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REQUIREMENTS FOR MANUFACTURE OF ALUMINUM ARCHITECTURAL SPECIALTIES

TECHNICAL AIDS BRANCH

INTERNATIONAL COOPERATION ADMINISTRATION

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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 Suburban Research Corporation, Gaithersburg, Maryland.

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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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ALUMINUM ARCHITECTURAL SPECIALTIES

This report presents information on total investment involved, machinery required, and manufacturing costs for establishing and operating a small plant to produce the following aluminum articles for the construction trade:

Sliding doors
Louver type windows
Windows of various types
Aluminum frames for picture glass doors
Show cases for stores
Doors for showers
Gutters and Down Spouts (also in copper)

Recommendation

A plant of 2500 square feet employing from four to six shop men under an owner-operator in a rented building can produce the products listed on a satisfactory basis with an equipment investment of about $10,000 and additional working capital of $20,000 by operating as a sheet metal assembly plant using stock sheets as raw material, with framing, rails, and stiffeners entering the assembly process as purchased shapes or extrusions and with decorative panels and hardware being purchased as finished parts.

Scope of the Question

The production of architectural specialties in aluminum includes a wide range of products and processes. All such specialties could not be produced in a single modest plant. The scope of this present discussion is limited, then, by practical considerations and by the nature of the original inquiry, to specific products for the construction trade and to such other products as may be produced with the same basic equipment and methods. A further requirement guiding the preparation of this report is the need for a plant of minimum outlay to be economically self-sustaining.

Materials and Processes

All of the products listed above, except copper gutters and down spouts, are assembled in aluminum from sheets and shapes. Shapes of light cross section can sometimes be formed from sheet, but decorative shapes of any thickness in common use and simple shapes such as angles and channels of heavier cross section cannot be made on light sheet metal equipment. Many shapes are made as extrusions and the only other method which could be used locally would be milling machine operations on solid bar stock at prohibitive cost. Accordingly, it is economical to buy such items in mill lengths of five to twenty-four feet as semi-finished inventory rather than to form them locally. Supply of such items in most areas will be found to be adequate. Foundry products, including hardware items such as door knobs, hinges, and decorative medallions and panels should also be treated as purchased items.

If these premises are kept in mind, the plant under discussion becomes a sheet metal fabricating plant with capacity to cut stock sheets and shapes, to form the sheets by bending in a variety of ways, and to assemble the resulting pieces into the products listed. Since only aluminum and copper in light gages are required for forming, the plant equipment investment can be limited to tools of low power requirements, as long as they are large enough to handle commercial sizes of raw material.

The processes the plant must be prepared to perform may be divided into breaking down raw materials by shearing sheets and by sawing shapes to length, forming of sheet materials by bending in a hand brake or press brake or by rolling, crimping, bending or lock-forming, finishing shapes by notching, drilling, welding or rivetting, and final assembly by welding or other suitable means. The process requirements determine the flow of work and the selection and placement of equipment.

A word of caution is in order with respect to inventory of shapes and other semi-finished material such as hardware. The shapes required may be classified by types, such as framing for doors and windows, but the number of such shapes commercially available are larger than the number it will be economical to inventory. The selection of the individual items to be carried in inventory by a particular shop will be sharply influenced by customers' requirements. Accordingly, inventory selection should be deferred until these customers' requirements have been clearly defined. The available shapes may be readily determined by contacting aluminum warehousing activities, if available, or by corresponding directly with importers or the major prime producers of shapes and extrusions in

the United States. Excellent technical advice and assistance are available from these suppliers who are listed in the last section of this report.

The welding process recommended, and for which equipment is provided in the following section of this report, is known by a variety of trade names in the United States. There are two basic types of arc welding employing inert gases, such as helium and argon, as a shield for the arc. The type best suited to the requirements under discussion is one which employs a tungsten electrode and accomplishes the weld by melting or puddling the pieces to be joined in the immediate area of the joint. If sufficient material is not available in the design of the pieces to permit sound welds by heat alone, additional material is added by introducing a filler rod of suitable composition to the field of the arc. Power requirements for the process include a high frequency oscillator which produces a low current to stabilize the arc for alternating current operation. This method, employing a tungsten electrode as a heating element only, is suitable for welding thin sections of aluminum as well as heavier sections. The other inert gas shielded arc method, employing a consumable electrode and direct current power equipment, is suitable only for heavier work having section thicknesses of one-eighth inch or greater. The tungsten electrode method is not as fast in terms of welding inches per minute in continuous operation, but the operating costs per hour are about the same for both methods and the gages of sheet material to be used in this plant clearly indicate the method to be chosen. Spot welding equipment, while not included in the present recommendation, should be kept in mind as a useful addition to plant capacity as the business grows.

Plant Equipment and Layout

The suggested plant layout utilizes a building 40' x 60' with a personnel door into the office and a single 12' overhead door in front for both shipping and receiving. Raw materials storage is provided next to the overhead door in racks for sheets and shapes. The materials break-down equipment, a radial saw for shapes and a shear for sheets, are each located conveniently to the stock materials storage areas. The notcher and the welder are positioned on either side of the saw for further processing of shapes after cutting. Adjacent to the shear, a hand brake and a press brake are located for forming sheet stock after cutting. The area immediately behind the cutting and forming sections includes two finishing tables and the slip rolls for making additional pieces within the capacity of that machine as may be required. Drill presses and a

hand bender for bars and shapes are located on the rear wall of the building behind the finishing tables. A long work bench with hand tools and a suitable assortment of small bench machines is provided adjacent to the finishing tables along the side wall returning to the finished inventory storage area. Many types of fittings can be fabricated here as a bench activity.

Down spouts and gutters may be purchased in mill lengths as semi-finished material and cut to length and partially assembled in the plant in accordance with the requirements of individuals jobs. Both gutters and down spouts may also be formed from sheet stock as a manufacturing activity within the plant using either the press brake or the hand brake. The choice is one of local economics. Most small shops in the United States rely on hand brake operations for these classes of products when prefabricated materials are not used. If the quantities of such products to be manufactured in each size or shape are sufficient, press brake operations with the required die costs may be warranted. Press brake dies are available in a very wide range of sizes and types for many kinds of applications and the ultimate investment of the plant in such dies will be substantially larger than the initial investment suggested. These dies have a long useful life over which to recover the investment, but it should be noted that they require proper care for satisfactorily working aluminum. Such dies must be lubricated in use and in storage and must be polished from time to time to maintain the surface appearance of the finished work. Die maintenance must not be neglected.

Recommended equipment, with appropriate costs:

1.	Squaring Shear, 8' x 18 gage, Foot Powered, w/precision back gage	$1850.
2.	Press Brake, 8' x 16 gage, 2 hp	3650.
3.	Dies for Press Brake	600.
4.	Hand Brake, 8' x 16 gage, w/molding forms	600.
5.	Slip Rolls, 2½" x 36", Hand operated	325.
6.	Drill Press, Floor Model, 3/4" capacity	350.
7.	Drill Press, Floor Model, 1/2" capacity	175.
8.	Radial Saw	300.
9.	Notcher, 6" Hand operated	175.
10.	Bender-cutter, Hand operated, rod & strip	375.
11.	Welder, inert gas (helium or argon)	1250.
12.	Bench Machines and Hand Tools	1350.
	TOTAL.	$11000.

Personnel Considerations

Personnel requirements for the proposed plant should receive the most careful consideration of the owner-operator. A minimum force would require a good mechanic as a working supervisor who must be skilled in inert gas welding techniques and in press and hand brake operations. A semi-skilled man could operate the shear, saw, and notcher in cutting materials to size. At least two helpers are required for handling sheets to the shear, for drill press operations, and for other operations requiring more than one man. A preferred plan for staffing the plant would involve hiring two mechanics, one as a working supervisor who would concentrate his direct labor efforts on set up, operation and maintenance of the press brake, hand brake, shear and slip rolls, with the other mechanic responsible for welding, sawing, notching and drilling. The supervisor would then be a sheet metal man, primarily, and the other mechanic would be skilled in all operations required to make up frames for doors, windows, show cases, and the like. The semi-skilled man is still needed and the helpers might be increased to three in number. A monthly cost estimate for such a preferred work force follows:

Working supervisor,	175 hrs. @ $2.20	$385.
Welder	175 hrs. @ 2.10	365.
Semi-skilled man	175 hrs. @ 1.60	280.
Helpers	520 hrs. @ 1.00	520.
	TOTAL.	$1550.

Capital Requirements

Capital requirements consist of land and buildings, production equipment, materials inventory, payroll and overhead for the time required to turn over operating money. The following breakdown of these elements must be regarded as illustrative, rather than absolute, and must be modified in terms of local currencies and conditions.

Land & Building, single story warehouse type, 2400 sq. ft. @ $6.50 per sq. ft.	$15360.
Machinery & equipment	11000.
Raw Material Inventory	4500.
Shop Labor, 2 months, 2000 hrs. @ $1.50	3000.
Overhead @ 80% of Shop Labor	2400.
TOTAL.	$36260.

The listed costs are based on turning operating money every two months, achieving six turns per year. Such management will only be possible if required materials are warehoused by others in the area and the customers are local customers who may be expected to pay promptly upon receipt of invoice. Changes from these conditions in any individual situation will have an impact on the actual operating money required. A more conservative view, reflected in the recommendation on the first page of this report, might be to assume three turns per year for operating money and to add a rental figure of $150 per month in order to permit use of the capital of others for land and buildings. The revised requirements would be:

Machinery & equipment	$11000.
Inventory, 4 months	9000.
Shop Labor, 4000 hrs. @ $1.50	6000.
Overhead, w/o rent, @ 80%	4800.
Rent, 4 months	600.
TOTAL.	$31400.

Manufacturing Costs

The recommended plant, on a rental basis with a work force of six men and an owner-operator, should be economically self-sustaining although it will not be the lowest cost plant which could be achieved with a somewhat larger capital outlay. An operation employing forty to sixty men, instead of four to six, can be equipped at a cost of approximately a thousand dollars per shop man with the most efficient tools and will show an operating cost figure for labor, material, and overhead in the amount of about a thousand dollars per shop man per month. Since about two thirds of this cost is in material, the efficiency of the operation is evident.

By comparison, a monthly cost forecast in detail is given for the initial operation recommended.

Shop Labor, 1000 hrs. @ $1.50	$1500.
Overhead @ 80% of Shop Labor	1200.
Rent	150.
Material fabricated	2250.
TOTAL.	$5100.

The operating cost per man in the shop on this basis is $5100 divided by six, or $850 per man per month.

The overhead figure includes the personal drawing account or salary allowance for the owner-operator and such items as heat, light, consumable supplies including welding materials, taxes, interest, office supplies and expense, and telephone. The percentage of shop labor allowed may be somewhat higher than will be needed in an individual case. As the business grows, the overhead rate should be watched with the purpose of reducing it until it might become 40% to 50% of labor and the rent figure should be considered a part of the overhead under discussion just as interest on other capital is an overhead cost. A larger building and a much larger work force will be required to achieve such overhead targets.

The sales volume produced in such a shop, at full capacity, is estimated at $85,000 to $100,000 annually - the variation reflecting a reasonable range in the product mix for a particular year. If the rent and other overhead factors are regarded as fixed in amount, the break-even point for the operation can be achieved with four shop men producing a volume of $60,000 - $65,000 annually. Profitable operation of the business suggests the additional work force recommended in this report.

References

Forming and Bending Kaiser Aluminum, a thorough discussion of technical considerations written in language suitable for general use, published by Kaiser Aluminum & Chemical Sales, Inc., 919 North Michigan Boulevard, Chicago 11, Illinois.

Welding Alcoa Aluminum, a text covering all phases of welding techniques in common use, with data tables, published by Aluminum Company of America, Pittsburgh 19, Pennsylvania.

Aluminum in Modern Architecture, Volumes I & II, pictorial presentations and architectural engineering information on the use of aluminum in buildings all over the world, written and published by Reynolds Metals Company, Louisville, Kentucky.

Architectural Aluminum, a handbook of shapes and alloys of aluminum and their architectural uses, by Reynolds Metals Company.

Wysong and Miles Company, Greensboro, North Carolina, manufacturers of sheet metal forming equipment.

The Peck, Stowe & Wilcox Company, Southington, Connecticut, manufacturers of "Pexto" brand of sheet metal brakes, shears, slip rolls, punches and hand tools.

Dreis & Krump Manufacturing Company, 7400 South Loomis Boulevard, Chicago 36, Illinois, manufacturers of "Chicago" brand sheet metal brakes.

The Lockformer Company, 4615 West Roosevelt Road, Chicago 50, Illinois, manufacturers of sheet metal flanging and seaming equipment.

Famco Machine Company, 3100 Sheridan Road, Kenosha, Wisconsin, manufacturers of shears, presses, saws, and drill presses.

O'Neil-Irwin Manufacturing Company, Lake City, Minnesota, manufacturers of light sheet metal processing equipment, including bench tools, under the brand name of "di-acro."

Buffalo Forge Company, Buffalo, New York, manufacturers of a line of single and multiple spindle drill presses.

Maplewood Machinery Company, 2634-38 Fullerton Avenue, Chicago 47, Illinois, manufacturers of roll forming equipment, hand and bench tools for sheet metal fabrication.

Whitney Metal Tool Company, Rockford, Illinois, manufacturers of a general line of power tools and hand tools for sheet metal and shapes fabrication.

De Walt, Inc., Lancaster, Pennsylvania, manufacturers of radial saws and woodworking tools.

Linde Air Products Company, a division of Union Carbide and Carbon Corporation, 30 East 42nd Street, New York 17, New York, manufacturers and distributors of inert gas shielded arc welding equipment and argon and helium gases, as well as other products.

The firms and products listed above are not to be regarded as a complete listing of sources for equipment and technical information. It is a representative list only and no endorsement of specific firms or products by inclusion in such a list shall be taken as expressed or implied. There

are many other firms in every equipment category who will be glad to be of assistance and consular and other economic representatives of the United States will assist in establishing suitable contacts with such sources.

In addition to the publications and catalogues of manufacturers listed above as references, private trade sources and consulting engineers skilled in the art have been of considerable assistance in the preparation of this report. The authors gratefully acknowledge their indebtedness.

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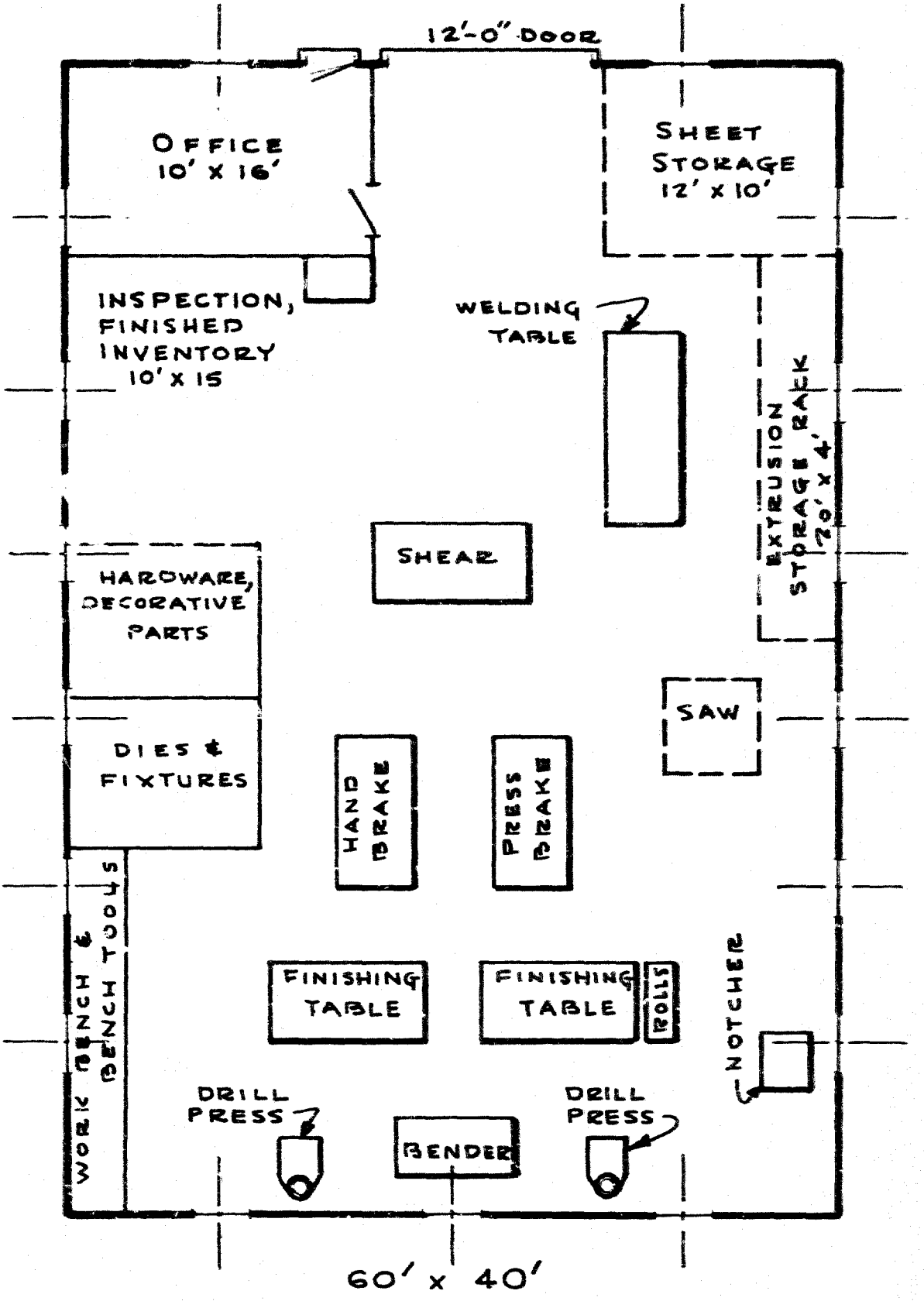
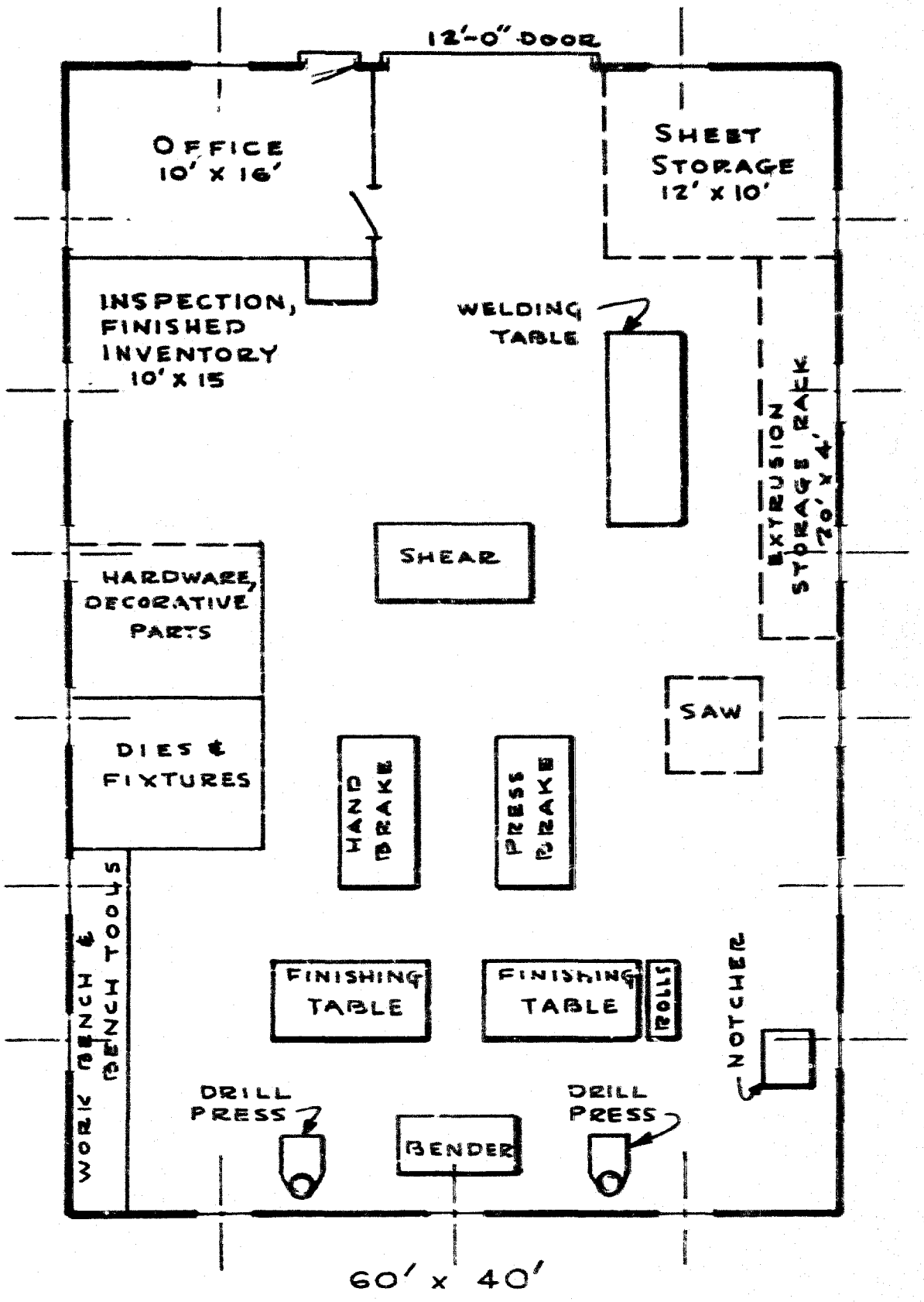
PLANT LAYOUT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