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PLANT REQUIREMENTS FOR MANUFACTURE OF FARM HAND TOOLS

TECHNICAL AIDS BRANCH

INTERNATIONAL COOPERATION ADMINISTRATION

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FOREWORD

This manual is a revision of an earlier report of the same type issued in 1955. This revised version includes current costs of labor, machinery, equipment and materials, as well as additional information relative to organizing, financing, energy, markets, sales, financial and economic factors.

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This manual is designed to provide a general picture of the factors which must be considered in establishing and operating a small-scale factory of this type. It should prove useful in creating interest in the subject, and serve to give enough understanding of the related considerations to help government officials, other leaders and businessmen to determine whether the potential deserves more-detailed attention.

However, it is important to note that in most cases plans for the actual development and installation of a plant will require expert engineering and financial advice in order to meet specific local situations. For further information and assistance, readers should contact their local Productivity Center, Industrial Institute, Servicio, or United States Operations Mission.

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

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The original report was prepared by the Methods Engineering Council, Pittsburgh, Pennsylvania.

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TABLE OF CONTENTS

	Page
Introduction	1
General Assumptions	2
Product Specifications	3
Manufacturing Operations	3
Basic Operations	4
Manufacturing Unit Used	8
Direct Materials	9
Production Machines and Equipment	10
Tools and Equipment	11
Furniture and Fixtures	12
Plant Layout	13
Plant Site	13
Building	13
Power	13
Fuel	13
Water	13
Direct Labor	14
Indirect Labor	14
Supplies	15
Manufacturing Overhead	15
Manufacturing Costs	15
Depreciation	15
Working Capital	16

	Page
Fixed Assets	16
Capital Requirements	16
Sales Revenue	17
Recapitulation of Costs, Sales and Profits	17
Budget Control	18
Budget Control Accounts	18
Purchase Requisition	19
Voucher Check	20
Engineers	21
Training	22
Safety	23
Summary	24
Materials and Supplies	24
Market Factors	24
Export Markets	25
Marketing Problems	25
Economic Factors	26
Personnel	26
Laws and Regulations	26
Financial Factors	27
Financial Requirements of the Project	27
Short Term Bank Credits	27
Financial Plan	27

	Page
Summary	28
Bibliography	30
Abbreviations	30
A Helve Hammer	31
200 ton Forging Press	32
Farm Hand Tools to be Produced	33
Distribution	36
Alligator Shear	37
Radial Saw	38
Circular Saw	39
Special Lathe	40
Guage Lathe	40
Special Chucking Machine	41
Sanding Machine	41
Plant Layout General	42
Plant Layout	43

INTRODUCTION

This manual covers tools for the farm that are used through the application of human effort. It does not encompass farm implements that are operated through animal or mechanical energy.

The primary process used in the production of these farm hand tools in the plant discussed is forging. Basically the forging process is characterized by the application of energy to a piece of plastic metal. The energy applied may take the form of light but rapid blows as would be obtained from a small hammer; heavier and slower blows as would be obtained from a larger and heavier hammer; or squeezing or pressing as would be obtained from a hydraulic press. The metal is made plastic by heating it to a temperature of about 2200° F. Many ramifications of the forging process are in use, but the result of them all is to refine, compact, and flow-shape metal. The essential element in all such processes is to have the equipment used suit the need. This need is governed by such considerations as the quantity of production desired, the quality required of the product, the complexity of the shape to be formed, the amount of money available for investment in equipment, and so on.

Because the volume of production in the plant covered by this manual will not be sufficient to justify costly drop forging equipment and its accompanying expensive dies, the process of hammer forging by power hammers is proposed. A power hammer is illustrated in figure 1. This process is essentially the art of blacksmithing excepting that the muscle power of the blacksmith is replaced by electrically driven hammers. In addition some of the skill required by the blacksmith to form properly the article he is forging is transferred to the dies used in the power hammers. These dies have simple contours in them that tend to produce the desired shape automatically. Nevertheless, a fairly high degree of skill is required on the part of the hammerman who operates a power hammer. He must know how to use his equipment and how to manipulate the material he is working with in order to produce a part that is of acceptable quality. Furthermore he must be able to do so with no loss of effort or time.

In addition to power hammers, a mechanical forging press is also required to obtain uniformity in the shape of certain tools and to produce shapes that would otherwise be very difficult to obtain. A mechanical press of the type proposed is shown in figure 2.

The other operations and pieces of equipment needed in the proposed plant are discussed later in this report.

GENERAL ASSUMPTIONS

In order to make realistic estimates in this manual, 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 and on United States costs.

3. Labor costs are based on the average for the industry as recently published by 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 eight hours per day, 50 weeks per year. This is modified by bringing in preparatory help 1/2 hour early each day, (42 1/2 hours weekly).

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 methods and selling costs
   C. In-freight and out-freight
   D. Taxes

   While general estimates will be made of each of these items, for the purpose of completing cost estimates, adjustment should be made in accordance with actual local costs. In fact, all cost estimates contained in this manual should be adjusted to conform to local conditions.

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

PRODUCT SPECIFICATIONS

Ten agricultural hand tools have been selected as the items to be manufactured. These are sketched in figures 3, 4, and 5. They are shown complete with handles and ready for use. The sketches are dimensioned, with dimensions as close approximations. The metal portion of the tool will be forged in one piece from forging quality carbon steel ranging in carbon content from .35% to .75%. All handles will be made from No. 1 Grade White Ash or its equivalent in locally-grown lumber.

All tools except items 6, 7, and 10, (mattock, pick, and machete) are secured to their handles by means of bands forged as part of the working portion of the tool. Anchoring the handles in these bands is accomplished by rivets that extend completely through the band and are spun closed. The pick and mattock are designed to accept large-head handles that do not require anchoring. The machete will use a two-piece handle fastened by full-thru rivets. The D-handle for the round point spade will be assembled from two mild steel stampings and a short wooden dowel.

All metal parts will be lacquered in an opaque color while all handles will have a clear lacquer finish. These coatings will protect the tools as well as make them attractive.

The dimensions and shapes of these tools may be modified to a reasonable degree without affecting the required facilities materially or raising the cost of manufacturing them.

The tools are designed for hard service, and will be used principally on plantations, farms, orchards, and in industry. Home-owners may also buy tools of this type.

The customary lines of distribution in the United States for hand tools are shown in figure 6.

MANUFACTURING OPERATIONS

The manufacturing operations required to produce the tools are grouped into three general divisions:

1. Make blade of tool
2. Make handle for tool
3. Assemble blade and handle

The operations required for each of the above divisions are listed in table I.

Table I -- Basic operations for the manufacture of farm hand tools

Operation	Farm Hand Tool									
	Hay Fork	Digging Fork	Rake	Mattock Hoe	Planters Hoe	Mattock	Pick	Spade	Long Handled Shovel	Machete
Working Element										
Cut forging blank from bar	x	x	x	x	x	x	x	x	x	x
Heat and first draw blade	x	x	x	x	...	x	x	...	...	x
Heat and second draw blade	...	...	...	x	...	x	x	...	...	...
Heat and finish draw blade	x	x	x	x	x	x	x	x	x	x
Heat and draw handle band	x	x	x	...	x	...	...	x	x	...
Heat and form handle band	x	x	x	...	x	...	...	x	x	x
Heat and shape blade	x	x	x	...	...	...	...	x	x	...
Heat treat	x	x	x	x	x	x	x	x	x	x
Degrease	x	x	x	x	x	x	x	x	x	x
Grind	x	x	x	x	x	x	x	x	x	x
Lacquer	x	x	x	x	x	x	x	x	x	x
Handles										
Saw planks to length	x	x	x	x	x	x	x	x	x	x
Rip handle blanks	x	x	x	x	x	x	x	x	x	x
Season	x	x	x	x	x	x	x	x	x	x
Turn to shape	x	x	x	x	x	x	x	x	x	x
Round end	x	x	x	x	x	x	x	x	x	...
Sand	x	x	x	x	x	x	x	x	x	x
Cut in half longitudinally	...	...	...	...	...	...	...	...	...	x
Cut to length	...	...	...	...	...	...	...	x	...	x
Lacquer	x	x	x	x	x	x	x	x	x	x
Pierce rivet holes, blank, and form	...	...	...	...	...	...	...	x	...	...
Degrease	...	...	...	...	...	...	...	x	...	...
Lacquer	...	...	...	...	...	...	...	x	...	...

Table I -- Continued

Operation	Farm Hand Tool									
	Hay Fork	Digging Fork	Rake	Mattock Hoe	Planters Hoe	Mattock	Pick	Spade	Long Handled Shovel	Machete
Assembly										
Assemble D-handle and rivet	...	...	...	...	...	...	...	x	...	...
Drill rivet holes in main handle for D-handle	...	...	...	...	...	...	...	x	...	...
Rivet D-handle to main handle	...	...	...	...	...	...	...	x	...	...
Assemble handle to handle band or blade	x	x	x	...	x	...	...	x	x	x
Drill rivet holes in handle and handle band or blade	x	x	x	...	x	...	...	x	x	x
Rivet handle band or blade to handle..	x	x	x	...	x	...	...	x	x	x
Grind handle	...	...	...	...	...	...	...	...	...	x

In the manufacture of all these tools, the same general operations are carried out. First, the steel of the proper carbon content for the item to be made is obtained from the steel storage area. Depending upon the tool, the blank for producing a tool is prepared either by cutting off a length of material or by stamping a simple shape out of the material. In the first case an alligator shear is used such as is illustrated in figure 7. In the second case, the proper dies are put into the mechanical press of figure 2 and this machine is used.

These blanks are delivered to the forge furnace that supplies the first power hammer used to forge the blade of the tool. There they are placed in the forge furnace by the heater. When they have been heated to the correct temperature, the heater removes one with his tongs and passes it to the hammerman. He then places a cold blank into the furnace to replace the one removed. In the meantime the hammerman forges the blank until the metal becomes too cold or until the part is completely formed. If the part cannot be completely formed before the metal gets too cold, it must be reheated and forged some more. Some of the blades must be heated and forged five times while others can be formed in only three heatings. The volume of metal in the blade, the shape of the blade, and the amount of forging that must be done all combine to determine how many reheats are necessary.

When the blade and handle band (if there is one) are forged, the next step is heat treatment. This step is carried out to obtain the best physical properties from the steel. Without heat treatment, the blades would become dull too quickly, would bend, or would undergo some other undesirable physical change. Heat treating requires either a good deal of skill on the part of the operator or expensive equipment with automatic temperature and atmosphere controls. The first alternative has been selected for the plant under consideration. The heat treater heats the blade or a portion of it in a furnace similar to a forging furnace. When the metal reaches the proper temperature range -- as indicated by its color -- he removes it from the furnace and quenches or cools it in oil. A Brinnel tester is used to measure and control the results obtained in this operation.

Those blades that are quenched in oil must have the oil removed from them before further handling. This is accomplished in a degreasing tank containing a solvent for oil. Several blades are loaded into a wire mesh basket and, by use of a hoist mounted on a jib crane, the basket is immersed in the solvent. After remaining there for a short time, the basket is removed and the parts are allowed to dry.

Grinding on belt grinders is then performed to sharpen, point, dress, and clean up the metal blades. The amount of grinding required depends upon the blade. Some require relatively little, while others, such as the digging fork blade, require more.

After grinding, the blades and their handle bands are hung on a dipping fixture, dipped in lacquer, and set aside to dry.

The procedure followed in manufacturing the handles for the above blades begins when unseasoned lumber is received in rough-sawn planks. Planks of the correct thickness are sawed on a radial saw such as is shown in figure 8 into the lengths required to make the various handles. Then these short lengths are sawed lengthwise into blanks having the correct cross-sectional dimensions for the various handles. A circular saw is used for this operation. See figure 9. Before the blanks can be used, however, they must be seasoned. This is accomplished by stacking them in a structure with a roof but without sides so that air can circulate freely around them.

After two months of drying or seasoning, the blanks are taken to one of the handle-forming lathes illustrated in figures 10 and 11 and turned to the correct shape. If the handle requires a rounded end to make it more comfortable to use, this operation is performed by inserting the proper end of the turned handle into a special machine illustrated by figure 12. Revolving cutters in this machine automatically round the end.

The handles are next sanded on a sanding machine similar to the one in figure 13 so that they are smooth to hold and will not create blisters on the hands of the user.

A somewhat different process is followed to manufacture the machete handles. They are formed on a lathe in the same manner as the other handles excepting that several handles are formed on one blank. After sanding, all the handles on a blank are cut in half lengthwise. This operation is followed by sawing the half-blanks into individual half-handles. Then the half-handles are lacquered with clear lacquer. This is accomplished by dipping. Long handles are lacquered using the squeegee process. This process involves dipping the handles into lacquer and then wiping off the excess by pulling the handle through a hole surrounded by flexible rubber strips.

The short wooden portion of the spade D-handle is made in essentially the same way as the machete handle. However, the blank containing several individual handles is not sawed in half lengthwise.

The metal portions of this D-handle are produced by forming them in the 200-ton mechanical press. Although a small punch press could handle this work, it would mean purchasing an additional piece of equipment. Therefore, the use of the 200-ton press is proposed. After forming, the parts are degreased and lacquered in the same manner as the blades of the tools.

Assembling a handle to a blade to form a complete tool is accomplished by:

1. Forcing the handle into the handle band or positioning the handle halves to the blade.

2. Drilling the rivet holds in the handle band or blade and handle simultaneously.

3. Reveting the handle band or blade to the handle using a rivet spinner.

In the case of the spade, the D-handle is manufactured as a sub-assembly and then riveted to the main handle by the process outlined above. After riveting, the machete handle is smoothed by sanding or grinding.

With the exception of the machete, mattock, and pick, no packaging for shipment is required. The tools are tied together with cord in bundles of six and twelve.

The machete, mattock, and pick are, however, packaged. Machetes are packed in quantities of one dozen in cardboard cartons. Pick and mattock heads are packed in quantities of six per cardboard carton. The handles for these items are shipped separately tied into bundles of six and twelve.

MANUFACTURING UNIT USED

The manufacturing unit used in this manual is an individual tool. To determine the number of each type of tool to be produced, two things were taken into consideration. First, the comparative requirements for each type of tool, and second, the full loading of the 200-ton mechanical press. The quantities of each type of tool to be manufacturedd per week are listed below. If it is possible to limit the number of different items run during a week, greater efficiency of operation will, of course, result through decreased setups.

Item	Weekly Production	Annual Production	Actual
Hay Ford	885	44,250	_____
Digging Fork	83	4,400	_____
Rake	885	44,250	_____
Mattock hoe	442	22,100	_____
Planters' hoe	222	11,100	_____
Mattock	442	22,100	_____
Pick	442	22,100	_____
Spade	133	6,650	_____
Long-handled shovel	885	44,250	_____
Machete	885	44,250	_____
Totals	5309	265,450	_____

DIRECT MATERIALS

The direct materials required for the production of the above listed quantities of tools are given in table II, together with their costs. Steel and lacquer may have to be imported. Lumber, however, should be available within the country in which the plant is located.

Six dollars per hundred pounds has been used for estimating steel prices and ten cents per board foot for estimating lumber prices. Lacquer costs about $3.00 per gallon when purchased in 55-gallon drums.

Table II -- Direct materials required for one year's production

Item	Annual Production	Steel	Lumber
Hay fork	44,250	$ 3,300	$ 3,720
Digging fork	4,400	660	390
Rake	44,250	3,990	4,565
Mattock hoe	22,100	1,960	2,280
Planters' hoe	11,100	999	1,040
Mattock	22,100	8,980	4,510
Pick	22,100	7,980	4,510
Spade	6,650	1,197	320
Long-handled shovel	44,250	7,980	3,345
Machete	44,250	2,655	530
TOTAL STEEL AND LUMBER		$ 38,701	$ 25,210

Annual Cost of Steel	$38,701
Annual Cost of Lumber	25,210
Annual Cost of Lacquer, 1,309 gallons @ $3.00	3,927
	$67,838

PRODUCTION MACHINES AND EQUIPMENT

Table III

Description	Units	Installed Price Each	Installed Total Price	Actual Price Each	Actual Total Price
STEEL STORES AND CUTOFF					
½ Ton Crane	1	$ 12,000	$12,000	$_____	$_____
Bar Shear 2" x 2" stock	1	4,000	4,000	_____	_____
FORGE SHOP					
Forge Furnace	4	6,000	24,000	_____	_____
200 Ton Mechanical Press	1	20,000	20,000	_____	_____
200 Pound Helve Hammer	4	6,000	24,000	_____	_____
100 Pound Upright Helve Hammer	2	4,000	8,000	_____	_____
Forging Dies	35		14,000	_____	_____
Tongs	25	4	100	_____	_____
Platform Hand Life Truck	1	400	400	_____	_____
Skid Boses on Special Racks	36	125	4,500	_____	_____
GRIND CLEAN AND HEAT TREAT					
Belt Grinder - 2 belt	2	1,700	3,400	_____	_____
Heat Treat Furnace	1	7,000	7,000	_____	_____
Oil Quench Tank	1	200	200	_____	_____
Brinnell Tester	1	500	500	_____	_____
Degreasing Tank	1	500	500	_____	_____
Degreasing Basket	4	50	200	_____	_____
WOOD WORKING					
Radial Saw	1	700	700	_____	_____
Table Saw	1	600	600	_____	_____
Gauge Lathe	1	1,200	1,200	_____	_____
Special Lathe	1	1,800	1,800	_____	_____
End Rounder	1	300	300	_____	_____
Sanding Machine	2	400	800	_____	_____
Lumber Wagons	2	200	400	_____	_____
LACQUER AND ASSEMBLY					
Lacquer Dip Tank	2	200	400	_____	_____
1/2" Drill Press	1	200	200	_____	_____
Rivet Spinner	1	800	800	_____	_____
500 Pound Jib Crane & Hoist	1	1,000	1,000	_____	_____
TOTAL COST INSTALLED			$131,000	$_____	$_____

TOOLS AND EQUIPMENT

It is assumed that this plant will product most of its own forging dies and will maintain them and perform most of the maintenance work on the machines within the plant. To do so, a small but versatile tool room will be necessary. The equipment required for such a tool room follows.

Table IV

Description	Units	Estimate Price Each	Estimate Total Price	Actual Price Each	Actual Total Price
TOOL ROOM AND MAINTENANCE					
#2 Milling Machine	1	$14,000	$14,000	$_____	$_____
16" x 4' Lathe	1	12,000	12,000	_____	_____
8" Pedestal Grinder	1	225	225	_____	_____
10" x 24" Surface Grinder	1	6,000	6,000	_____	_____
#2 Morse Taper Drill Press	1	350	350	_____	_____
Oxy-acetylene Equipment	1	200	200	_____	_____
Inspection Equipment (micrometers, height gauges, and the like)	---	1,000	1,000	_____	_____
Jib Crane and Chain Hoist	1	700	700	_____	_____
Work Bench	2	75	150	_____	_____
Hand Tools, Cutting Tools	---	1,000	1,000	_____	_____
Typewriter	1	150	150	_____	_____
Adding Machine	1	125	125	_____	_____
TOTAL			$35,900		$_____

FURNITURE AND FIXTURES

Table V

Description	Units	Price Each	Total Price	Actual Price Each	Actual Total Price
Packing Bench	1	$ 100	$ 100	$_____	$_____
Storage Shelves, Racks, and Bins	---	---	600	_____	_____
OFFICE					
Typewriter	1	150	150	_____	_____
Adding Machine	1	125	125	_____	_____
Desks and Chairs	6	125	750	_____	_____
Filing Cabinets	5	75	375	_____	_____
TOTAL COST OF FURNITURE AND FIXTURES			$2,100		$_____

Production Machinery and Equipment	$131,000
Other Tools and Equipment	35,900
Furniture and Fixtures	2,100
TOTAL COST OF MACHINERY AND EQUIPMENT	$169,000

PLANT LAYOUT

Figures 14 and 14A illustrate the arrangement of the departments, the amount of space required by each and the location of the equipment.

PLANT SITE

To provide for eventual expansion, the land for the plant site should contain at least 30,000 square feet. The site should be level, well-drained, and should be located as advantageously as possible with respect to transportation, power, water, fuel, sources of markets and labor. The cost of such a site is estimated at $1,000.

BUILDING

A one-story building, 80 feet by 90 feet, or 7,200 square feet, will provide ample space for all operations, including an office. It may be constructed with any suitable building materials. It is estimated that the complete building, including adequate plumbing and wiring, will cost about $3.50 per square foot, or a total of about $25,200.

In addition, a lean-to without sides, about 80 feet by 40 feet, or 3,200 square feet, will be needed to store wood handle blanks for seasoning. The cost of the lean-to is estimated at $2.00 per square foot, or $6,400. Total cost of the buildings is estimated at $31,600.

POWER

About 780 kilowat hours per day of power will be required. Based on a cost of $.025 per kilowat hour, the annual cost of power for all purposes is estimated at $4,800.

FUEL

It is estimated that the fuel consumption for production, heating and sanitary purposes will amount to about $1,200 per year.

WATER

Water requirements for the purposes of production, heat, sanitary facilities, drinking purposes and fire protection is estimated at $300 per year.

DIRECT LABOR

Some employees will not be utilized full time on one type of work. For example, the two men assigned to the Steel Storage and Cut Off Department will be available part time to do material handling and janitorial duties; the 200-ton press operator and his heater will be available for miscellaneous duties during die changes excepting when they help to change the dies. The radial saw operator will also have sufficient time to operate the special lathe; the special machine for handling ends can be operated by the employees regularly assigned to the sanding machines; and one operator can be assigned to both the 1/2" drill press and the rivet spinner with additional assistance provided by the lacquer tank operator.

The hammermen and the heat treater are the only direct or indirect labor personnel needing a high degree of skill. These men should have experience in their work before they are employed in this plant. All other employees can learn their jobs in a relatively short time.

Department	Number Needed	Hourly Rate	Annual Payroll	Actual Payroll
Steel Storage & Cut off	2	$1.50	$ 6,000	$_____
Forging	12	2.00	48,000	_____
Heat Treat	1	2.00	4,000	_____
Heat Treat Helper	1	1.60	3,200	_____
Cleaning and Grinding	3	1.70	10,200	_____
Woodworking	4	1.70	13,600	_____
Lacquering and Assembly	2	1.70	6,800	_____
Materials Handling	2	1.50	6,000	_____
TOTAL	27		$97,800	$_____

INDIRECT LABOR

Department	Number Needed	Hourly Rate	Annual Payroll	Actual Payroll
Receiving, Finished Stores and Shipping	2	$1.60	$ 6,400	$_____
Tool Room, Maintenance and Setup	2	2.50	10,000	_____
Bookkeeper	1		5,000	_____
Secretary	1		3,000	_____
Forging Engineer	1		7,600	_____
Manager	1		10,000	_____
Watchman	1		3,000	_____
TOTAL			$45,000	$_____

DEPRECIATION

Description	Estimated Cost	Life Years	Estimated	Actual
Buildings	$ 31,600	20	$ 1,580	$_____
Production Tools and Equipment	131,000	15	8,733	_____
Other Tools and Equipment	35,900	10	3,590	_____
Furniture and Fixtures	2,100	10	210	_____
TOTAL ANNUAL DEPRECIATION			$14,113	$_____

SUPPLIES

Description	Estimated Cost	Actual Cost
Grease and Oil	$ 100	$_____
Sand paper, tools and bits	500	_____
Dies	3,000	_____
Maintenance Materials	2,000	_____
Office and Other	700	_____
TOTAL	$ 6,300	$_____

MANUFACTURING OVERHEAD

Description	Estimated	Actual
Indirect Labor	$ 45,000	$_____
Supplies	6,300	_____
Power	4,800	_____
Fuel	1,200	_____
Water	300	_____
Depreciation	14,113	_____
TOTAL	$ 71,713	$_____

MANUFACTURING COSTS

Description	Estimated	Actual
Materials	$ 67,838	$_____
Direct Labor	97,800	_____
Manufacturing Overhead	71,713	_____
TOTAL	$237,351	$_____

WORKING CAPITAL

Description	Estimated	Actual
Materials (60 days)	$ 12,080	$_____
Direct Labor (30 days)	8,150	_____
Manufacturing Overhead (30 days)	8,846	_____
Reserve Collections (30 days)	34,969	_____
TOTAL WORKING CAPITAL	$ 64,045	$_____

FIXED ASSETS

Description	Estimated	Actual
Land	$ 1,000	$_____
Buildings	31,600	_____
Production Tools and Equipment	131,000	_____
Other Tools and Equipment	35,900	_____
Furniture and Fixtures	2,100	_____
TOTAL	$ 201,600	$_____

CAPITAL REQUIREMENTS

Description	Estimated	Actual
Working Capital	$ 64,045	$_____
Fixed Assets	201,600	_____
TOTAL	$ 265,645	$_____

SALES REVENUE

In the United States manufacturers do not sel rectly to the individual users of farm hand tools. On occasion, they d sell to large industrial users of such equipment, large farms, or to farmers' associations. Manufacturers usually sell to wholesalers. The wholesaler, in turn, sells to the retailer, and the retailer sells directly to the individual user.

Typical United States factory selling prices for the items being considered are shown below, together with the annual gross sales.

Item	Annual Production	Sales Price	Annual Sales	Actual Sales
Hay Ford	44,250	$1.78	$ 78,765	$_____
Digging Fork	4,400	1.60	7,404	_____
Rake	44,250	1.28	56,640	_____
Mattock Hoe	22,100	1.28	28,288	_____
Planters Hoe	11,100	1.00	11,100	_____
Mattock	22,100	1.84	40,664	_____
Pick	22,100	1.80	39,780	_____
Spade	6,650	1.63	10,840	_____
Long Handled Shovel	44,250	1.60	70,800	_____
Machete	44,250	1.50	66,375	_____
TOTAL ANNUAL GROSS SALES			$410,656	$_____

RECAPITULATION OF COSTS, SALES AND PROFITS

Item		Estimated	Actual
Direct Materials	$ 67,838		$_____
Direct Labor	97,800		_____
Manufacturing Overhead	71,713		_____
Total Manufacturing Costs		$ 237,351	_____
Interest on Loans	$ 8,000		_____
Insurance	2,000		_____
Legal	1,000		_____
Auditing	2,000		_____
Unforeseen Expense	16,305		_____
Total Administrative Costs		29,305	_____
Sales Commissions, Travel, Freight, Allowances, Discounts and Bad Debts		55,000	_____
Profit before Taxes		89,000	_____
TOTAL ANNUAL GROSS SALES		$ 410,656	$_____

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	$_____	$ 1,083	$ 13,000	$_____
20	Sales	_____	4,583	55,000	_____
30	Direct Materials	_____	5,653	67,838	_____
40	Supplies	_____	525	6,300	_____
51	Power*	_____	400	4,800	_____
52	Water*	_____	25	300	_____
53	Fuel	_____	100	1,200	_____
60	Unforeseen Expense (Reserve Account)	_____	1,351	16,305	_____
71	Direct Labor*	_____	8,150	97,800	_____
72	Indirect Labor*	_____	3,750	45,000	_____
80	Depreciation (Reserve Account)	_____	---	14,113	_____

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

PURCHASE REQUISITION	COMPANY NAME	DATE

☐ 10 ADMINISTRATION ☐ 40 SUPPLIES

☐ 20 SALES ☐ 50 UTILITIES

☐ 30 MATERIALS ☐ 60 UNFORESEEN EXPENSE

INDICATE BELOW THE USE OF MATERIALS

☐ DIRECT MATERIALS ☐ MAINTENANCE SERVICES

☐ MAINTENANCE MATERIALS ☐ OPERATING SUPPLIES

	PLEASE ORDER THESE MATERIALS OR SERVICES	DELIVERY WANTED	
QUANTITY	DESCRIPTION	UNIT	TOTAL

QUOTES FROM		REQUISITIONED BY	
QUOTES FROM		APPROVED BY	
QUOTES FROM		ORDER NO.	ORDER DATE

R. W. MITCHELL MANUFACTURING COMPANY

1422 BOSWORTH STREET. S. E.

65-22
514

ANYWHERE, U. S. A._____19____ No. 10000

PAY _____ DOLLARS $ _____

TO THE ORDER OF

R. W. MITCHELL MANUFACTURING COMPANY

TO FIRST NATIONAL BANK
ANYWHERE, U. S. A.

BY SAMPLE CHECK

VICE PRESIDENT

ACCOUNT NUMBER

Sample voucher check to be used for the payment of all expenditures in connection with Budget Control.

R. W. MITCHELL MANUFACTURING COMPANY

ENGINEERS

The services of professional engineers are desirable in the design of this plant, even though the proposed plant is small.

A correct design is one which provides the greatest economy in the investment of funds and establishes the basis of operation that will be most profitable in the beginning and will also be capable of expansion without expensive alteration.

The addresses of professional engineers who specialize in industrial design, some of whom may be willing to undertake such work on low cost projects overseas, can be secured by reference to the published cards in various engineering magazines. They may also be reached through their national organizations, one of which is the

National Society of Professional Engineers
2029 K Street, Northwest,
Washington 6, D. C.

Manufacturers of industrial equipment employ engineers familiar with the design and installation of their specialized products. These manufacturers are usually willing to give prospective customers the benefit of technical advice by those engineers in determining the suitability of their equipment in any proposed project.

The equipment manufacturers also know, and can recommend, professional engineers in private practice, who are willing and able to provide appropriate consulting services.

TRAINING

Manufacturing an inferior quality of product during the training period could create sales resistance that might be difficult to cope with later. To avoid such possibilities, the quality of the product should be maintained at all times, including the training period.

In some areas skilled operators may be available locally. In other areas all the operators may have to be trained.

If skilled operators are not available, adequate training would be assured by using one or more of the following methods:

A. If the plant is designed and installed by a competent engineering firm, the contract should be negotiated, if possible, on a turn-key basis. On this basis the contractor agrees to operate the plant and produce the quality and quantity of the product stated in the contract for an agreed period of time. Such a contract would assure adequate personnel training, since full quantity and quality could not be produced with an untrained organization.

B. The engineering firm that designs and installs the plant can usually make training arrangements to have key personnel placed, for training purposes, in a foreign industry that produces the same type of product. This would provide training for the key personnel while the plant is being installed.

C. If neither of the above methods is possible, then qualified and experienced individuals should be employed for the key positions, either permanently or temporarily, to perform the key operations and assist in training the organization, even if they must be secured outside the country.

D. The manager should have years of successful experience in this type of business and be fully qualified in all phases of management, including the training of employees.

SAFETY

There is always danger of accident and injury in any industrial plant. Because of this, the manager should take specific action to bring to the attention of each employee the importance of safety precautions and intelligent first aid.

Practically all machines have safety appliances, and the manager should see that these are in good working condition and that the operators are making full use of them.

In addition to constant watchfulness to make sure that all practicable safety precautions are taken, first aid supplies should be readily available. One complete first aid kit should be maintained near the manager's office, and others at appropriate places throughout the plant. Some of the employees should be trained to provide first aid service.

The use of accident posters in the plant have proved to be of value in reducing accidents. It is recommended that such posters be used, and that some direct special action be taken by the manager, at least once each month, to bring to the attention of all personnel the importance of safety precautions.

A fire brigade should be established and each member trained as to his responsibility in case of fire. Fire drills should be conducted periodically.

It is recommended that the employees be encouraged to offer suggestions or recommendations relative to prevention of accidents, removal of fire hazards and maintaining general interest in all safety factors.

SUMMARY

A small plant, built and operated according to the assumptions made in this manual would be a profitable undertaking.

There are some determinations, however, that should be made before a decision is reached to build and operate such a plant. Among the necessary determinations to be made are those with respect to the following items:

MATERIALS AND SUPPLIES

1. Are all materials and supplies available locally?
2. Is the local material market competitive?
3. Are satisfactory delivery of local materials assured at reasonable prices?
4. What materials and supplies must be imported?
5. Are they available in world markets at competitive prices?
6. Would prompt delivery of imported materials and supplies be assured so that large inventories would not be required?

MARKET FACTORS

1. Is there already a demand for the product?
   - A. Who are the principal consumers?
   - B. Who are possible new consumers?

2. How is demand for the product now satisfied?
   - A. By local production? If so, what is the volume of annual production?
   - B. What percentage of consumption is filled by local production?
   - C. By imports? If so, what is the volume of annual imports?
   - D. What percentage of consumption is met by imports?
   - E. From what areas are imports derived?

3. What is the estimated annual increase in local consumption over the next five years?
   - A. How were such estimates made?
   - B. By reference to official figures on population growth, family budgets, imports, etc.?
   - C. By consultation with trade or industry, ministries, associations, bankers, commercial houses, wholesalers, retailers, industrial consumers, etc.?

4. If the product is already being manufactured, can the existing and estimated future local market absorb production of the new plant without price-cutting or other dislocations?

5. Would the estimated sales price and quality of the new product make it competitive with an imported equivalent?
   A. After adjusting cost to local conditions, is the estimated sales price of the product so high that tariff protection is necessary to protect it from imports?

EXPORT MARKETS

1. Could the product compete in export markets on the basis of price, quality and dependability of supply?
2. Can export markets for the product be developed?
3. If so, in what areas and in what annual volume?
4. What procedures would be necessary to develop export markets?
5. What would it cost?

MARKETING PROBLEMS

1. In calculating costs of the product, has adequate allowance been made for the expense of a sales department, advertising and promotion that might be required?

2. Do consumer prejudices against locally manufactured products exist?
   A. If so, why?
   B. Would they apply to the new product?
   C. If so, how could they be overcome and what would it cost to do so?

3. Do marketing and distribution facilities for the product exist?
   A. If not, can they be set up?
   B. What would it cost to do so?

4. Will the product be sold to:
   A. Wholesalers?
   B. Retailers?
   C. Direct to consumer?
   D. Other industries?
   E. Government?

ECONOMIC FACTORS

1. How much foreign exchange (and in what currency) is required to import machinery, equipment and supplies:
   A. How much foreign exchange (and in what currency) is required for annual interest payments and amortization of any loans contracted to import machinery and equipment, or for payment of royalties and technical services?
   B. How much foreign exchange (and in what currency) is required for annual import of raw materials and supplies?
   C. What are estimated annual foreign exchange earnings and in what currencies?
   D. Has careful consideration been given to the possibility of depreciation in the foreign exchange value of the local currency?
   E. Has careful consideration been given to the possibility of import controls, or restrictions on availabilities of foreign exchange necessary to operate the business?
   F. What benefits would the new business bring to the economy in the use of local raw materials: in employment and in technology?
   G. Do dependable facilities exist for transportation, power, fuel, water and sewage?
      (1) If not, can existing deficiencies be eliminated satisfactorily?
      (2) What would be the cost to do so?

PERSONNEL

1. Is there an adequate labor supply near the plant location?
   A. If not, how can the problem be solved?

2. Can the problem of training competent management and supervisory personnel be solved?
   A. Also, the training of skilled labor?
   B. Is technical advice available in the locality?
   C. If not, where can it be obtained and what will it cost?

LAWS AND REGULATIONS

1. Do existing labor laws, government regulations, laws and taxes favor establishment of new business?
   A. If not, can existing obstacles be removed?
   B. If so, how and when?

FINANCIAL FACTORS

1. Technical advice on selection of machinery and equipment.
   A. In selecting the machinery and equipment for the new plant, have reputable and competent engineers and technicians been consulted?
   B. Have they been asked for advice on the most suitable types of machinery and equipment for the process and locality?
   C. Have they carefully compared costs of various suppliers?
   D. Credit terms offered purchasers?

FINANCIAL REQUIREMENTS OF THE PROJECT

1. In estimating the cost of the project, has careful consideration been given to:
   A. The effect on costs of delays in construction schedules?
   B. In delivery and installation of machinery and equipment?
   C. In import of essential raw materials and supplies?

2. In calculating cash flow and working capital requirements, has careful consideration been given to:
   A. Maintaining adequate inventories of raw materials?
   B. Supplies and spare parts?
   C. Seasonal fluctuations in the business?
   D. The time required to liquidate credit sales to customers and bad debts?
   E. The period necessary to get the plant into production?
   F. Cash required to amortize its principle loans?

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

SHORT TERM BANK CREDITS

1. Has it been possible to make arrangements with local banks to finance short-time working capital requirements of the business?

FINANCIAL PLAN

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

GLOSSARY

Bar stock	A general term used to describe material having small cross sectional dimensions in comparison to its length and yet being relatively stiff.
Blank	1. A piece of material prepared to be made into a product by additional operations. 2. A piece punched out of a sheet or strip of material.
Board foot	A unit of lumber measurement one foot wide, one foot long, and one inch thick or its equivalent.
Die	One of a pair of cutting or shaping tools which when moved toward each other produce a certain desired form in an object or surface by pressure or a blow.
Draw	To stretch, spread, or shape metal by passing it through dies, by stamping with a series of dies, or by hammering.
Drop forge	To form between dies by raising one die and allowing it to fall toward the other.
Forge	To form into a desired shape by heating and hammering or squeezing.
Forge furnace	A heating chamber used to raise the temperature of metal to the forging range of 2200°-2300°F.
Form	To shape, mold, or fashion into a certain state or condition.
Hammer man	An individual who operates a forging hammer.
Heater	An individual whose work is to heat or increase the temperature of an object.
Helve hammer	A power hammer, consisting essentially of a heavy head or die at one end of a lever lifted by power and dropping by its own weight on the work resting on an anvil or another die.

Pierce	To make a hole or holes through material.
Plastic	Capable of being molded or formed.
Rip	To saw or split wood lengthwise of the grain.
Season	To dry lumber either in the open air or a kiln so it is in the best condition for use.
Setup	The make-ready and put away operations required in order to perform work of a different kind.
Starping	An object stampted, pressed, or drawn into a definite shape from a blank.
Tongs	A device for taking hold of an object. Common tongs consist of two pieces hinged together like a pair of pincers or scissors.
Turn	To shape material by applying a cutting tool to it while revolving as in a lathe.
Upright helve hammer	A variety of helve hammer in which the die mounted on the lever is guided in its movement so as to mate more closely with the anvil or die and form objects to closer tolerances.

BIBLIOGRAPHY

TEXTBOOKS

Forging Handbook	Waldemar Naujoks
Manual of Open Die Forging	Open Die Forging Industry

PERIODICALS

Wood Worker	S. H. Smith Co. 2232 N. Meridian Street Indianapolis 7, Indiana
Metal Progress	American Society for Metals Mount Morris, Illinois

ABBREVIATIONS

^{o}F	Degree Fahrenheit
%	Percent
"	Inch or Inches
'	Foot or Feet
@	At the price of
#	Pound or Pounds
Approx.	Approximately

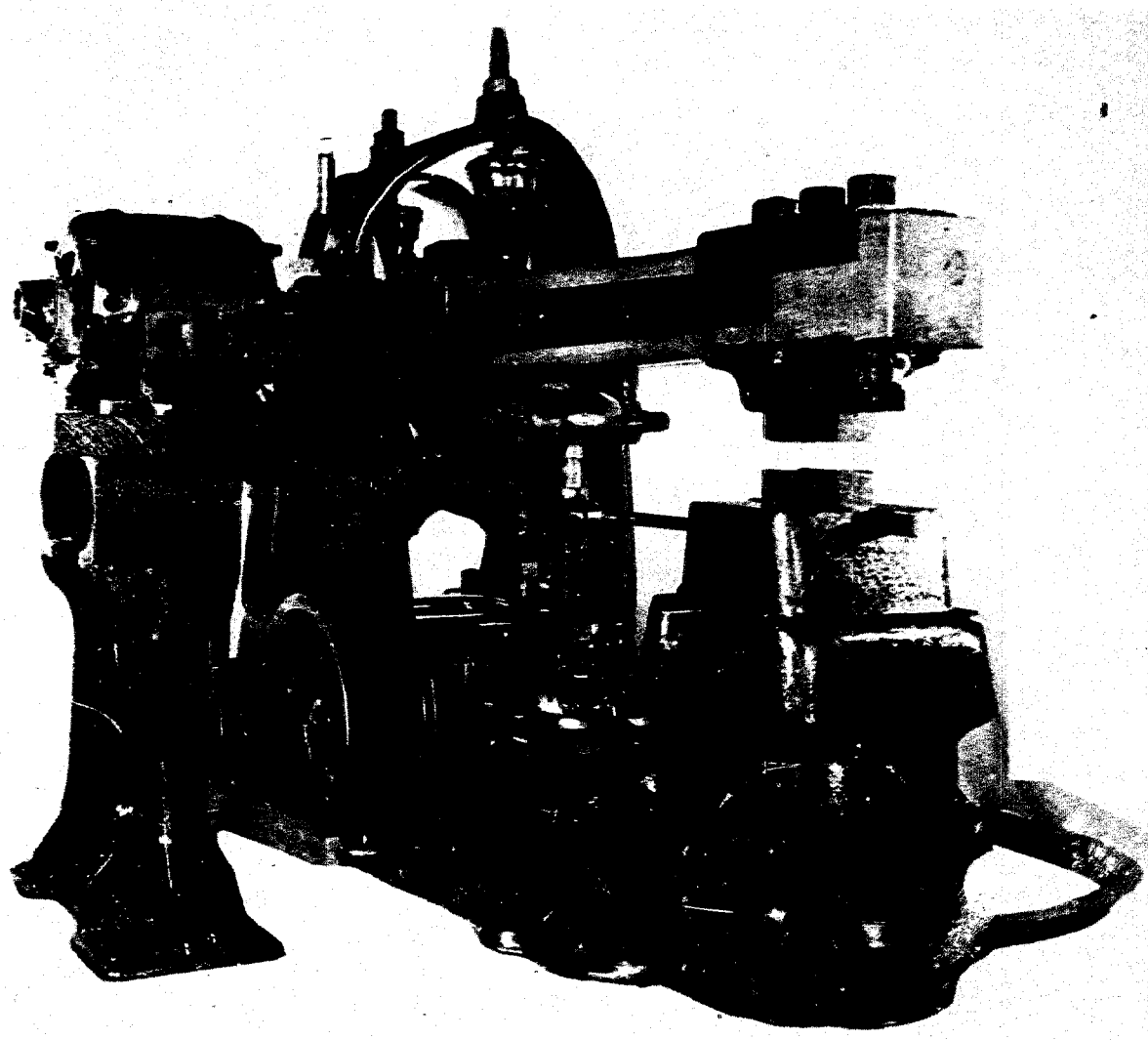


Figure 1 - A helve hammer

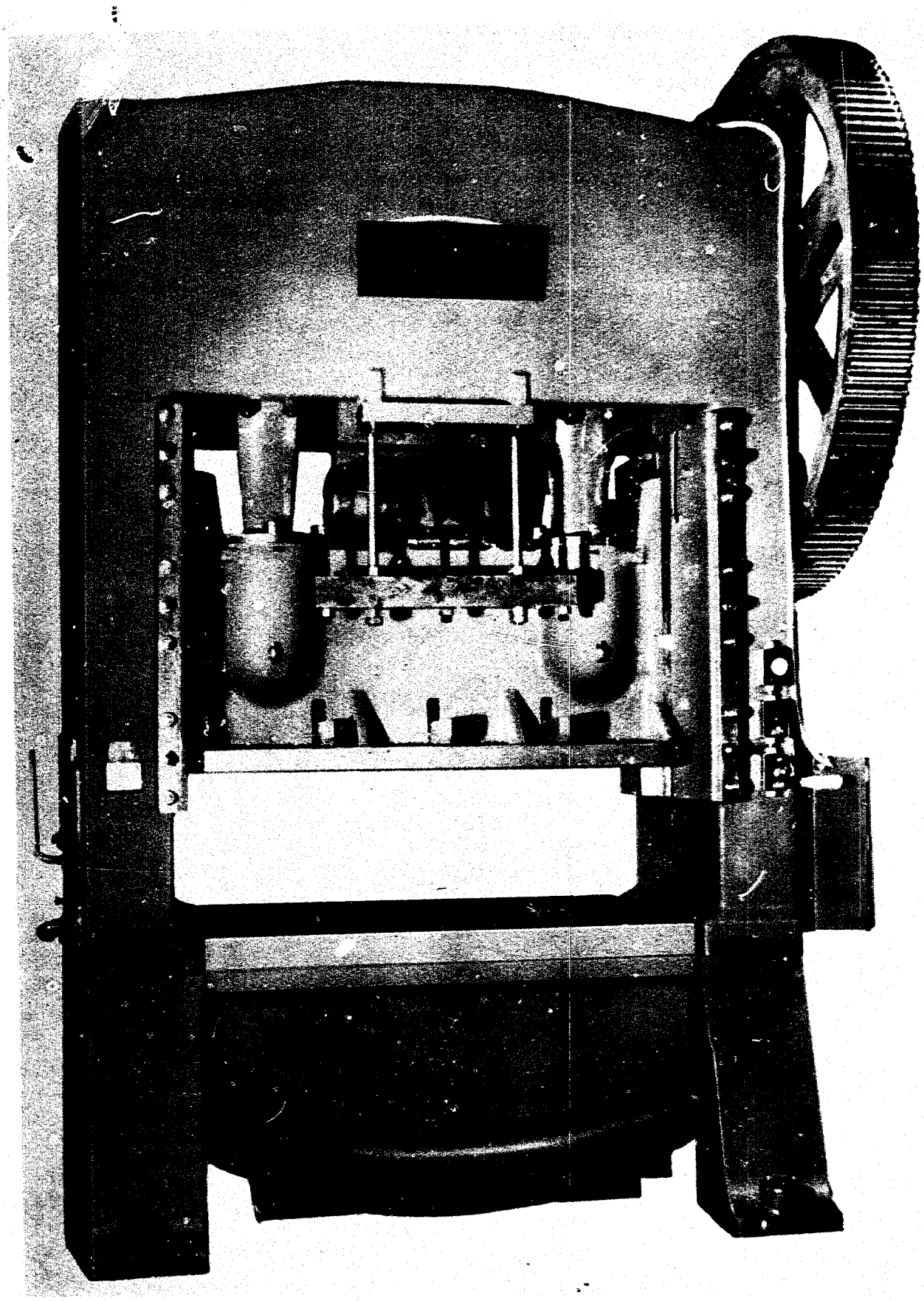


Figure 2 - A 200-ton mechanical forging press

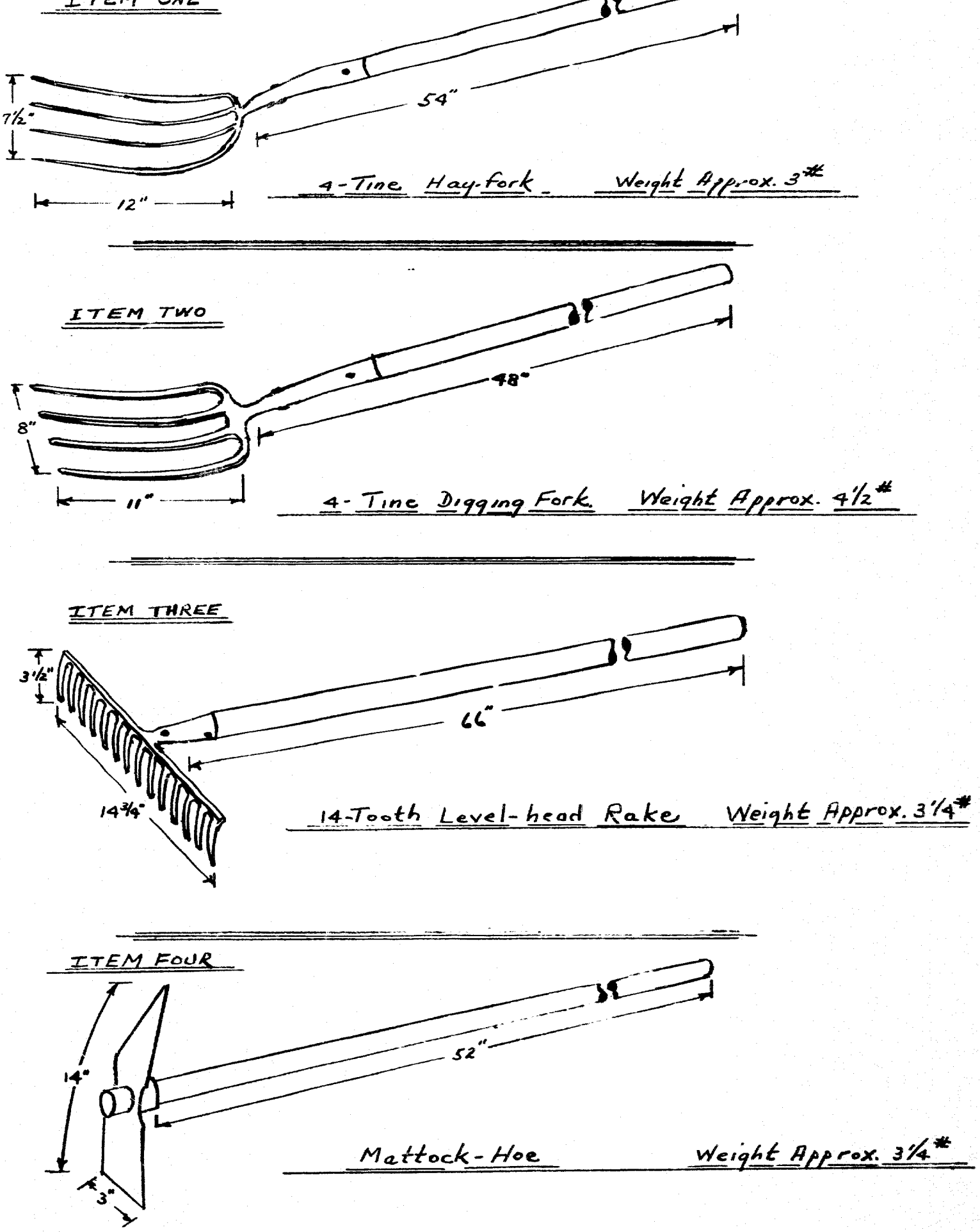


Figure 3 - The farm hand tools to be produced

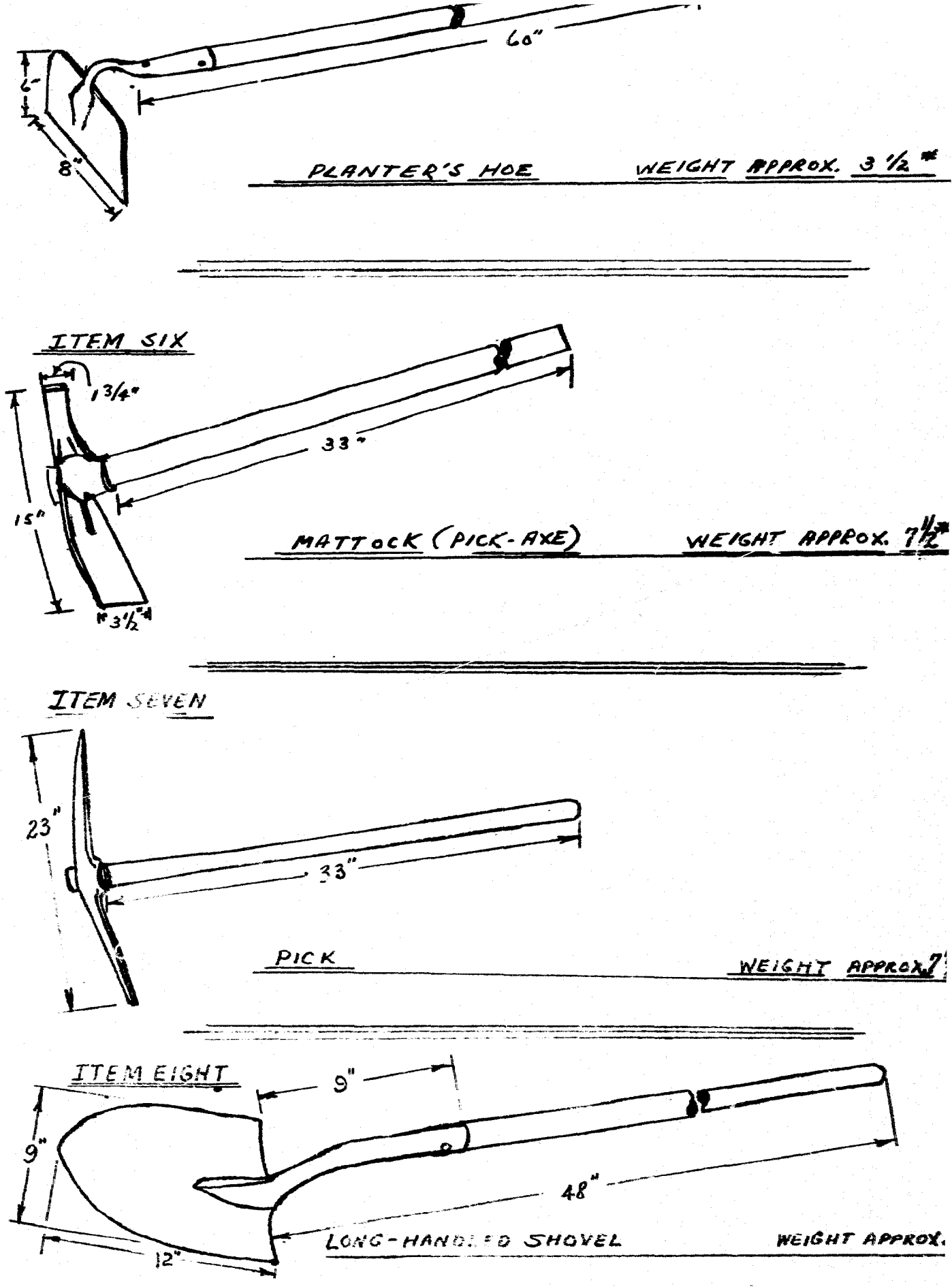


Figure 4 - The farm hand tools to be produced

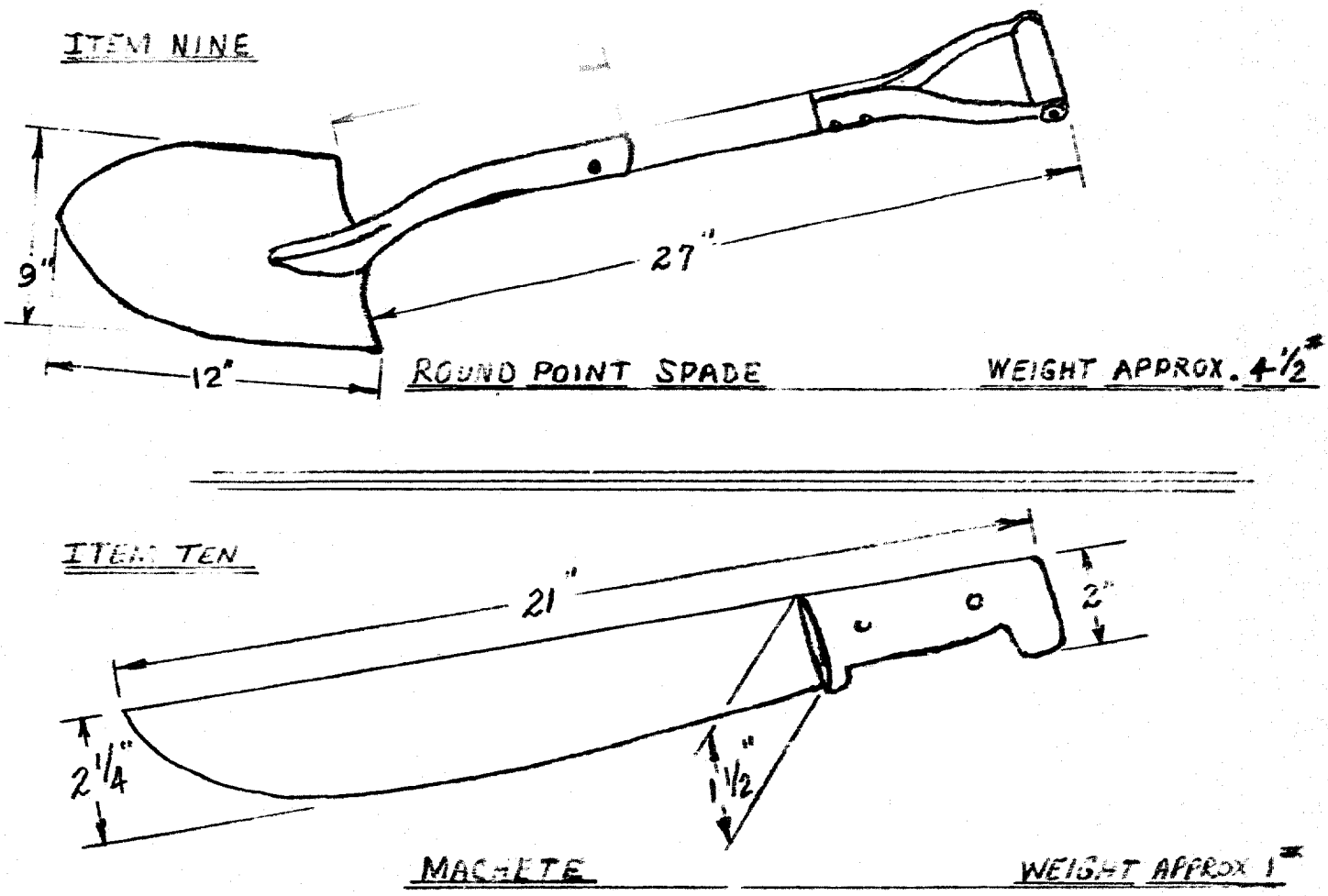


Figure 5 - The farm hand tools to be produced

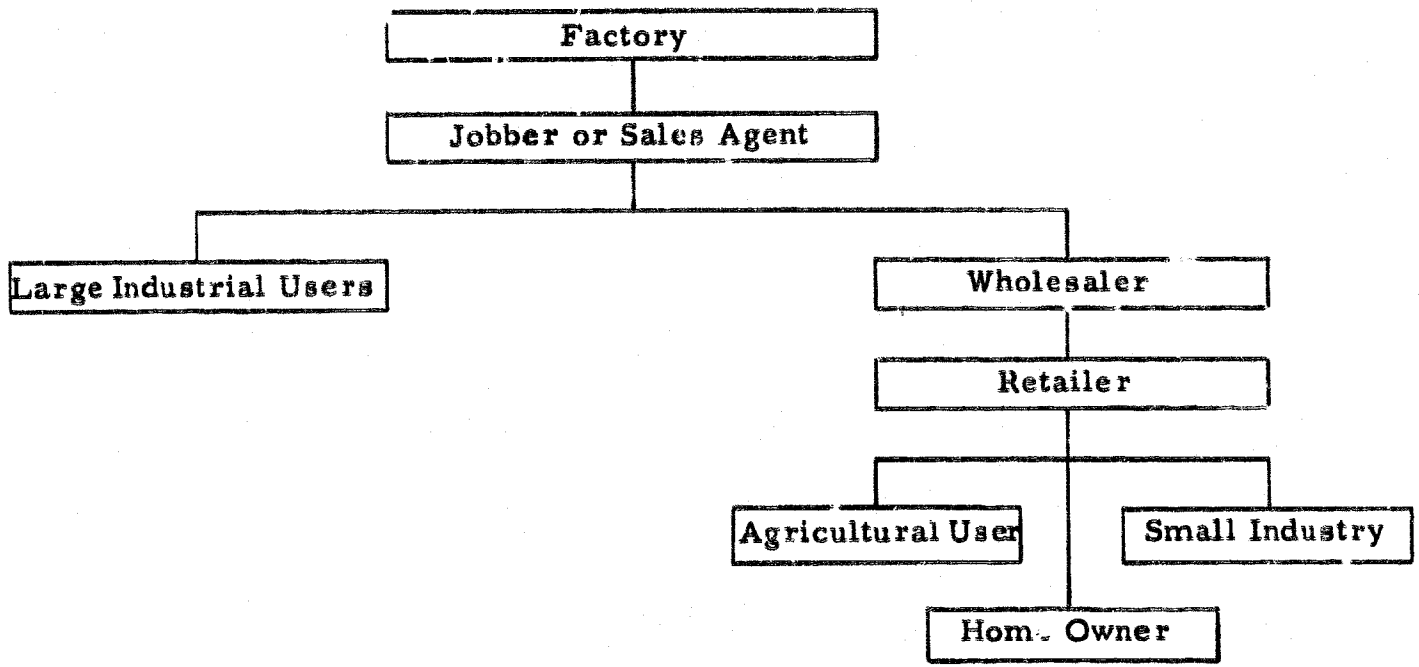


Figure 6 - The customary lines of distribution for farm hand tools in the United States

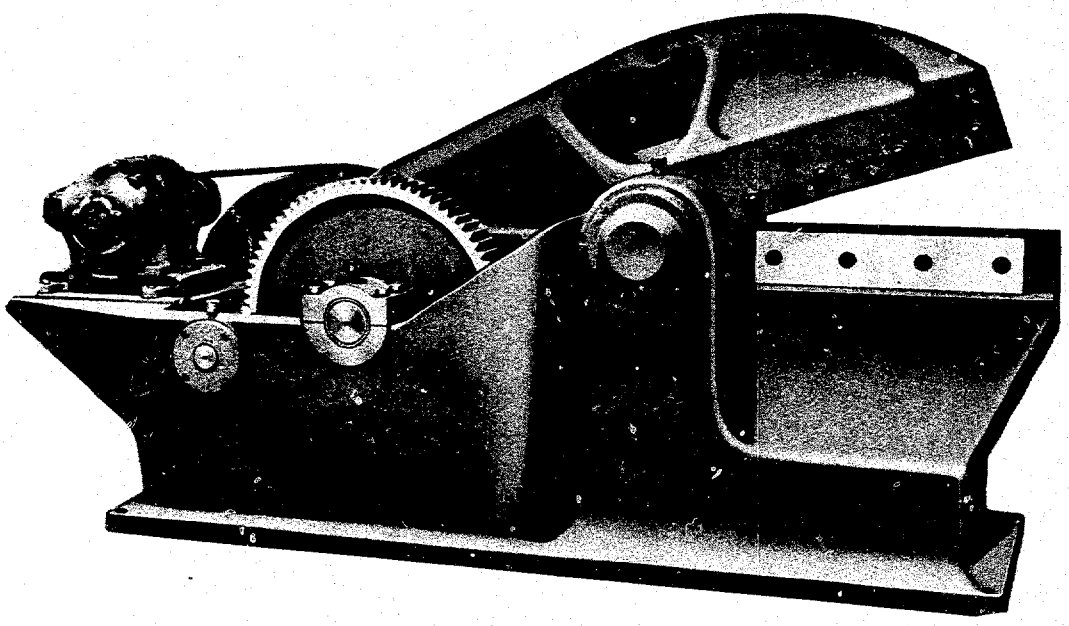


Figure 7 - An alligator shear for bar stock

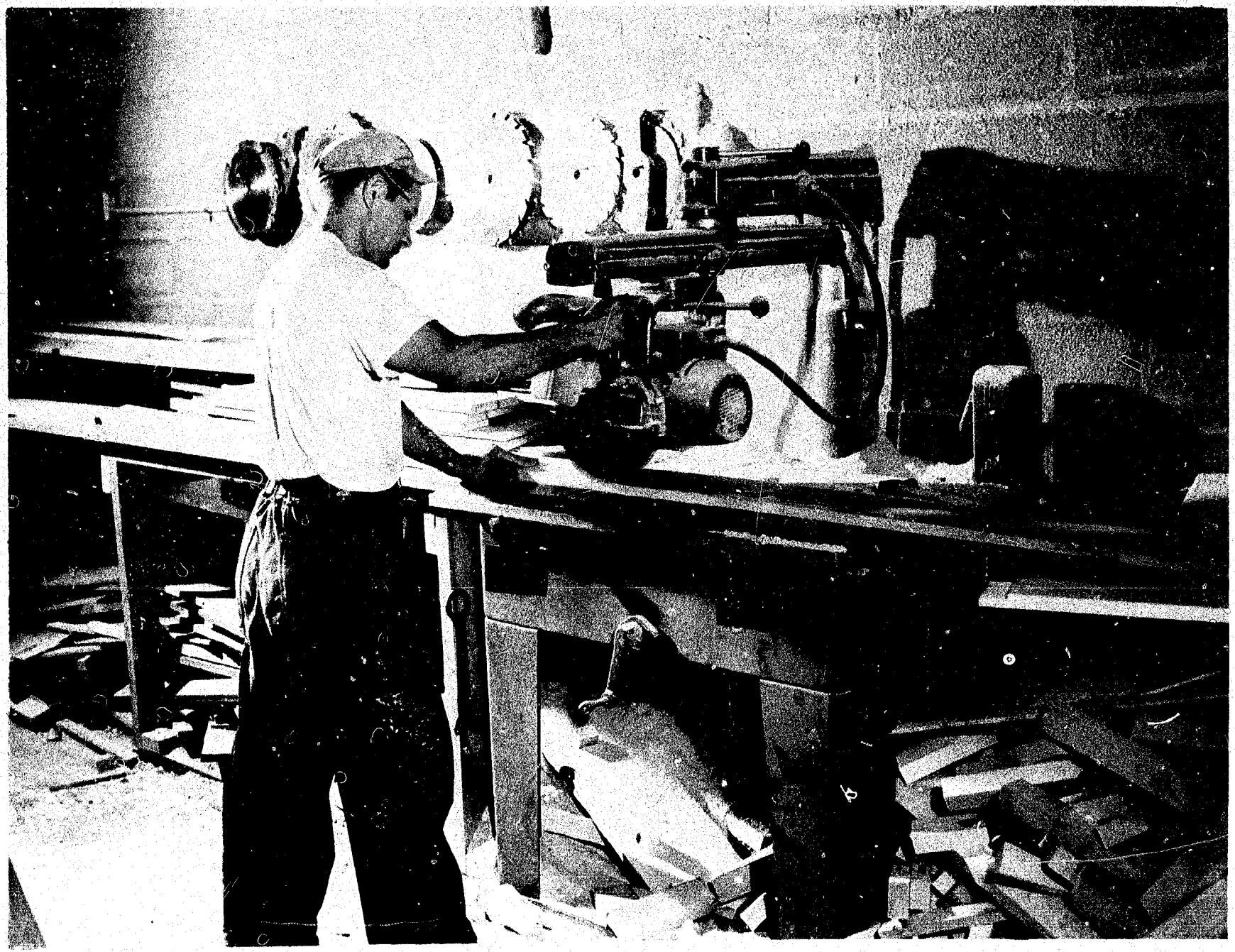


Figure 8 - A radial saw in use

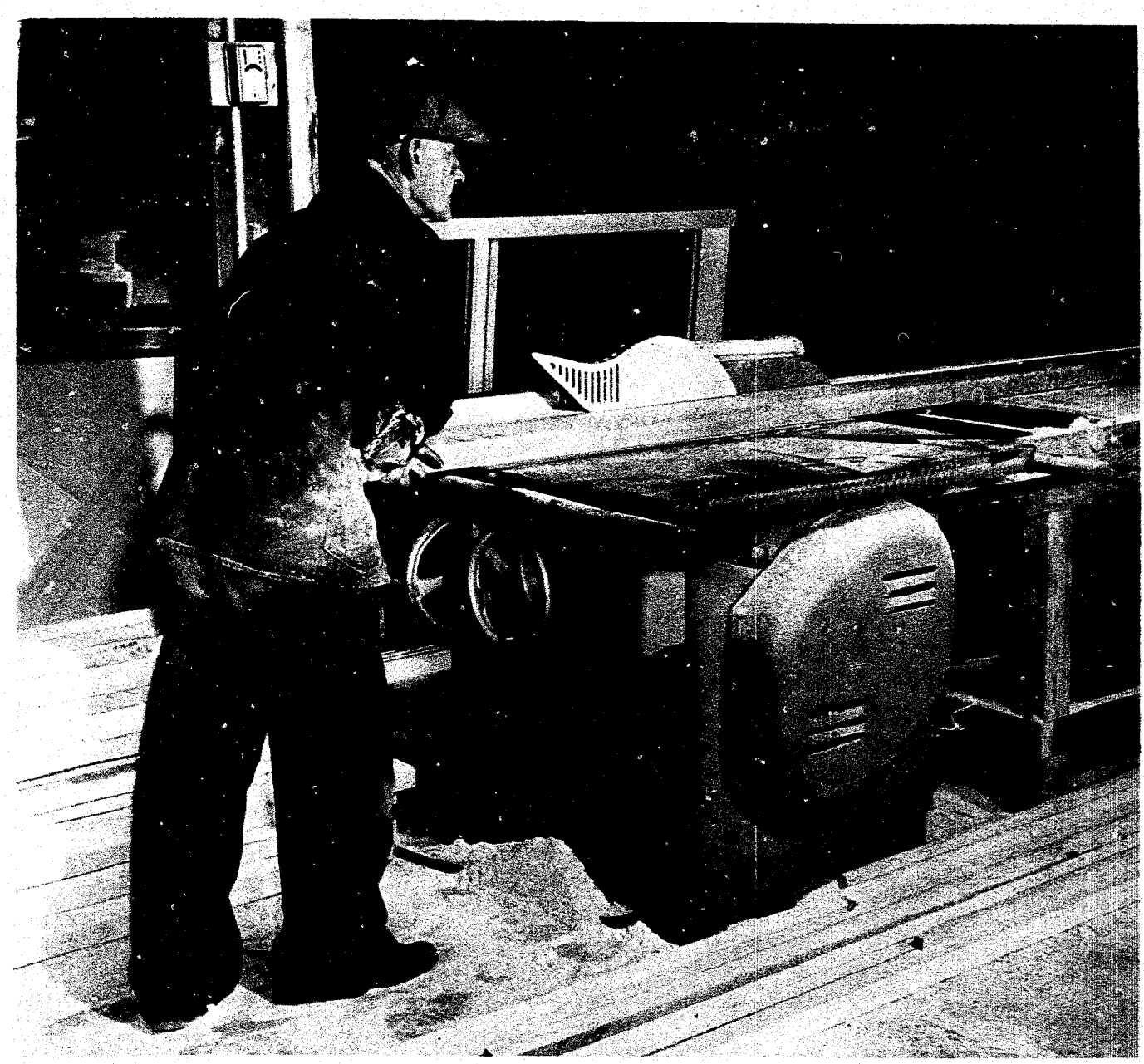


Figure 9 - A circular saw in use

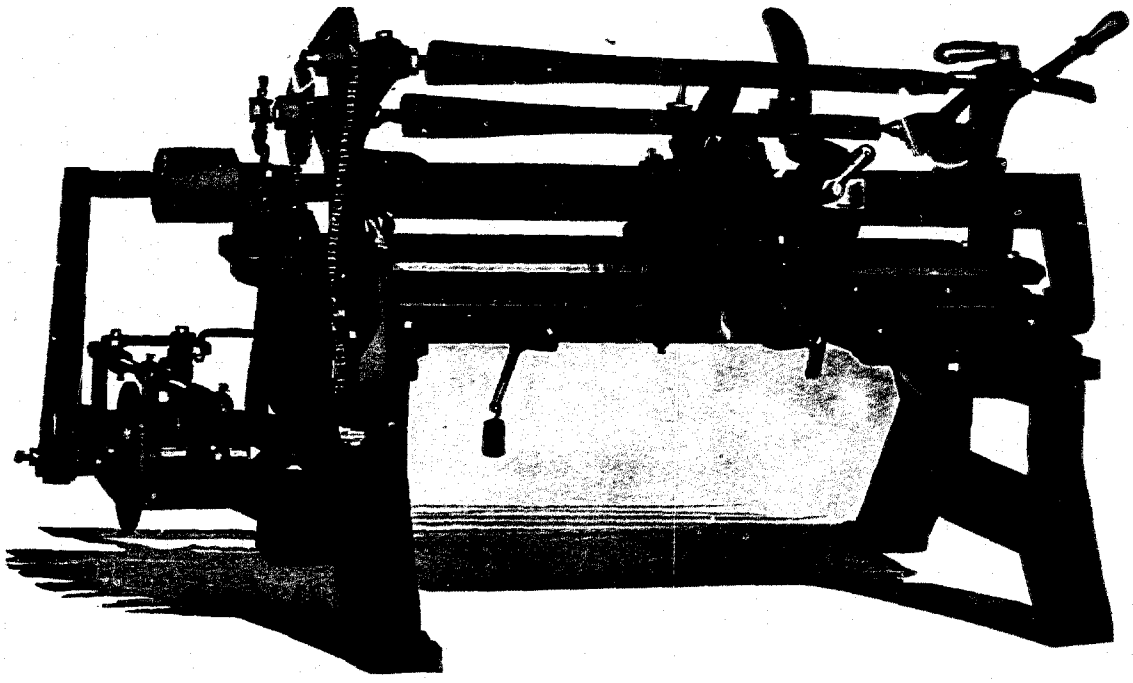


Figure 10 - A special lathe used for turning handles having irregular cross sections

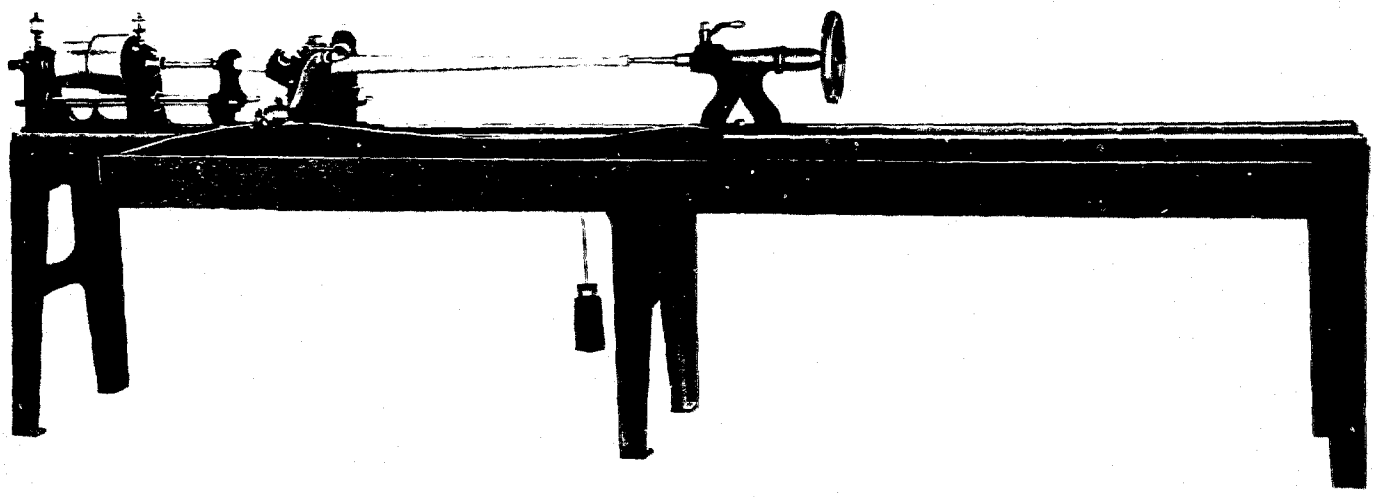


Figure 11 - A gauge lathe used for turning handles having circular cross sections

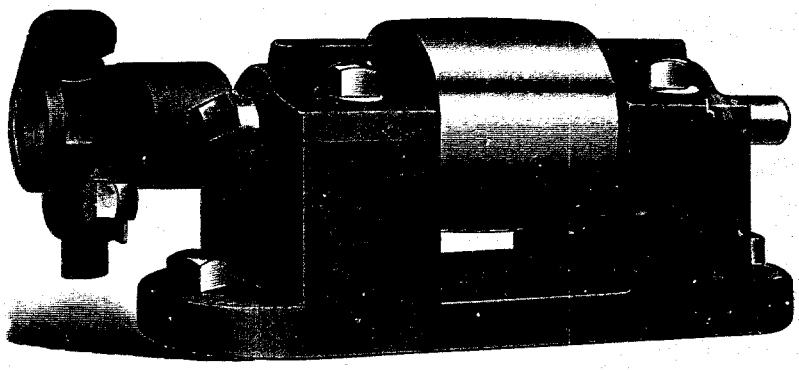


Figure 12 - Special (chucking) machine for rounding handle ends

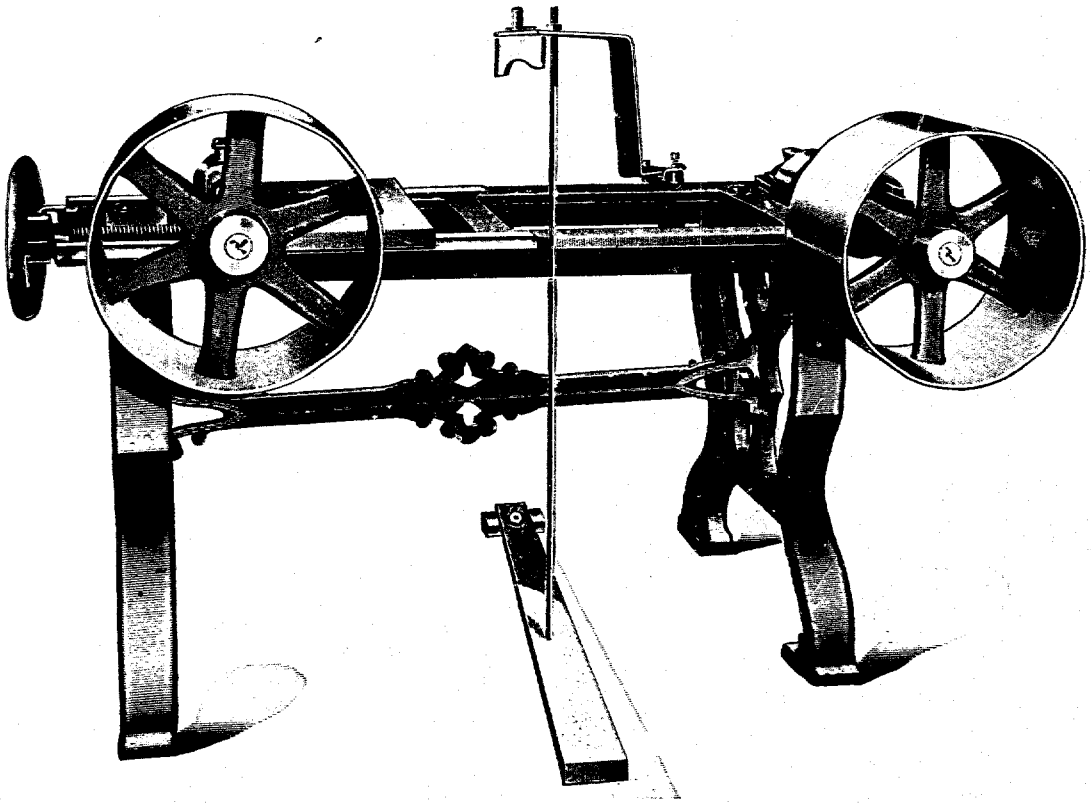


Figure 13 - Sanding machine for handles

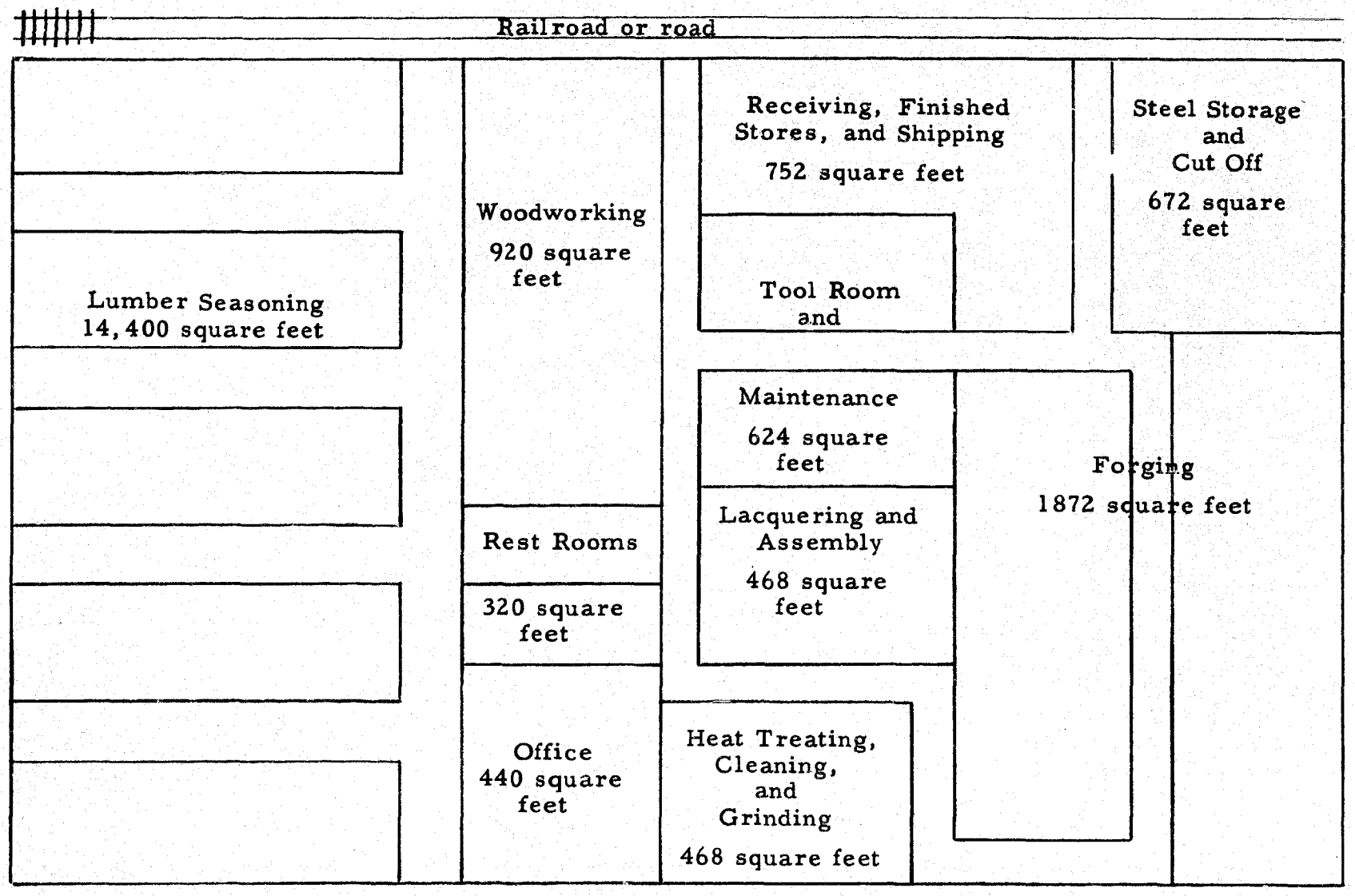
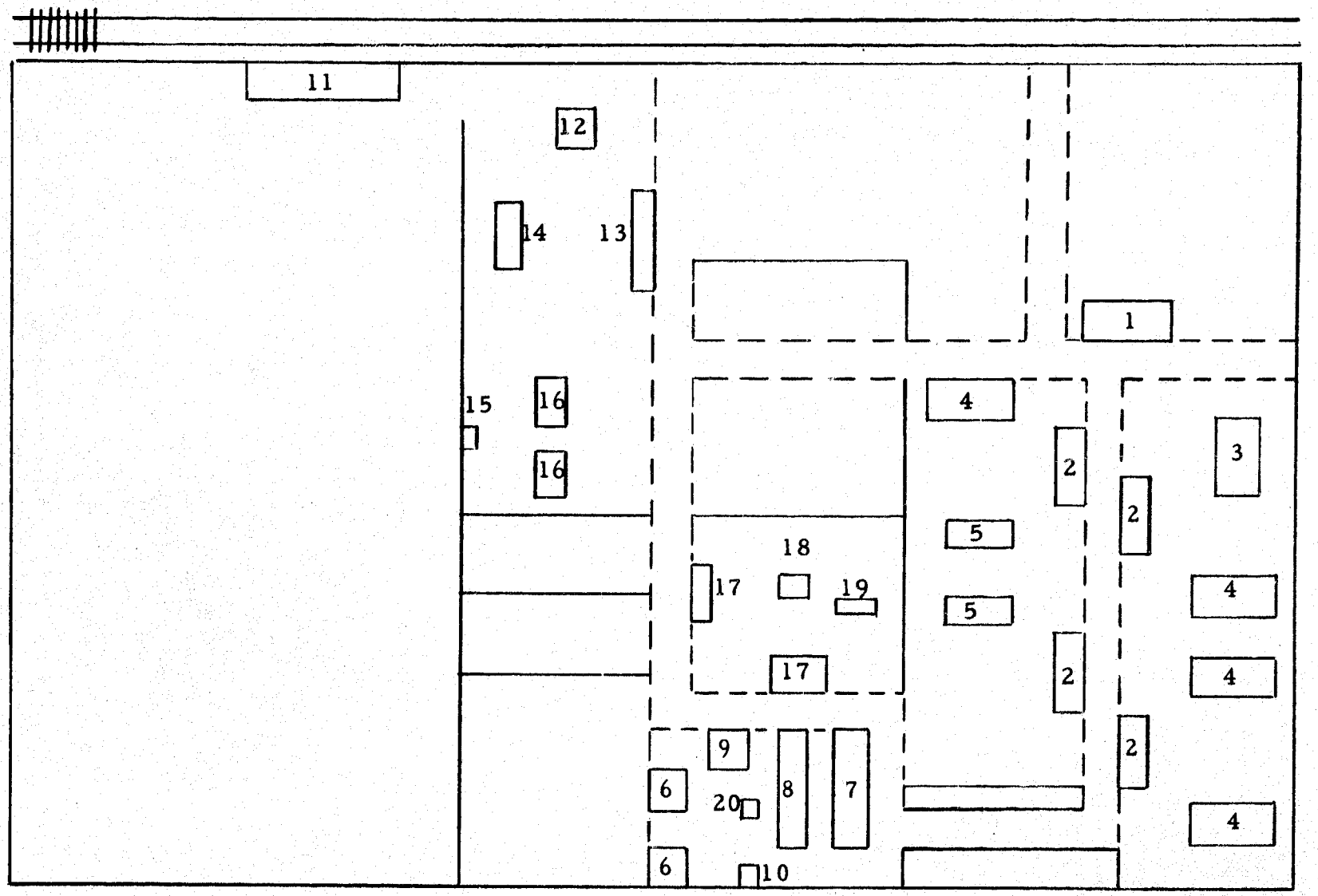


Figure 14 - Preliminary plant layout (General)



Scale: 1" = 16'

Key

1. Bar shear
2. Forge furnace
3. 200-ton mechanical press
4. 200# helve hammer
5. 100# upright helve hammer
6. Belt grinder
7. Heat treat furnace
8. Oil quench tank
9. Degreaser
10. Brinnel tester
11. Radial saw
12. Table saw
13. Gauge lathe
14. Special lathe
15. Special machine
16. Sanding machine
17. Lacquer tank
18. Drill press
19. Rivet spinner
20. 500-pound jib crane

Figure 14a - Preliminary plant layout

INTERNATIONAL COOPERATION ADMINISTRATION

SERVICES OF THE INDUSTRIAL TECHNICAL COOPERATION PROGRAM

TYPE III – TECHNICAL AIDS FOR OVERSEAS

- **INDUSTRIAL REPORTS SERVICE**

Provides basic information regarding:

1. Data and reference materials relating to private capital mobilization and its application in economic development.
2. Requirements for establishing and operating small factories in basic industries.
3. Man-hour requirements, operational characteristics, and equipment utilization in representative U. S. factories in selected industries.
4. Man-hour and materials savings through standardization, simplification, and specialization studies.
5. Supervisory and other specialized training procedures and techniques.
6. U. S. experience in specialized fields.

- **TECHNICAL DIGEST SERVICE**

Provides digests and abstracts, full length articles, and bibliographical references on U. S. developments in products, processes, and work techniques derived from U. S. technical, scientific, and trade periodicals, and other pertinent sources.

- **TECHNICAL INQUIRY SERVICE**

Provides answers to individual questions relating to products, processes, machinery and equipment, production operations, work techniques, management practices and concepts, factory engineering, and basic requirements for industrial production.

- **TRAINING MATERIALS SERVICE**

Provides basic materials for use by specialized technicians in the conduct of management, supervisory and specialized training courses in host countries.

- **TECHNICAL LITERATURE SERVICE**

Provides recommendations and guidance regarding current useful world-wide publications relating to industry and productivity improvement; distributes carefully selected and representative new publications of particular value for program use; and facilitates mission literature procurement.

- **U. S. BOOK EXCHANGE SERVICE**

Provides, on Mission approval, technical and scientific books and periodicals on exchange basis to overseas libraries.

VISUALS AND NEW MEDIA

Provides technical advice and guidance to missions on new industrial visuals. Provides for cooperative program adaptation and use a variety of visual materials, including loan exhibits, silk-screen display panels, graphic brochures, slide and sound kits, and related materials.

- **TECHNICAL FILM SERVICE**

Provides guidance for and facilitates procurement of U. S. technical and training films for program use; provides representative U. S. technical industrial films and filmstrips on loan basis for short-term program requirements; and facilitates adaptation of films into foreign language versions for program use overseas.