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REQUIREMENTS FOR MANUFACTURE OF HIGH ALUMINA REFRACTORY BRICK AND CEMENT

DEPARTMENT OF STATE
AGENCY FOR INTERNATIONAL DEVELOPMENT
COMMUNICATIONS RESOURCES DIVISION
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A.I.D.
Reference Center
Room 1656 NS

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 Agency for International Development, but merely a citation that is typical in its field.

This report was prepared by the George H. Andrews Engineering Associates, Inc., 411 Southern Building, Washington 5, D. C., for the technical aids program through the facilities of the Office of Technical Services, U. S. Department of Commerce.

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

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INTRODUCTION

The purpose of this report is to present basic information for establishing a manufacturing plant in a foreign country to produce high alumina refractory brick and cement. The aluminum oxide (Al_2O_3) content of high alumina refractory brick may range from 50 percent to about 99 percent, depending on the refractory requirements.

Rectangular shapes called "straights" usually account for a large percentage of the production of the plant. Shapes such as wedges, arches, feather wedges, keys, and other special shapes are made with the same basic equipment, using the same materials, but are usually made in smaller numbers.

The machinery and equipment used to produce these high alumina refractory bricks could be used to produce some other types of fire clay refractory bricks. However, it would not be advisable to make basic refractories - chrome or magnesite - or silica refractories with this machinery and equipment, because of the danger of contamination. Even very small amounts of the ingredients used in the production of basic or silica refractories might remain in or on the machinery and equipment when changing over from one to the other, which could adversely affect the quality of the high alumina refractory bricks and more particularly, the high alumina or clay material would seriously affect the quality of the basic or silica brick.

The specifications for the high alumina refractory bricks and cement to be produced by the plant described in this report are shown on page 3, under Product Specifications.

High alumina refractory bricks are used in rotary kilns and in non-ferrous metal smelting operations where other types of refractory or fire bricks will not meet the temperature requirements and resistances to chemical attack at high temperatures.

The aluminum oxide content of high alumina refractory bricks may reach as high as 98 or 99 percent for some special uses. For producing bricks of such high refractory value, the materials would have to be treated or processed prior to mixing and pressing to drive off volatile matter, effect certain crystalline changes, and convert the high alumina raw material to a non-shrinking aggregate.

Calcining and electric fusing are processes which are used for these purposes. If calcined or electrically fused materials are purchased for making very high heat-duty refractory bricks, the crushing operation would be eliminated.

In general, as the alumina content of the raw materials increases, the refractoriness of the finished product also increases. By careful formulating of the composition, a product of the desired properties may be obtained.

GENERAL ASSUMPTIONS

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

1. The costs of the buildings 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 in the United States Bureau of Labor Statistics.

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 8 hours per day, 5 days per week, and 50 weeks per year; however, the kiln firing operation will require 24-hour attendance, 7 days per week.

7. No special provision is made for the training of personnel. It is assumed that the learners' 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 report should be adjusted to conform to local conditions.

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

PRODUCT SPECIFICATIONS

All information and figures contained in this report are based on the production of high alumina refractory bricks and cement of not over 70 percent aluminum oxide. The bricks will be 9" X 4½" X 3" straights or their equivalents in arches, wedges, feather wedges, keys, and other special shapes.

PRODUCTION CAPACITY

The preparation equipment in this plant will produce material for 10,000 high alumina refractory bricks per day, five days per week. The firing or burning equipment (the kilns) will produce an average of about 6,000 bricks per day, seven days per week. All cost figures contained in this report are based on the production of 6,000 high alumina refractory bricks per day and 400 tons of high alumina cement per year. This production may be increased to about 10,000 high alumina refractory bricks per day, five days per week, with a corresponding increase in the production of cement, by adding the required additional kiln capacity for firing.

MANUFACTURING UNITS

The manufacturing units for the products of this plant are:

One brick - 9" X 4½" X 3"

One ton of cement.

The bricks are usually sold by the thousands and the cement is usually sold in 100 pound bags.

MANUFACTURING OPERATIONS

Crushing and Storage

Upon being received, the flint clay or high heat-duty clay is fed directly into the jaw crusher through a hopper. After being crushed to a size that can be handled by the grinder it is carried by belt conveyors to the raw materials storage piles. The same process is followed for the bauxite unless it is purchased already crushed, in which case it would be taken or conveyed directly to storage. Normally the crusher would be located at one end of the raw materials storage building. Brick damaged in the manufacturing or firing process are put back through this crusher and reused.

The materials are piled on the concrete floor of the storage building and are kept there for further processing.

Grinding

The tractor shovel is used to transport the materials from the raw materials storage piles to the apron feeder for feeding into the grinder or dry pan where it is ground to proper size for screening.

The grinder consists of a revolving pan on which rest two steel tired rollers. As the pan revolves on a vertical axis, the rollers turn on a horizontal axis, crushing the material between the rollers and pan bottom.

Screening and Milling

A bucket elevator takes the ground material to the vibrating screens for classifying as to size. Any material which does not pass through the screens is returned to the grinder for further processing. A certain portion of this material is diverted to a ball mill for further grinding to 100 mesh fineness. The milling is a continuous operation. Upon discharge from the mill, the material goes to the air separator which removes the usable part from that which must be remilled. From the air separator a belt conveyor carries the milled material to the storage bins where it is held for batching. That material which has passed through the screens, and which is not to be milled, is conveyed to the storage bins.

In some cases the bauxite may be purchased already ground. In this event it goes directly to the bins.

Batching and Mixing

The batching hopper and scales are used to weigh out the proper amounts of each of the raw materials for a 2,000 pound batch. For a 70 percent aluminum oxide refractory brick, 40 percent flint clay and 60 percent bauxite, or 800 pounds of flint clay and and 1,200 pounds of bauxite might constitute the mixture. From the scales

the materials go directly into the mixer which thoroughly combines them in a revolving pan with plows.

In the production of cement, the mixture is taken at this point by a conveyor to a bagging machine to be put into 100-pound bags. A finer screen is used when grinding cement as compared to grinding for the manufacture of brick.

Pressing or Molding

In the production of bricks, the mixture is moistened in the mixer and an air setting bonding material may be added after which it is conveyed to the press which molds the bricks automatically under high mechanical or hydraulic pressure. The mixture is not plastic and requires the high pressure to hold the particles together until it is fired. The press ejects the bricks and they are piled by hand onto steel pallets on which they are taken by fork lift truck to the drying rooms.

Drying

The green bricks are dried on the pallets for a period of one to two days. The drying is the first step in hardening the bricks. It is a lower temperature process than the firing or burning and is continued for a shorter period of time.

Firing

After the drying period, the bricks are taken by fork lift truck to the kilns for firing. The dried bricks are taken off the pallets and set in the kilns, in a checker-work pattern which will allow

free circulation of the hot products of combustion. As a safeguard against possible sticking or fusing, a thin sprinkling of fine sand may be thrown over the top of each layer of dried bricks before the next layer is set.

For a 70 percent high alumina refractory brick, a number 18 cone is used for determining the completion of the firing process. The tip of a number 18 cone would touch the supporting plaque at approximately 2650° Fahrenheit. The firing time for a 30,000 brick capacity kiln with 70 percent Al_2O_3 bricks is about seven days.

Cooling, Storage and Shipping

After the firing period, the bricks must be left to cool for about four days before they are removed.

Fork lift trucks remove the bricks from the kilns on skids and take them to the shipping storage building. They are usually shipped on these skids. If the distance is not great, they are cross-stacked and no problem is encountered in shipping. If they are to be shipped a considerable distance and may have to be transferred enroute, the bricks should be strapped to the skids.

A typical schedule of operation for the production of high alumina refractory bricks follows:

Operation	Approximate Time
Manufacturing Operations	1 day
Drying	2 days
Setting the Kilns	3 days
Firing	7 days
Cooling	4 days
Unloading the Kilns	2 days

DIRECT MATERIALS

The direct materials required for the manufacture of 1,500,000 70 percent high alumina refractory brick per year (6,000 per day) and 400 tons of high alumina cement per year:

Item	Unit	Number Units	Unit Cost	Annual Cost Estimated	Annual Cost Actual
Bauxite	Ton	5,355	$ 12.00	$ 64,260	_____
Flint clay or high heat duty clay	Ton	3,570	$ 4.00	14,280	_____
Multiwall paper bags	M	8	$ 100.00	800	_____
Steel bands				800	_____
Fine sand				100	_____
Total				$ 80,240	_____

SUPPLIES

Item	Annual Cost Estimated	Annual Cost Actual
Pyrometric cones	$ 100	_____
Lubricants	200	_____
Hand tools	100	_____
Cutting tools	100	_____
Office supplies	200	_____
Gas, oil and maintenance for truck, tractor and fork lift trucks	1,000	_____
Welding rods	100	_____
Repair parts and maintenance materials	12,000	_____
Total	$ 13,800	_____

DIRECT LABOR

Job Classification	Number Needed	Hourly Rate	Annual Cost Estimated	Annual Cost Actual
Raw materials handling and grinding	2	$2.00	$ 8,000	_____
Blending and mixing	1	$2.50	5,000	_____
Press operator	2	$2.50	10,000	_____
Fork truck operator	2	$2.00	8,000	_____
Kiln setting	2	$2.00	8,000	_____
Kiln unloading	2	$2.00	8,000	_____
Kiln firing	4	$2.00	16,000	_____
Yardman	1	$1.50	3,000	_____
Total	16		$ 66,000	_____

INDIRECT LABOR

Job Classification	Number Needed	Hourly Rate	Annual Cost Estimated	Annual Cost Actual
Manager	1		$ 10,000	_____
Foreman	1		7,500	_____
Office	2		8,000	_____
Maintenance	1		4,000	_____
Receiving and shipping	1		3,500	_____
Truck driver	1		4,000	_____
Total	7		$ 37,000	_____

PRODUCTION TOOLS AND EQUIPMENT

Item	Number Needed	Cost Estimated	Cost Actual
Hopper and vibrating feeder	1	$ 3,500	_____
Belt conveyors	2	6,000	_____
Tractor shovel	1	8,000	_____
Apron feeder (with drive)	1	3,000	_____
Rim discharge grinder or dry pan (complete)	1	22,000	_____
Bucket elevator (with motor and drive)	1	3,500	_____
Double deck vibrating screens and hoppers (Number 6 and finer screens)	2	8,000	_____
Belt conveyor (with motor and drive)	1	2,500	_____
Storage bins (20-ton capacity)	6	12,000	_____
Batching hopper and scales	1	2,500	_____
Belt conveyor (with motor and drive)	1	3,500	_____
Mixer (10- to 14-foot capacity)	1	7,500	_____
Bagging machine	1	3,500	_____
Belt conveyor (with motor and drive)	1	2,500	_____
Dry press (8-15 M brick per day capacity -- complete)	1	42,000	_____
Impact press (4-5 M brick per day capacity)	1	22,500	_____
Dies		5,000	_____
Air compressor	1	3,000	_____
Bee hive kilns (30-foot inside diameter - 30,000 brick capacity)	4	128,000	_____
Fuel equipment for kilns (piping, cocks)		25,000	_____
12" X 18" jaw crusher (with drive and motor)	1	11,000	_____

Item	Number Needed	Cost Estimated	Cost Actual
Ball mill feeder (belt type)	1	1,800	_____
Ball mill (with motor)	1	13,000	_____
Bucket elevator	1	3,000	_____
Air separator	1	4,000	_____
Dryer	1	30,000	_____
Oil storage tanks	4	5,000	_____
Foundations for heavy equipment		20,000	_____
Maintenance equipment including - drill press, shaper, power hacksaw, heat treat furnace, surface grinder, hand tools, benches and cabinets		20,000	_____
Transformer station and wiring		20,000	_____
Initial engineering and installation		71,500	_____
Total		$ 512,800	_____

OTHER TOOLS AND EQUIPMENT

Item	Number Needed	Cost Estimated	Cost Actual
Welding equipment (electric)		$ 1,500	_____
Electric recorder of kiln temperature	1	2,500	_____
Fork lift trucks	2	10,000	_____
Dump truck (8-ton)	1	7,500	_____
Wheel barrows	10	500	_____
Steel drying pallets (3' X 4')	100	2,000	_____
Wooden skids	500	2,000	_____
Safety guards for machinery		500	_____
Laboratory (for testing)		1,500	_____
Total		$ 28,000	_____

FURNITURE AND FIXTURES

Item	Number Needed	Unit Cost	Cost Estimated	Cost Actual
Desks and chairs	3	$150	$ 450	_____
Filing cabinets	3	$ 50	150	_____
Adding machine	1	$150	150	_____
Typewriter	1	$150	150	_____
Total			$ 900	_____

PLANT LAYOUT

A plant layout showing the locations of the buildings and kilns is shown on page 35. A diagram showing the flow of work and the location of machinery and equipment used in the manufacturing operations is shown on page 36.

PLANT SITE

Because of the nature of this business and the weight and bulkiness of both the raw materials and the finished products, the plant must be located on a railroad.

A plant site of about two acres will be required. The plant site should be located as advantageously as possible with respect to power, water, fuel, sources of labor, and markets.

The estimated cost of the plant site is $2,000.

BUILDINGS

	Approximate Size	Cost Estimated	Cost Actual
Raw materials receiving and storage -- Paved flooring, gabled roof, 20 feet high sides from ground to eaves, sides closed halfway down from eaves to afford protection from the weather while permitting free movement of vehicles.	70 feet X 120 feet 8,400 square feet	$ 20,160	_____
Grinding and milling -- building may be made of any suitable local materials.	70 feet X 60 feet 4,200 square feet	$ 16,800	_____
Manufacturing (mixing and pressing) and dryer building -- Should be of concrete block or similar material. Its purpose is to house the mixer and presses and the dryer which provides controlled heat for the bricks being dried on the pallets. It is separated from the grinding and milling operations by the storage bins.	70 feet X 70 feet 4,900 square feet	$ 19,600	_____
Brick storage -- building with relatively low roof, essentially a corrugated roof supported by uprights to cover the finished bricks prior to shipment. Offices, lab and shop are located at the end of this structure.	70 feet X 155 feet 10,850 square feet	$ 22,440	_____
Total		$ 79,000	_____

POWER

The connected load is 205 horsepower. Based on operating the preparation equipment one shift, 5 days per week and operating the kilns 24 hours per day, 7 days per week, during firing, the cost of electrical power is estimated at $12,000 per year.

WATER

A relatively small amount of water is needed for production. The cost of this amount plus water for sanitation purposes and fire protection is estimated at $200 per year.

FUEL

It is estimated that the annual fuel consumption for production and heating will be approximately 540,000 gallons of oil, which at the rate of $.07 per gallon, will cost $37,800.

TRUCK

An eight-ton dump truck is included in "Other Tools and Equipment". The wages of the truck driver are shown in "Indirect Labor". The cost of the truck operation and maintenance are included in "Supplies". The estimated cost of the truck is $7,500.

* * * * * * * * * * *

DEPRECIATION

Item	Estimated Cost	Years Life	Cost Estimated	Cost Actual
Building	$ 79,000	20	$ 3,950	_____
Production tools and equipment	507,800	10	50,780	_____
Other tools and equipment	20,500	10	2,050	_____
Furniture and fixtures	900	10	90	_____
Dies	5,000	5	1,000	_____
Truck	7,500	4	1,875	_____
Total			$ 59,745	_____

MANUFACTURING OVERHEAD

Item	Cost Estimated	Cost Actual
Depreciation	$ 59,745	_____
Indirect labor	37,000	_____
Power	12,000	_____
Water	200	_____
Fuel	37,800	_____
Supplies	13,800	_____
Total	$ 160,545	_____

MANUFACTURING COST

Item	Annual Estimated	Annual Actual
Direct materials	$ 80,240	_____
Direct labor	66,000	_____
Manufacturing overhead	160,545	_____
Total	$ 306,785	_____

FIXED ASSETS

Item	Cost Estimated	Cost Actual
Land	$ 2,000	_____
Buildings	79,000	_____
Production tools and equipment	512,800	_____
Other tools and equipment	28,000	_____
Furniture and fixtures	900	_____
Total	$ 622,700	_____

WORKING CAPITAL

Item	Time	Estimated	Actual
Direct materi	30 days	$ 6,690	_____
Direct labor	30 days	5,500	_____
Manufacturing overhead	30 days	13,380	_____
Reserve for sales collections	30 days	54,170	_____
Total		$ 79,740	_____

CAPITAL REQUIREMENTS

Item	Estimated	Actual
Fixed assets	$ 622,700	_____
Working capital	79,740	_____
Total	$ 702,440	_____

* * * * * * * * * * * * *

SALES REVENUE

The production capacity of the preparation equipment shown in this report is about 10,000 high alumina refractory bricks of the specified size per 8-hour day. The production capacity of the kilns averages at least 6,000 high alumina refractory bricks per day. The annual sale of bagged cement is estimated at 400 tons. At an average selling price of $420 per 1,000 bricks and $50 per ton for the cement, the total annual sales revenue would amount to:

1,500 X $420	=	$630,000
400 X $ 50	=	20,000
Total		$650,000

RECAPITULATION OF COSTS, SALES AND PROFITS

Item	$	Annual Estimated	Actual
Direct materials	$ 80,240		_____
Direct labor	66,000		_____
Manufacturing overhead	160,545		_____
Total manufacturing costs		$ 306,785	_____
Interest on loans	21,000		_____
Insurance	2,100		_____
Legal	1,500		_____
Auditing	2,500		_____
Unforeseen expense	48,115		_____
Total administrative costs		75,215	_____
Sales expense		50,000	_____
Freight-out, bad debts, discounts and allowances		40,000	_____
Profit before taxes		178,000	_____
Annual gross sales		$ 650,000	_____

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 to 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	$_____	$ 2,258	$ 27,100	$_____
20 Sales	_____	7,500	90,000	_____
30 Direct materials	_____	6,687	80,240	_____
40 Supplies	_____	1,150	13,800	_____
51 Power*	_____	1,000	12,000	_____
52 Water*	_____	16	200	_____
53 Fuel	_____	3,150	37,800	_____
60 Unforeseen expense (Reserve account)	_____	4,010	48,115	_____
71 Direct labor*	_____	5,500	66,000	_____
72 Indirect labor*	_____	3,083	37,000	_____
80 Depreciation (Reserve account)			59,745	_____

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

PURCHASE REQUISITION	COMPANY NAME	DATE

- ☐ 10 ADMINISTRATION
- ☐ 20 SALES
- ☐ 30 MATERIALS
- ☐ 40 SUPPLIES
- ☐ 50 UTILITIES
- ☐ 60 UNFORESEEN EXPENSE

INDICATE BELOW THE USE OF MATERIALS

- ☐ DIRECT MATERIALS
- ☐ MAINTENANCE MATERIALS
- ☐ MAINTENANCE SERVICES
- ☐ 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.

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.

OTHER CONSIDERATIONS

There are other important subjects, shown below, that should be fully investigated and considered. Information on these subjects is usually available from such sources as banks, government agencies, exporters and importers, wholesalers, retailers, transportation companies and manufacturers.

MATERIALS AND SUPPLIES

1. Are all materials and supplies available locally?
2. Is the local material market competitive?
3. Is 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?

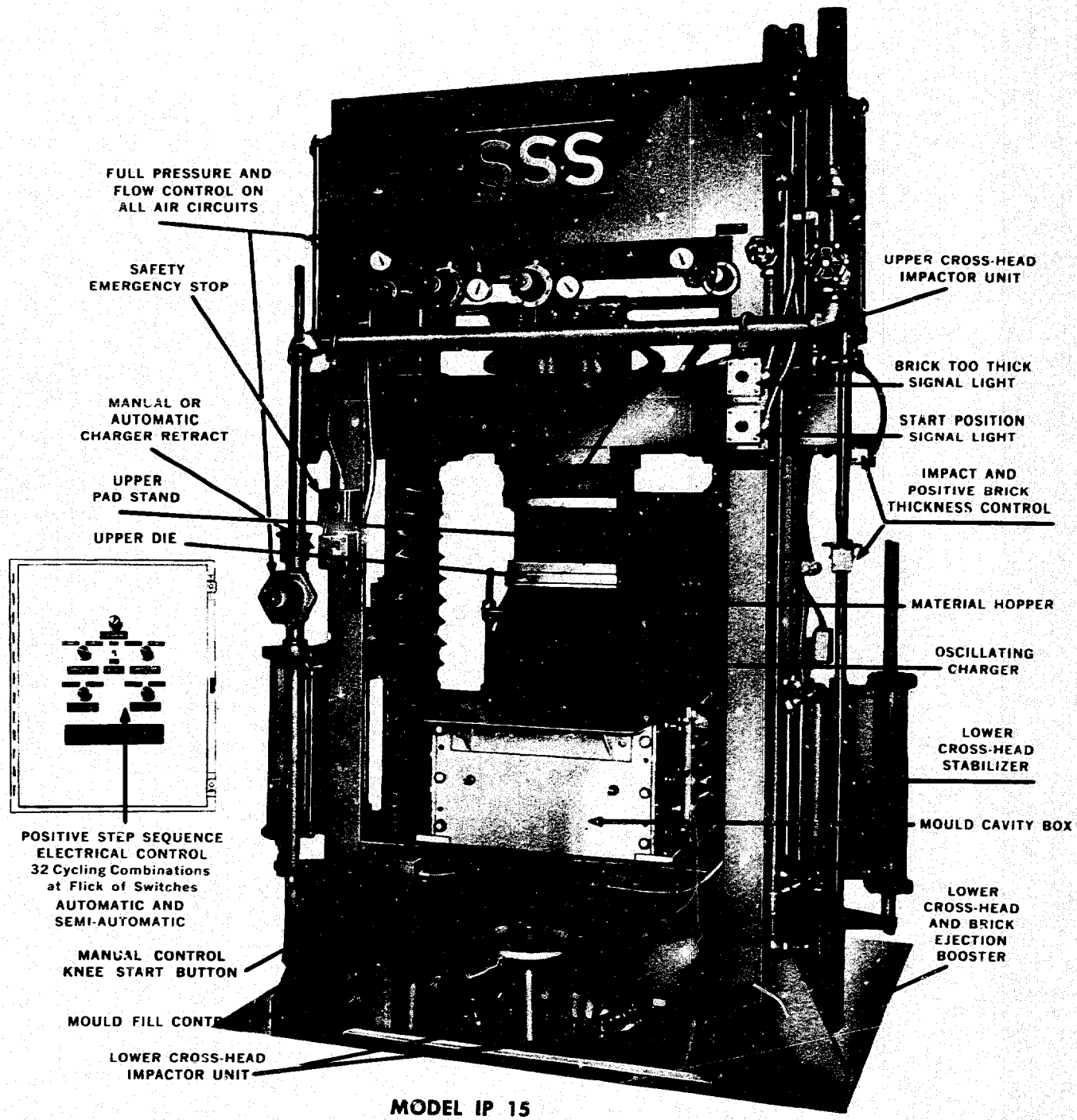
3. If the economy is in a period of inflation, has full allowance been made for the influence of rising prices and wages on the cost of the project and on working capital requirements?

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:

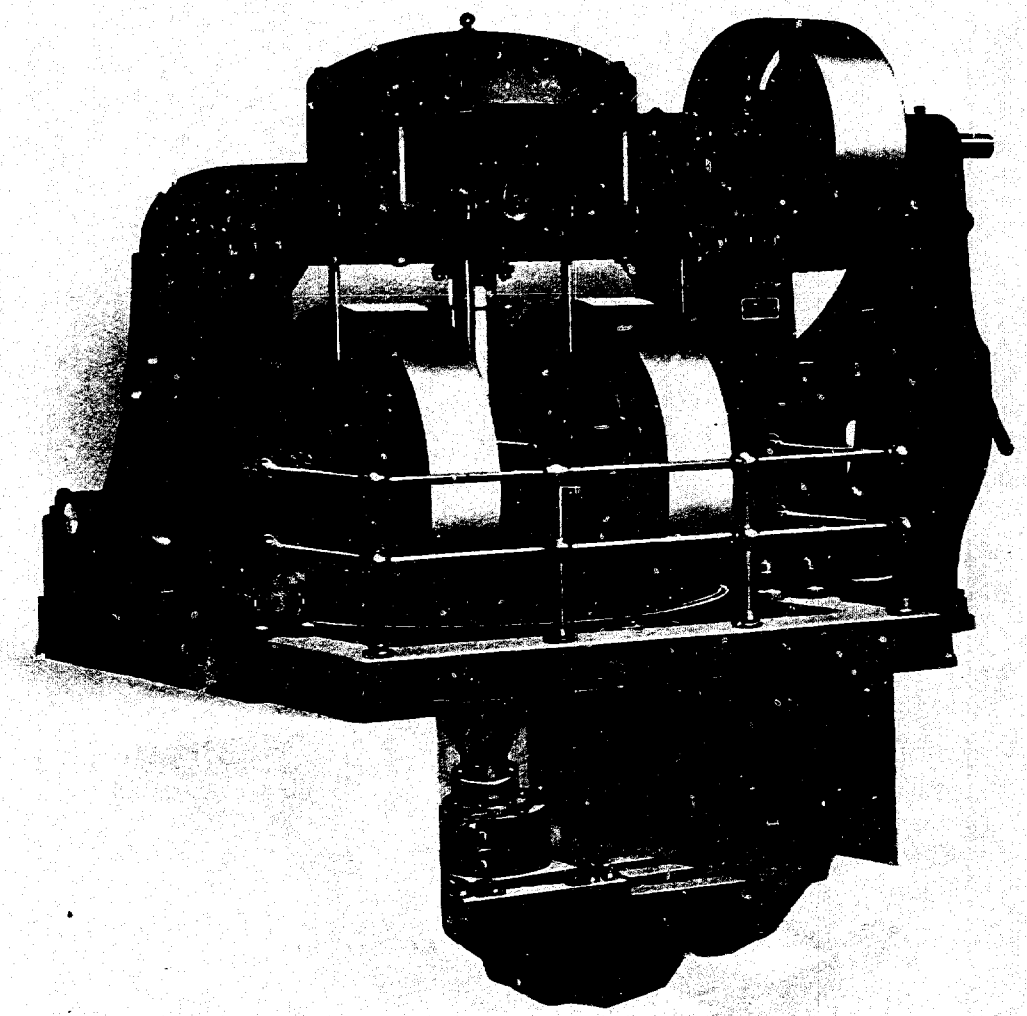
1. Has a definite plan to finance the project been worked out?
   A. Is sufficient capital available locally?
   B. If not, what is the plan to obtain the required capital?



MODEL IP 15
PATENTS APPLIED FOR

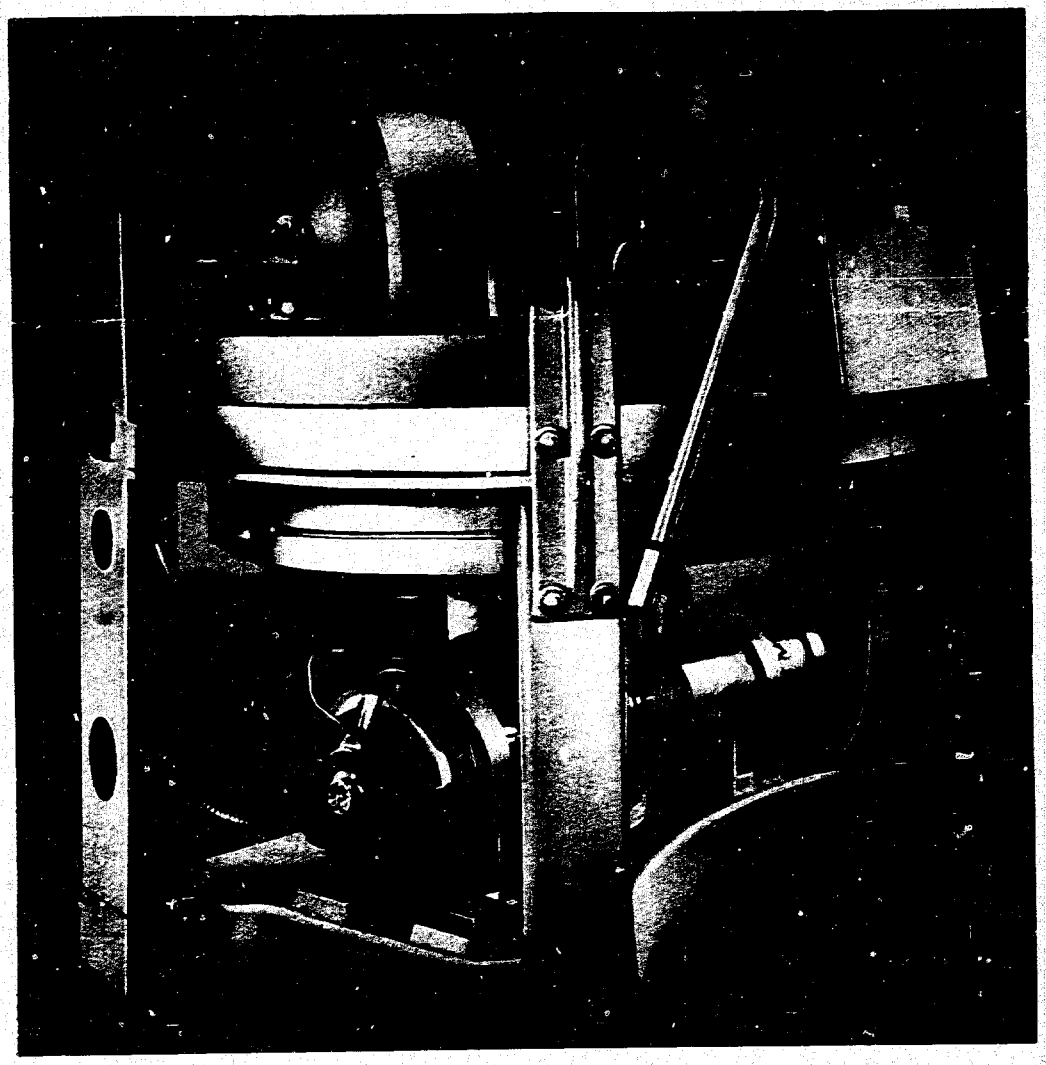
PNEUMATIC IMPACT PRESS

Courtesy
The Ohio Fire Brick Company
Oak Hill, Ohio



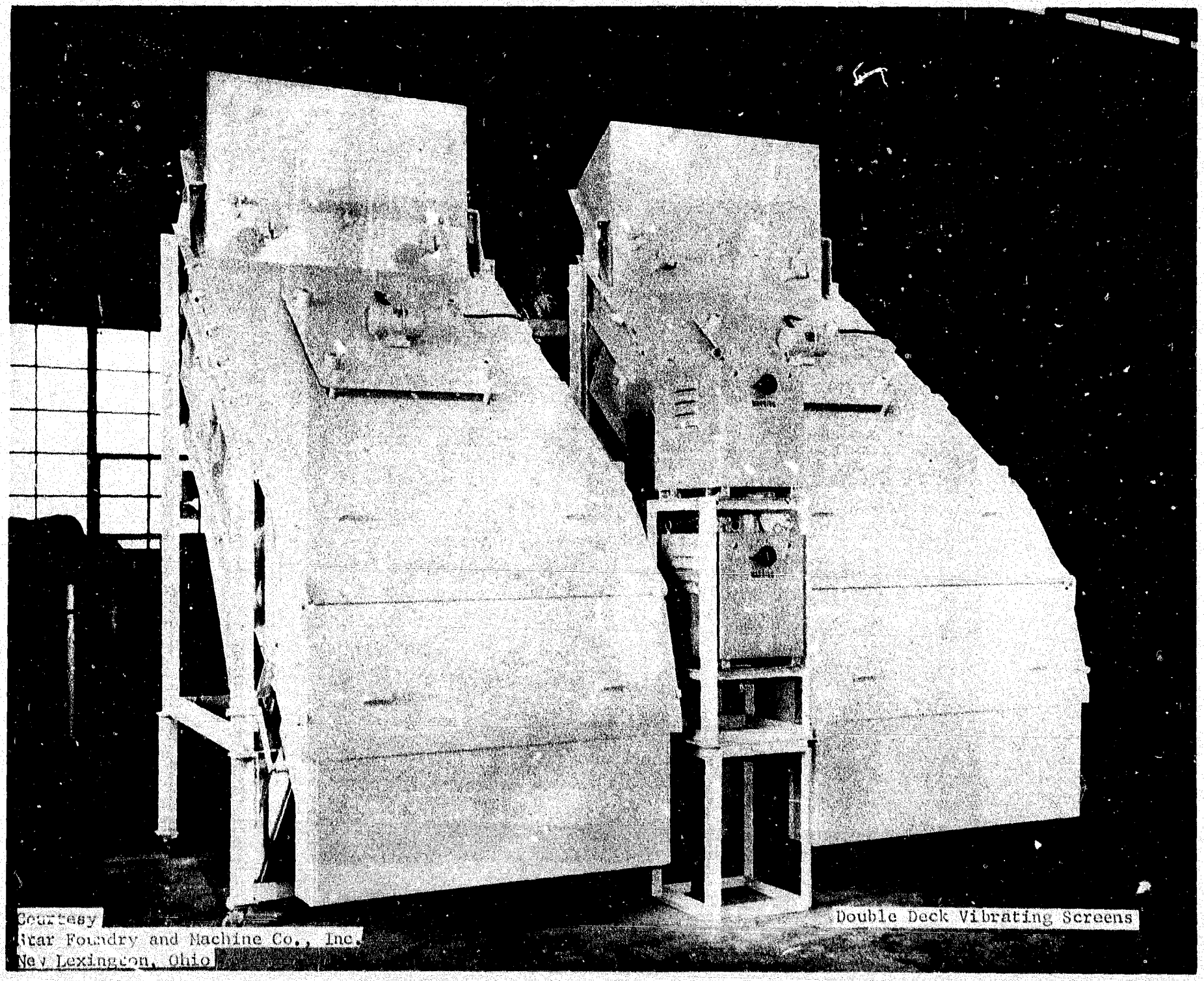
GRINDING PAN

Courtesy
The Stevenson Company
Wellsville, Ohio



MIXER

Courtesy
Clearfield Machine Company
Clearfield, Pennsylvania



Courtesy
Star Foundry and Machine Co., Inc.
New Lexington, Ohio

Double Deck Vibrating Screens

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TEXTBOOKS

1. Modern Refractory Practice. 3d edition.
Harbison-Walker Refractories Company.
1950. 439 p. illus. $15.00.

Harbison-Walker Refractories Company
Pittsburgh, Pennsylvania

Contains both general and technical information on wide range of refractories, including high alumina refractories.

2. High Temperature Technology. I. E. Campbell.
1956. 526 p. illus. $15.00.

John Wiley and Sons, Incorporated
440 Fourth Avenue
New York, New York

Surveys the achievements to date of publication in materials and techniques and describes proven methods of measuring temperatures and properties.

3. Refractories. 3d edition. F. H. Norton. 1949.
782 p. illus. $12.50.

McGraw-Hill Book Company, Inc.
330 West 42d Street
New York 36, New York

Scope of the refractories industry in the United States. Refractory raw materials, molding methods, drying, firing, kilns, some special refractory materials.

PERIODICALS

1. Brick and Clay Record. Monthly. $7.00/year.

Industrial Publications, Inc.
5 South Wabash Avenue
Chicago 3, Illinois

Materials and manufacturing of bricks, refractories, and other similar products.

2. Ceramic Age. Monthly. $8.00/year.

   Ceramic Publications, Inc..
   Ninth-Chester Building
   Cleveland 14, Ohio

   Production magazine covering industrial ceramics, refractories, structural clay products, raw materials, equipment.

TECHNICAL PAPERS

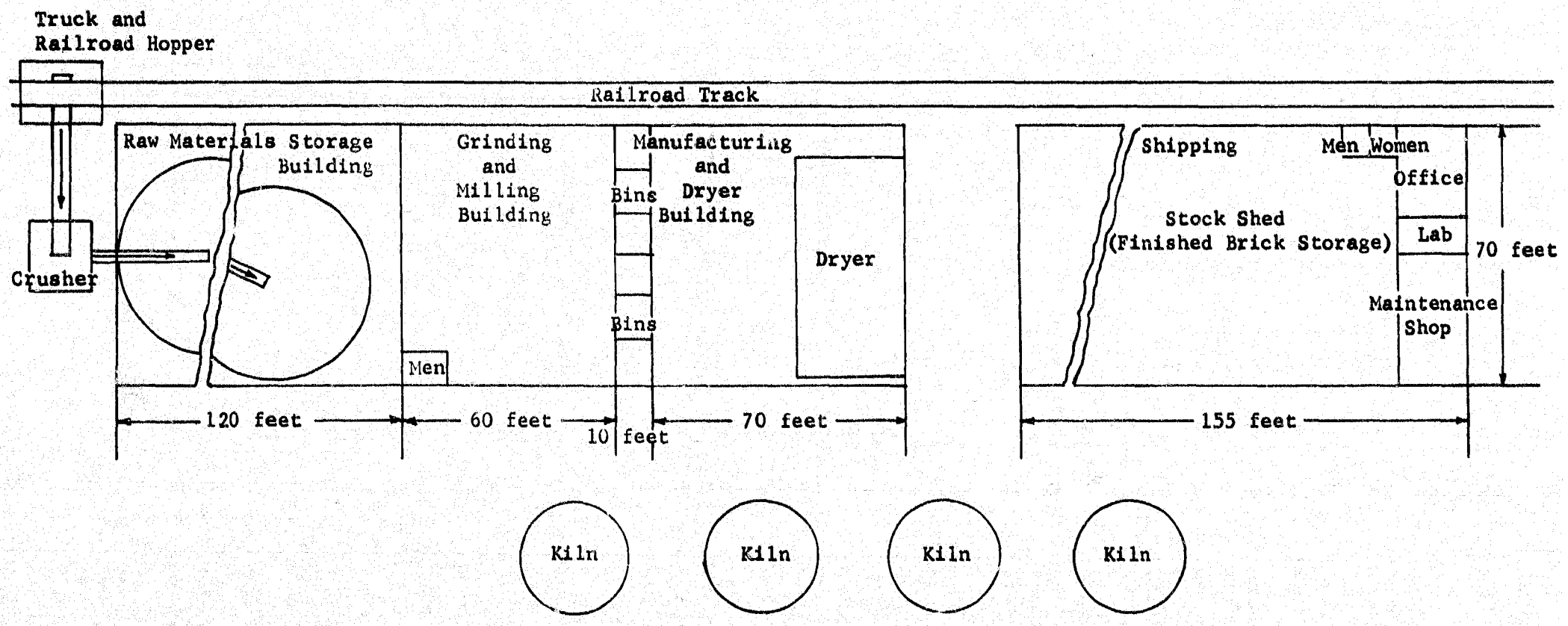
1. "Calcining Clays for Better Product Control". R. C. Weigel. Ceramic Age 69 (5): pp. 14-16. May 1957. $1.00.

   Ceramic Publications, Inc.
   Ninth-Chester Building
   Cleveland 14, Ohio

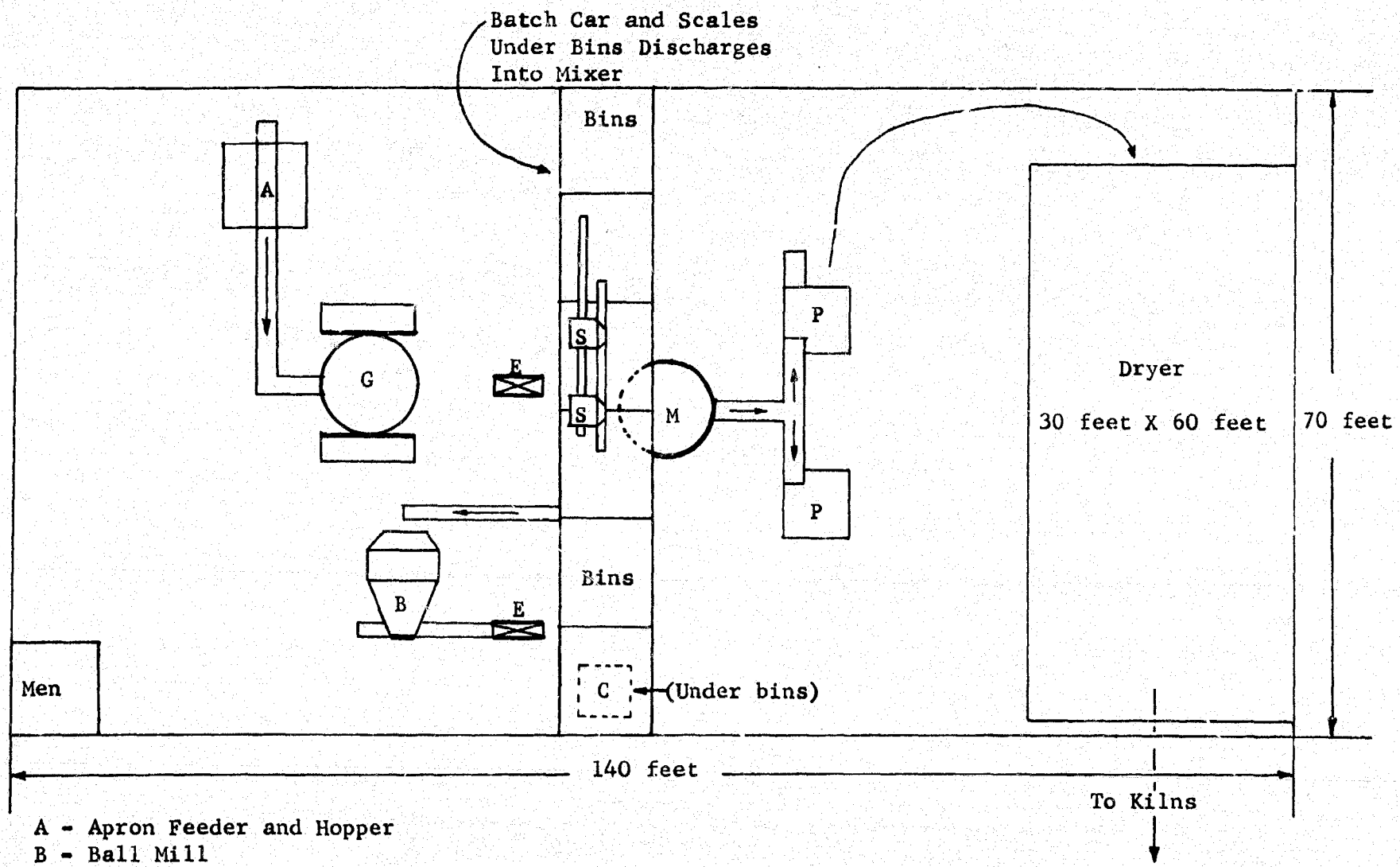
TRADE ASSOCIATIONS

1. Special Refractories Association
   11 West 42d Street
   New York 36, New York

PLANT LAYOUT



PLANT LAYOUT AND WORKFLOW



A - Apron Feeder and Hopper
B - Ball Mill
C - Bagging Machine
G - Grinder
E - Bucket Elevators
M - Mixer
P - Presses
S - Screens over Bins