PLANT REQUIREMENTS FOR MANUFACTURE OF PHARMACEUTICAL GLASS

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

FOREWORD

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

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

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

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

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

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Washington, Pennsylvania

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INTRODUCTION

The small pharmaceutical glass plant described in this report is intended to manufacture glass tubing, ampoules and vials for antibiotics. Other pharmaceutical products such as syringes and glass for laboratory uses can be produced in this plant.

GENERAL ASSUMPTIONS

In order to make realistic estimates in this report, 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 twenty-four hours a day, seven 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 except taxes, 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.

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

PRODUCTION SPECIFICATIONS

The glass tubing ampoules and vials produced in this plant will be of neutral glass. The ampoules and vials shall have a capacity of from five to eight cubic centimeters. Other sizes and other products may be produced in this plant but for the purpose of this report only the above products will be considered.

PRODUCTION CAPACITY

The annual capacity of this plant is about seven tons of glass per day which will produce ten million ampoules and fifteen million vials per year having a capacity of from five to eight cubic centimeters and provide some additional tubing for other products.

MANUFACTURING UNIT

The manufacturing unit of this plant is one ton of neutral glass. The number of ampoules and vials that can be produced from one ton of glass will depend on the capacity of the product.

MANUFACTURING OPERATIONS

The raw materials are placed in storage. The sand and lime are screened and beneficiated so that they contain less than .03 percent of iron oxide and then placed in bins.

Exact amounts of materials are weighed according to the glass formula, mixed and fed into the refractory lined, heated tank furnace where they are held at temperatures from 2,650 to 2,800°F. until a homogenous glass is formed.

The glass then flows from the melting furnace into a forebay where the glass is properly conditioned. The glass runs through a special flow lip of the forebay which is equipped with a flow control gate and then out onto a rotating mandrel sleeve. The glass flows off the end of this mandrel in the form of tubing. The inside of the tubing is supported by forming air at accurately controlled pressure which passes through the center of the mandrel.

The formed tubing is drawn by the tube drawing machine and is supported by adjustable rollers on the tube runway. At the drawing machine the tubing is cut into standard lengths and is ready for further processing. If the tubing is not immediately used the ends must be glazed to prevent end checking. The tubing is then cut to exact required length and fed into the vial or ampoule machines for final processing.

The finished product is then inspected and packed in cartons ready for shipping or storage.

DIRECT MATERIALS

The direct materials required for the manufacture of neutral glass include the following:

A. Sand - Silicon dioxide beneficiated to contain less than .03 percent of iron oxide.

B. Soda ash

C. Limestone - Calcium carbonate, calcium oxide, or magnesium beneficiated if necessary to contain less than .03 percent of iron oxide.

D. Feldspar

E. Borax

F. Zinc oxide

G. Fluorspar

H. Cullet

The following is a standard formula for neutral glass having a basis of 1,000 pounds of sand.

Material	Pounds	Cost Per Pound	Estimated Cost	Actual Cost
Sand	1,000	$.004	$ 4.00	
Soda ash	350	.020	7.00	
Limestone	180	.016	2.88	
Feldspar	330	.020	6.60	
Borax	100	.025	2.50	
Zinc	60	.110	6.60	
Fluorspar	10	.025	.25	
Cullet	300	.005	1.50	
Total			$ 31.33	

Based on the melting of 8.25 tons of direct materials per day to produce seven tons of products the daily cost of direct materials will amount to approximately $259.00.

On this basis the annual cost of direct materials would amount to $90,650.

PLANT LAYOUT

A plant layout indicating the location of the equipment is shown on the last page of this report. The process is automatic up to and including the manufacturing of the tubing. From there on the operations are semi-automatic. However, the production operation continues on to the shipping department without any backtracking.

PLANT SITE

To provide for eventual expansion, the plant site should contain about four acres of well drained land. 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.

BUILDINGS

A one-story building will be required about 80 feet wide by 250 feet long or about 20,000 square feet of floor space. The building may be constructed of any suitable local fireproof material.

The cost of the building is estimated at about $4.00 per square foot or approximately $80,000.

POWER

It is assumed that a dependable supply of electric power will be available from public power service lines. However, a 100 kilowatt stand-by diesel power plant is included in the list of equipment for the purpose of keeping the essential manufacturing equipment in operation in case of a power failure.

The total connected load is 250 kilowatts.

On this basis the annual cost of power is estimated at $6,000.

WATER

The water requirement is estimated at approximately 50 gallons per minute or about 25,000,000 gallons per year. Much of the water can be drained into a sump or cooling pond and be reused.

The annual cost of water is estimated at $1,000.

Consideration should be given to the availability of water in selecting the site for the plant.

FUEL

The fuel requirements for this plant are estimated at approximately 186,000 gallons of Bunker B oil per year.

On this basis the cost of Bunker B oil will amount to about $9,300 per year.

Bunker B oil must be preheated before using.

Gas, either natural or bottled, is required for the operation of the processing equipment used in forming the products.

The cost of gas is estimated at about $20 per day or approximately $7,000 per year.

On this basis the total annual cost of fuel is $16,300.

TRUCK

A panel truck will be required for local deliveries and for pick-up purposes.

The cost of the truck is included in other tools and equipment.

The cost of the truck driver is included in indirect labor.

The cost of operation and repair is included in supplies.

PRODUCTION TOOLS AND EQUIPMENT

Description	Estimated Cost		Actual Cost
Tubing equipment			
Tank furnace	$ 109,000		
Furnace burners and heavy oil system	11,500		
Instrumentation for furnace forebay and mandrel oven	9,000		
Block cooling system	4,000		
Compressed air system	11,500		
Forebay and mandrel oven	11,500		
Mandrel preheat and handling accessories	4,000		
Forebay and mandrel oven	11,500		
Mandrel machine including tube forming air supply unit and spare operating accessories	17,250		
Tube runway including fan	11,500		
Tube drawing machine complete with hot cutoff unit	28,750		
Clipper and glazing machine	11,500		
Tube size sorting machine	11,500		
Total tubing equipment		$ 252,500	
Forming equipment			
Ampoule and vial forming, vial bottom closing, annealing and cutting, gas booster and air pressure blower equipment	$ 30,000		
Total forming equipment		30,000	

The forming equipment will require special adaptation in accordance with the actual products required since the shape, volume capacity, and the production capacity should be know by the suppliers of the equipment. Usually samples of the desired products are provided for this purpose.

General equipment			
Fuel oil tanks and pump, batch mixer, scale, shuttle conveyor, cullet crusher, valves and fittings	$ 36,000		
Machine shop equipment	30,000		
Stand-by power unit	14,000		
Total general equipment		80,000	

Production tools and equipment - continued

Description	Estimated Cost		Actual Cost
Other tools and equipment			
Hand tools	$ 300		
Cutting tools	700		
Welding equipment	500		
Pick-up truck	2,500		
Total other tools and equipment		$ 4,000	
Total production tools and equipment		$ 366,500	

FURNITURE AND FIXTURES

Description	Number Required	Unit Cost	Estimated Cost	Actual Cost
Desks and chairs	4	$ 150	$ 600	
File cabinets	4	75	300	
Typewriter	1	150	150	
Adding machine	1	150	150	
Total			$ 1,200	

SUPPLIES

Item	Annual Cost Estimated	Actual
Lubricants	$ 200	
Hand tools	125	
Cutting tools	200	
Office supplies	200	
Welding rods	100	
Truck gas, oil and maintenance	500	
Maintenance materials and parts	3,675	
Total	$ 5,000	

DIRECT LABOR

Occupation	Number Required	Hourly Rate	Annual Cost Estimated	Annual Cost Actual
Batch mixer	1	$ 2.00	$ 5,600	
Batch mixer helpers	3	1.80	15,120	
Tank foreman (working)	1	2.50	7,000	
Tank teasers	3	1.80	15,120	
Machine operators	3	1.80	15,120	
Fuel oil	1	1.80	5,040	
Carton foreman (working)	1	1.80	5,040	
Carton labor	2	1.50	8,400	
Warehouse foreman (working)	1	1.80	5,040	
Warehouse labor	2	1.50	8,400	
Laborers	3	1.50	12,600	
Watchman	1		4,000	
Total	22		$ 106,480	

INDIRECT LABOR

Occupation	Number Required	Hourly Rate	Annual Cost Estimated	Annual Cost Actual
Manager	1		$ 10,000	
Superintendent	1		8,000	
Bookkeeper	1		5,000	
Typist	1		3,200	
Shipping clerk	1	$ 1.80	3,600	
Master mechanic	1	2.50	7,000	
Chemist	1		8,000	
Truck driver	1	1.60	3,200	
Total	8		$ 48,000	

DEPRECIATION

Item	Estimated Cost	Years Life	Annual Depreciation Estimated	Actual
Building	$ 80,000	20	$ 4,000	
Production tools and equipment	173,500	15	11,700	
Tank furnace	109,000	5	21,800	
General equipment	80,000	10	8,000	
Other tools and equipment	4,000	4	1,000	
Furniture and fixtures	1,200	10	120	
Total			$ 46,620	

MANUFACTURING OVERHEAD

Item	Annual Cost Estimated	Actual
Depreciation	$ 46,620	
Indirect labor	48,000	
Supplies	5,000	
Power	6,000	
Water	1,000	
Fuel	16,300	
Total	$ 122,920	

MANUFACTURING COSTS

Item	Annual Cost Estimated	Actual
Direct materials	$ 90,650	
Direct labor	106,480	
Manufacturing overhead	122,920	
Total	$ 320,050	

FIXED ASSETS

Item	Estimated Cost	Actual Cost
Land	$ 2,000	
Buildings	80,000	
Production tools and equipment	173,500	
Tank furnace	109,000	
General equipment	80,000	
Other tools and equipment	4,000	
Furniture and fixtures	1,200	
Total	$ 449,700	

WORKING CAPITAL

Item		Estimated Cost	Actual Cost
Direct materials	- 30 days	$ 8,000	
Direct labor	- 30 days	8,900	
Manufacturing overhead	- 30 days	10,200	
Reserve for sales collections	- 30 days	50,000	
Total		$ 77,100	

CAPITAL REQUIREMENTS

Item	Estimated Cost	Actual Cost
Fixed assets	$ 449,700	
Working capital	77,100	
Total	$ 526,800	

SALES REVENUE

Ampoules and vials are sold by the gross. The plant has a capacity of 25,000,000 or 173,611 gross of ampoules and vials five to eight cubic centimeters capacity.

The tubing equipment will produce more tubing than is required for the ampoules and vials. The sale of the excess tubing is estimated at $79,200.

The average factory selling price for the ampoules and vials produced in this plant is $3.00 per gross. On this basis the annual sales of ampoules and vials would amount to about $520,800.

The annual gross sales are estimated at $600,000.

RECAPITULATION OF COSTS, SALES AND PROFITS

Item	Estimated Cost		Actual Cost
Direct materials	$ 96,250		
Direct labor	106,480		
Manufacturing overhead	122,920		
Total manufacturing costs		$ 320,050	
Interest on loans	$ 20,000		
Insurance	2,000		
Legal	2,400		
Auditing	3,600		
Unforeseen expense	27,950		
Total administrative costs		55,950	
Sales commissions, travel, freight out, bad debts, discounts and allowances, and packaging materials		50,800	
Profit before taxes		173,200	
Annual gross sales		$ 600,000	

ALTERNATE FORMING PLANT

A plant could be established to produce ampoules and vials without the tube making equipment. The glass tubing could be purchased and processed on the forming machine. Such a plant would require much lower fixed investment as shown below. However, the profits would also be much lower since the cost of imported tubing would greatly exceed the cost of tubing produced at the plant.

The fixed investment and other costs for forming ampoules and vials from tubing would be approximately as follows:

Fixed assets

Item	Estimated Cost	Actual Cost
Land	$ 1,000	
Building	32,000	
Machinery and equipment	100,000	
Other tools and equipment	4,000	
Furniture and fixtures	1,200	
Total	$ 138,200	

Depreciation

Item	Estimated Cost	Years Life	Annual Depreciation Estimated	Actual
Building	$ 32,000	20	$ 1,600	
Machinery and equipment	100,000	10	10,000	
Other tools and equipment	4,000	4	1,000	
Furniture and fixtures	1,200	10	120	
Total			$ 12,720	

Manufacturing overhead

Item	Annual Cost Estimated	Actual
Depreciation	$ 12,720	
Indirect labor	48,000	
Supplies	3,780	
Power	3,000	
Water	500	
Fuel	7,000	
Total	$ 75,000	

Manufacturing costs

Item	Annual Cost Estimated	Actual
Direct materials	$ 275,000	
Direct labor	70,000	
Manufacturing overhead	75,000	
Total	$ 420,000	

Working capital

Item		Estimated Cost	Actual Cost
Direct materials	- 30 days	$ 22,900	
Direct labor	- 30 days	5,800	
Manufacturing overhead	- 30 days	6,300	
Reserve for sales collections	- 30 days	50,000	
Total		$ 85,000	

Recapitulation of costs, sales and profits

Item	Estimated Cost		Actual Cost
Direct materials	$ 275,000		
Direct labor	70,000		
Manufacturing overhead	75,000		
Total manufacturing costs		$ 420,000	
Interest on loans	$ 20,000		
Insurance	2,000		
Legal	2,400		
Auditing	3,600		
Unforeseen expense	21,200		
Total administrative costs		49,200	
Sales commissions, travel, freight out, bad debts, discounts and allowances, and packaging materials		50,800	
Profit before taxes		80,000	
Annual gross sales		$ 600,000	

USE OF SILICON

Ampoules and vials for some purposes are manufactured from normal glass and sprayed inside with silicon. Where large volumes of such products are required it would reduce the direct material cost to produce normal glass tubing. Where the volume for normal glass tubing is small it would be advisable to produce neutral glass only.

However, spraying the inside of the tubing with silicon has a definite value for both natural and neutral glass, specially where the contents are expensive. Spraying with silicon produces a non-wetting surface since the liquid will not stick to the sides. In tubes that are not sprayed with silicon about ten percent of fluid is added to compensate for the fluid that sticks to the sides. On tubing that has been sprayed with silicon about five percent extra fluid will suffice since the fluid flows freely from the sides.

Spraying equipment is not expensive and the spraying operation can be accomplished quickly and easily after the tubing has been cut to length ready for forming.

One operator with suitable spraying equipment would be able to spray the entire production of this plant; therefore, the additional cost to the purchaser would be small.

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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	$_____	$ 2,333	$ 28,000	$_____
20	Sales	_____	4,233	50,800	_____
30	Direct Materials	_____	7,554	90,650	_____
40	Supplies	_____	416	5,000	_____
51	Power*	_____	500	6,000	_____
52	Water*	_____	83	1,000	_____
53	Fuel	_____	1,358	16,300	_____
60	Unforeseen Expense (Reserve Account)	_____	2,321	27,950	_____
71	Direct Labor*	_____	8,870	106,480	_____
72	Indirect Labor*	_____	4,000	48,000	_____
80	Depreciation (Reserve Account)	_____	3,975	47,700	_____

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

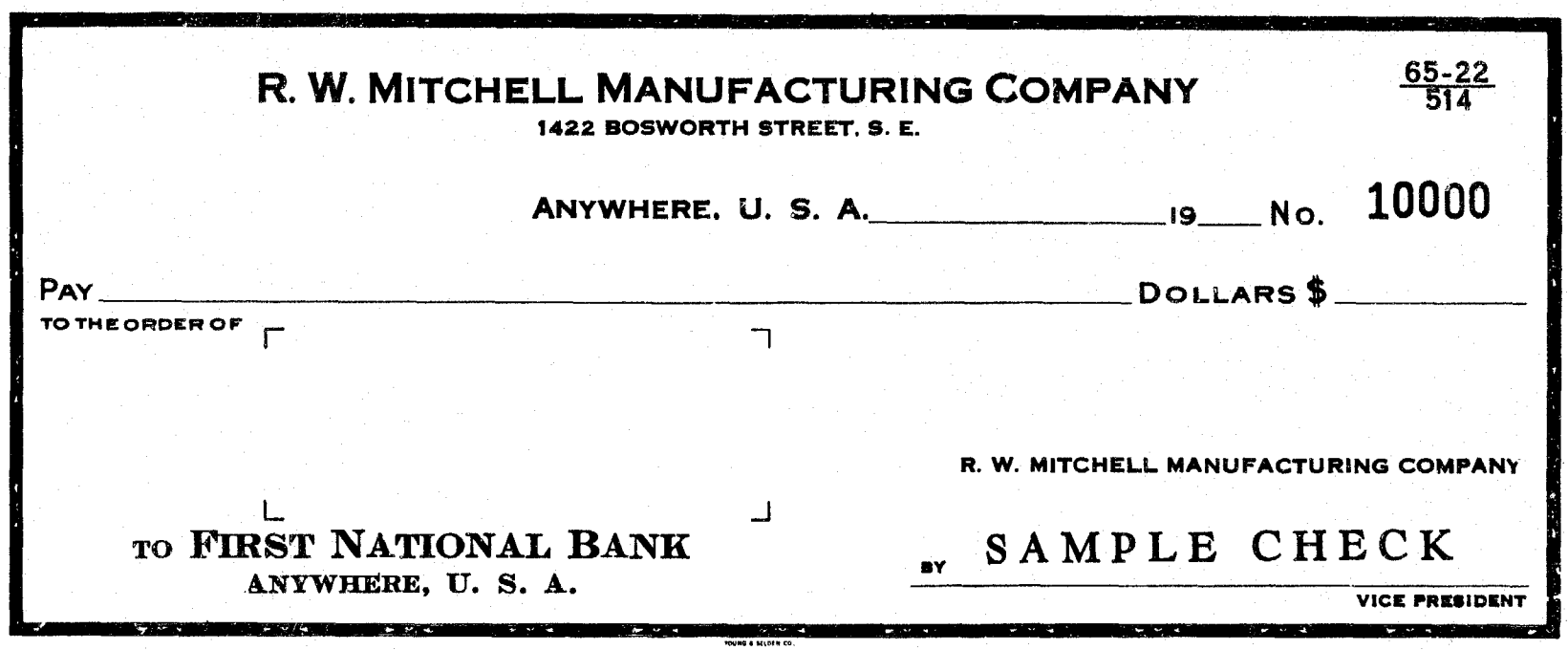
INDICATE BELOW THE USE OF MATERIALS

☐ 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



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 has 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. 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?

BIBLIOGRAPHY

Textbooks

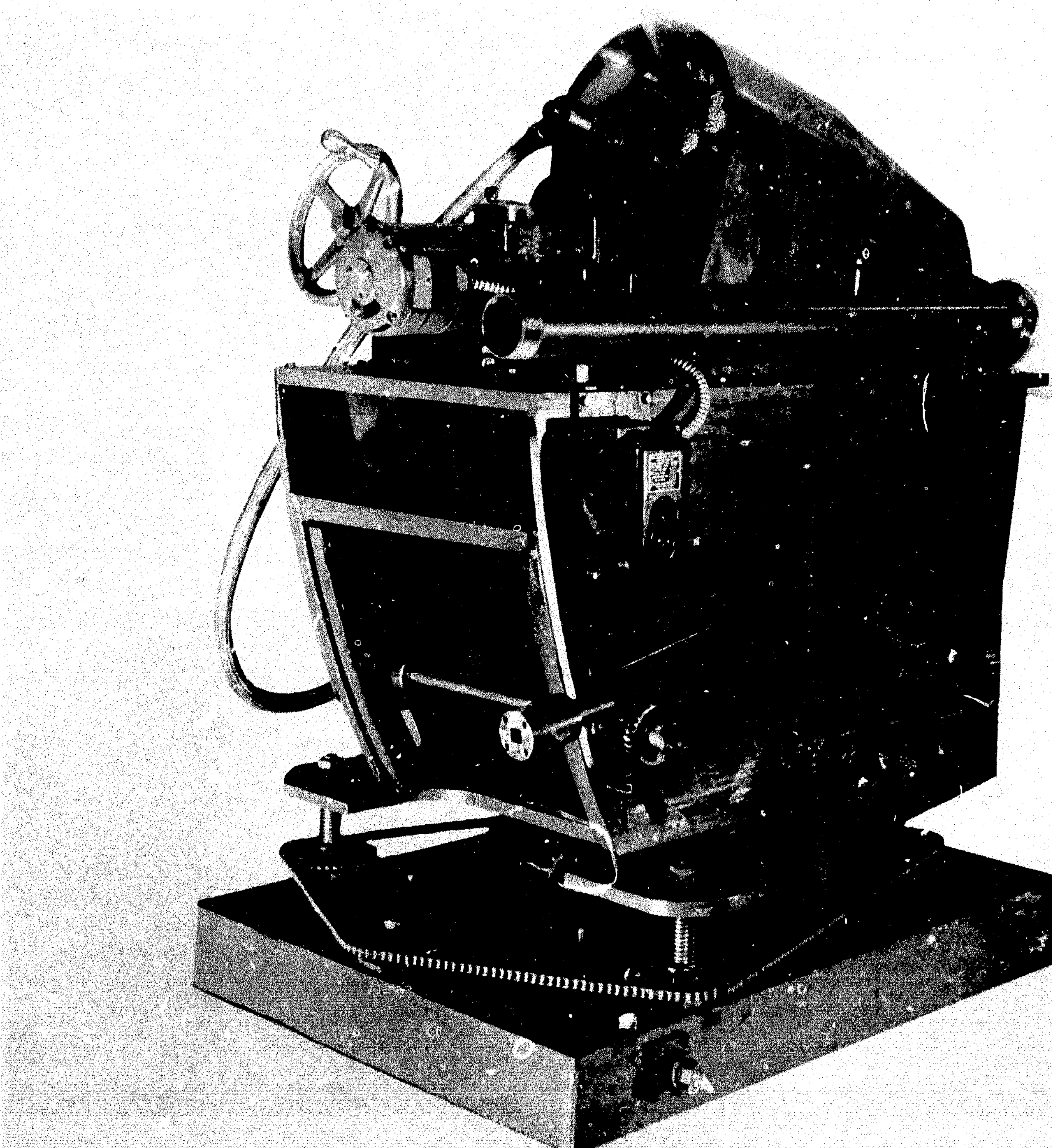
Modern Glass Practice	Industrial Publishers 59 South Wabash Avenue Chicago, Illinois
Properties of Glass	Reinhold Publishing Company 430 Park Avenue New York 22, New York

Periodicals

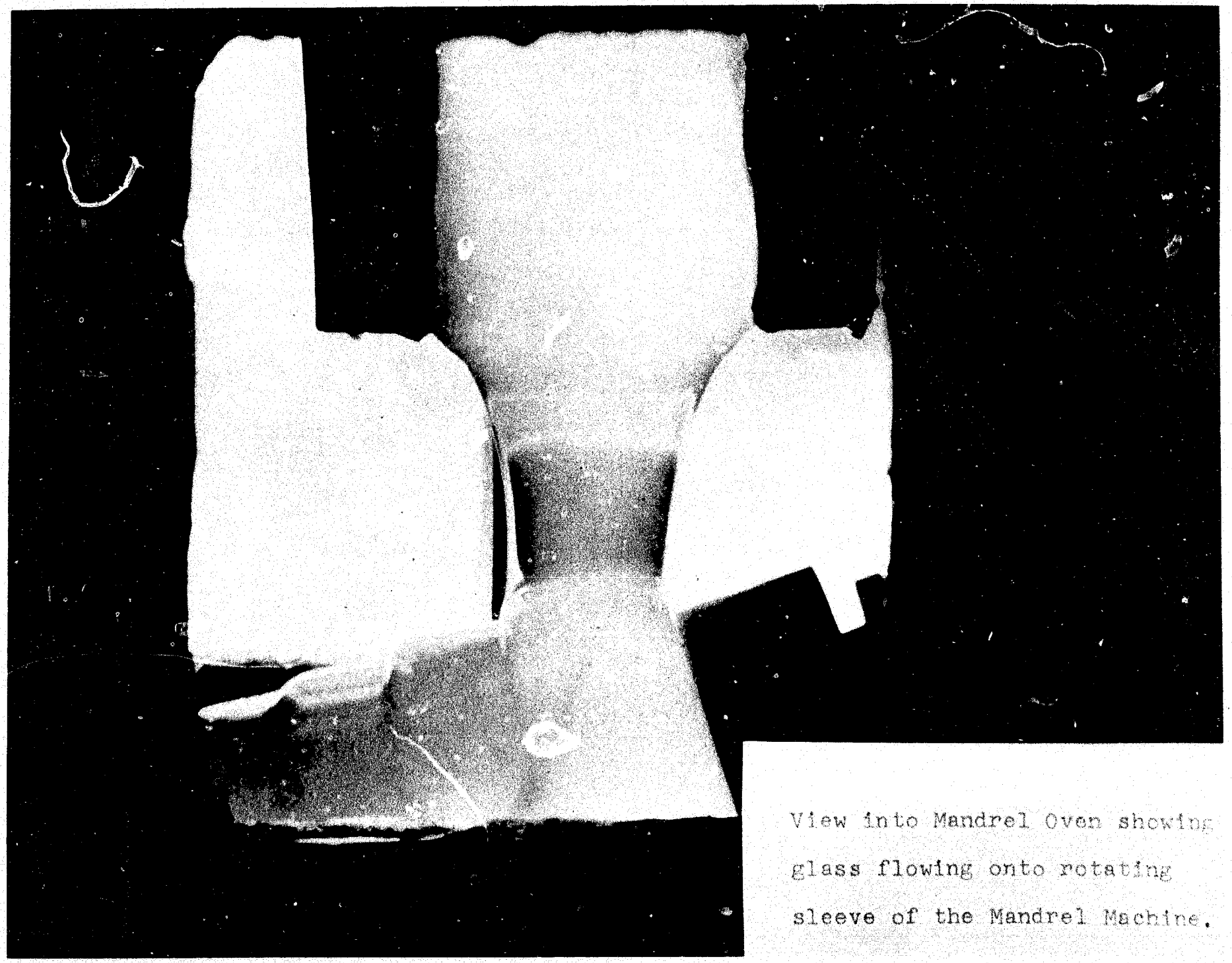
Glass Industry	Ogden Publishing Company 52 East 42nd Street New York 6, New York
Glass Design	Ashlee Publishing Company, Inc. 130 West 57th Street New York, New York

ABBREVIATIONS

$^{o}F.$	Degree Fahrenheit
No.	Number

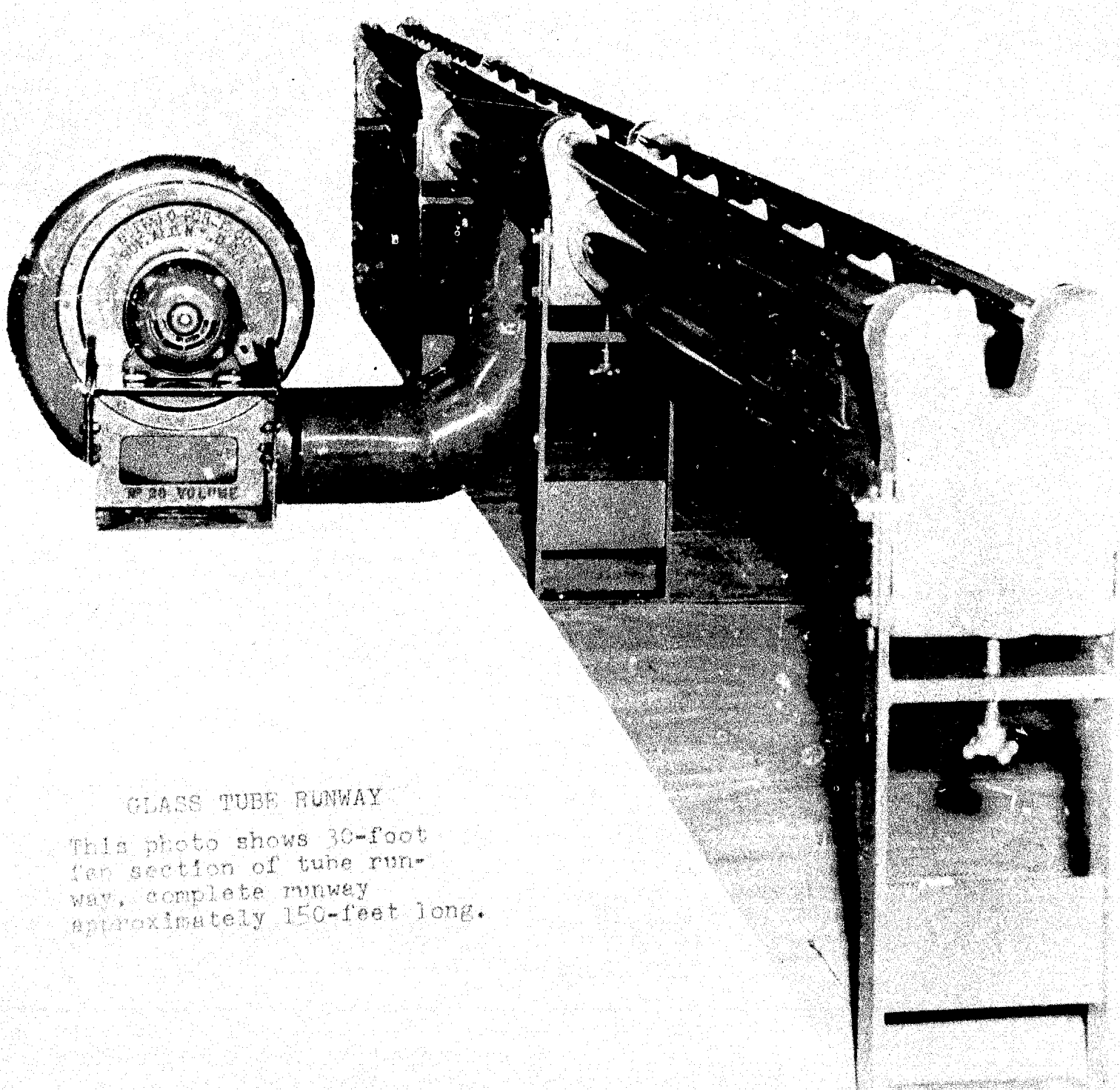


GLASS TUBE
MANDREL MACHINE



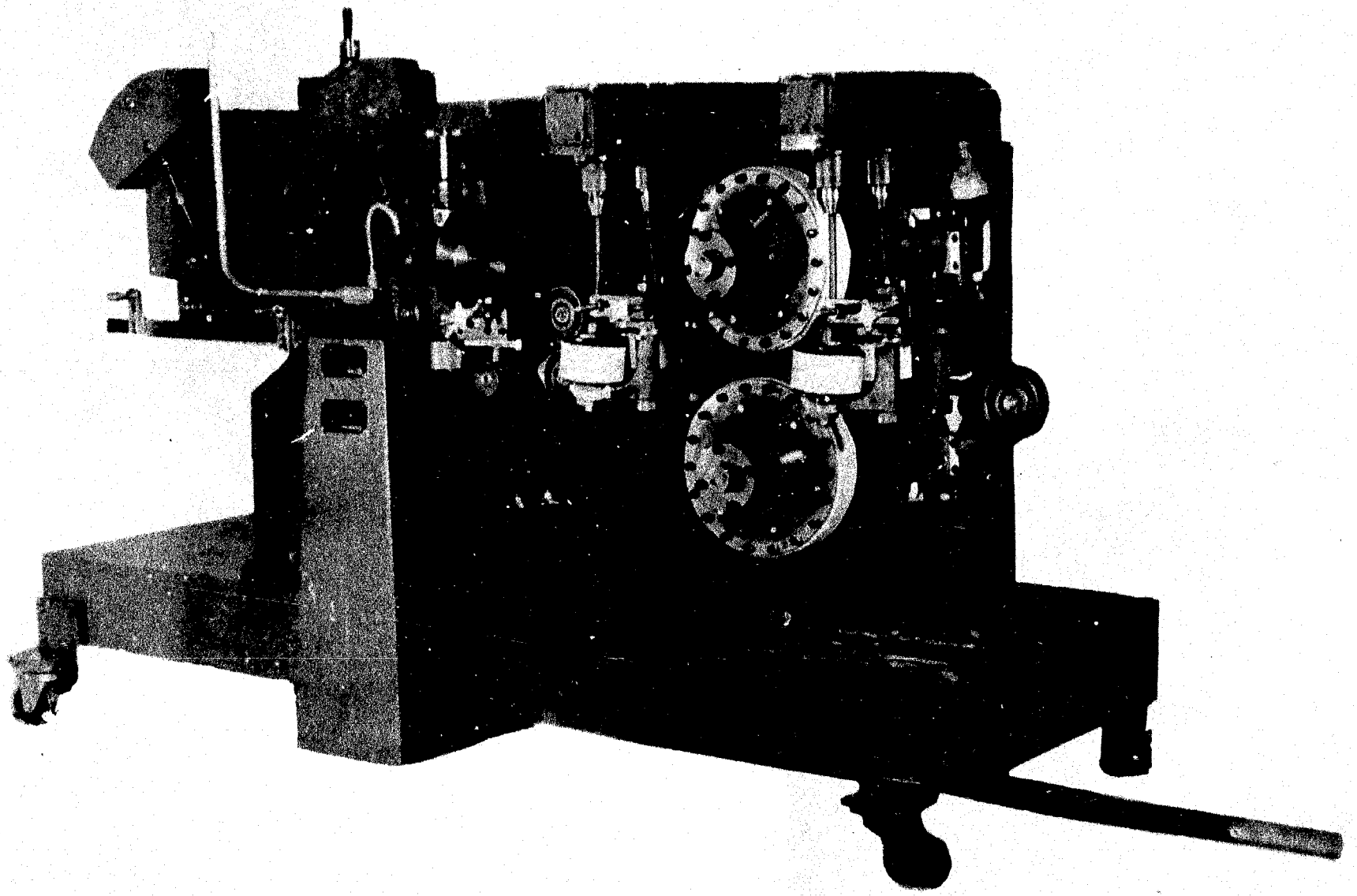
View into Mandrel Oven showing glass flowing onto rotating sleeve of the Mandrel Machine.

iew into front of
andrel Furnace, showing
lass tubing flowing from
delivery end of the
mantrel sleeve.



GLASS TUBE RUNWAY

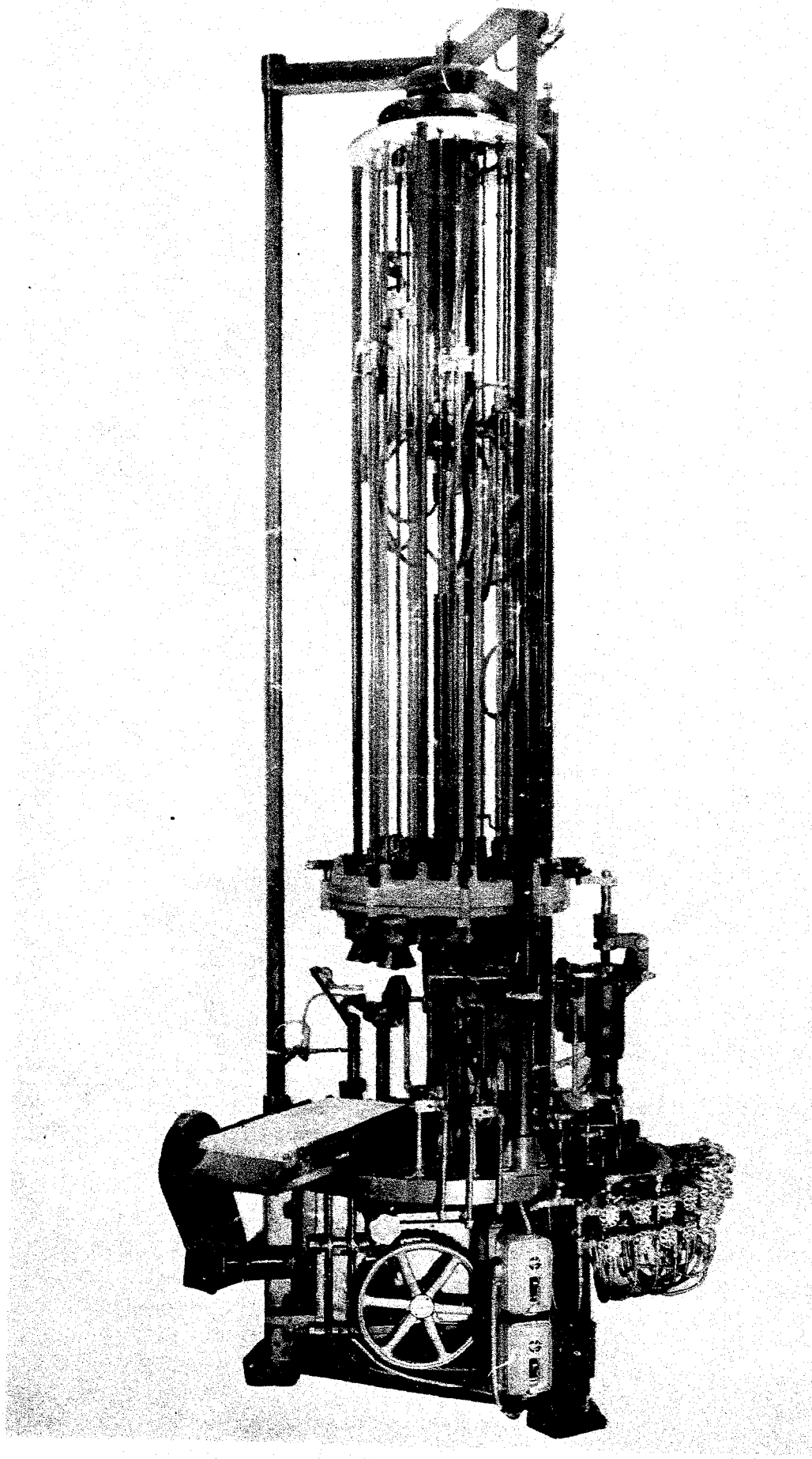
This photo shows 30-foot fan section of tube runway, complete runway approximately 150-feet long.



GLASS TUBE DRAWING MACHINE

Complete with Saw Type
Cut-off Unit

AUTOMATIC AMPOULE MACHINE



PLANT LAYOUT