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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 Methods Engineering Council, Pittsburgh, Pennsylvania.

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BUILDING BRICKS

INTRODUCTION

Brickmaking is one of the oldest industries in history. Many mechanical developments and changes in production methods have been made through the years to increase production capacity, reduce costs, and to permit rigid size, shape, and quality specifications. The basic operations, however, have remained the same.

Brick is made by molding clay or shale into the desired shape and size while moist and pliable, and drying or hardening it in the sun or in heated ovens. When sufficiently baked, or fired, the brick is used as a building or paving material.

The processes for making brick are comparatively simple. The basic principles are accepted as standard throughout the industry today. Many deviations from standard methods have been developed and adopted by various plants because of specialty product requirements, and labor and social legislation. To simplify the problem of setting up a brickmaking plant, however, only the customary methods are described here.

There are three basic methods of making brick. They are:

1. the dry press method,
2. the stiff mud method, and
3. the soft mud method.

The dry press method is usually used in the manufacture of firebrick and various refractory shapes. The stiff mud and soft mud methods are most commonly used in manufacturing building brick in the United States. The raw materials are the same, regardless of the method.

The soft mud method consists of pressing the prepared materials into wooden molds. In the stiff mud process, the material possesses enough consistency and strength to support its own weight so it can be extruded and cut into the desired length.

The soft mud method was chosen as the subject of this report because it can be adapted to the variable conditions of climates easier than the other methods, and because:

1. A wider range of clays and shales can be used,

2. The equipment is more readily adapted to different material qualities, and different sizes and shapes of brick, and

3. Less equipment is required.

Therefore, this report pertains to the soft mud method of making common building brick.

GENERAL ASSUMPTIONS

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

1. The costs of building, equipment, and material necessary are based on United States prices.

2. Labor costs used are the average for the industry and skill described, based on recently published figures of the United States Bureau of Labor Statistics.

3. All other costs, statistics, and figures are based on current United States prices.

4. Adequate heat, light, water, and electricity are available at the plant site.

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

6. The plant operates on a 40-hour week -- a one-shift labor force.

7. No special provision is made in the calculations for 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 methods 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 brochure should be adjusted to conform to local conditions.

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

PRODUCT SPECIFICATIONS

The brick used as the basis of this report is limited to one standard which is comparable to the common red brick used by the building trades in the United States. The specifications of this brick are as follows:

Length	. . . . . 8"
Width	. . . . . 3 3/4"
Depth	. . . . . $2\frac{1}{4}$"
Weight (dry)	. . . . . 5 lbs.
Color*	. . . . . Clay red

*Color: Natural color (red) resulting from the firing action upon the iron oxides in the clay.

Production is limited to one size of brick to minimize the initial cost of setting up the plant. Equipment and setup changes will be kept at a minimum by producing only this one basic size: the costing and pricing procedures will be easy to maintain, raw materials can be kept at a minimum, and the production loss resulting from inexperienced labor will be kept at a minimum.

With the stiff mud process, it is also possible to make hollow brick. Specifications are the same as for the solid brick just described, except that there are three holes about 3/4" in diameter going through the $2\frac{1}{4}$" dept. The main advantage of this hollow brick is reduced shipping costs. Actually, production costs may be as much as 10% higher as it takes much more power to make the holes -- which are made by extruding.

With the soft mud process, it is not possible to make a hollow brick. It's not possible to maintain the sand structure -- the slipping agent. However, it is possible to compensate by use of a frog or panel. A frog is a depression on one side of the brick which can be as large as 1-inch deep x three-quarters the length x three-quarters the width.

There are no appreciable differences in cost nor in method in making the solid brick with a frog as compared to a plain solid brick. Therefore, there is no distinction made between the two types for the remainder of this report.

MANUFACTURING OPERATIONS

There are seven basic operations in the manufacture of brick using the soft mud process:

1. Mining (winning)
2. Preparation
3. Pugging
4. Molding (forming)
5. Drying
6. Firing (burning)
7. Inspection

However, before starting full scale manufacturing operations the clay must be tested to ascertain its suitability for use in brickmaking. This step is of the utmost importance and is, therefore, discussed in the following paragraph prior to discussion of the seven steps mentioned above.

Testing of clay

While clays and shales suitable for brickmaking are found in many different places, it is essential that the clay be tested before using it in regular production. The full procedure for testing clay requires considerable experience in the brickmaking field. Essentially, the testing is done by making sample lots of brick and testing them after processing or firing.

A chemical test, however, may be prepared in a laboratory equipped for testing soils at an approximate cost of fifty dollars ($50.00). This test would show the composition and proportions of the main chemical elements in the clay. The chemical test would cover the suitability of the clay within broad limits only. Such a test would, in effect, be a negative one, in that it might show up certain undesirable characteristics in the clay. However, it would not prove conclusively that the clay being

tested would be definitely suitable for brickmaking. The real test would be in making sample lots of brick, with clay samples taken from different areas of the clay deposit. The most important points to look for in the test are (1) the fusion point of the clay, and (2) the burning behavior of the brick.

Initial tests should be made by a technician with a full knowledge of the procedure. Subsequently the foreman or man in charge of the plant may make the necessary tests when it becomes necessary to take the initial supply of clay from a new deposit. One acre of clay deposit should make 850,000 bricks per foot of depth.

Mining (or winning)

Mining is the operation of digging the raw materials from the earth and delivering it to the plant site. The mining method will depend upon local conditions such as depth of supply, distance from the plant, and quantity available in a particular location. The clay would be dug with a power shovel and loaded on a dump truck. It would be hauled by the truck to the plant. Figure 1 shows a diagram of a power shovel for this purpose.

Figure 2 illustrates the operation of dumping the mined clay at the plant. The upper photograph illustrates the dumping operation. The lower photograph shows the hopper into which the clay has been dumped.

The mining operation should maintain a few days' supply of material in advance of the plant needs. The practice of storing the raw material has, in the past few years, proven to have several advantages which are worth while.

1. Plant production is not interrupted by delays or breakdowns in the mining operation.

2. The weathering effect of storing the materials makes them more workable and tends to improve the product.

Preparation

Preparation consists of removing foreign materials from the clay or shale that is obtained in the mining operation. In the preparation, the clay or shale is processed into a satisfactory plastic condition for molding. The preparation processes for shale and clay differ due to the differing native conditions of the two materials.

There are basically two methods of preparing clay. It can be soaked over night with water and the stones and other foreign matter removed

by hand the next day, or mechanical equipment can be used for the primary reduction (grinding) and pug milling. The mechanical method provides the most uniform and consistent quality on a day-to-day basis. Excessive losses can be expected in the molding, drying, and firing operations if proper preparation and quality control is not maintained.

The preparation is handled with two machines; a granulator and a disintegrator. The granulator breaks down the material by impact of rotating blades. It is illustrated in figure 3. The disintegrator is usually a two-roll crushing type machine that breaks down or pulverizes the material.

Shale requires both grinding and screening (and is, therefore, more expensive). This operation is performed in a dry pan machine in which the shale is finely ground and screened to obtain a uniform, granular size. The ground shale is stored there until required at the pug mill.

The processes and costs presented here are limited to the production of brick with clay to maintain a minimum capital requirement.

Pugging

In this operation water is added to the prepared shale or clay. Figure 4 shows a photograph of the mechanism of a pug mill. The operation is the same for either type of raw material, and approximately the same quantity of water is needed for plasticizing purposes. It is important that not too much water be added; approximately 16 oz. are needed for each 5 pounds of clay or shale. As the water content increases, shrinkage in the drying and burning increases. This results in losses of material in process and defective brick.

Molding (or Forming)

Molding is the operation of putting the brick into the desired shape and size. In the soft mud process, it is performed by mechanically pressing the pugged material into forms. Figure 5 shows an automatic brick machine of the type covered in this report.

When the raw material has been through the pug mill, it is moved into a hopper at the brick press. The press automatically moves the material from the hopper in measured quantities to the chamber under the press plunger. The material is fed into the form through die openings with each down-stroke of the machine. The filled mold is removed on the upstroke and an empty mold is inserted.

Excess material is then removed from the top of the mold with an operation called "strikeoff". The mold is then tapped with a mallet, or

bumped on the sides and ends, to loosen the brick in the mold. Bricks are then removed from the mold. This operation is called dumping. It is performed by inverting the mold onto a pallet.

The empty mold is then sanded with a fine, dry sand that facilitates the removal of the pressed brick. The sanded mold is then ready to be placed in the press again. Several molds are used to maintain a high machine utilization.

Striking and dumping are hand operations performed by helpers at the brick press.

Production losses should not exceed 5% of the original raw material. Plant capacity is usually established in gross figures; net production is determined by subtracting the losses in forming, drying, and firing from the plant capacity figure.

Drying

Drying is the operation of removing excess moisture from the formed brick prior to the firing operation. In the drying operation, approximately one pound of moisture is removed from the size of brock specified in this manual. Therefore, the physical nature of the material, and the amount of heat it will withstand in drying, will affect the drying cycle time.

In this operation the molded brick are stacked on small cars. They must be spaced to permit a maximum of air circulation. They are then placed in a drying tunnel. Figure 6 illustrates the drying operation. The upper photograph shows the molded brick being stacked on the cars; the lower photograph shows the mouth of the drying tunnel.

Drying time will range from 28 to 48 hours in a waste heat drying tunnel. To obtain the best yield, the dryer tunnel must be controlled according to the physical properties of the raw material, and the humidity of the drying air must be controlled to prevent the formation of "checks" (small cracks) in the brick which are caused by too rapid removal of moisture from the outside surfaces.

Firing

Firing, or burning as it is sometimes called, refers to a kiln operation in which the clay products are heated to the fusion point. This causes the physical and chemical changes necessary to obtain the hardness, durability, and structural qualities desired. Figure 7 shows the dried brick being stacked inside the kiln for firing.

Fuel costs for drying will vary with the characteristics of the clay and shale, and with the locality in which the plant site is situated. The actual requirements in B.T.U. per 1,000 brick will have to be determined under production conditions and with the fuel available in any particular locality. It is estimated that the specified production would require 175 tons of coal per week.

After firing, the brick is drawn from the kiln, allowed to cool slowly, and put into storage to await delivery to the buyer.

Inspection

Inspection requirements for common building brick are not too rigidly set. The main quality considerations are:

1. Size
2. Color
3. Checks (cracks)

The inspection operation can be performed after the completion of the firing operation at the time the brick are put into storage.

MANUFACTURING UNIT USED

The unit of production most generally used in the industry is 1,000 brick. Therefore, unit costs are expressed on that basis in this report.

The net production per week from this plant will be 243,505 brick of the common, red, building type. The means of determining this quantity and the materials required are shown in the following calculations.

Calculation of Production Quantity

	Estimate	Actual
Brick molding machine capacity per hour (gross brick) (20 molds/minute x 6 brick each mold x 60 minutes)	7,200 brick	_____
Working time in hours per day (allowing 12.5% time for unavoidable and personal delays)	7.12 hours	_____
Brick formed per day	51,264	_____
Less: Expected 5% loss in forming, drying, and firing	2,563 brick	_____
Net production per day	48,701	_____
Net production per five-day week (40 hour week)	243,505	_____
Net annual production per 1000 units	13,175	_____

DIRECT MATERIALS

Clay

51,264 gross brick per day @ 5 pounds each = 256,320 pounds per day
= 128.16 tons per day
= 32,040 tons per year

Water

Approximately 16 ounces for each 5 pounds of clay or one United States gallon for each 40 pounds of clay.

256,320 pounds of clay per day ÷ 40 = 6,408 gallons per day
= 1,602,000 gallons per year

*Parting sand (For dusting brick molds)

100 pounds/1000 brick = .10 pounds/brick
51,264 brick/day x .10 = 5,126.4 pounds = 640.00 tons per year

* Note: The sand imparts its color characteristics to the finished brick and because the sand acts as a slipping agent, it affects the quality of the brick as the brick is removed from the mold after forming. This sand is an important material and requires careful selection as to grain size and mineral properties in order to obtain the proper slipping factor for the dumping operation as well as to obtain the desired color range. The prospective manufacturer will have to experiment with the sands in his locality to obtain the best sand to use with the clay and shale available.

Table I - Direct materials needed for one year's production

Material	Quantity per Year	Estimated Unit Price	Estimated Total Price	Actual Unit Price	Actual Total Price
Clay	32,040 tons	$.05	$1600	____	____
Water	1,602,000 gallons	.0025	4000	____	____
Sand	640 tons	5.00	3200	____	____
Total annual cost			$8800	____	____

PRODUCTION TOOLS AND EQUIPMENT

Table II lists the equipment required in clay mining and production of brick for a plant of this size, with a total estimated cost of $327,240 in the United States.

Table II

Description	Units Required	Estimated Unit Price	Estimated Total Price	Actual Unit Price	Actual Total Price
Power shovel, 2/4 yard capacity - self propelled with gasoline motor	1	$22,000	$22,000	____	____
Dump truck, 4-ton capacity	2	6,000	12,000	____	____
Granulator, 15,000 bricks per hour capacity	1	8,000	8,000	____	____
Disintegrator and 2 roll crusher, including 21' connecting conveyor	1	12,000	12,000	____	____
Pug mill, 10,000 bricks per hour capacity	1	8,000	8,000	____	____
Automatic brick machine, 13,500 bricks per hour capacity with unloader	1	33,000	33,000	____	____
Molds for brick machine	30	20	600	____	____
Tunnel dryers, 110' long x 4' wide x 63 1/2" high above tracks with recirculating air facilities	6	14,000	84,000	____	____
Cars for drying tunnel, 90" long x 45 1/2" wide x 60" high	145	100	14,500	____	____
Pallets, 36" long x 11" wide x 3/4" thick with 1" air spaces - 14 gauge galvanized sheet steel	12,760	1.50	19,140	____	____
Kilns, 30' inside diam.- 80,000 bricks capacity	7	16,000	112,000	____	____
Conveyors, belt conveyors connecting raw material supply, granulator, disintegrator, roll crushers, and pub mill	100 feet	20	2,000	____	____
Total			$327,240		____

OTHER TOOLS AND EQUIPMENT

Table III lists the necessary items of equipment for maintenance, and other non-manufacturing functions, showing a total estimated cost of $19,700 in the United States.

Table III - Tools and equipment required other than for production.

Description	Units Required	Estimated Unit Price	Estimated Total Price	Actual Unit Price	Actual Total Price
Brick bearer barrows, 18" wide flat bottom, high back	6	$ 35	$ 210	____	____
Wheel barrows, 4 1/2 cubic feet capacity for general plant use	8	40	320	____	____
Hand tools, such as mallets, hammers, wrenches			600	____	____
Maintenance equipment, 16"-18" engine lathe	1	2,020	2,020	____	____
Maintenance equipment, 12" pedestal grinder - 2 HP	1	550	550	____	____
Maintenance equipment, drill press - 1 1/2" capacity, sliding head	1	2,000	2,000	____	____
Factory supplies			600	____	____
Maintenance equipment, such as machine shop and maintenance hard tools, grease guns, micrometers and pyrometers		1,400	1,400		
Delivery trucks, 5 ton*	2	6,000	12,000	____	____
Total			$19,700	____	____

*In addition to the 2 dump trucks for hauling raw materials, 2 delivery trucks will be required.

FURNITURE AND FIXTURES

Table IV lists the office equipment required in this plant, showing a total estimated cost of $1,400 in the United States.

Table IV - Furniture and fixtures

Description	Units Required	Estimated Unit Price	Estimated Total Price	Actual Unit Price	Actual Total Price
Office desks, flat top, wood, 60" x 32 "	3	$150	$450	_____	_____
Office desks, typewriter type, 60" x 32 "	1	180	180	_____	_____
Chairs, swivel, wood	3	33	99	_____	_____
Chairs, typewriter type, adjustable	1	36	36	_____	_____
File cabinet, 4 drawer, legal size, locking type	2	125	250	_____	_____
Storage cabinet, 78" x 36" x 18", for office supplies	1	85	85	_____	_____
Typewriter, standard office type	1	150	150	_____	_____
Adding machine, ten key tape model	1	150	150	_____	_____
Total			$1,400		_____

PLANT LAYOUT

Figure 8 illustrates the floor plan of a building that would provide adequate space for the production ofbricks specified in this manual. The approximate locations of the major items of equipment are shown together with the space requirements of the various departments and areas. The yard area surrounding the building is also shown.

PLANT SITE

To provide space for brick storage and for eventual expansion, a site of level, well-drained land having suitable clay or shale material, comprising at least 10 acres would be desirable. The site should be as advantageously located as possible with respect to transportation, power, water, fuel, sources of material, labor and markets. The value of the land is estimated at $5,000.

If possible, the plant should be located on a hillside with a road above the plant. In this way, the materials can flow by gravity into the storage bins and feed down into the processes. Where this is not possible, the raw materials can be elevated from ground level by mechanical conveyor to the granulator and disintegrator.

BUILDING

About 12,600 square feet of floor space as shown below are required for this plant. In the United States a building of this type, including wiring and plumbing, will cost about $3.50 per square foot.

Estimated Cost of Building

Processing and forming sections	10,600 square feet	$ 37,100
Maintenance section	720 square feet	2,520
Showers and locker rooms	648 square feet	2,268
Office	640 square feet	2,240
Grading of yard		872
Total cost of Building and yard improvement		$ 45,000

POWER

The power consumption will amount to about 2,000 K.W.H. per day. The annual cost of power is estimated at $10,000.

WATER

The cost of water including that required for sanitary purposes and fire protection is included in the cost of materials since a large amount of water is used for mixing.

FUEL

About 175 tons of coal per week or 8,750 tons per year will be required for firing brick. At an average price of $4.27 per ton the annual cost of fuel would be about $37,363.

PERSONNEL REQUIREMENTS

Table V

Direct labor

	Needed	Hourly Rate	Annual Estimated Cost	Actual Cost
Quarry workers (power shovel and dump truck operators)	3	$2.00	$ 12,000	$_____
Hourly production employees				
First shift	28	1.75	98,000	_____
Second shift (to tend dryers and kilns)	4	1.50	12,000	_____
Hourly rated employees (helpers and learners)	4	1.25	10,000	_____
Week-end tenders and material handlers for dryers and kilns	5	1.50	15,000	_____
Totals	44		$147,000	$_____

Table VI

Indirect labor

	Needed	Hourly Rate	Annual Estimated Cost	Actual Cost
Manager	1	$	$ 8,000	$_____
Foreman	1		6,000	_____
Maintenance man	1	2.00	4,000	_____
Bookkeeper	1		5,000	_____
Truck drivers (delivery)	2	1.50	6,000	_____
Secretary clerk	1		4,000	_____
Totals	7		$33,000	$_____

KEY MEN AND SKILLS

The plant manager should be a ceramics engineer and he should be thoroughly experienced in the handling of ceramic production problems. The foreman should be a leader and have a good understanding of the plant and production. The maintenance men should have sufficient mechanical and electrical skill to maintain the plant equipment. The power shovel and dump truck operators should be skilled in the operation of heavy equipment. The balance of the employees are unskilled in the sense that they do not require extensive prior training.

DEPRECIATION

Table VIII - Estimated depreciation schedule

Item	Price	Actual Price	Year's Life	Estimated Per Year	Actual Per Year
Building	$ 45,000	$_____	20	$ 2,250	_____
Production tools and equipment	315,240	_____	10	31,524	_____
Dump trucks	12,000	_____	4	3,000	_____
Other tools and equipment	7,700	_____	10	770	_____
Delivery trucks	12,000	_____	4	3,000	_____
Furniture and fixtures	1,400	_____	10	140	_____
Total	$ 393,340			$ 40,648	_____

SUPPLIES

Item	Annual Estimated	Annual Actual
Lubricants	$ 300	$_____
Hand tools	500	_____
Maintenance materials	1,700	_____
Office supplies	500	_____
Maintenance of trucks	2,000	_____
Total	$ 5,000	_____

MANUFACTURING OVERHEAD

Item	Estimated	Actual
Depreciation	$ 40,648	_____
Indirect Labor	33,000	_____
Supplies	5,000	_____
Power	10,000	_____
Fuel	37,363	_____
Total	$ 126,011	_____

FIXED INVESTMENT

Land	$ 5,000	_____
Buildings	45,000	_____
Production Tools and Equipment	315,240	_____
Other Tools and Equipment	7,700	_____
Dump Truck	12,000	_____
Delivery Truck	12,000	_____
Furniture and Fixtures	1,400	_____
Total	$ 398,340	_____

WORKING CAPITAL

Direct Material Inventory	- 30 days	$ 740	_____
Direct Labor	- 30 days	12,250	_____
Manufacturing Overhead	- 30 days	10,500	_____
Reserve Sales Collections	- 30 days	40,583	_____
Total		$ 64,073	_____

CAPITAL REQUIREMENTS

Fixed Investment	$ 398,340	_____
Working Capital	64,073	_____
Total	$ 462,413	_____

SALES REVENUE

Brick of the common red type sell for $40 per thousand. This includes delivery within a ten mile radius in truck load lots of 3,100 brick. Based on this selling price, the annual gross sales would amount to $487,000. When brick is sold at the plant an allowance is usually made to offset delivery cost.

RECAPITULATION OF COSTS, SALES AND PROFITS

	Estimated		Actual
Direct Material	$ 8,800		_____
Direct Labor	147,000		_____
Manufacturing Overhead	126,011		_____
Total Manufacturing Costs		$ 281,811	_____
Interest on Loans	$ 10,000		_____
Insurance	2,000		_____
Legal	1,000		_____
Auditing	2,000		_____
Unforeseen Expense	15,189		_____
Total Administrative Costs		30,189	_____
Sales Commissions, Travel, Freight Out, Bad Debts, Discounts and Allowances		65,000	_____
Profit before Taxes		110,000	_____
Total Annual Gross Sales		$ 487,000	_____

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	$_____	$ 1,250	$ 15,000	$_____
20	Sales	_____	5,416	65,000	_____
30	Direct Materials	_____	733	8,800	_____
40	Supplies	_____	416	5,000	_____
51	Power*	_____	833	10,000	_____
52	Water*	_____	0	0	_____
53	Fuel	_____	3,113	37,363	_____
60	Unforeseen Expense (Reserve Account)	_____	1,800	15,189	_____
71	Direct Labor*	_____	12,250	147,000	_____
72	Indirect Labor*	_____	2,750	33,000	_____
80	Depreciation (Reserve Account)	_____	---	40,648	_____

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

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?

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Textbooks

The Clay Worker's Handbook	J. B. Lippincott Company East Washington Square Philadelphia 5, Pennsylvania
Clay Working Problems	Brick and Clay Worker Industrial Publications Inc. 5 South Wabash Avenue Chicago 3, Illinois

Periodicals

The Brick and Clay Record	Brick and Clay Record 5 South Wabash Avenue Chicago 3, Illinois
Ceramic Industries	Brick and Clay Record 5 South Wabash Avenue Chicago 3, Illinois

ABBREVIATIONS

'	Foot or feet
"	Inch or inches
lb.	Pound
lbs.	Pounds
%	Percent
@	At
H.P.	Horsepower
K.W.H.	Kilowatt hour or hours
B.T.U.	British thermal unit or units
B.C.	Between Centers

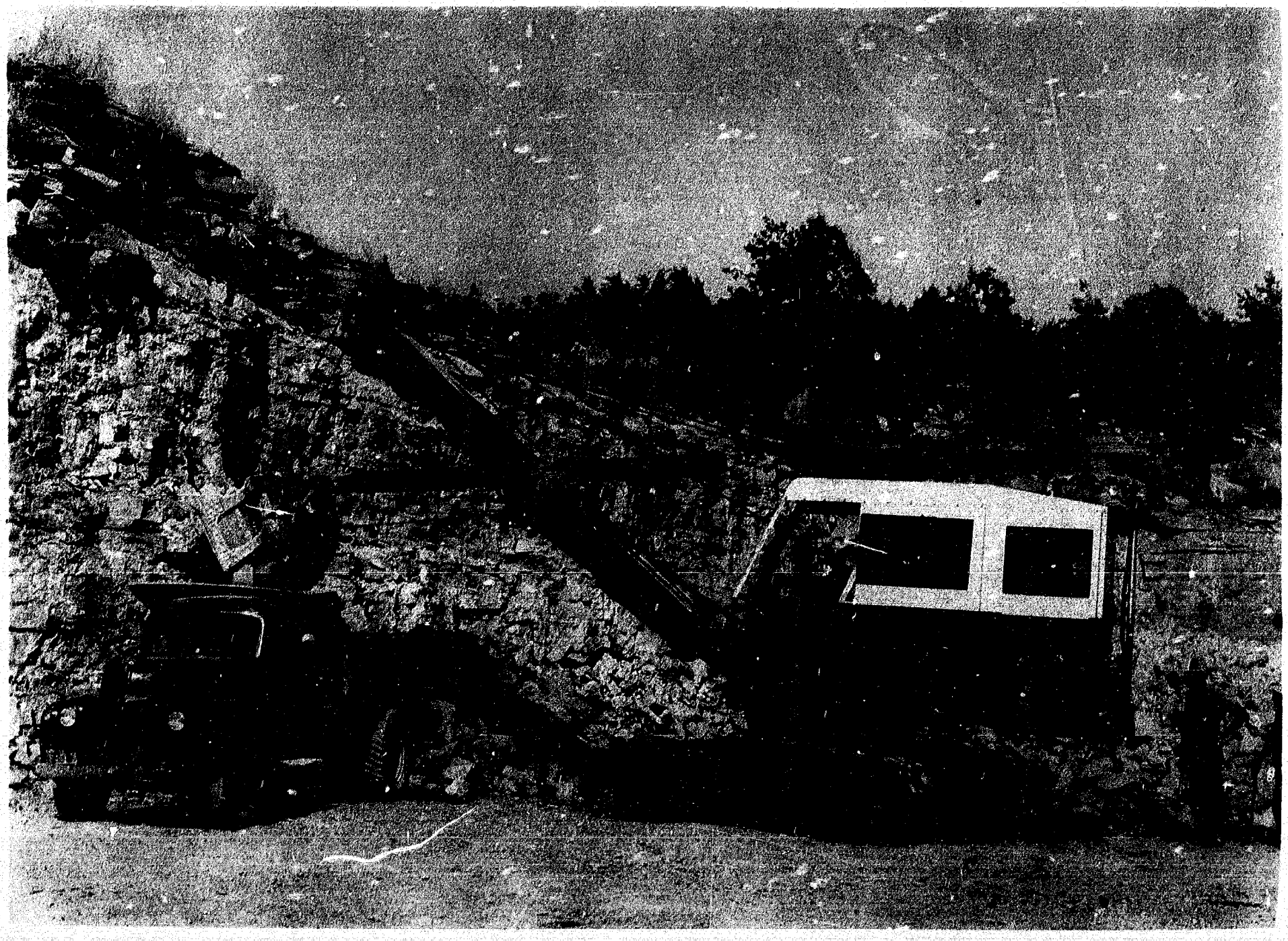
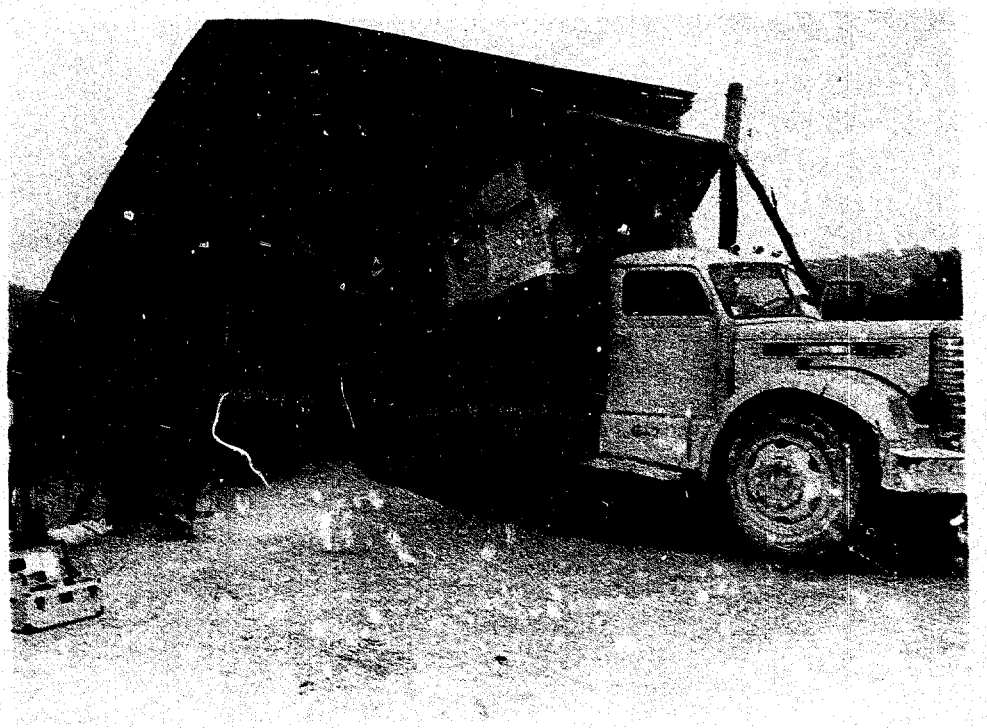
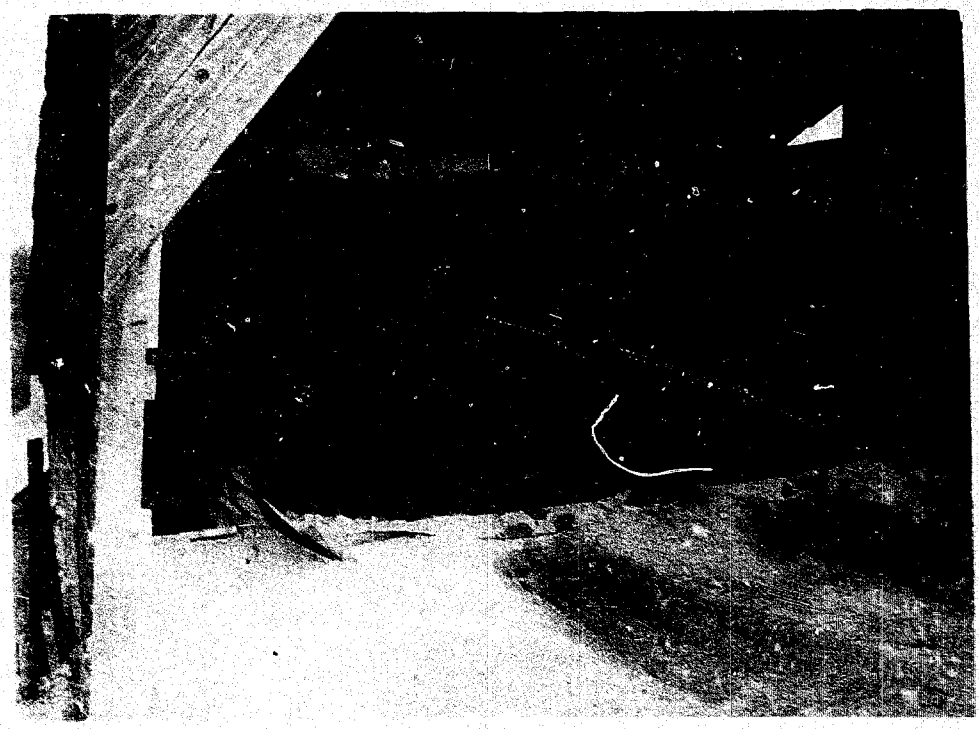


Figure 1 - Power shovel of the type used for mining of clay or shale used in the



Dumping clay



Hopper into which clay is dumped

Figure 2 - Delivery of clay to the plant

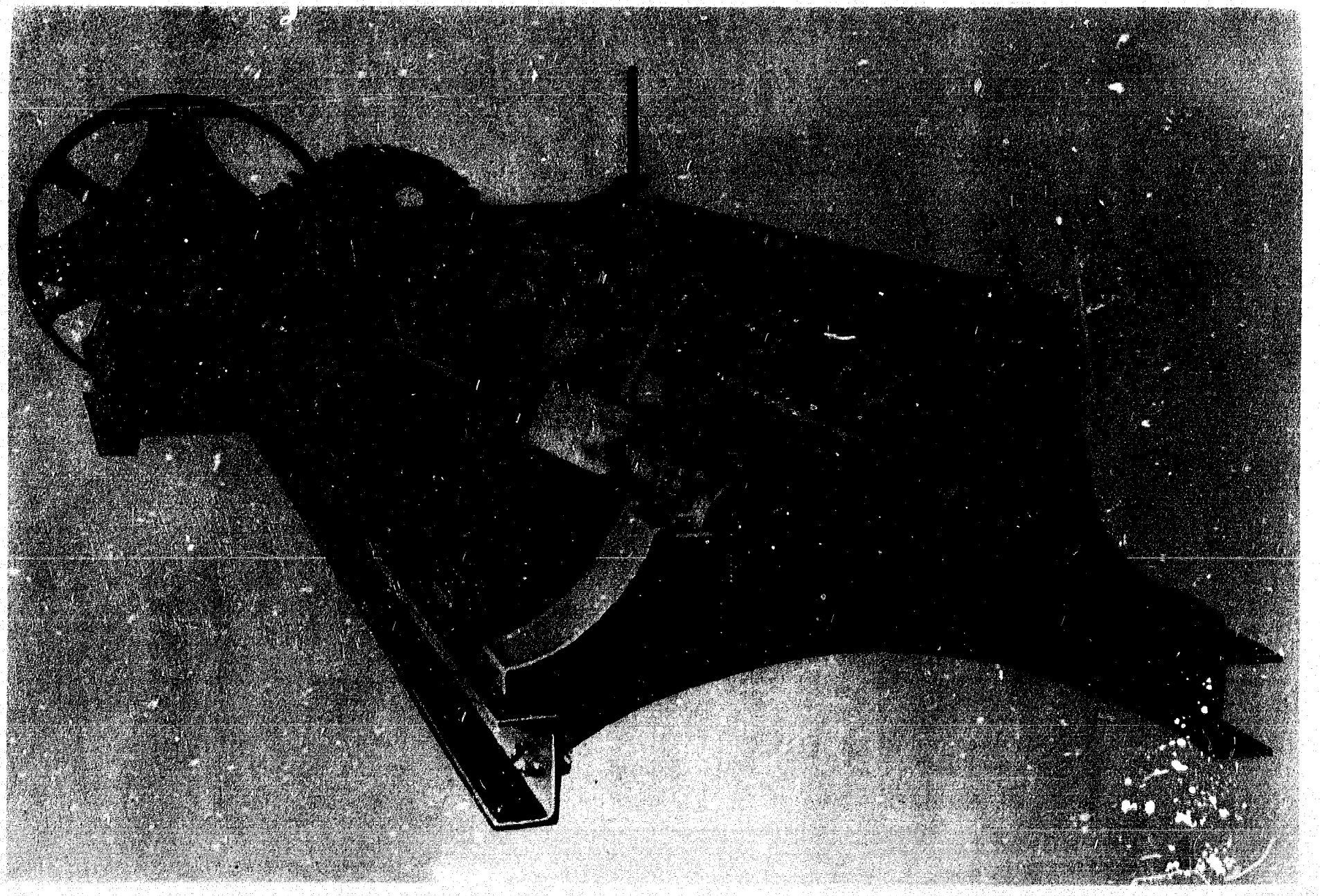


Figure 3 - Granulator

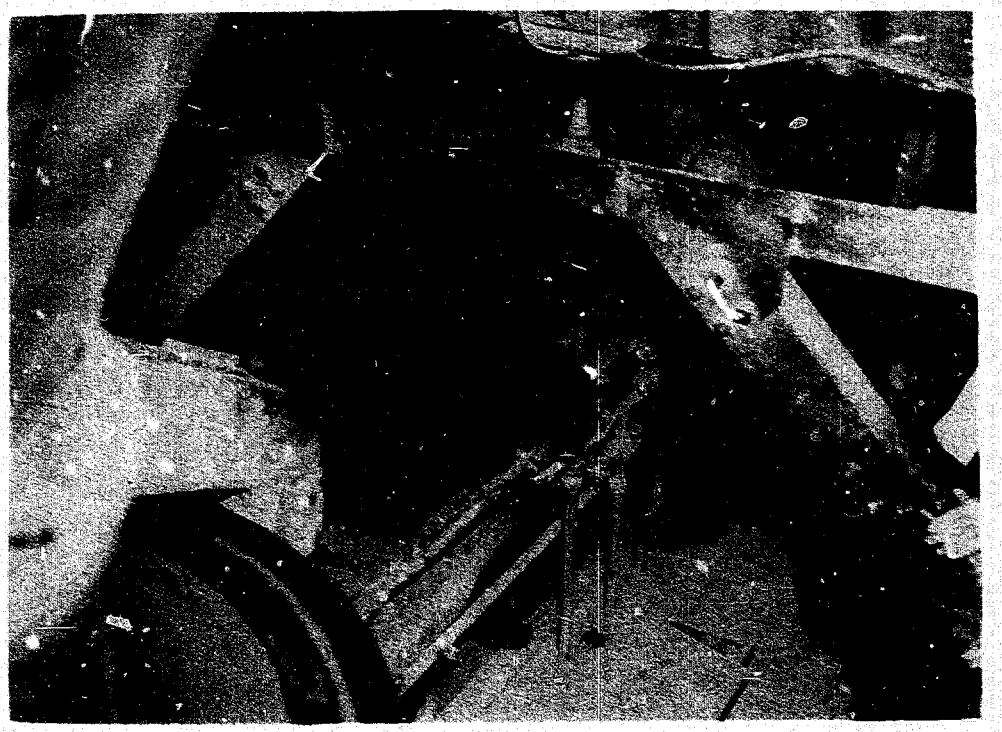
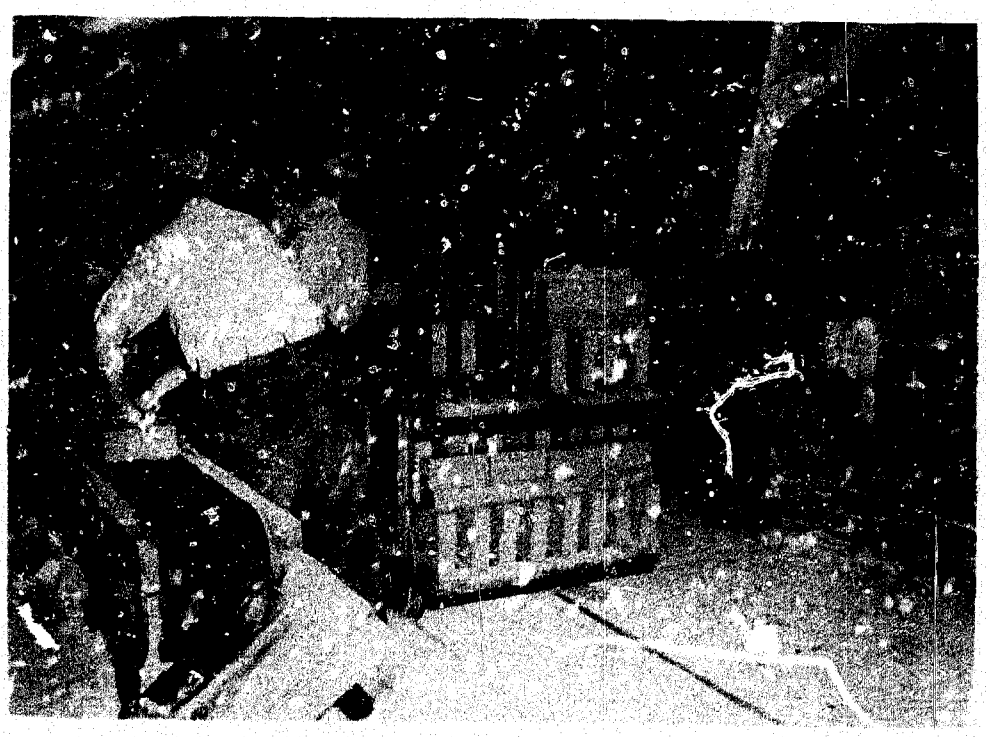
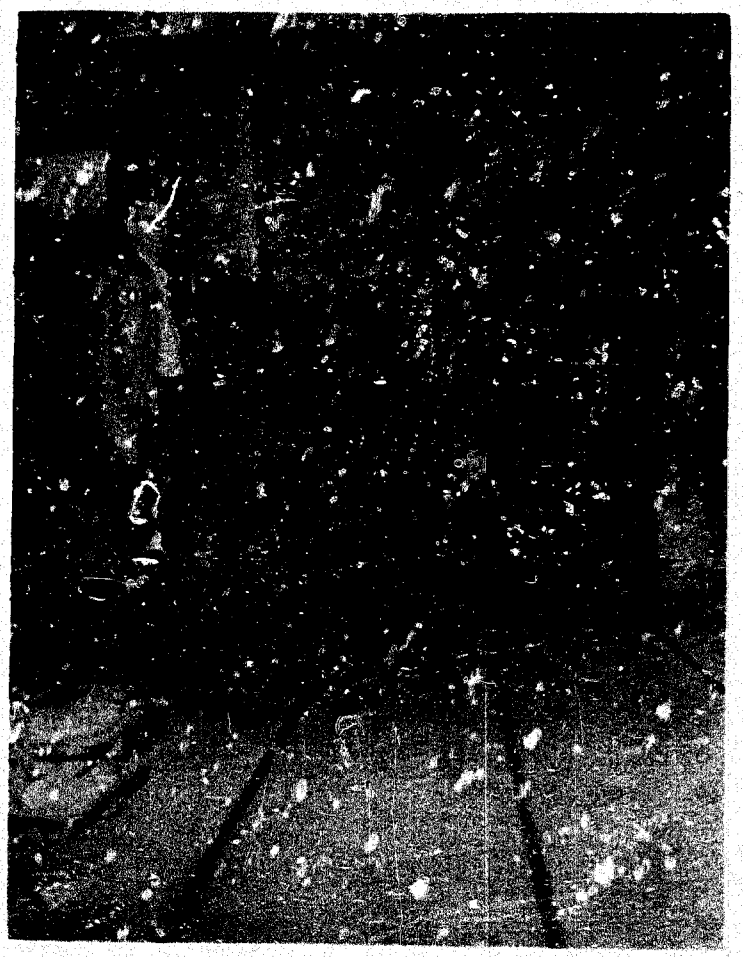


Figure 4 - Pug mill in operation



Stacking brick on cars



Entrance to drying tunnel

Figure 6 - Brick drying operations

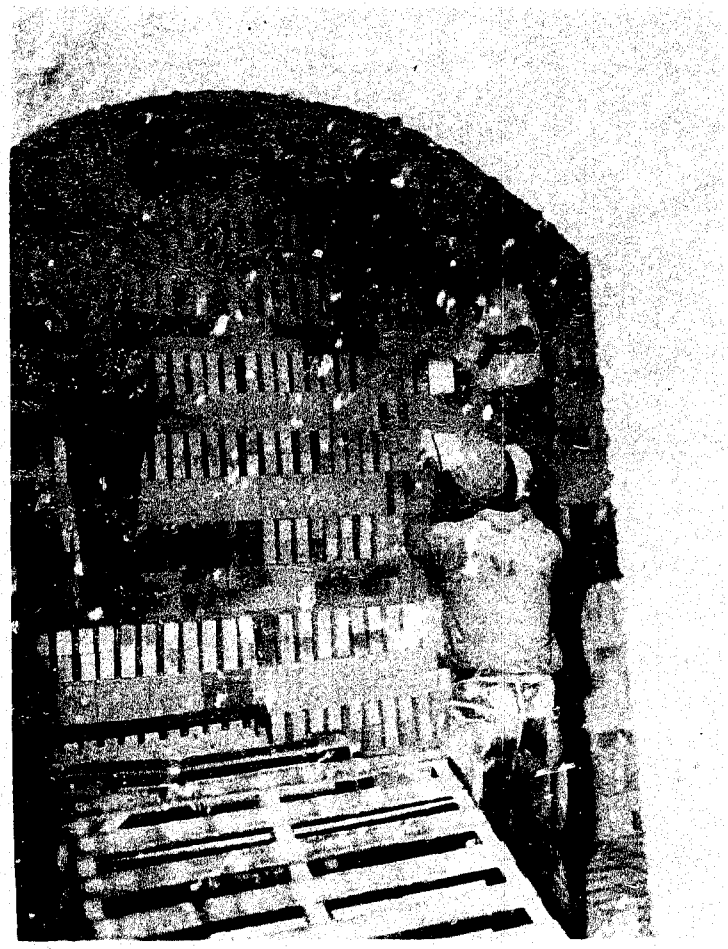
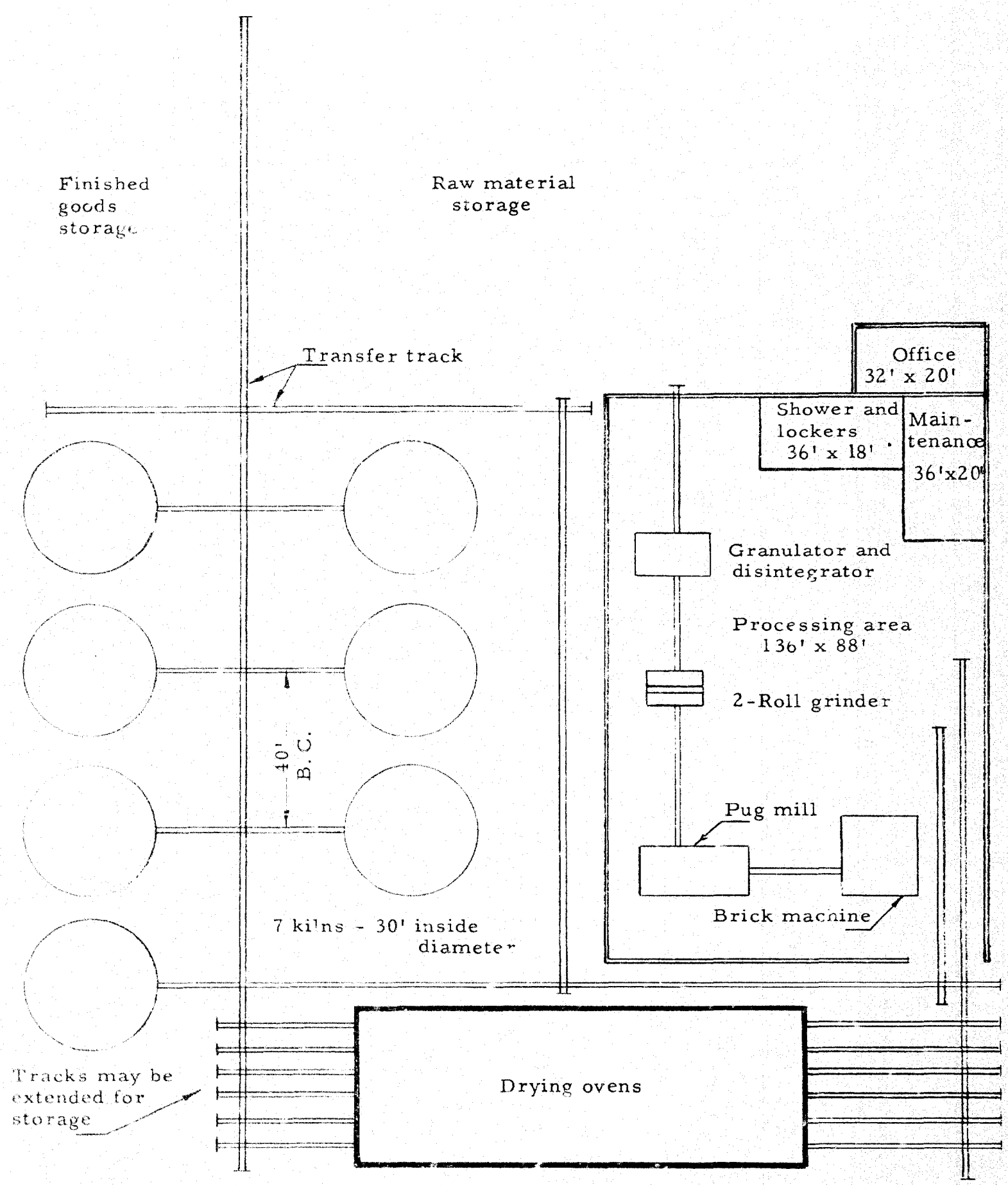


Figure 7 - Stacking bricks in kiln for firing



Building height - 20 feet

Scale: 1/4" = 8' approximately

Figure 8 - Preliminary plant layout