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PLANT REQUIREMENTS FOR MANUFACTURE OF REFRIGERATED WALK-IN COOLERS

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 Wolf Management Engineering Company, Chicago, Illinois.

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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.

Code Number
58

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REFRIGERATED WALK-IN COOLERS

HISTORY

The history of refrigeration cannot be written in terms of any one country, for its development is the result of the efforts of people of many nationalities. Methods of cooling were known to many ancient peoples. Earlier than 1,000 B.C. the Chinese harvested ice and stored it for later use.

Primitive man must have learned that his meat kept better in winter than in summer. Caves, wells, underground storage and spring houses were used as cool places for the storage of milk, butter and some dairy products. Other foods were preserved by salting, spicing or pickling, smoking and dehydration by drying in the sun.

In the nineteenth century, when it was realized that refrigeration was necessary for the proper preservation of food, the harvesting and storage of natural ice was introduced on a commercial basis. Efficient methods for harvesting natural ice from lakes, rivers, ponds and smaller streams were developed. Methods were introduced to lessen the loss by melting while the natural ice was stored in ice warehouses or used in refrigerated ships, railroad cars and other food transportation means.

The need for refrigeration brought the commercial cooler and the domestic ice box in which a separate compartment or container was filled with ice which kept the food storage compartment at a low temperature. The ice to fill these coolers and ice boxes had to be delivered to the customer from the natural ice storage warehouses. To effect this distribution in the urban areas, ice companies were organized with varying amounts invested in distribution and plant facilities, and these companies were supplemented by independent dealers and ice peddlers whose only capital might be a single wagon and team.

Even with the existence of large ice companies, the business was by no means stable, for during seasons of shortage, prices were prohibitively high, while in years when ice was plentiful business was demoralized by price wars. However, the ever increasing demand for refrigeration emphasized the need for the production of manufactured ice and, ultimately, the development and manufacture of mechanical refrigeration.

In the latter part of the nineteenth century, inventors devoted their attention to the problem of devising practical refrigerating machinery. Early refrigeration machines fell into two classes, those that used air, and those that used some material which could be vaporized and liquefied alternately.

Machines employing air as a refrigerant were called compressed-air, or cold-air machines, and though they played a significant role in the history of refrigeration, the vastly more important machines were those using refrigerant liquids capable of being alternately vaporized and liquefied. These machines utilizing the vapor-compression system, called compression machines, were the design upon which numerous improvements were made, finally resulting in the mechanically refrigerated cold-storage warehouses of the early twentieth century.

In the second quarter of the twentieth century, rapid strides were made in the development of the refrigeration units as we now know them. Demands for refrigeration grew because of the increased knowledge of the advantages obtained in the cold storage of foods, medicines, blood plasma, etc. and because of the controlled cold essential in laboratories for certain types of research; in metal-working industries for preparing steel in the manufacture of precision tools and gauges; in storing annealed aluminum alloys; in blast-furnace operations to remove moisture from the air blast; in assimilating the climatic conditions required for testing airplane engines and electronic equipment, and numerous other applications in the fields of industry and research.

Improvements in refrigeration machines and refrigerants broadened the refrigeration industry and brought into being the design and construction of cold storage warehouses, refrigerated rooms, commercial coolers for retail and wholesale merchants, home-sized refrigerators, frozen food locker plants, artificial ice skating arenas, as well as the design and production of compressors, condensers, evaporators, valves, etc. used in the refrigeration industry.

GENERAL ASSUMPTIONS

In order to make realistic estimates, it has been necessary to use certain general assumptions. These are:

1. Material, equipment and machinery costs are based on 1956 prices in the United States.

2. Labor rates are those prevailing in similar manufacturing plants in the United States.

3. Adequate and suitable water, electrical, sewage and transportation facilities are available at plant site.

4. The plant will operate 22 eight-hour shifts per month, or 250 working days per year.

5. The necessary material, accessories and equipment are available in suitable quantities, quality and at proper prices.

6. The market is available or can be readily developed, and the time is favorable for starting the proposed enterprise.

MANUFACTURING

The subject of this report is the manufacture or fabrication of commercial or walk-in coolers (see Figures 1 - 5). It is intended to present the data in a form that a potential plant operator would find useful to consider before entering the business of making walk-in coolers.

Before undertaking the manufacture of walk-in coolers, the prospective investor is advised to have a complete administrative, operating and financial analysis made by a reputable firm of management engineers. This analysis would take into consideration local factors which would affect the operation.

The manufacture of walk-in refrigerated coolers, as outlined in this report, comprises the following procedures:

1. Preparing the design of the cooler.
2. Procuring materials and equipment.
3. Building the cooler box.

4. Assembling the walk-in cooler.
5. Painting and finishing the completed product.

Since walk-in coolers are built in a wide range of sizes, the cooler boxes will vary from 6 feet wide by 6 feet long by 8 feet high to 18 feet wide by 20 feet long by 12 feet high. All dimensions are outside dimensions. The size of the box depends upon the requirements of the customer as to space available, amount of storage desired, and the type of material or product to be stored.

The cooler box itself is constructed by first making the sides, top and bottom into panels similar to room walls insofar as sills, studs and cross braces are concerned. The design of the panel frame will be based on strength required as determined by the designer.

After the panels are completed, they are ready to be assembled into the cooler box. Since this assembly is done at the customer's place of business, the assembly cost is added to the base price of the walk-in cooler box. The usual charge for this operation is 35 cents per square foot of cooling surface.

It is found from previous experience in the United States that approximately 50% of the walk-in coolers which a manufacturer is called upon to build include the necessary refrigeration equipment. Because of the wide range of cooler box sizes, temperature to be maintained in the cooler, and kinds of material or food products to be stored, a specific refrigeration unit must be selected for each application. It is recommended that the manufacturers of refrigeration equipment be consulted, before purchasing the unit, to insure customer satisfaction and meet all requirements.

DESIGN SUGGESTIONS

As an aid to the operator of a plant fabricating walk-in coolers, general construction suggestions are set forth in this study.

The framework of the cooler, including all uprights, plates, studs and cross members, is generally constructed of clear, odorless, moisture-resisting, seasoned fir.

The interior lining, including the ceiling, and all outer surfaces are covered with clear 1-inch X 4-inch kiln-dried fir.

The exterior of the ceiling and the interior surface of the floor are usually 1-inch X 4-inch fir flooring.

All seams are finished with 1-inch X 3-inch trim strips with 2-inch X 2-inch finish strips at the ceiling joints. The floor is trimmed with quarter round, and the exterior is finished with 1-inch X 3-inch casings.

All exposed surfaces are finished with two coats of special, moisture-resisting, refrigerator shellac.

Where porcelain is desired as a facer, it is applied over the fir walls, not directly over the insulation and framework. (See Figure 3)

The practice in design and fabrication of walk-in refrigerated coolers is to have panel sections not over 12 feet in length. For example, a cooler that is to be 16 feet long by 10 feet wide by 9 feet high would be designed with the lengthwise side walls (the 16-foot sides) made up of two panels 8 feet long. These two panels would be bolted together and the bolt holes countersunk so as to make both the bolt head and the nut flush with the panel surface. (See Figure 6)

Generally, four inches of fiberglass are used as insulation with two layers of black, odorless, frost-proof insulating paper applied over the fiberglass. The over-all wall thickness measures 5-1/4 inches.

Standard entrance doors are 2 feet 6 inches wide and 6 feet high. The door framework and all exposed sheathing is clear, kiln-dried fir. Doors are insulated with 4-inch fiberglass. Both doors and frames are equipped with heavy jumbo gaskets. Door sills are heavy oak, covered with iron thresholds. All doors are 1-1/8 inch offset, overlapping. Service windows and locker compartment doors, when required, are 1-1/8 inch offset, overlapping and double gasketed with heavy air-tight gasketing. Windows are triple glazed with rubber seal glazing strips.

Main door hardware consists of three double ball-bearing, extra heavy forged brass hinges and one wedge type, cadmium-plated door lock. On other than plain storage coolers, all hardware is chromium plated.

Heavy angle iron wall stirrups and supporting ceiling rods are furnished with all coolers.

All coolers are equipped with flap-type, exhaust ventilator.

The following special interior appointments can be furnished at extra cost:

> An 18-inch wide fir, slatted display shelf, flush with the window opening, if any, and extending the length of the inside wall.
>
> Display meat rails with plated hooks.

Doweled platter rack, accommodating around 24 standard service platters, used primarily in market coolers.

Drip pans and drain baffles made of heavy gauge, copper-bearing galvanized iron insulated with 1-inch of solid cork-board.

Many special interior assemblies for specific commodity or use of the cooler.

In those countries where the rodent is a nuisance factor, walk-in cooler boxes are protected by putting a two-foot-high wire mesh screening around the bottom of the cooler box, both on the outside and on the inside.

Since walk-in refrigerated cooler boxes are fabricated in panel sections, all sections and parts are clearly marked for identification to facilitate proper installation in the field.

FABRICATION PROCESS AND FLOW CHART

The general procedure for building walk-in refrigerated coolers usually followed in manufacturing plants in the United States is outlined on the flow chart shown in Figure 7. Also shown in Figure 7 is a floor plan and machinery layout for good operating practices.

The rough lumber usually is stored in the rear of the building in piles according to the dimensions and type of lumber. Rough lumber usually is in random lengths.

The rough lumber is run through the planer or surfacer (see Figure 8) and surfaced to the desired thickness. At this point, the boards are still in random lengths. After planing, the finished boards are placed on a warehouse truck to be wheeled into position for feeding to the next operation.

In step two, the boards are cut to the desired length on the swing, or cutoff saw. (see Figure 9) Again the boards are placed on a truck and moved into position.

In step three, the boards are run through the table saw. (see Figure 10) In this operation, the boards are ripped to the desired widths. The warehouse truck again transports the boards to the following operation.

In step four, the boards are passed through the jointer machine (see Figure 11) where they are jointed and planed.

It is not necessary to run all the lumber through all steps of this procedure, as certain pieces are ready to be used in the frame after step two. For example, the 2-inch X 4-inch lumber is ready for use after it is surfaced on all sides and cut off to the specified length. Also, steps three and four can be omitted on the tongue and grooved flooring used for the exterior surface of the ceiling and the interior surface of the floor.

The radial saw (see Figure 14) because of the variety of operations that can be handled by it, is recommended for a manufacturing plant of this type. Such a saw can be used as a cutoff, or swing saw, as well as a rip saw, and can be used for these purposes when either the regular swing saw or table saw are overloaded with work or shut down for repair.

The uses to which the portable electric drills, saws and sanders are put and the benefits derived from their use need not be elaborated upon. They are indispensible in the woodworking trade. The portable electric impact wrench saves many hours of labor when used to drive the lag screws which hold the panel sections together. (Figures 12 to 16)

The finished pieces of lumber are placed in a position handy to the erection floor where the panels are built. The building of the individual panels is step five and is made up of a number of operations. First, the base framework is built of 2-inch X 4-inch lumber. Upon completion of the frame, one side is covered by two layers of the moisture-proof paper, and the 1-inch X 4-inch siding is put on over the paper.

The frame is then turned over so that the side just completed is face down, and the fiberglass insulation is placed between the uprights which usually are spaced two feet apart, inside dimension. (The fiberglass insulation is obtainable in 2-foot widths.) After the fiberglass is inserted, this panel side is covered with two layers of the moisture-proof insulation paper, and the 1-inch X 4-inch siding is nailed on over the paper.

The panel now is complete and is set aside for delivery and final field erection. The cooler door is hung, and the desired interior appointments are installed. The finishing trim, inside and out, is added at the time of erection in the field.

The cooler panels usually are painted in the shop and, if necessary, retouched after erection.

ECONOMICS

Building Requirements

In temperate zones, the building costs would be nominal. Data from various plants of like capacity in the United States indicate that a building 50 feet wide by 100 feet long and 14 feet high is adequate for the manufacturing operations and storage of materials. This conclusion is based on producing a walk-in cooler box of an average size, that is, 16 feet long by 10 feet wide by 9 feet high, outside dimensions.

The cost of constructing a one-story, garage-type building of this size would vary with the materials used. For comparison, however, a building with steel roof beams, supported in the center of the building on steel columns and on the outer ends by the pilasters of the concrete block walls, would cost $4.25 per square foot. The building would have a composition roof.

The cost would include electric wiring for light and power, unit-type heaters, separate office space, glazing, painting, etc.

50 feet by 100 feet = 5,000 square feet
5,000 square feet @ $4.25 = $21,250.00

Equipment Requirements

A similar economically-operated plant in the United States would show an annual production of approximately 84 walk-in coolers of the average size previously mentioned. Experience shows this production would be equally divided between cooler boxes with refrigeration and those without refrigeration.

As previously stated, they are built in a wide range of sizes, but over a year's period an average sized unit can be selected to be used as a basis for cost analysis. The cooler used in this study is 16 feet long by 10 feet wide by 9 feet high.

The capacity of the cooling unit required will vary even in coolers of the same size, since the cooling capacity desired will depend on the temperature to be maintained, the item or product to be stored, and other controlling factors. Therefore, in this report, only walk-in coolers without refrigeration are used in the calculations. The manufacturers of the refrigeration equipment will recommend the capacity of the unit for each cooler.

When the cooler manufacturer orders the refrigeration unit, he handles this specification as he would any other item that is ordered as an extra, and adds the extra cost in his quotation to the customer.

A plant to produce approximately 84 walk-in coolers annually would require the following machinery and Equipment:

Item	Number Required	Size	Unit Cost	Total Cost
Saw, table	1	12" blade	$2,092.00	$2,092.00
Saw, cutoff	1	16" blade	863.30	863.30
Saw, radial	1	8" blade	1,095.00	1,095.00
Jointer	1	20" X 8'-0"	2,020.00	2,020.00
Planer-surfacer	1	16" blade	1,545.30	1,545.30
Drill, electric portable	1	1/4"	59.00	59.00
Drill, electric portable	1	1/2"	107.50	107.50
Saw, electric portable	1	7" blade	114.50	114.50
Wrench, impact portable	2	3/4" kit	198.00	396.00
Sander, belt	2	4" X 24"	150.00	300.00
Trucks, warehouse, lumber	4	36" X 60"	155.00	620.00
Total cost of machinery				$9,212.60

Note: Each carpenter provides his own hand tools.

Material Requirements

The prices of material and hardware items are the current prices in like quantities as now are quoted by similar manufacturing plants in the United States. The quantities of material and hardware items used in this study are the estimated amounts required for one month's operation cycle for the capacity of the plant herein considered.

Item	Unit	Unit Price	Quantity	Monthly Cost
Lumber: fir or birch (any similar local odorless wood)	Board foot	$0.125	16,373 f.b.m.	$2,046.63
Insulation: Fiberglass* 4" thick, 2'-0" wide	Square foot	0.10	22,064 f.b.m.	220.64

* Corkboard can be substituted for this insulation if economical.

Item	Unit	Unit Price	Quantity	Monthly Cost
Insulation: Corkboard, pure, solid, 1" thick	Square foot	$0.05	1,000	$ 50.00
Insulation: Paper, black, moisture-proof, odorless	Roll, ea. 500 square feet	2.40	22	52.80
Hardware	1 set/each cooler	54.01	7 sets	378.07
Steel	Pound	0.10	400	40.00
Shellac	Gallon	2.90	50	145.00
	Monthly total cost			$2,933.14

Based on an annual production of 84 coolers, material cost per cooler would be:

$$\frac{\$2,933.14 \times 12 \text{ months}}{84} = \$419.02 \text{ per cooler}$$

Direct Labor

Occupation	Hourly Rate	Number Required	Total Daily Wage
Carpenter	$2.65	7	$148.40

Total monthly direct labor based on 22 working days per month $3,264.80

Indirect Labor

Occupation	Hourly Rate	Number Required	Total Daily Wage
Superintendent	$ 3.50	1	$ 28.00
Office clerks	1.50	2	24.00
Janitor	.90	1	7.20
Total indirect labor			$ 59.20

Total monthly indirect labor based on 22 working days per month	$1,302.40

The labor cost per cooler is:

$$\frac{(\$3,264.80 + \$1,302.40) \times 12 \text{ months}}{84 \text{ coolers}} = \$652.46$$

Overhead

Depreciation
(Assuming no scrap value)

Item	Estimated Cost	Life Years	Yearly Depreciation
Building	$21,250.00	20	$ 1,062.50
Machinery	9,212.60	10	921.26
Office equipment	550.00	10	55.00
Total depreciation per year			$ 2,038.76

Overhead Expenses Per Year

Depreciation	$ 2,038.76
Telephone and telegraph	840.00
Miscellaneous expense	300.00
Power, light and water	624.00
Total yearly overhead	$ 3,802.76

Overhead expenses per cooler:

$$\frac{\$3,802.76}{84} = \$45.27$$

Unit Cost of Manufacturing

Item	Cost Per Cooler
Material	$ 419.02
Labor	652.46
Overhead	45.27
Total manufacturing cost per cooler	$1,116.75

Annual Manufacturing Cost

Cost figures based on an average sized cooler 10 feet wide by 16 feet long by 9 feet high, outside dimensions, are:

$$84 \times \$1,116.75 = \$93,807.00$$

Sales Revenue

The cost figures are based on an average sized walk-in cooler so the sales figures are on the same basis. The retail sales price quoted on a walk-in cooler box, as previously described, is $1,829.80, f.o.b. plant, knocked-down.

Annual sales volume would be:

$$84 \times \$1,829.80 = \$153,703.20.$$

Capital Requirements

Estimated Working Capital	
Inventory (3 months) $2,933.14 X 3	$ 8,799.42
Direct labor (3 months) $3,264.80 X 3	9,794.40
Indirect labor (3 months) $1,302.40 X 3	3,907.20
Selling, general and administrative (3 months) $896.60 X 3	2,689.80
Total estimated working capital	$25,190.82

Estimated Fixed Capital

Land	---
Building	$ 21,250.00
Production machinery and tools	9,212.60
Office and engineering equipment	550.00
Total estimated fixed capital	$ 31,012.60

Estimated Total Capital

Working capital	$ 25,190.82
Fixed capital	31,012.60
Estimated total capital	$ 56,203.42

Profit and Loss Projection

The following is an estimated profit and loss statement for one year's operation, based on the revenues and expenses estimated in this report:

Gross sales	$ 153,703.20
Less manufacturing cost	93,807.00
Gross profit on sales	59,896.20
Less controlled expense, selling, engineering and advertising expenses (estimated at 7% of gross sales)	10,759.22
Net profit (subject to deductions for taxes, insurance and miscellaneous expenses)	$ 49,136.98

CONCLUSIONS

It is apparent, on the basis of the conservative estimates presented in this report, that a plant to fabricate walk-in refrigerated coolers would be a profitable enterprise if all factors are as favorable as assumed herein.

It is to be noted that the walk-in cooler operation in this study would really be a jobbing plant making cooler boxes in sizes required by a variety of customers. Also, the cooler boxes would be produced with and without the refrigeration equipment. When the refrigeration equipment is included with the cooler box, it is handled as an extra cost item and is added to the retail sales price of the cooler box.

REFRIGERATION CONSULTANTS

Copeland Refrigeration Corporation, Sidney, Ohio

Curtis Manufacturing Company, St. Louis, Missouri

Brunner Manufacturing Company, Utica, New York

Frick Company, Waynesboro, Pennsylvania

Worthington Corporation, Harrison, New Jersey

Carrier Corporation, Syracuse, New York

Frigidaire Division, General Motors Corporation, Dayton, Ohio

York Corporation, York, Pennsylvania

Wolf Management Engineering Company, Chicago, Illinois

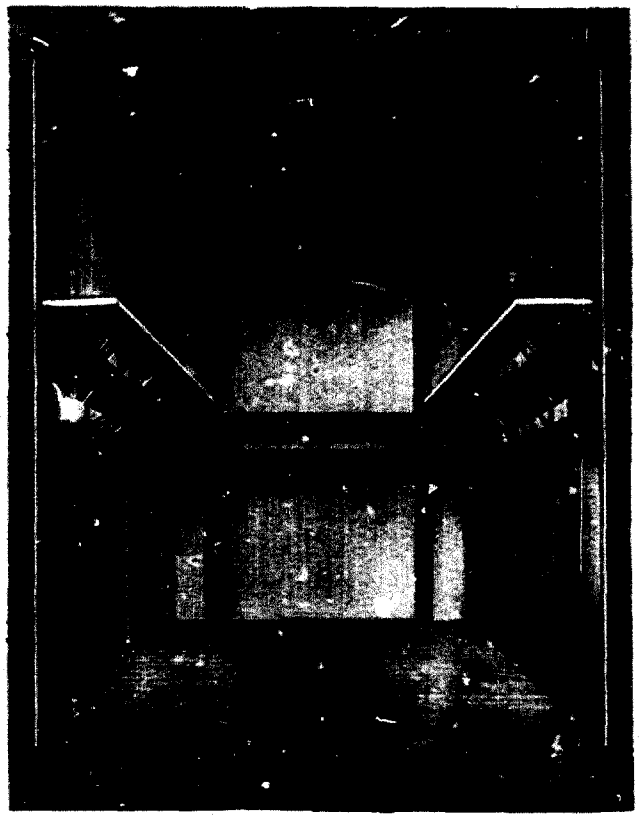

Figure 1
Typical Interior Meat Cooler

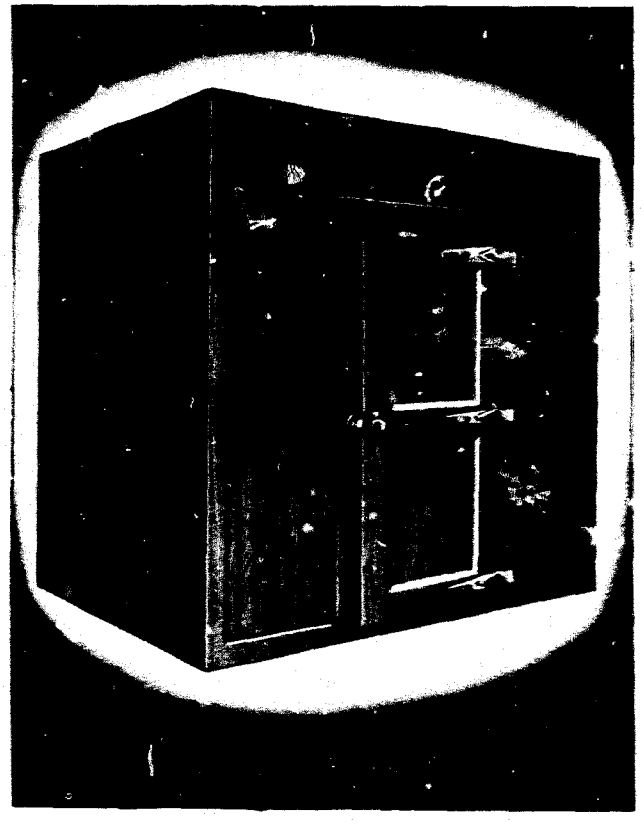

Figure 2
Typical Regular Cooler

Courtesy Bromann Bros.
Chicago, Illinois

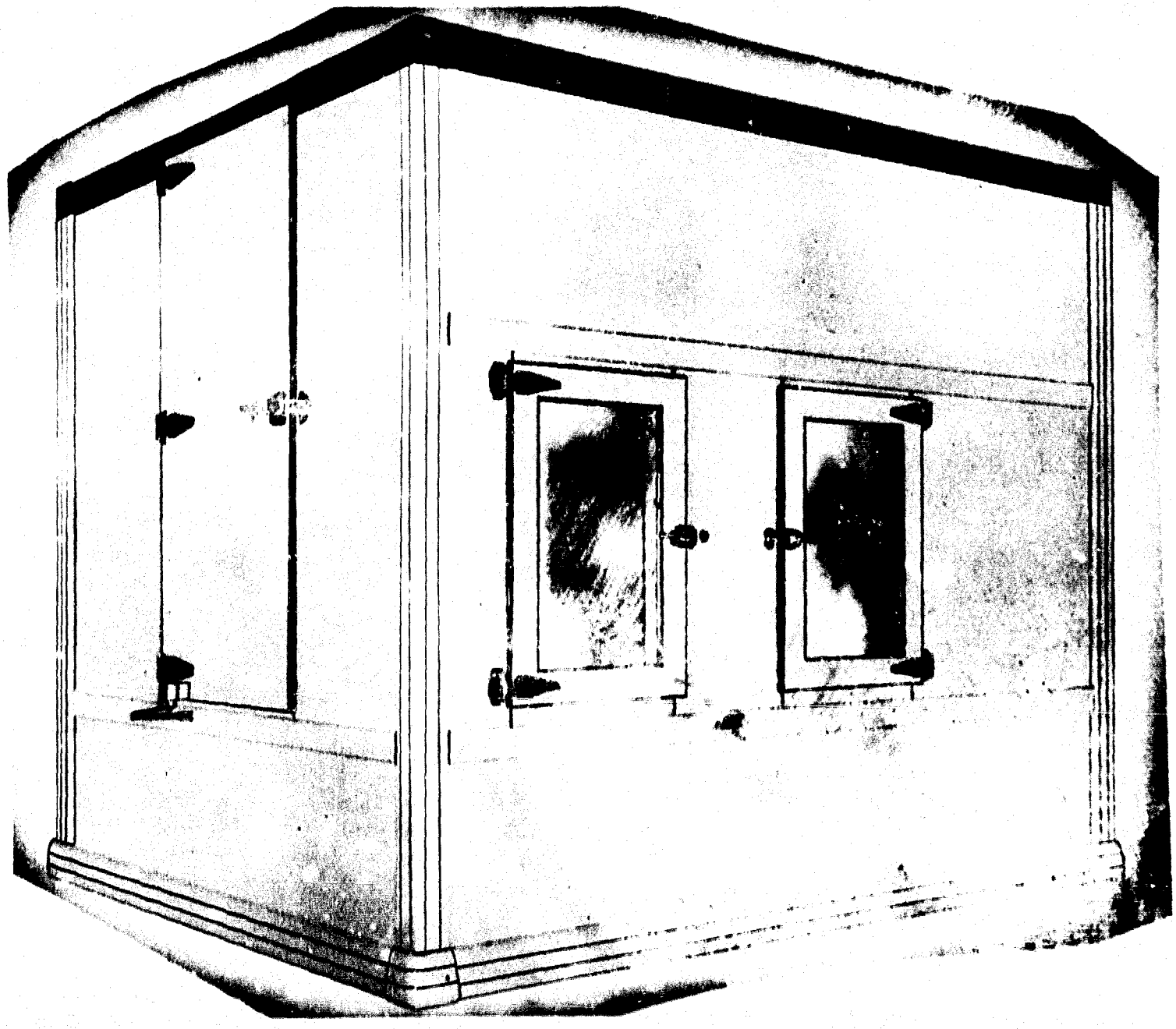

Figure 3
Typical Porcelain Finish Box

Courtesy Bromann Bros.
Chicago, Illinois

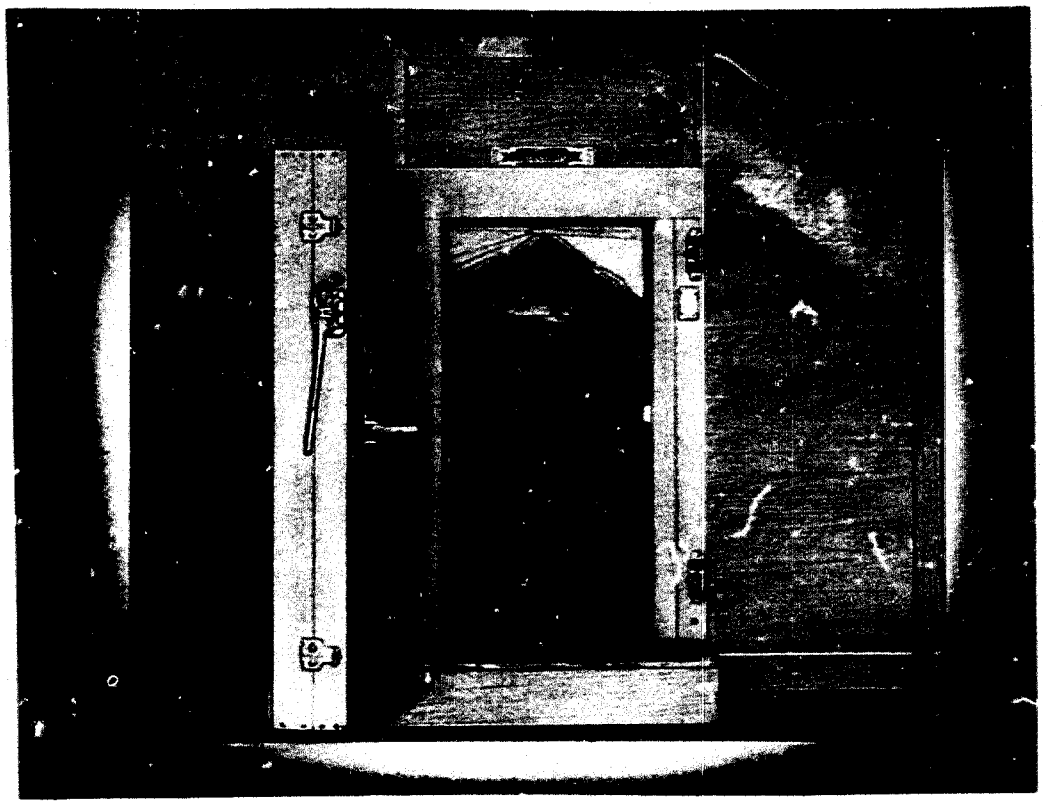

Figure 4
Typical Freezer Box

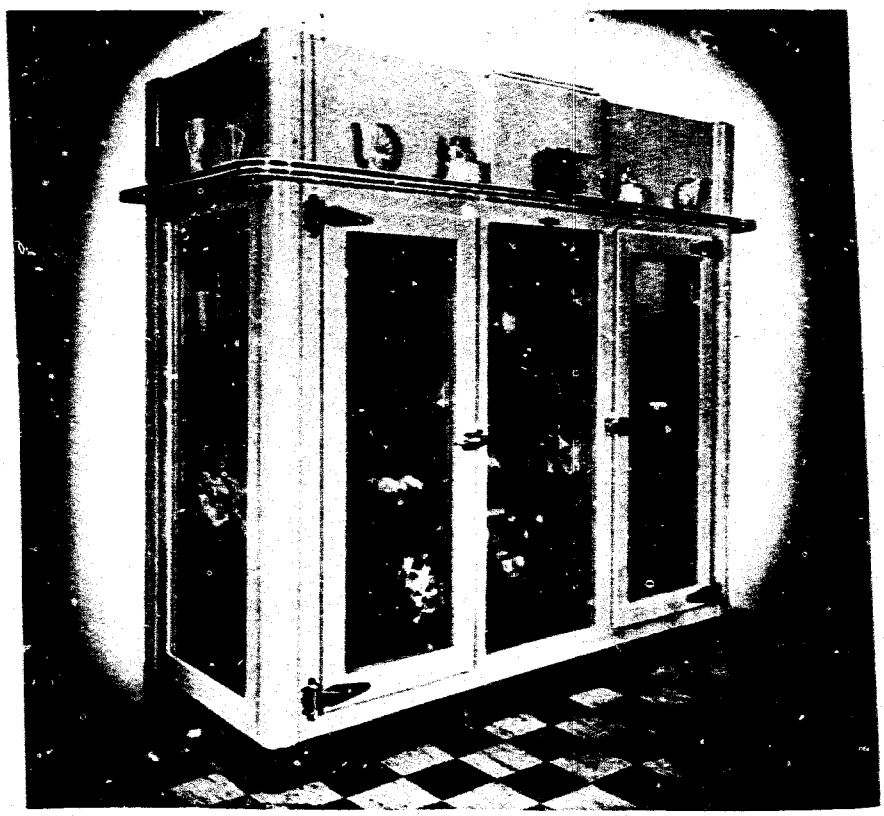

Figure 5
Typical Florist Box

Courtesy Bromann Bros
Chicago, Illinois

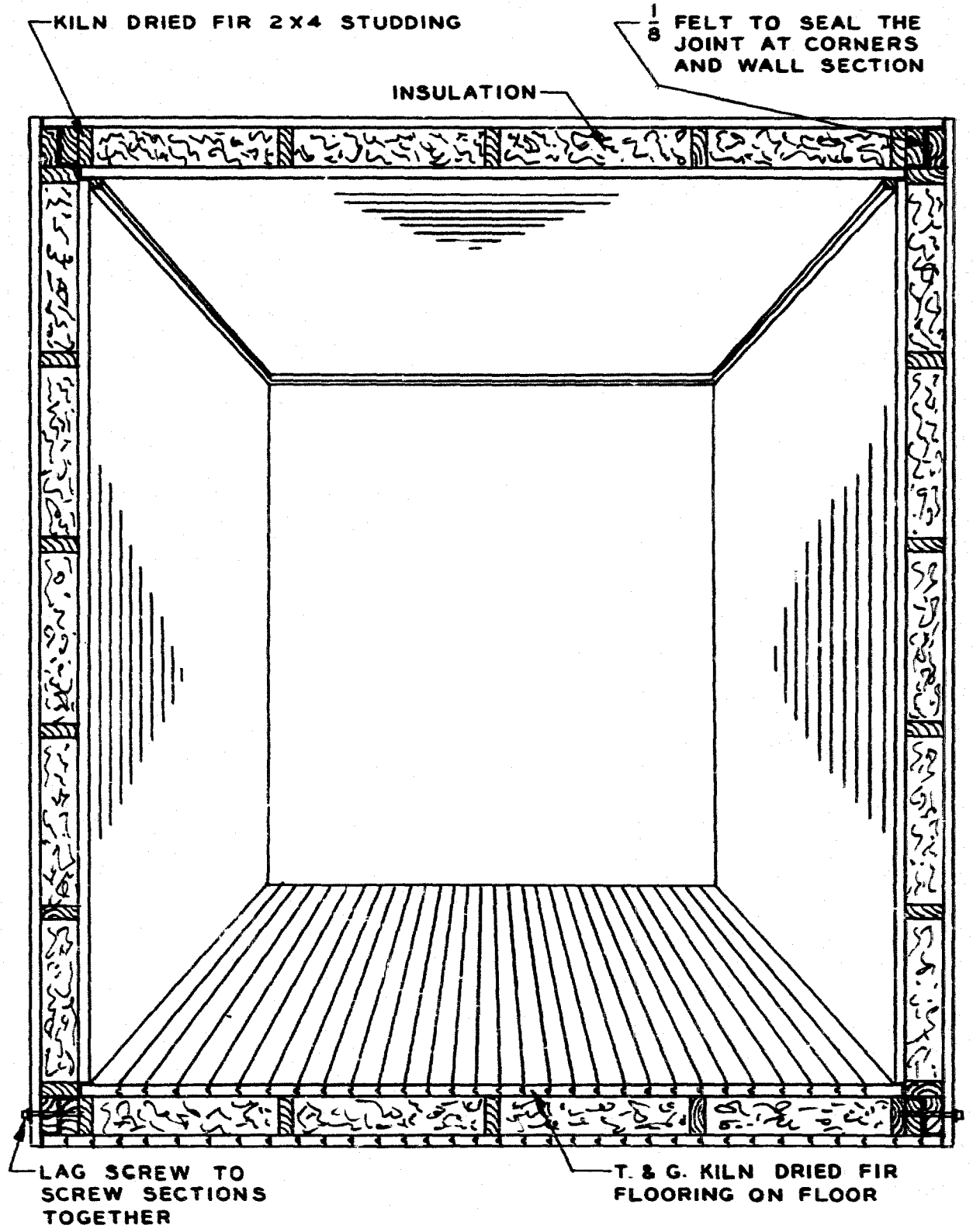

Figure 6
Panel Construction

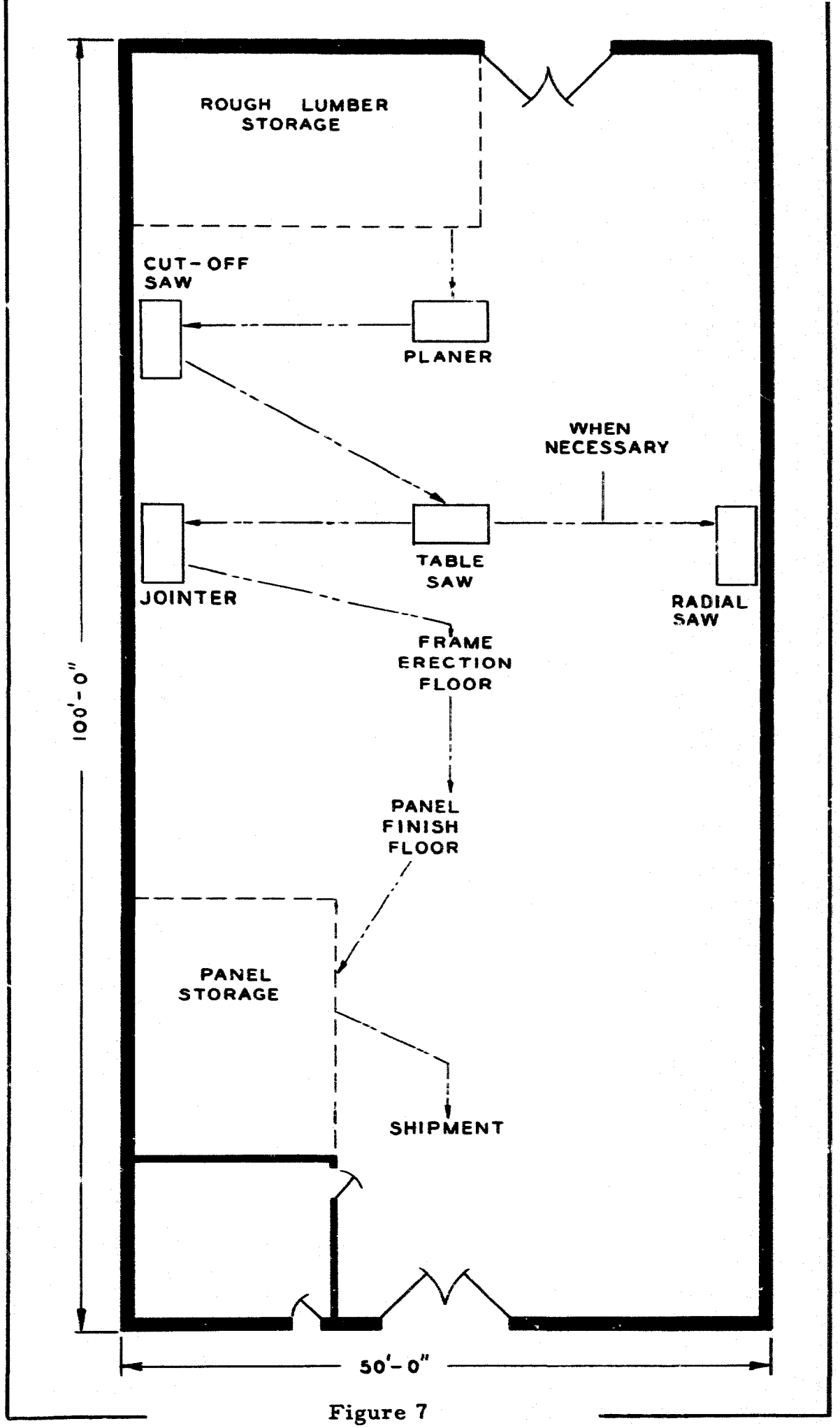

Figure 7
Flow Chart and Machinery Layout

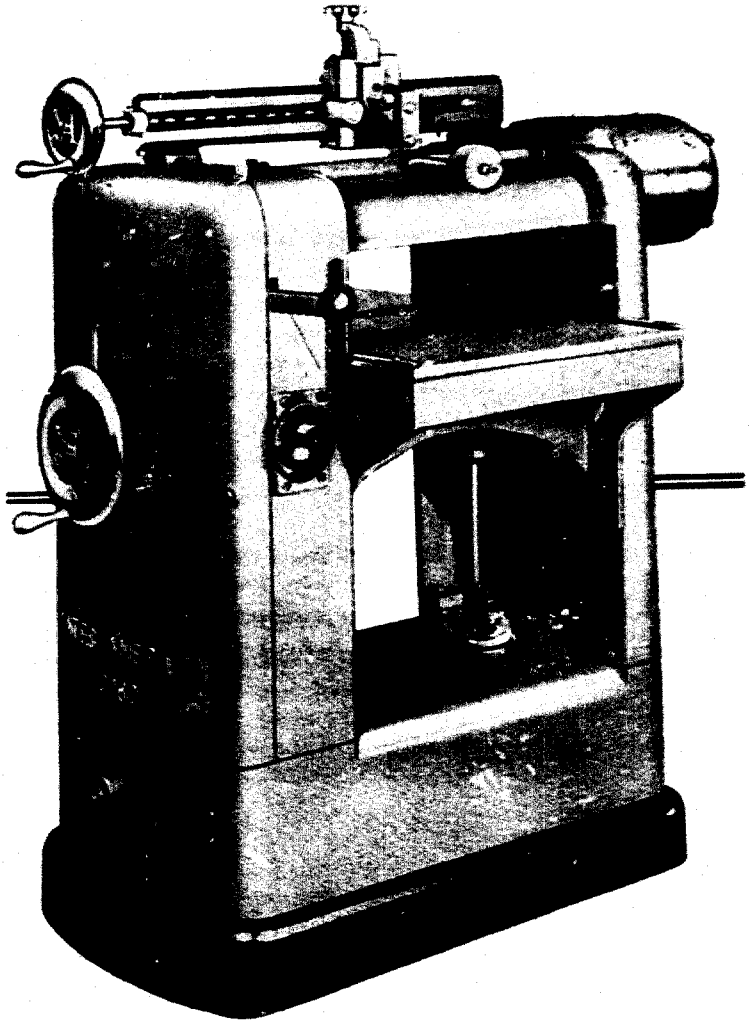

Figure 8
Typical Planer or Surfacer

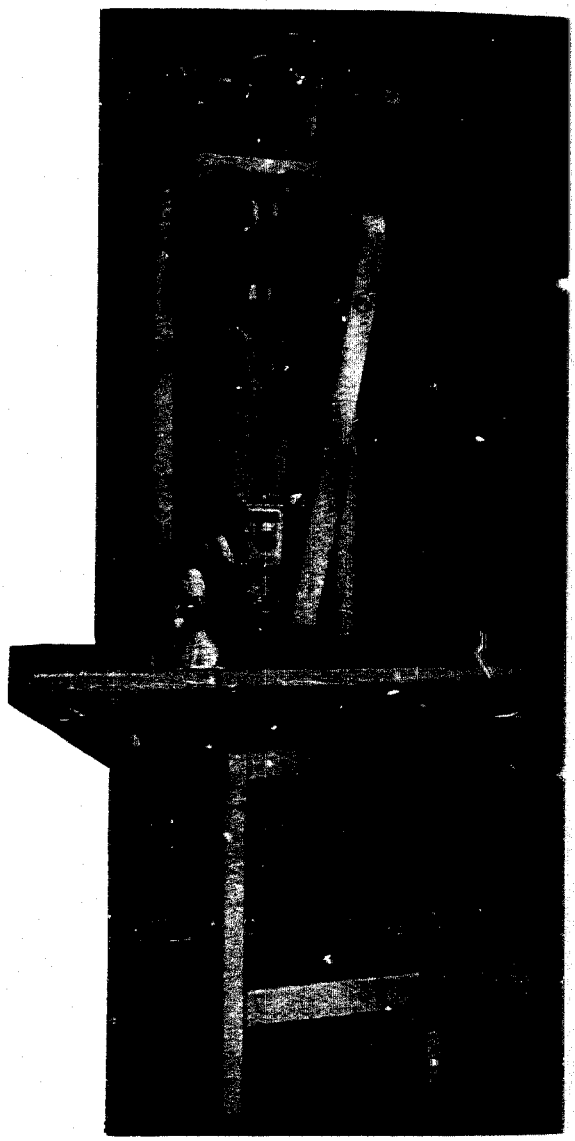

Figure 9
Typical Swing or Cutoff Saw

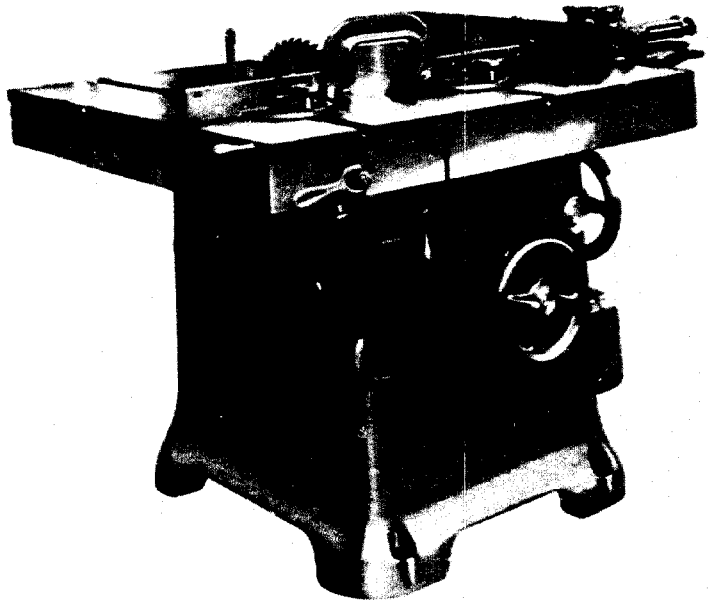

Figure 10
Typical Table Saw

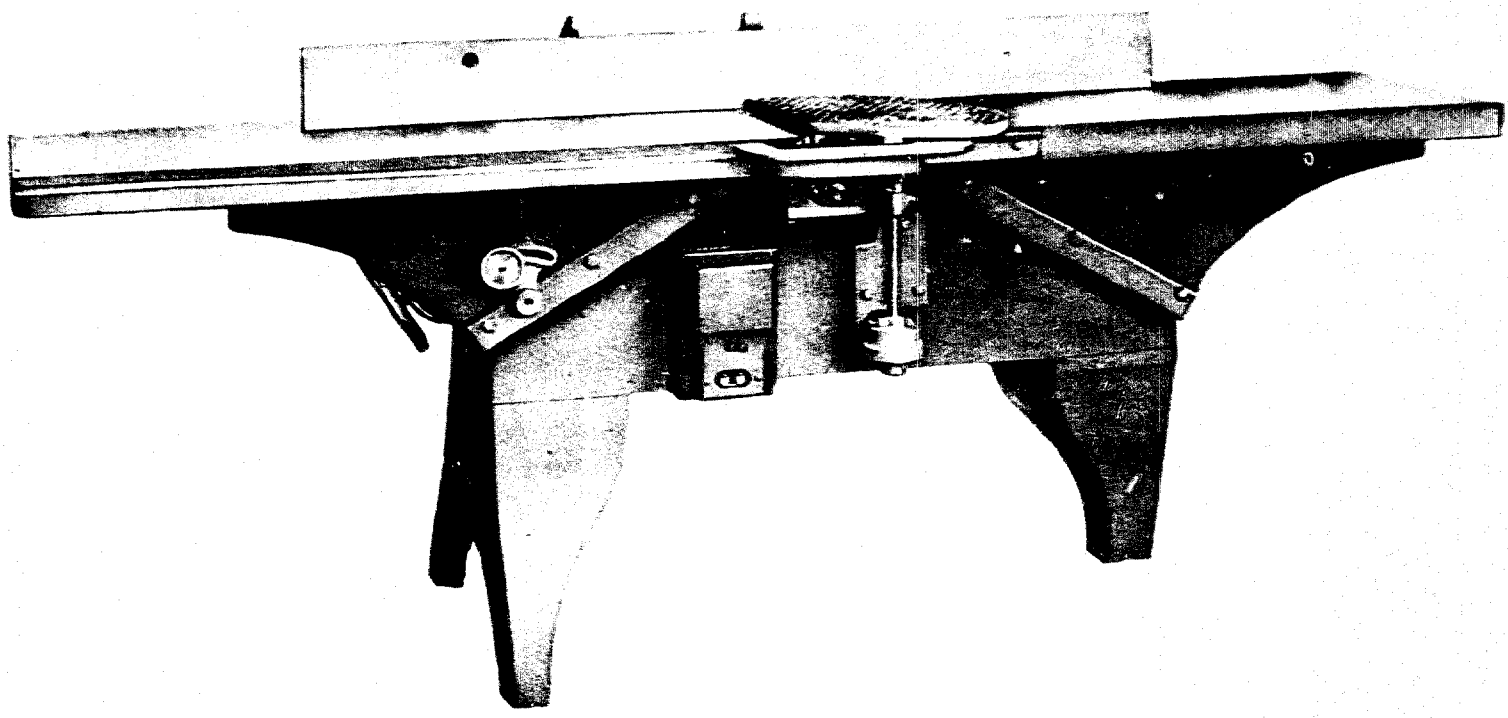

Figure 11
Typical Jointer

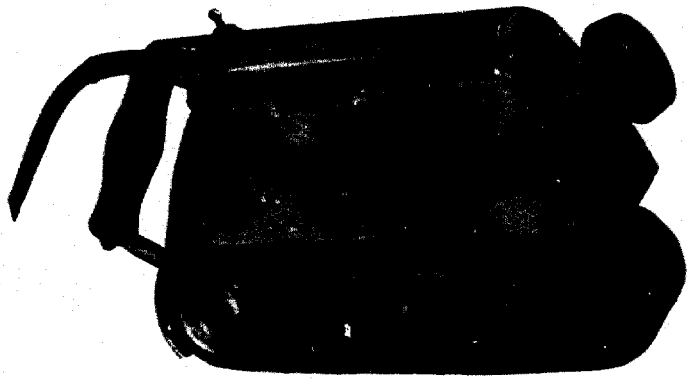

Figure 12
Portable Sander

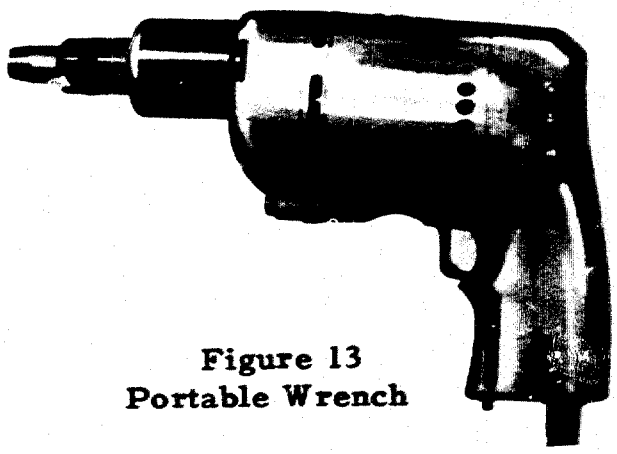

Figure 13
Portable Wrench

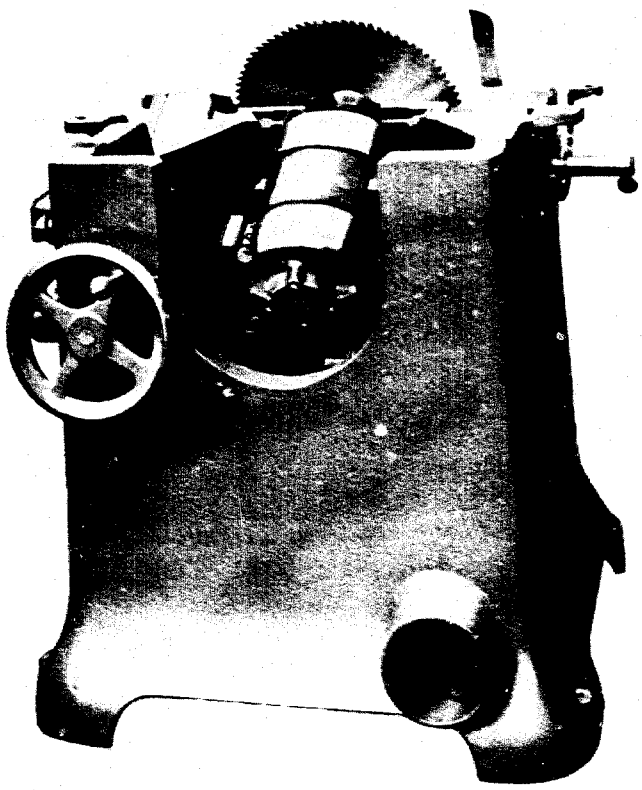

Figure 14
Typical Padial or Variety Saw

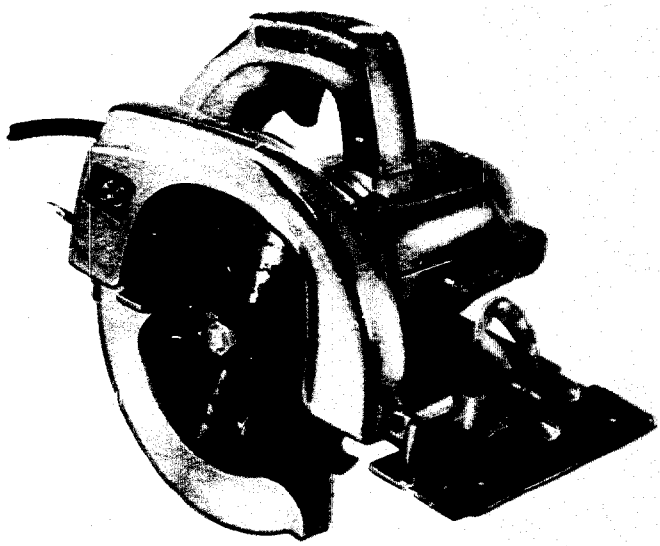

Figure 15
Portable Saw

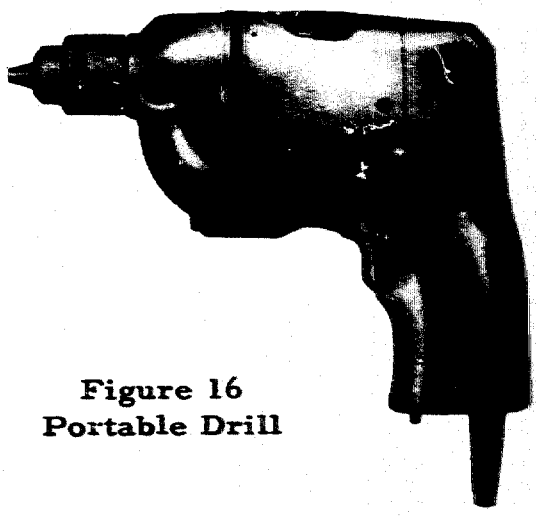

Figure 16
Portable Drill