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PLANT REQUIREMENTS TO SET UP AND OPERATE A GRAY IRON JOBBING FOUNDRY

DEPARTMENT OF STATE
AGENCY FOR INTERNATIONAL DEVELOPMENT
COMMUNICATIONS RESOURCES DIVISION
WASHINGTON 25, D. C.

REVISED
MAY 1959

FOREWORD

This manual is a revision of an earlier report of the same type issued in 1955. This revised version includes current costs of labor, machinery, equipment and supplies, as well as additional information relative to engineering, training, safety, markets, sales, financial and economic factors.

* * * * * * * *

This manual is designed to provide a general picture of the factors which must be considered in establishing and operating a small-scale factory of this type. It should prove useful in creating interest in the subject, and serve to give enough understanding of the related considerations to help government officials, other leaders and businessmen to determine whether the potential deserves more-detailed attention.

However, it is important to note that in most cases plans for the actual development and installation of a plant will require expert engineering and financial advice in order to meet specific local situations. For further information and assistance, readers should contact their local Productivity Center, Industrial Institute, Servicio, or United States Operations Mission.

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

* * * * * * * *

The original report was prepared by the Wolf Management Engineering Company, Chicago, Illinois.

Technical information, as well as review, was provided by R. Poliakoff, Industrial Consultant, 126 Eleventh Avenue, New York 11, New York.

* * * * * * * *

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PR-17

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GRAY IRON JOBBING FOUNDRY

INTRODUCTION

"In a broad sense, the art of founding may be described as making a hole in sand and filling it with fluid metal. In the cold state, the metal retains the shape and contour of the hole and is to that extent a metal casting."

So simply does the Encyclopedia Britannica, describe the art, yet today's foundries, casting steel, iron, brass, aluminum, and other metals, can be highly specialized and utilize the most modern techniques in metallurgical science, testing devices, and mechanized equipment.

There are over 4,000 foundries in the United States alone, employing over half a million workers. Although some establishments employ over a thousand workers, most foundries, especially in the gray iron classification, are small operations with less than 100 workers.

Almost every machine for war or civilian purposes is dependent upon castings. Automobiles, dwelling houses, public utilities and railroads all require castings, thereby making foundry products of basic importance to the existence and progress of modern civilization.

Because of the variety of metals used and the limitless number of items that are cast, it is difficult, if not impossible, to made generalized statements regarding cost of production and equipment requirements that are comprehensively accurate. Because iron castings are most widely used, the present discussion will concern itself with what is known as "gray iron" castings.

A further complication arises in that foundries are of two general types: production and jobbing.

Production foundries may be departments of large establishments engaged in the mass production of items, of which the casting is only one step in the entire process of manufacture and assembly; or they may be independent foundries making many identical castings where work is repetitive and the foundry process is highly mechanized in order to secure minimum costs. Not only is much of the work done on machines, but the handling of materials is almost completely conveyorized.

The job foundry, on the other hand, stands ready to produce for any customer who comes along, provided the foundry has facilities suitable to make the castings required.

Under the circumstances, this manual will be predicated on establishing a small gray iron foundry doing a general or jobbing business, and turning out a production of about 8 tons a day of finished castings. This production level was selected because it represents a small, yet economical unit, employing 30 to 35 men.

GENERAL ASSUMPTIONS

In order to make realistic estimates in this manual, certain assumptions are made. These are:

1. The costs of the building and general facilities are based on United States Prices.

2. Material costs are based on sizes and specifications of materials used in the United States.

3. Labor costs are based on the average for the industry as recently published by the United States Bureau of Labor.

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

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

6. The plant operates eight hours a day, five days a week, and fifty weeks per year.

7. No special provision is made for the training of new personnel. It is assumed that learner's rates are paid in such cases.

8. The following items cannot be estimated realistically:

   A. Land value
   B. Distribution and selling costs
   C. In-freight and out-freight
   D. Taxes

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

   In fact, all cost estimates contained in this manual should be adjusted to conform to local conditions.

9. Columns are provided in the tables included in this manual to facilitate the conversion of cost figures to conform with local costs.

SPECIFIC ASSUMPTIONS

The following factors were considered in planning the proposed foundry:

1. It would operate on a "jobbing" basis, that is, it would get its business from a considerable number of customers who would naturally order castings in a great variety of shapes and sizes. It is also assumed that the customers would supply their own patterns to the foundry.

2. The foundry would be a small unit, turning out from 5 to 10 tons a day of finished castings; the tonnage for any particular day would be determined by the type of work being done; the average output is estimated at 8 tons. Such a foundry would employ from 30 to 35 workers.

3. Although the majority of work would consist of "small" castings weighing from half a pound to 50 pounds in weight, occasionally larger ones, ranging up to perhaps a ton in weight, would be poured.

4. Because of the relatively small size of the foundry, and the wide range of casting sizes which could normally be expected in a business of this type, no attempt has been made to recommend specialized machinery or elaborate mechanization. Such improvements could and should be made only after the nature of the business is definitely known, and where the cost of such equipment can be justified because of increased productivity or savings in labor cost.

5. Patterns will be furnished by the customers ordering castings, except for possible proprietary items which the proposed foundry may control.

CAST IRON

The term "cast iron" covers a wide range of iron-carbon-silicon alloys containing from 2% to 4% carbon and 0.25% or more of silicon in combination with varying percentages of manganese, sulphur, and phosphorus, and sometimes one or more of special alloying elements, such as nickel, chromium, molybdenum, and vandium.

Cast iron contains so much carbon that, as cast, it is not usefully malleable. It usually contains from 1.7% to 4.0% carbon and in most cases, an important percentage of silicon.

Cast iron is widely used in engineering and allied industries because of the ease with which it may be cast, its low cost and wide range of useful physical properties. Due to incomplete understanding, the attainable properties are not always appreciated and are frequently subordinated to secure low cost, with a corresponding decrease in utility.

Cast iron may be broadly grouped into four classes:

Gray Iron

This is cast iron which has a gray fracture as cast. In general, it is readily machinable with ordinary tools. The combined carbon usually does not exceed 0.8% and may be much lower.

White Iron

This is cast iron having a white fracture. It is very hard and difficult to machine. The carbon is practically all in the form of iron carbide. Most white iron castings are produced in malleable foundries, where they are heat-treated to make malleable cast iron. Some white iron casting are not heat-treated but are used in white form for such products as grinding balls, where resistance to wear is of greatest importance.

Mottled Iron

Cast iron having a mottled structure and fracture, showing a mixture of gray iron and white iron.

Chilled Iron

Cast iron with some section purposely cooled so fast by chills that the carbon is retained in combined form, or as white iron, while other sections are allowed to cool naturally, so that the carbon is retained in the form found in gray iron. A chilled roll is an example of this type of iron.

FOUNDRY PROCESSES

The manufacture of iron castings include the following major steps:

1. Design
2. Preparation of pattern or core equipment
3. Molding or core making
4. Melting and pouring
5. Cleaning, finishing and inspecting

Design

In designing castings, the engineer must consider such factors as type of metal, section size, moldability, and ease of cleaning.

Patterns

Planning and making the proper patterns and core box parts, from engineering drawings, have an important bearing on the production of good castings, especially when minimum cost is considered. Even when the purchaser is to supply the patterns, the foundry staff should be consulted as to the type and details of patterns and core box parts.

Molding

Molding consists in making the form into which the metal is to be cast. The most common type is sand molding, in which the sand is used in a "green" or moist state, or in a "dry" state. Loam molds are used in certain cases. Other mold forms are "permanent," or long-life molds.

1. Green Sand Molding

   Where the mold material is a moist refractory sand and the metal is poured into the moist mold, the process is known as green sand molding. This method is used in producing most iron castings.

2. Dry Sand Molding

   When the mold material is kept moist during molding but is subsequently dried before the casting is poured, the process is known as dry sand molding. This method is extensively used in the production of large castings, or where the contours must be accurately preserved, such as in the making of air-cooled cylinders for gasoline engines.

   Sand casting methods are applicable to the production of any number of molds from a single pattern. Sand molds are made by hand or by machines, the method used being dependent on the size and shape of casting, number of castings to be produced, and the facilities available.

3. Loam Molding

   The mold form is built of a brick backing coated with a special loam and sand mixture. The loam is applied in a wet condition, and the mold is dried before final assembly.

4. Permanent Molds

This term is commonly applied to that type of foundry mold which is made of metal and from which a large number of castings can be made. Centrifugal castings are a special type in which the molds are rotated rapidly while the metal is being poured.

5. Core Making

The interior surfaces of castings are generally formed by cores of sand and binding materials which are made in special boxes, then baked, and inserted in the mold after the pattern has been withdrawn. In some molding operations, baked cores are used to form exterior surfaces of castings.

Melting Methods

Cast iron is usually melted in one of the following types of furnaces, or by a combination of these types.

1. Cupola

The cheapest, oldest type, and most extensively used is the cupola, which is, essentially, a vertical steel cylinder lined with refractory material. Within the cupola is placed alternate layers of coke and iron; air is forced through them and the iron is melted by contact with the hot gases. The molten metal drips down through the incandescent fuel to the bottom of the furnace, and when a plug is removed, the iron is run into ladles, ready for the pouring operation.

2. Air Furnace

This has long been used in producing certain high-grade cast irons, because tests can be made during the melting process and because the metal is more subject to control than in the cupola. The entire charge is placed in the furnace at one time, melted down in one mass on a hearth, and tapped when the proper temperature and composition are reached.

3. Electric Furnace

Because quality can be quite accurately controlled and higher temperatures secured, the electric furnace is sometimes used in melting cast iron. However, since the cost is ordinarily greater than in the cupola, the electric furnace is generally used only when special high quality iron is desired.

As the metal is withdrawn from the furnace, it is transferred to ladles and poured into the molds. When the metal has cooled sufficiently, the molds are broken open and the castings removed for cleaning.

Cleaning, Finishing and Inspecting

Adhering sand is removed by brushing or tumbling in a revolving barrel, or by abrasive action of sand or steel shot. The gates, risers, and fins not already broken off in handling, are removed, and rough places on the casting smoothed by chipping or by grinding.

1. Inspecting

   A quick inspection is generally made when the castings are received in the cleaning room so that no further labor may be wasted on defective work. After the cleaning, a thorough inspection is made, and the perfect castings are ready for shipment to the customer.

2. Heat Treating

   In some foundries, and for special purposes, the finished castings are placed in annealing boxes, heated in a furnace and then cooled very slowly to room temperature. This process makes the castings stronger and more resistant to shock and fatigue.

MANUFACTURING OPERATIONS

Molding sand, which has been properly conditioned by having water and certain binders added to it, is packed around the pattern, which is placed within a box-like frame -- the flask, generally made in two sections -- by the molder. The larger and heavier types of castings would be molded by hand, but the usual run of work would be done on molding machines that either squeeze or jolt the sand around the pattern, thereby saving much hard labor and getting more productivity from the molders.

Specifically, the molder makes sure that the sand is carefully packed around the pattern; cuts the pouring holes (sprues) and grooves (gates) to act as paths for the molten metal to flow into the cavity of the mold; cuts holes (risers) in order that the mold may fill completely; and punches additional holes (vents) to allow for the escape of gas and steam. When the mold is completed, the molder removes the pattern

from the sand, carefully repairs any damages to the surfaces of the mold; and when there are to be any hollow spaces inside the casting, he sets the cores in place before the mold sections are joined and ready for pouring.

The molders are assisted by helpers, who do much of the work requiring a minimum of skill.

Previously, the cores, which form the inner surfaces of hollow castings, have been made in the core room by the core makers, who take conditioned core sand, which has had binders added to it, and pack this sand into a core-box exactly the size of the finished core.

Core making is the reverse of molding. In the first case, the core is made by packing sand into a pattern, while in molding, the sand is packed around a pattern.

As the cores are fragile, it is necessary to bake them in a core oven to give them the necessary strength. The core oven tender operates the oven, which may be either oil or gas fired.

The proper preparation of sand plays an important part in reducing trouble and preventing casting imperfections. "Mulling" is the process of kneading the sand, water, and binders into a homogeneous mixture, and provision should be made for the proper conditioning of both molding sand and core sand.

The finished mold, having been placed on the floor, is ready for pouring. It would be normal practice for the molders to work for about five hours, and then spend the next three hours pouring their own castings. This keeps the responsibility for perfect castings in the hands of one individual, and less defective work will probably result.

During the morning, the melter, or cupola tender, with his helper, have examined the inside of the furnace, and patched any cracks or broken spots in the lining that may have developed during the previous heat. They will then weigh and load into (charge) the cupola the pig iron, scrap iron, flux, and any special alloy metals, in the proportions determined by the foundry superintendent as being necessary to produce the castings desired.

Shortly before pouring time, the cupola tender ignites the fuel, turns on the air blast, and regulates the pressure so that the melted iron can be tapped out in the right quantities and at the proper temperature, about 2,500 degrees Fahrenheit. Ordinarily, the metal is tapped into large ladles which are suspended from a tram-rail, and can be readily moved to various positions on the molding floor. From these large ladles, the iron is poured into the small hand ladles which the molders use in pouring their castings.

As a casting should be poured in a continuous flow, a large ladle, 2,000-pound capacity, is provided to handle the extra large work. Also, a special hoist, or crane, is necessary to handle this ladle.

As a great volume of steam and disagreeable fumes are given off when the metal is poured in the molds, suitable exhaust fans should be installed so as to remove them from the molding floor.

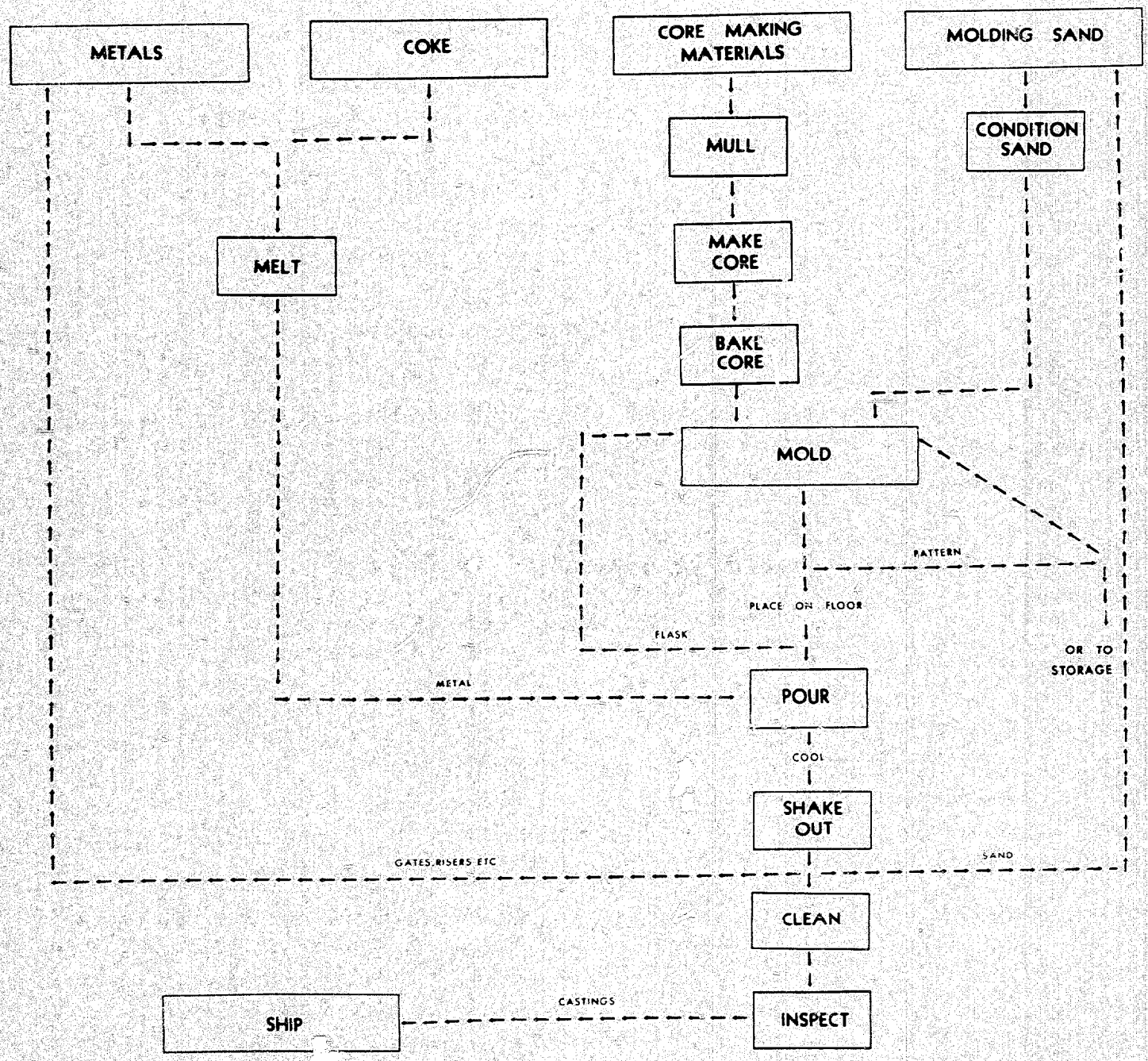
Shaking-out is heavy and dirty labor; it could well be done, after the castings have cooled sufficiently, by a second-shift gang. The shake-out men knock open the molds, pull out the castings with hooks, and move them to the cleaning room. Then these men remove all old cores from the sand, pick out the tramp metal, and recondition the molding sand for the next day's use. Core sand is destroyed and not recoverable. Conditioning could either be accomplished by a sand-cutter plus screening and hand shoveling, or by means of a mulling machine.

Cleaners remove the adhering sand and excess metal that is not part of the finished casting. Castings of ordinary size would be tumbled for smoothness in a revolving metal barrel, and excess material in the form of fins, gates, and risers would be chipped or ground off.

The finished castings are inspected by the supervisor in charge of the cleaning room and also of the shipping room.

A schematic flow chart is included on the following page showing the progressive steps which materials and supplies make as they proceed through the foundry operations.

FLOW CHART
GRAY IRON FOUNDRY



PRODUCTION TOOLS AND EQUIPMENT

For a job foundry of this capacity the following equipment is recommended:

Description	Units Needed	Estimated Cost		Actual Cost
Melting Department				
No. 3 Cupola	1	$ 3,000		
Spark Arrester	1	200		
Roof Board		150		
Blower with Motor and Controls	1	2,700		
Charging Hoist and Floor	1	1,400		
Cupola Lining	1	1,100		
Balanced Type Car	1	1,500		
Platform Scale	1	1,100		
			$ 11,150	
Core Room				
Benches - homemade	1	$ 200		
Core Oven - drawer type	1	3,300		
			3,500	
Sand Preparation				
Sand Conditioning Equipment	1		1,100	
Molding Department				
Molding Machines	4	$ 2,500		
Air Jolt Hand Roll-Overs	2	1,100		
250-lb Trolley Ladles	3	500		
One-Ton Ladle	1	600		
Ladles	3	800		
50-lb Shanks and Ladles	10	200		
Tram Rail Installation	1	3,000		
Crane System, 3-ton Hoist	1	2,500		
			11,200	

Production Tools and Equipment - Continued

Description	Units Needed	Estimated Cost		Actual Cost
Flask Equipment				
Pop-Off Flasks, Aluminum	12	$ 1,200		_____
Loose Flasks, Wood		1,200		_____
Jackets	84	1,344		_____
Bottom Boards	1,200	1,440		_____
Cover Plates	500	800		_____
Air Hoses and Nozzles		200		_____
Shovels, Riddles, Screens		1,200		_____
			$ 7,384	_____
Cleaning Room				
Double Grinder	1	$ 2,200		_____
Tumbler	1	3,000		_____
Air Grinders	2	260		_____
Chipping Hammers	2	260		_____
Chipping Benches - homemade		200		_____
			5,920	_____
General				
Exhaust Fans, 36-inch	2	700		_____
Air Compressor, 1,200 CFM	1	3,000		_____
Pick-Up Truck	1	2,500		_____
			6,200	_____
Total			$ 46,454	_____
Other Equipment				
Maintenance Tools			1,500	_____
Office Equipment				
Desks, chairs, typewriter, files, bookcase			800	_____
Total Equipment Cost			$ 48,754	_____

PLANT LAYOUT

A diagrammatic layout is shown on the following page.

PLANT SITE

To provide for eventual expansion, a tract of level well drained land approximately 1/2 acre would be adequate. The site should be as advantageously located as possible with respect to transportation facilities, power, water, fuel, sources of labor and markets. The cost of the land is estimated at $2,000.

BUILDING

A one-story fireproof building 100 feet x 75 feet or 7,500 square feet with an "A" roof, or monitor roof and a minimum of 16 feet for side walls would be required.

The diagrammatic layout indicates the approximate area that would be required, and the approximate location of this equipment required.

A building of this type can be built in the United States including adequate wiring and plumbing at $4.00 per square foot of floor space. The cost of this building is estimated at $30,000.

POWER

The power consumption in a small foundry is not very large. The cost of power is estimated at $1,200.

WATER

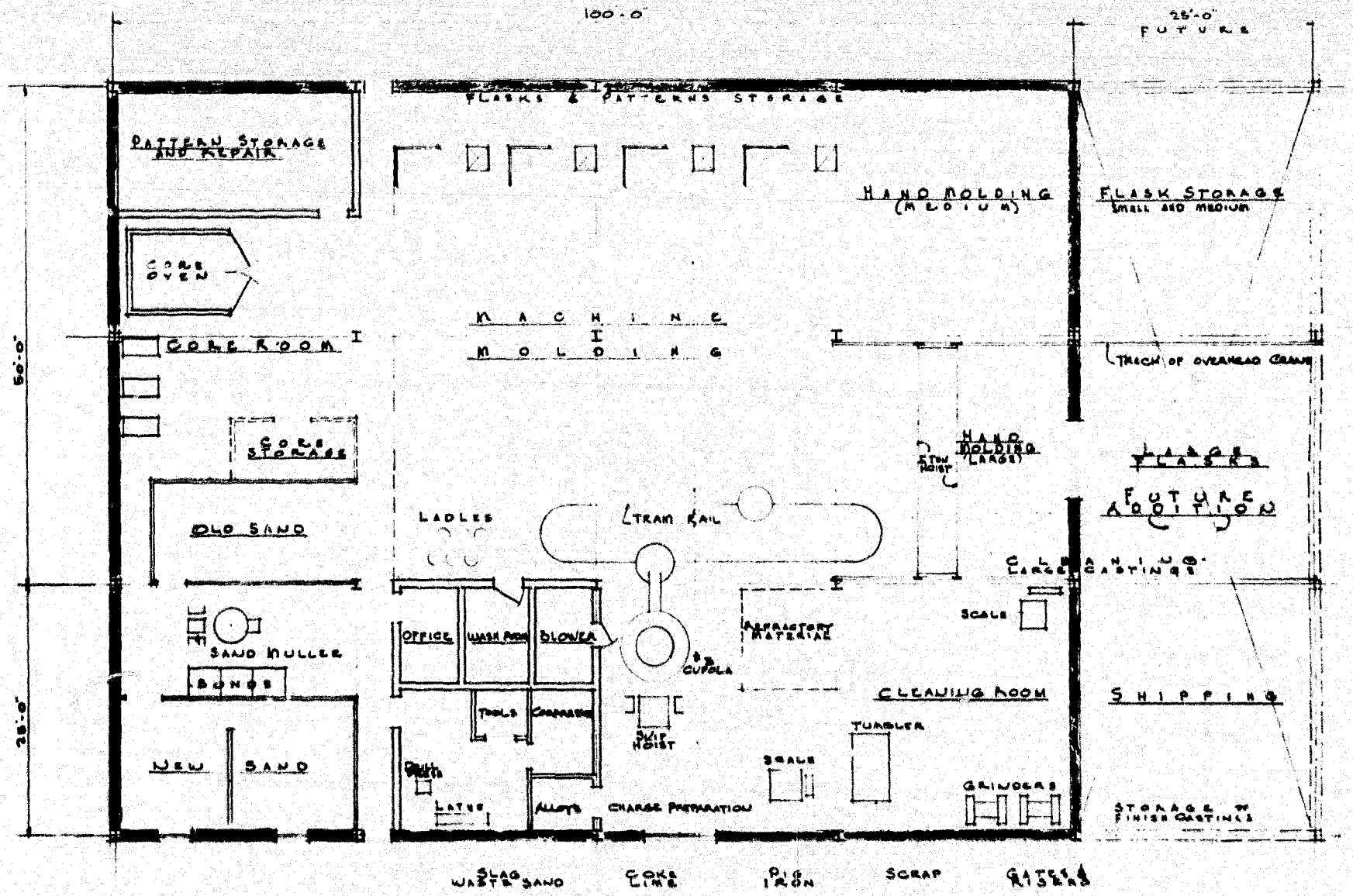
The water consumption for production, sanitary purposes and fire protection is estimated at $400.

FUEL

The cost of fuel is included in the Material Requirements.

TRUCK

A one-ton pick-up truck is included in the General Equipment. The cost of gas, oil and repairs is included in Supplies and the cost of a truck driver is included in the Indirect Labor.



DIAGRAMATIC LAYOUT
of
SMALL GRAY IRON FOUNDRY
SCALE 1/8" = 1'-0"

MATERIAL REQUIREMENTS

Item	Units Needed	Estimated Unit Cost	Estimated Total Cost	Actual Cost
Metal*	2,000 tons	$ 70.00/ton	$140,000	_____
Coke	120 tons	33.33/ton	4,000	_____
Core Sand	528 tons	2.75/ton	1,400	_____
Molding Sand	792 tons	2.65/ton	2,100	_____
Other Supplies:				
Fire Brick				
Fire Clay				
Parting Sand				
Limestone or other Flux				
Sea Coal				
Pitch				
Corn Flour				
Core Oils				
Wires				
Rods and Chaplets			5,000	_____
Total Cost of One Year's Materials			$152,500	_____

* Includes pig iron, scrap, manganese, silicon; and alloy briquettes.

SUPPLIES

Description	Estimated Yearly Cost	Actual Cost
Maintenance Materials	$ 1,000	_____
Truck Gas, Oil and Repairs	500	_____
Lubricants and Hand Tools	600	_____
Power	1,200	_____
Water	400	_____
Office Supplies	500	_____
Total	$ 4,200	_____

DIRECT LABOR

Occupation	Personnel Required	Hourly Rate	Annual Cost	Actual Cost
Molders	7	$ 2.25	$ 31,500	_____
Molder Helpers	3	1.60	9,600	_____
Core Makers	3	2.25	13,500	_____
Core Oven Tender	1	2.00	4,000	_____
Cupola Tender	1	2.00	4,000	_____
Cupola Tender Helper	1	1.60	3,200	_____
Shake-Out Leader	1	2.25	4,500	_____
Shake-Out Men	4	1.80	14,400	_____
Casting Cleaners	4	1.80	14,400	_____
Pattern Maker	1	2.50	5,000	_____
Total	26		$104,100	_____

INDIRECT LABOR

Description	Personnel Required	Hourly Rate	Annual Cost	Actual Cost
Manager	1		$ 10,000	_____
Cleaning Room Foreman	1		6,000	_____
Maintenance	1	$ 2.00	4,000	_____
Bookkeeper	1		5,000	_____
Secretary-Clerk	1		3,600	_____
Janitor-Cleaner	1	1.60	3,200	_____
Truck Driver	1	1.60	3,200	_____
Total	7		$ 35,000	_____

DEPRECIATION

Description	Estimated Cost	Years' Life	Estimated Per Year	Actual Per Year
Building	$30,000	20	$ 1,500	_____
Production Tools and Equipment	46,454	15	3,097	_____
Other Tools and Equipment	1,500	5	300	_____
Furniture and Fixtures	800	5	160	_____
Pick-Up Truck	2,500	4	625	_____
Total			$ 5,682	_____

MANUFACTURING OVERHEAD

Item	Estimated Annual Cost	Actual Annual Cost
Indirect Labor	$35,000	_____
Power	1,200	_____
Water	400	_____
Supplies	4,200	_____
Depreciation	5,682	_____
Total	$46,482	_____

MANUFACTURING COST

Direct Labor	$ 104,100	_____
Direct Materials	152,500	_____
Manufacturing Overhead	46,482	_____
Total	$ 303,082	_____

Pounds of Castings per year 4,000,000

Manufacturing Cost per pound $.07577

FIXED ASSETS

Item	Estimated Cost	Actual Cost
Land	$ 2,000	
Building	30,000	
Production Tools and Equipment	46,454	
Other Tools and Equipment	1,500	
Furniture and Fixtures	800	
Pick-Up Truck	2,500	
Total	$ 83,254	

WORKING CAPITAL

In some locations it may be necessary to import a large part of the materials. In such cases about two months of direct material inventory should be maintained.

Item		Estimated Cost	Actual Cost
Direct Materials	- 60 days	$ 25,400	
Direct Labor	- 30 days	8,675	
Manufacturing Overhead	- 30 days	3,740	
Reserve - Sales Collections	- 30 days	40,000	
Total		$ 77,815	

CAPITAL REQUIREMENTS

Item	Estimated Cost	Actual Cost
Fixed Assets	$ 83,254	
Working Capital	77,815	
Total	$ 161,069	

SALES REVENUE

The price per pound actually received depends on many factors; for example, fly wheels which have a high average weight sell at $0.10 per pound, while radiator grilles bring $0.60 per pound. In the latter case, of course, the scrap rates and finishing costs are higher per pound. To make a realistic estimate of sales revenue, it is necessary to know the sales volume of each type of casting to be sold.

In order to make a conservative estimate of potential revenues in this manual, an average price of $0.12 per pound has been assumed.

At an average price of $0.12 per pound the annual sales volume would be 4,000,000 x $0.12 or $480,000.

RECAPITULATION OF COSTS, SALES AND PROFITS

Item	Estimated Cost		Actual Cost
Direct Labor	$ 104,100		_____
Direct Materials	152,500		_____
Manufacturing Overhead	46,482		_____
Total Manufacturing Costs		$ 303,082	_____
Interest on Loans	$ 5,000		_____
Insurance	2,000		_____
Legal	2,400		_____
Auditing	3,600		_____
Unforeseen Expense	13,918		_____
Total Administrative Costs		26,918	_____
Sales Commissions, Travel Freight Out, Bad Debts, Discounts and Allowances		60,000	_____
Profit before Taxes		90,000	_____
Total Annual Gross Sales		$ 480,000	_____

BUDGET CONTROL

A requisition form designed to provide accurate records of procurement and indicate the purpose of procurement with the least amount of time and effort is shown on the following page.

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 and water, are usually under contract and are easily checked by reference to monthly bills. For simplification, items (marked with an asterisk below) are omitted from the purchase requisition. Variations in the labor costs are easily reviewed by examination of the payroll vouchers. The simplified type of control thus provided makes certain that the manager can control expenditures promptly.

Following the requisition form, a sample voucher check is shown. Voucher checks should be used for the payment of all expenditures and the appropriate book account number placed on each voucher.

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 of any of the accounts, the bookkeeper will furnish the manager with a break-down of all expenditures relative to the budgeted accounts exceeded. All these supporting data can be secured by reference to the purchase requisitions and the check vouchers. 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

Account Number		Monthly Expense	Monthly Budget	Annual Budget	Actual
10	Administrative	$_____	$ 1,084	$ 13,000	$_____
20	Sales	_____	5,000	60,000	_____
30	Direct Materials	_____	12,700	152,500	_____
40	Supplies	_____	350	4,200	_____
51	Power*	_____	100	1,200	_____
52	Water*	_____	33	400	_____
53	Fuel	_____	---	---	_____
60	Unforeseen Expense (Reserve Account)	_____	1,159	13,918	_____
71	Direct Labor*	_____	8,675	104,100	_____
72	Indirect Labor*	_____	2,916	35,000	_____
80	Depreciation (Reserve Account)	_____	---	5,682	_____

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

PURCHASE REQUISITION	COMPANY NAME	DATE

☐ 10 ADMINISTRATION ☐ 40 SUPPLIES

☐ 20 SALES ☐ 50 UTILITIES

☐ 30 MATERIALS ☐ 60 UNFORESEEN EXPENSE

INDICATE BELOW THE USE OF MATERIALS

☐ DIRECT MATERIALS ☐ MAINTENANCE SERVICES

☐ MAINTENANCE MATERIALS ☐ OPERATING SUPPLIES

	PLEASE ORDER THESE MATERIALS OR SERVICES	DELIVERY WANTED	
QUANTITY	DESCRIPTION	UNIT	TOTAL

QUOTES FROM		REQUISITIONED BY	
QUOTES FROM		APPROVED BY	
QUOTES FROM		ORDER NO.	ORDER DATE

R. W. MITCHELL MANUFACTURING COMPANY
1422 BOSWORTH STREET, S. E.

65-22
514

ANYWHERE, U. S. A._____19____ No. 10000

PAY _____ DOLLARS $ _____
TO THE ORDER OF

R. W. MITCHELL MANUFACTURING COMPANY

TO FIRST NATIONAL BANK
ANYWHERE, U. S. A.

BY SAMPLE CHECK
VICE PRESIDENT

YOUNG & SELDEN CO.

ACCOUNT NUMBER

Sample voucher check to be used for the payment of all expenditures in connection with Budget Control.

R. W. MITCHELL MANUFACTURING COMPANY

ENGINEERS

The services of professional engineers are desirable in the design of this 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 6, D. C.

Manufacturers of industrial equipment 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 project.

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

TRAINING

Manufacturing an inferior quality of product during the training period could create sales resistance that might be difficult to cope with later. To avoid such possibilities, the quality of the product should be maintained at all times, including the training period.

In some areas skilled operators may be available locally. In other areas all the operators may have to be trained.

If skilled operators are not available, adequate training would be assured by using one or more of the following methods:

A. If the plant is designed and installed by a competent engineering firm, the contract should be negotiated, if possible, on a turn-key basis. On this basis the contractor agrees to operate the plant and produce the quality and quantity of the product stated in the contract for an agreed period of time. Such a contract would assure adequate personnel training, since full quantity and quality could not be produced with an untrained organization.

B. The engineering firm that designs and installs the plant can usually make training arrangements to have key personnel placed, for training purposes, in a foreign industry that produces the same type of product. This would provide training for the key personnel while the plant is being installed.

C. If neither of the above methods is possible, then qualified and experienced individuals should be employed for the key positions, either permanently or temporarily, to perform the key operations and assist in training the organization, even if they must be secured outside the country.

D. The manager should have years of successful experience in this type of business and be fully qualified in all phases of management, including the training of employees.

SAFETY

There is always danger of accident and injury in any industrial plant. Because of this, the manager should take specific action to bring to the attention of each employee the importance of safety precautions and intelligent first aid.

Practically all machines have safety appliances, and the manager should see that these are in good working condition and that the operators are making full use of them.

In addition to constant watchfulness to make sure that all practicable safety precautions are taken, first aid supplies should be readily available. One complete first aid kit should be maintained near the manager's office, and others at appropriate places throughout the plant. Some of the employees should be trained to provide first aid service.

The use of accident posters in the plant have proved to be of value in reducing accidents. It is recommended that such posters be used, and that some direct special action be taken by the manager, at least once each month, to bring to the attention of all personnel the importance of safety precautions.

A fire brigade should be established and each member trained as to his responsibility in case of fire. Fire drills should be conducted periodically.

It is recommended that the employees be encouraged to offer suggestions or recommendations relative to prevention of accidents, removal of fire hazards and maintaining general interest in all safety factors.

SUMMARY

A small plant, built and operated according to the assumptions made in this manual 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:

MATERIALS AND SUPPLIES

1. Are all materials and supplies available locally?
2. Is the local material market competitive?
3. Are satisfactory delivery of local materials assured at reasonable prices?
4. What materials and supplies must be imported?
5. Are they available in world markets at competitive prices?
6. Would prompt delivery of imported materials and supplies be assured so that large inventories would not be required?

MARKET FACTORS

1. Is there already a demand for the product?
   - A. Who are the principal consumers?
   - B. Who are possible new consumers?

2. How is demand for the product now satisfied?
   - A. By local production? If so, what is the volume of annual production?
   - B. What percentage of consumption is filled by local production?
   - C. By imports? If so, what is the volume of annual imports?
   - D. What percentage of consumption is met by imports?
   - E. From what areas are imports derived?

3. What is the estimated annual increase in local consumption over the next five years?
   - A. How were such estimates made?
   - B. By reference to official figures on population growth, family budgets, imports, etc.?
   - C. By consultation with trade or industry, ministries, associations, bankers, commercial houses, wholesalers, retailers, industrial consumers, etc.?

4. If the product is already being manufactured, can the existing and estimated future local market absorb production of the new plant without price-cutting or other dislocations?

5. Would the estimated sales price and quality of the new product make it competitive with an imported equivalent?
   A. After adjusting cost to local conditions, is the estimated sales price of the product so high that tariff protection is necessary to protect it from imports?

EXPORT MARKETS

1. Could the product compete in export markets on the basis of price, quality and dependability of supply?
2. Can export markets for the product be developed?
3. If so, in what areas and in what annual volume?
4. What procedures would be necessary to develop export markets?
5. What would it cost?

MARKETING PROBLEMS

1. In calculating costs of the product, has adequate allowance been made for the expense of a sales department, advertising and promotion that might be required?

2. Do consumer prejudices against locally manufactured products exist?
   A. If so, why?
   B. Would they apply to the new product?
   C. If so, how could they be overcome and what would it cost to do so?

3. Do marketing and distribution facilities for the product exist?
   A. If not, can they be set up?
   B. What would it cost to do so?

4. Will the product be sold to:
   A. Wholesalers?
   B. Retailers?
   C. Direct to consumer?
   D. Other industries?
   E. Government?

ECONOMIC FACTORS

1. How much foreign exchange (and in what currency) is required to import machinery, equipment and supplies:
   A. How much foreign exchange (and in what currency) is required for annual interest payments and amortization of any loans contracted to import machinery and equipment, or for payment of royalties and technical services?
   B. How much foreign exchange (and in what currency) is required for annual import of raw materials and supplies?
   C. What are estimated annual foreign exchange earnings and in what currencies?
   D. Has careful consideration been given to the possibility of depreciation in the foreign exchange value of the local currency?
   E. Has careful consideration been given to the possibility of import controls, or restrictions on availabilities of foreign exchange necessary to operate the business?
   F. What benefits would the new business bring to the economy in the use of local raw materials: in employment and in technology?
   G. Do dependable facilities exist for transportation, power, fuel, water and sewage?
      (1) If not, can existing deficiencies be eliminated satisfactorily?
      (2) What would be the cost to do so?

PERSONNEL

1. Is there an adequate labor supply near the plant location?
   A. If not, how can the problem be solved?

2. Can the problem of training competent management and supervisory personnel be solved?
   A. Also, the training of skilled labor?
   B. Is technical advice available in the locality?
   C. If not, where can it be obtained and what will it cost?

LAWS AND REGULATIONS

1. Do existing labor laws, government regulations, laws and taxes favor establishment of new business?
   A. If not, can existing obstacles be removed?
   B. If so, how and when?

FINANCIAL FACTORS

1. Technical advice on selection of machinery and equipment.
   A. In selecting the machinery and equipment for the new plant, have reputable and competent engineers and technicians been consulted?
   B. Have they been asked for advice on the most suitable types of machinery and equipment for the process and locality?
   C. Have they carefully compared costs of various suppliers?
   D. Credit terms offered purchasers

FINANCIAL REQUIREMENTS OF THE PROJECT

1. In estimating the cost of the project, has careful consideration been given to:
   A. The effect on costs of delays in construction schedules?
   B. In delivery and installation of machinery and equipment?
   C. In import of essential raw materials and supplies?

2. In calculating cash flow and working capital requirements, has careful consideration been given to:
   A. Maintaining adequate inventories of raw materials?
   B. Supplies and spare parts?
   C. Seasonal fluctuations in the business?
   D. The time required to liquidate credit sales to customers and bad debts?
   E. The period necessary to get the plant into production?
   F. Cash required to amortize its principle loans?

3. If the economy is in a period of inflation, has full allowance been made for the influence of rising prices and wages on the cost of the project and on working capital requirements?

SHORT TERM BANK CREDITS

1. Has it been possible to make arrangements with local banks to finance short-time working capital requirements of the business?

FINANCIAL PLAN

1. Has a definite plan to finance the project been worked out?
   A. Is sufficient capital available locally?
   B. If not, what is the plan to obtain the required capital?

BIBLIOGRAPHY

Textbooks

Cast Metals Handbook — American Foundrymans Society, Gulf and Wolf Road, Des Plaines, Illinois

Gray Iron Casting Handbook — Gray Iron Foundry Association of America, 930 National City Building, East 6th Street, Cleveland 14, Ohio

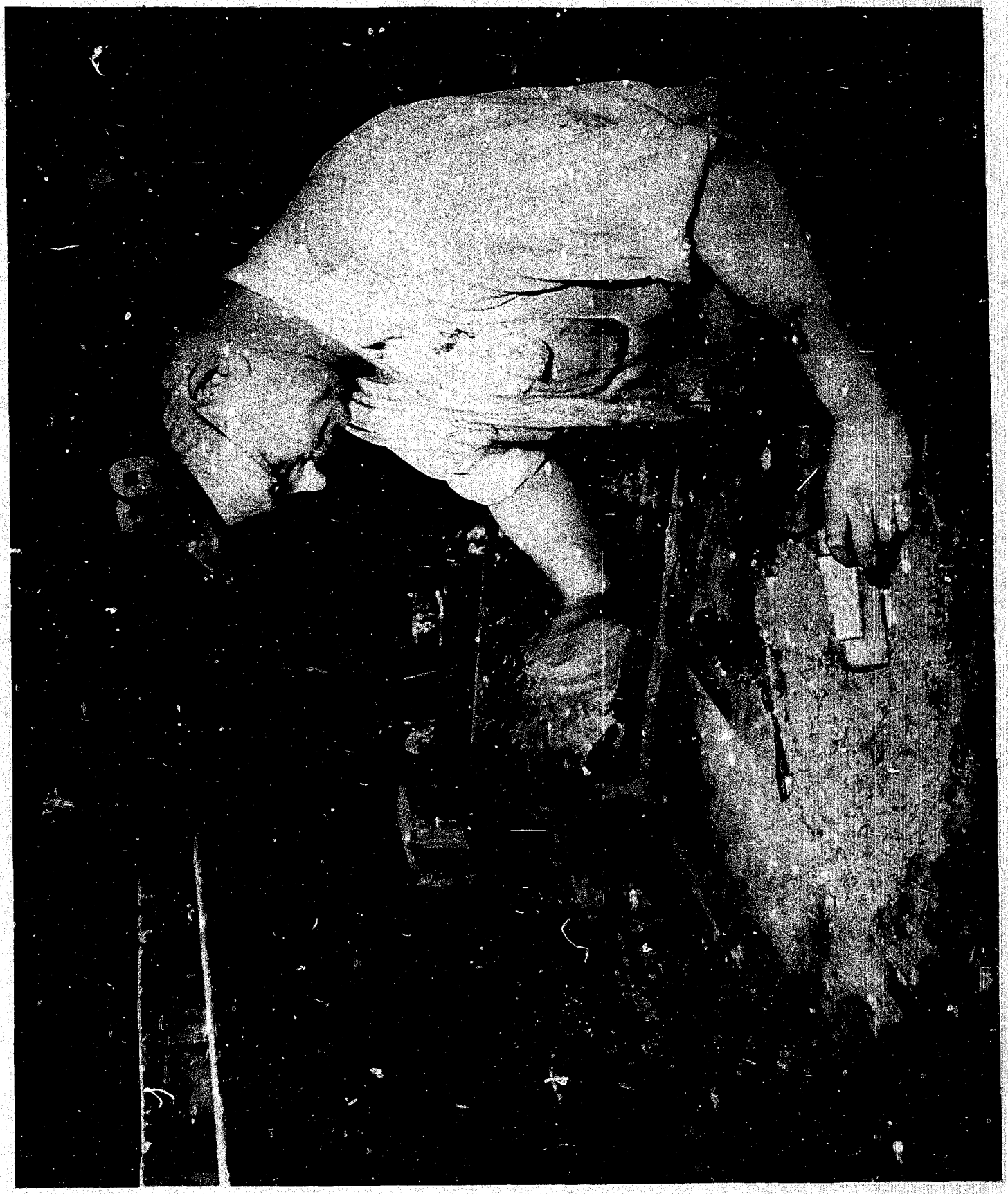
Periodicals

Foundry — Penton Publishing Company, Cleveland 13, Ohio

Iron Age — Chilton Company, Chestnut and 56th Street, Philadelphia 39, Pennsylvania

ABBREVIATIONS

CFM	Cubic feet per minute
lb	Pound
lbs	Pounds
%	Percent
'	Feet or foot
"	Inch or inches



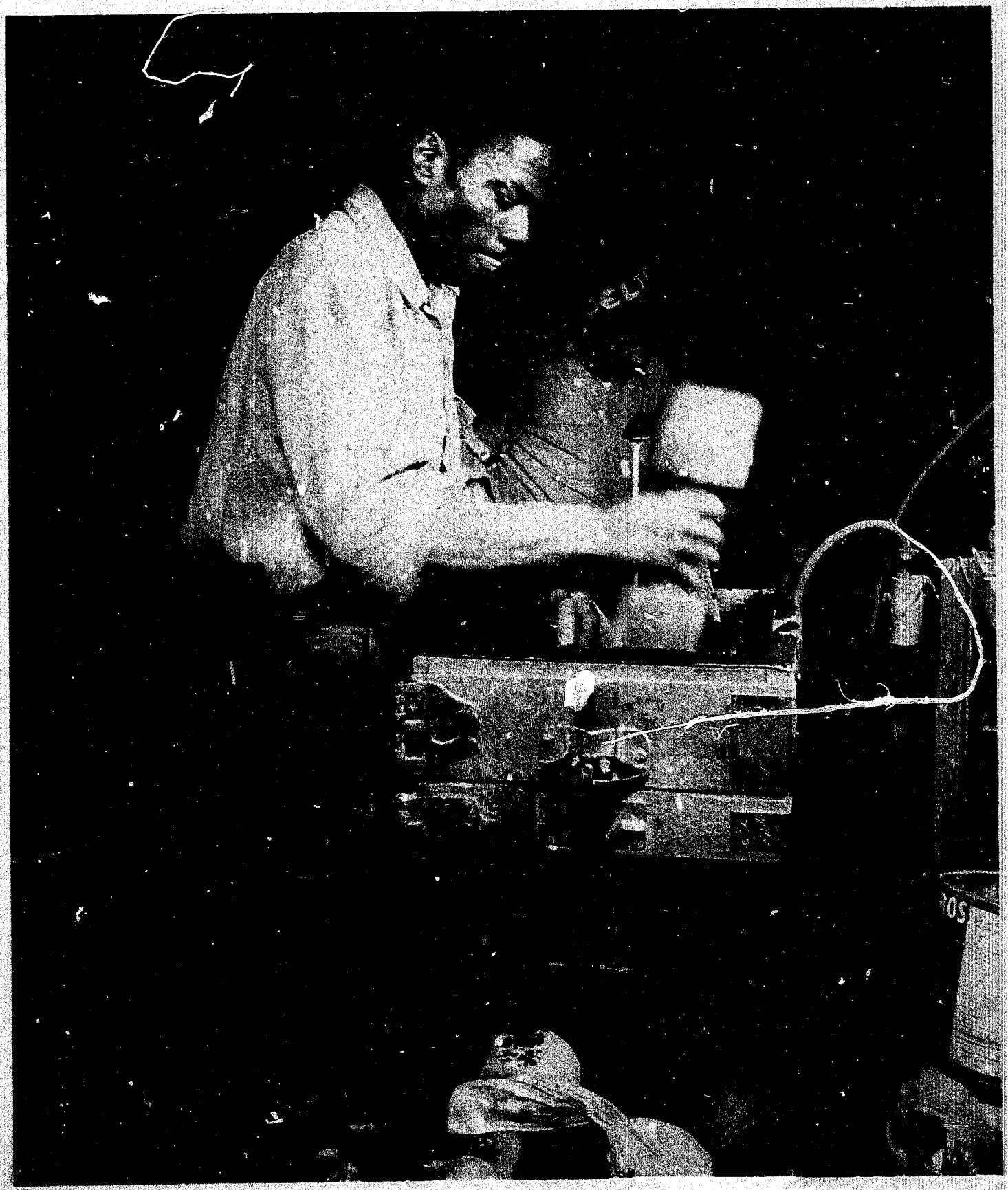


Figure 2
Ramming molding sand into flask

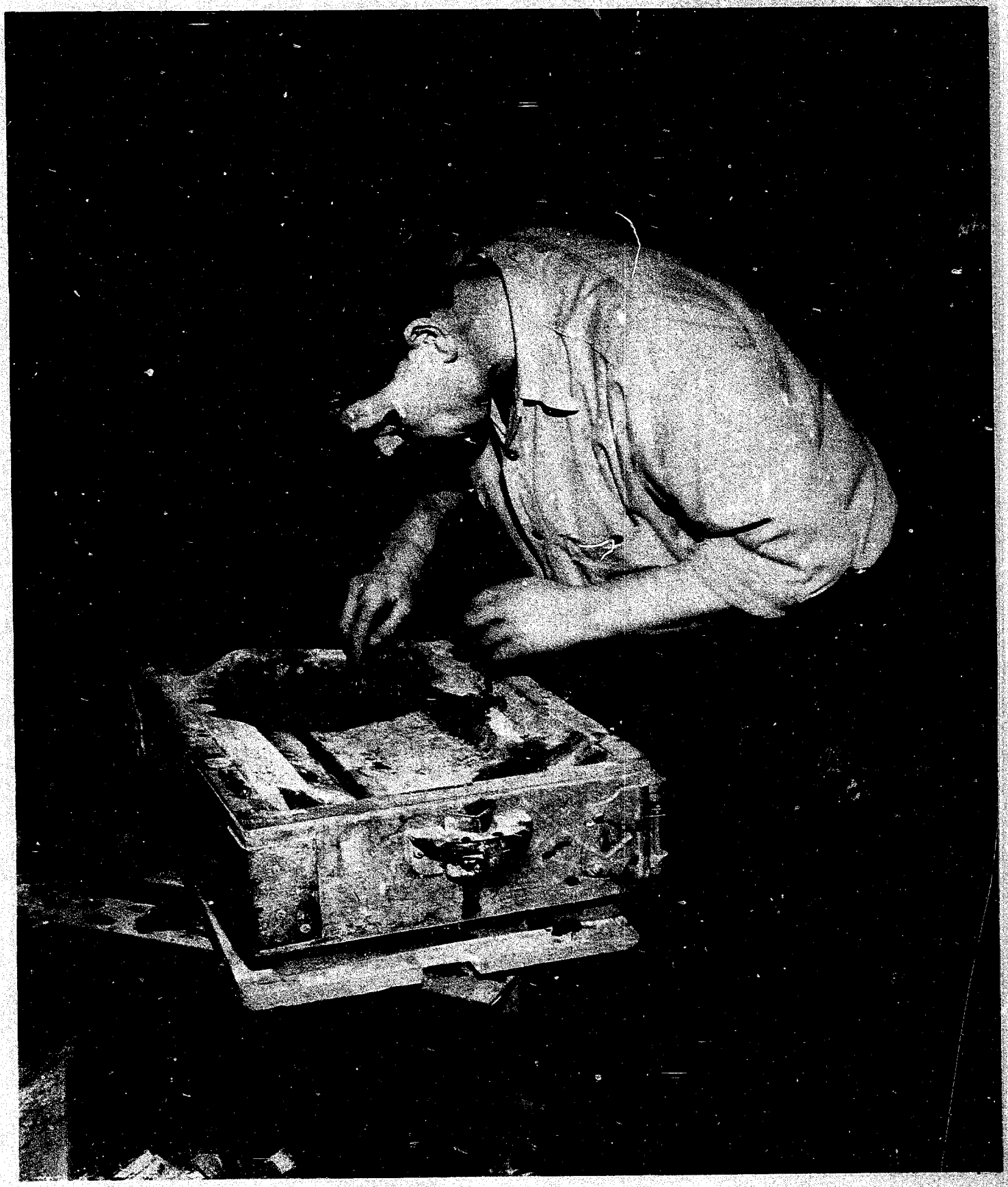


Figure 3
Touching up mold before closing

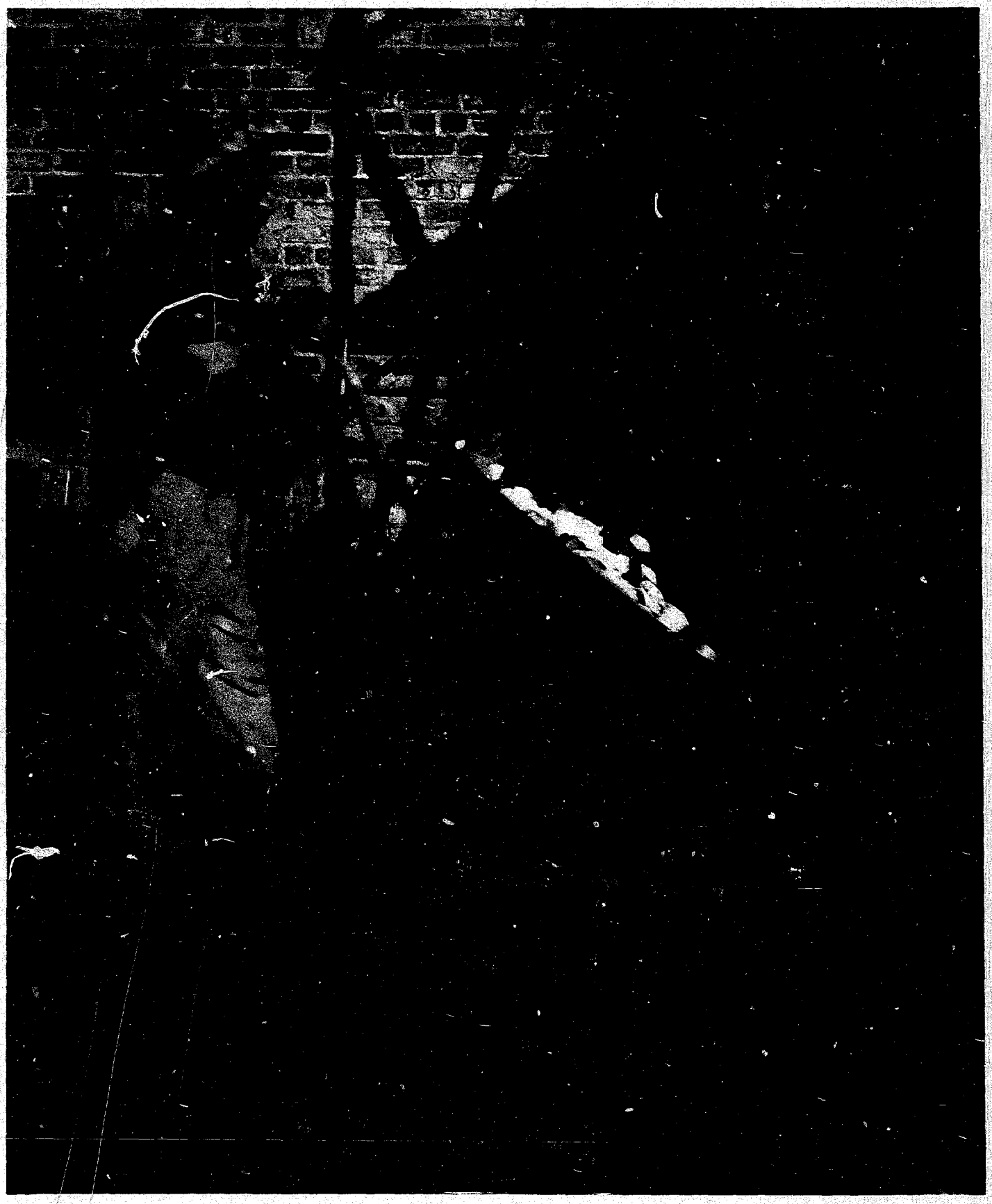


Figure 4
Charging coke and limestone into cupola hoist

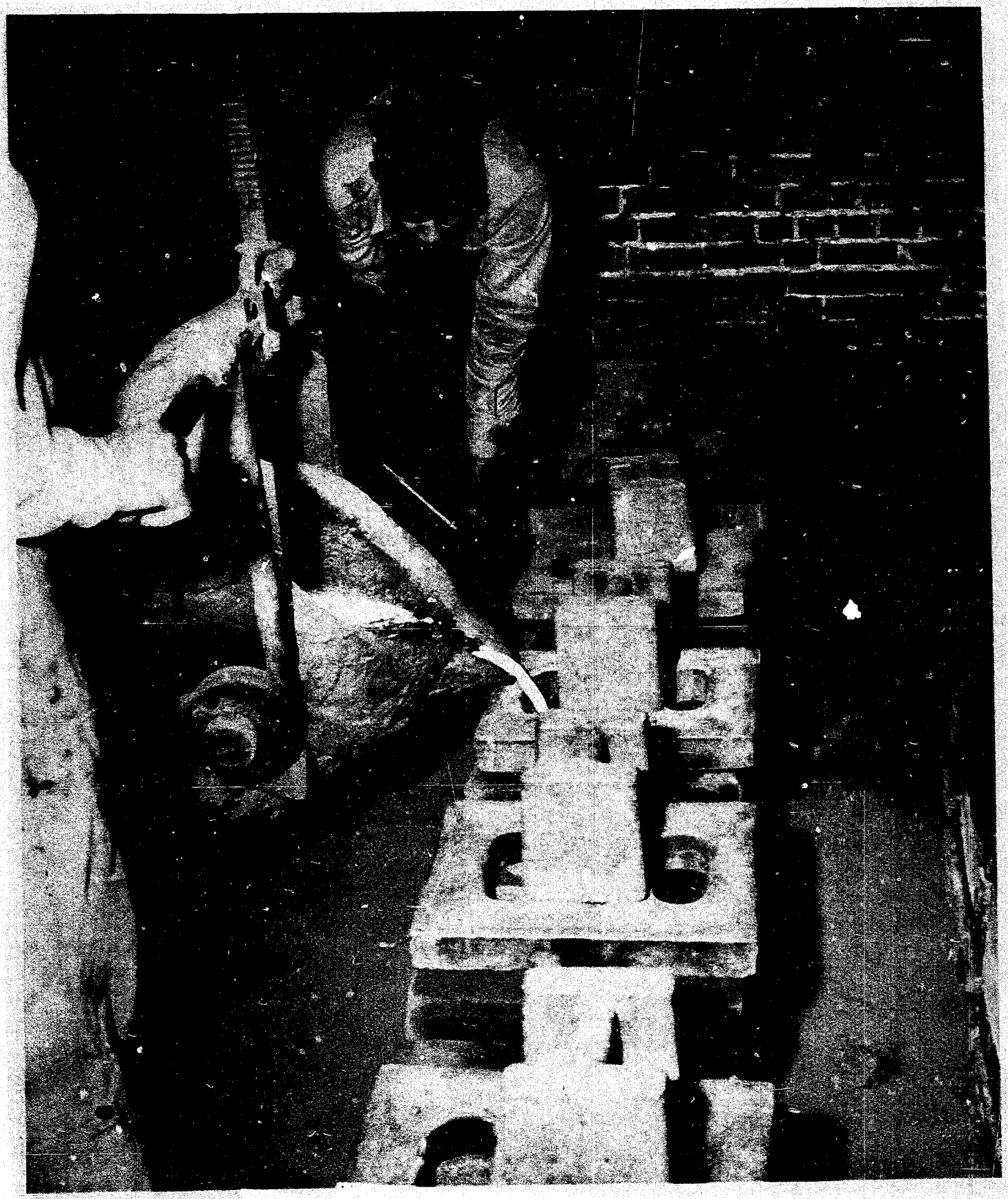


Figure 5
Pouring small molds

INTERNATIONAL COOPERATION ADMINISTRATION

SERVICES OF THE INDUSTRIAL TECHNICAL COOPERATION PROGRAM

TYPE III – TECHNICAL AIDS FOR OVERSEAS

- INDUSTRIAL REPORTS SERVICE

Provides basic information regarding:

1. Data and reference materials relating to private capital mobilization and its application in economic development.
2. Requirements for establishing and operating small factories in basic industries.
3. Man-hour requirements, operational characteristics, and equipment utilization in representative U. S. factories in selected industries.
4. Man-hour and materials savings through standardization, simplification, and specialization studies.
5. Supervisory and other specialized training procedures and techniques.
6. U. S. experience in specialized fields.

- TECHNICAL DIGEST SERVICE

Provides digests and abstracts, full length articles, and bibliographical references on U. S. developments in products, processes, and work techniques derived from U. S. technical, scientific, and trade periodicals, and other pertinent sources.

- TECHNICAL INQUIRY SERVICE

Provides answers to individual questions relating to products, processes, machinery and equipment, production operations, work techniques, management practices and concepts, factory engineering, and basic requirements for industrial production.

- TRAINING MATERIALS SERVICE

Provides basic materials for use by specialized technicians in the conduct of management, supervisory and specialized training courses in host countries.

- TECHNICAL LITERATURE SERVICE

Provides recommendations and guidance regarding current useful world-wide publications relating to industry and productivity improvement; distributes carefully selected and representative new publications of particular value for program use; and facilitates mission literature procurement.

- U. S. BOOK EXCHANGE SERVICE

Provides, on Mission approval, technical and scientific books and periodicals on exchange basis to overseas libraries.

- VISUALS AND NEW MEDIA

Provides technical advice and guidance to missions on new industrial visuals. Provides for cooperative program adaptation and use a variety of visual materials, including loan exhibits, silk-screen display panels, graphic brochures, slide and sound kits, and related materials.

- TECHNICAL FILM SERVICE

Provides guidance for and facilitates procurement of U. S. technical and training films for program use; provides representative U. S. technical industrial films and filmstrips on loan basis for short-term program requirements; and facilitates adaptation of films into foreign language versions for program use overseas.