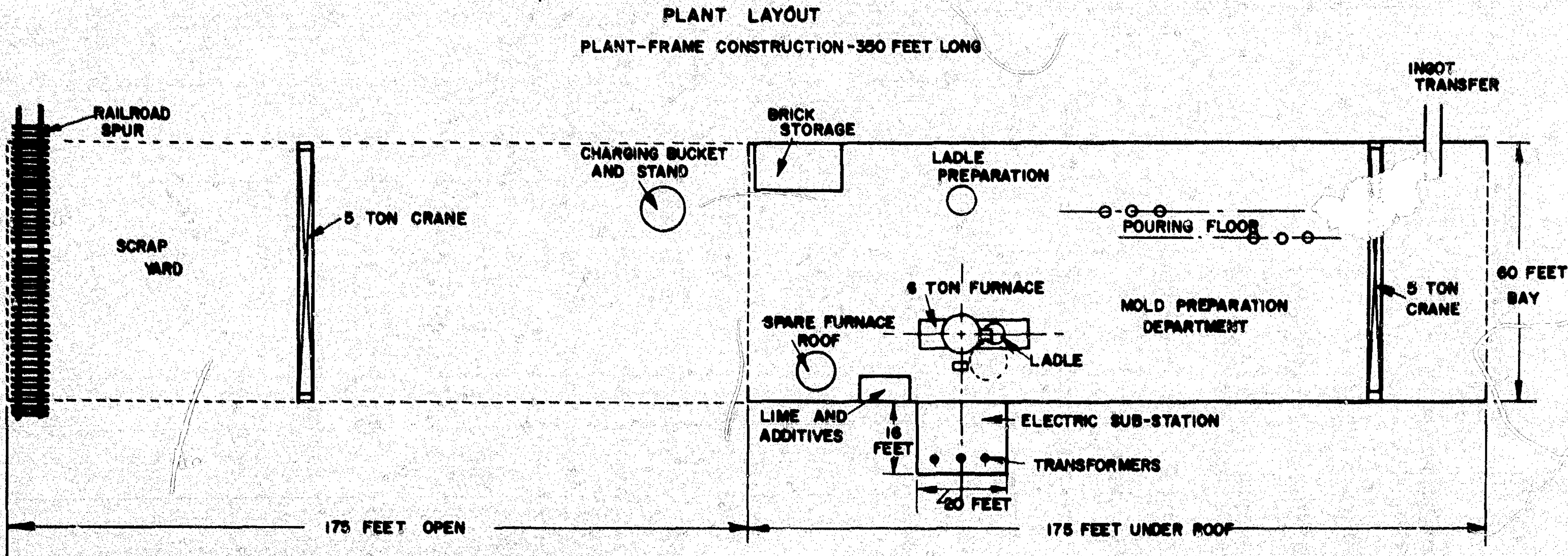
	Estimated Cost	Life Years	Annual Depreciation
Buildings	$ 106,600	20	$ 5,330
Equipment	200,000	15	13,333
Truck	2,400	4	600
TOTAL ESTIMATED ANNUAL DEPRECIATION			$ 19,263

CAPITAL INVESTMENT

Land, 10 acres	$ 1,000
Plant buildings	100,000
Office Building	6,600
Plant equipment	200,000
Truck	2,400
TOTAL ESTIMATED CAPITAL INVESTMENT	$310,000

WORKING CAPITAL REQUIREMENTS

Some of the raw materials and supplies may have to be imported. About 3 to 4 months' supply of these items should be kept on hand. It is estimated that the working capital required will be approximately $90,000.



THE FLOW OF PRODUCTION IS CONTINUOUS FROM THE SCRAP YARD TO THE INGOT TRANSFER. THERE IS NO BACK TRACKING.

CAPITAL REQUIREMENTS

Capital investment	$310,000
Working capital	90,000
TOTAL CAPITAL REQUIREMENT	$400,000

DIRECT MATERIALS

1.	20,000 tons of light steel scrap at $45 per ton	$ 900,000
2.	1,600 tons of light steel scrap to replace melting loss of 8 percent	72,000
3.	Ferroalloys, iron ore, and other additions	40,000
4.	Lime or limestone	10,000
5.	Magnesite and dolomite	10,000
	TOTAL ESTIMATED ANNUAL COST OF DIRECT MATERIALS	$1,032,000

SUPPLIES

Furnace linings, electrodes and spare parts	$ 50,000
Ladle linings, stopper rods and other repairs	20,000
Oxygen, lubricants, tools, and other supplies	5,000
Stripping equipment, stools and mold preparation materials and chemicals	5,000
TOTAL ESTIMATES ANNUAL COST OF SUPPLIES	$ 80,000

ANNUAL DIRECT LABOR

Allowing for holidays, vacations and for maintenance of the furnace, the plant will operate about 330 days per year, or about 7,900 hours per year.

Location	Men needed per shift	Men needed per day	Estimated Hourly Pay	Estimated Annual Pay	Actual Annual Pay
Scrap yard	1	3	$2.00	$ 15,800	$_____
* Furnace operators	3	9	2.50	59,250	_____
Crane Operator	1	3	2.00	15,800	_____
Mold and ingot storage	2	6	2.00	31,600	_____
		21			
TOTAL ESTIMATED ANNUAL DIRECT LABOR COST				$ 122,450	$_____

KEY MEN

* The furnace operators are the key men in this type of plant.

ANNUAL INDIRECT LABOR

Position	Needed	Estimated Annual Salary	Actual Annual Salary
Manager	1	$ 10,000	$_____
Chemist	1	8,000	_____
Bookkeeper	1	6,000	_____
Secretary	1	4,000	_____
Maintenance	1	6,000	_____
Truck Driver	1	3,000	_____
	6		
TOTAL ESTIMATED ANNUAL INDIRECT LABOR COST		$ 37,000	$_____

SAFETY

It is recommended that a safety committee be established as follows:

One furnace man
One mold man
One crane man
General Manager

This committee should meet twice each month to make safety recommendations, to review action taken on previous recommendations and to make sure that everything necessary for treating minor injuries is on hand.

First aid kits with supplies for treating minor injuries should be conveniently located in the plant and one kit should be kept in the office, as well.

The committee should select one man for each of the three 8 hour shifts to render all first aid. These men should be given some training in first aid practice.

SALES

The estimates shown in this brochure are based on an annual volume of 20,000 tons of steel. The estimated sales price of the steel is $75 per ton. Therefore, the annual sales volume of this plant, when operated under the conditions assumed, will amount to $1,500,000.

Since this plant is for the purpose of providing ingots for a small steel rolling mill, it will be located right beside the rolling mill to avoid shipping of ingots. Under this method, the sales are assured. Therefore, no sales cost is required.

RECAPITULATION OF COSTS, SALES AND PROFITS

	Estimated Cost	Actual Cost
Direct materials	$ 1,032,000	$
Supplies	80,000	
Power	80,000	
Fuel	500	
Water	500	
Direct labor	122,450	
Indirect labor	37,000	
Truck expense	500	
TOTAL ESTIMATED ANNUAL OPERATING COST	$ 1,352,950	$
Depreciation	$ 19,263	$
Insurance	5,000	
Legal and auditing	5,000	
Interest on loans	6,000	
Repairs to buildings	4,000	
Unforseen expense	27,787	
Profit before taxes	80,000	
TOTAL ESTIMATED ANNUAL SALES	$ 1,500,000	$

BUDGET CONTROL

A requisition form follows, which is designed to provide accurate records and control of costs, both direct and indirect, with the least amount of time and effort.

This form has an account number for each type of the various expenditures which the manager will review in detail, monthly or oftener, in order to control his expenses. Some items, such as power, water, fuel, are usually under contract and are easily checked by reference to monthly bills. For simplification, such items (marked with an asterisk on the attached list) are omitted from the purchase requisition. Variations in the labor costs are easily reviewed by examination of the payroll. The simplified type of control thus provided makes certain that the manager can control expenditures promptly.

At the end of each month the manager will receive a statement of all expenditures broken down by budget accounts. If the expenditures exceed the budgeted monthly allowances on any of the accounts, the bookkeeper will furnish the manager with a breakdown of all expenditures relative to the budgeted accounts exceeded. All these supporting data can be secured by reference to the purchase requisitions. This reference will enable the manager to determine what caused the over-expenditure and take corrective action.

If, at any time during each month, it becomes apparent that expenditures will exceed any of the budget accounts, the bookkeeper will bring this to the attention of the manager for his information and action.

BUDGET CONTROL ACCOUNTS

	Monthly Expenditures	Monthly Budget	Annual Budget
10 Administrative		$ 1,333	$ 16,000
20 General Plant		100	1,200
21 Furnace		4,166	50,000
22 Ladles		1,666	20,000
23 Molds and other supplies		833	10,000
* 24 Power		6,666	80,000
25 Electrical		133	1,600
30 Building		100	1,200
40 Materials		86,000	1,032,000
50 Unforseen Expense		2,340	28,084
* 60 Direct Payroll		10,204	122,450
* 61 Indirect Payroll		3,083	37,000
* 70 Fuel		41	500
* 71 Water		41	500
80 Truck expense		41	500
100 Special projects		—	—

Note: Number 10 includes insurance, legal and auditing and interest on loans.

PURCHASE REQUISITION	COMPANY NAME	DATE:

INDICATE BELOW THE DEPARTMENT OF PROJECT IN WHICH THE MATERIAL WILL BE USED:

( ) 10 ADMINISTRATIVE	( ) 22 LADLES	( ) 25 ELECTRICAL	( ) 70 FUEL
( ) 20 GENERAL PLANT	( ) 23 MOLDS & SUPPLIES	( ) 30 BUILDING	( ) 71 WATER
( ) 21 FURNACE	( ) 24 POWER	( ) 40 MATERIALS	( ) 80 TRUCK EXPENSE

INDICATE BELOW THE USE OF MATERIALS:	( ) 50 UNFORSEEN EXPENSE
( ) DIRECT MATERIALS ( ) MAINTENANCE MATERIALS ( ) MAINTENANCE SERVICES ( ) OPERATING SUPPLIES	( )100 SPECIAL PROJECT NUMBER: TITLE:

PLEASE ORDER THE FOLLOWING MATERIALS OR SERVICES	DELIVERY WANTED:

QUAN.	DESCRIPTION	UNIT	TOTAL	

QUOTES FROM:		REQUISITION BY:	
ORDER PLACED WITH		APPROVED BY:	
		ORDER NO.	ORDER DATE

SUMMARY

A small steel melting furnace built and operated to make steel ingots according to the assumptions made in this brochure, would be a profitable undertaking.

There are some determinations, however, that should be made before a decision is reached to build and operate such a plant. Among the necessary determinations to be made are those with respect to the following items:

SALES

Will the potential annual sales amount to at least 11,000 tons? The plant could operate at a fair profit on that volume of business.

SCRAP STEEL

Is scrap steel available in adequate amounts and at reasonable prices?

COSTS

After reviewing the estimates of cost and earnings shown in this brochure so they conform to actual local costs, where it is proposed to build the plant, will a profitable operation be indicated?

COMPETITION

Is there potential competition which will reduce the revenue below a profitable level, either by lowering prices or by reducing the volume of sales?

ORGANIZATION

Is there reasonable assurance that experienced men will be available for management and other key posts to initiate operations? Will suitable trainees be available for the permanent organization? The men in the key posts should be trained in advance of the initial operations of the plant.

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PERIODICALS

Iron Age, The Chilton Co., Publishers, Chestnut and 56th Streets, Philadelphia, Pennsylvania.

Steel, The Penton Publishing Company, Penton Building, Cleveland 13, Ohio.

Metal Progress, American Society for Metals, Mount Morris, Illinois.

ENGINEERS

The services of professional engineers are desirable in the design of a steel melting plant, even though the proposed plant is small. A correct design is one which provides the greatest economy in the investment of funds and establishes the basis of operation that will be most profitable in the beginning and will also be capable of expansion without expensive alteration.

The addresses of professional engineers who specialize in industrial design, some of whom may be willing to undertake such work on low cost projects overseas, can be secured by reference to the published cards in various engineering magazines. They may also be reached through their national organizations, one of which is the

National Society of Professional Engineers,
2029 K Street, Northwest,
Washington, D. C.

Manufacturers of industrial equipment usually employ engineers familiar with the design and installation of their specialized products. These manufacturers are usually willing to give prospective customers the benefit of technical advice by those engineers in determining the suitability of their equipment in any proposed industrial project.

The equipment manufacturers also know and can recommend professional engineers in private practice, who are willing and able to provide appropriate consulting services.