TECHNICAL INQUIRY SERVICE

BICYCLES

Bicycles.

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Technical Aids Branch
Office of Industrial Resources
INTERNATIONAL COOPERATION ADMINISTRATION
Washington 25, D. C.

FOREWORD

The Technical Inquiry Service answers inquiries from overseas on factory or commercial establishment, operation, management, and engineering. This brochure is one of a series based on these technical inquiries.

This 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 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 George H. Andrews, 416 Southern Building, Washington 5, D. C.

For further information and assistance, readers should contact their local Productivity Center, Industrial Institute, Servicio, or United States Operations Mission.

April 1958

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INTERNATIONAL COOPERATION ADMINISTRATION
OFFICE OF INDUSTRIAL RESOURCES

TECHNICAL INQUIRY SERVICE

IR-19242 PR

A SMALL BICYCLE MANUFACTURING PLANT

INTRODUCTION

The small bicycle plant described in this brochure is intended to manufacture bicycles where the demand for this product exists and where such a local operation would be practicable.

There are various designs of bicycles and accessories. The bicycle, on which the estimates of production and cost are made, is simple, sturdy and of excellent quality.

The machinery and equipment is capable of making more elaborate mechanisms where the nature of the market makes production of such models desirable.

GENERAL ASSUMPTIONS

In order to make realistic estimates, certain assumptions must be made. These are:

1. All costs, such as those for building, equipment, materials and supplies, are based on prices in the United States.

2. The operating costs, including labor used, are taken from the actual operating experience in the United States.

3. Adequate power and water are available at the plant site.

4. Adequate transportation facilities are available for the importation of materials and parts and for the distribution of the finished product.

5. All estimates are based on one 8-hour work shift per day, 5 days per week, or 40 hours per week.

6. A few more workers than are shown in the estimate will be required during the training period and peak production is not likely to be attained until the whole organization is thoroughly trained. It is estimated that this training will require from 6 weeks to 3 months.

7. Most of the materials and the supplies will not be available locally and must be imported.

8. A market analysis has proved that annual sales of at least 12,000 bicycles are possible.

9. The following items cannot be estimated realistically:

   A. Land value.
   B. Freight in and out.
   C. Distribution and sales cost.
   D. Taxes, interest, insurance, and other burdens.

   While general estimates will be made of each of these items, for the purpose of completing cost estimates, adjustments should be made in accordance with actual local costs.

   In fact, all costs contained in this brochure should be adjusted to conform to local conditions.

PRODUCT SPECIFICATIONS

The small bicycle plant described in this brochure is designed to produce a sturdy, good quality, 26-inch bicycle, of the type made and used in the United States. The usual diamond frame for men, and drop frame for women, is recommended. The frame will be made of steel tubing welded with modern welding equipment.

Each of the bicycles may be finished in any one of a variety of colors, but the estimates in this brochure are based on using not more than two colors of enamel. This enamel is the air dry type and will be applied with an air spray gun to assure an even, durable finish. Using air dry enamel eliminates the need for a baking oven, as well as the costs of an operator and heating the oven.

Smaller, 24-inch bicycles and children's bicycles also should be produced in this plant if the volume of sales, in each size, is large enough to provide a profitable production schedule. All estimates, however, are based on the production of adult size only.

MANUFACTURING OPERATIONS

MACHINE SHOP

The seat posts are cut to length on a power hack saw in the stock ro and routed to the machine shop for milling and bending operations, before going to the final assembly.

The steel flats for frame lugs are routed from the stock room to the punch press and to the bench grinder for burring before going to the welding benches to be welded into the rear end of the frame.

The frame tubing is routed from the stock room to the band saw for cutting to specified length; then to the milling machine for end milling as required; then to the drill press for drilling operations and finally, to the frame assembly.

FRAME ASSEMBLY

The required sizes and length of tubing are placed into a form and welded into a complete frame. The frame is then ground and polished where welded.

The frames are then placed on a pipe hung from the ceiling so that tl frames can be passed along to the degreasing and enameling operations and on to the final assembly benches. This eliminates any damage to the enamel that might occur from trucking and saves time and floor space.

ENAMEL

Degrease frame by dipping into a vat of hot water containing caustic soda and rinse by dipping into a vat of clear hot water.

Spray frame with a primer coat of enamel and hang up for drying.

Spray frame with a finish coat of enamel and hang up for drying.

Spray front fork, chain guard, fenders and fender braces with both primer and finish enamel. The spraying is done with an automatic air spray gun in a spray booth. An exhaust fan is located in the spray booth to remove the enamel fumes from the building.

WHEEL ASSEMBLY

Assemble hub, spokes and rim and adjust spokes so that the wheel is in perfect alignment. Assemble rim tape, tire and tube and inflate.

FINAL ASSEMBLY

All parts and subassemblies are arranged at assembly benches in the final assembly so that the assembler will have everything handy for performing the following operations:

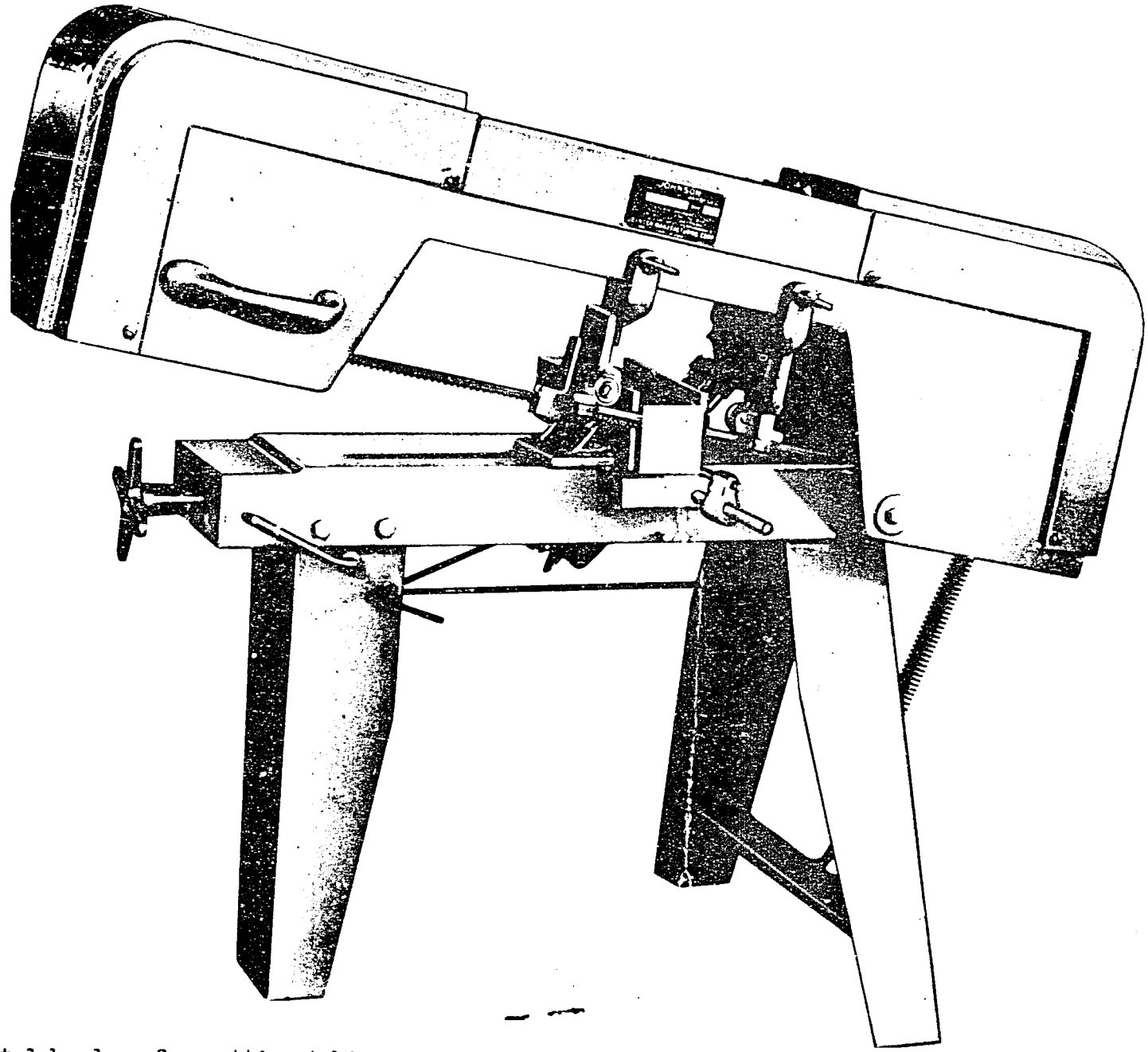
Install name plate.
Place seat post in frame.
Place end of seat post in vise with bicycle frame upside down, front end of frame resting on cloth-covered block on bench.
Install front fork complete.
Install fenders, braces and reflector.
Install crank hanger assembly and pedals complete.
Install rear wheel complete.
Install chain and adjust cones, and install chain guard.
Install front wheel and adjust cones.
Remove from vise, stand on wheels and install kick-stand.
Install stem, handle bars and grips.
Install and adjust seat.
Inspect.
Place in shipping carton.

PRODUCTION CAPACITY

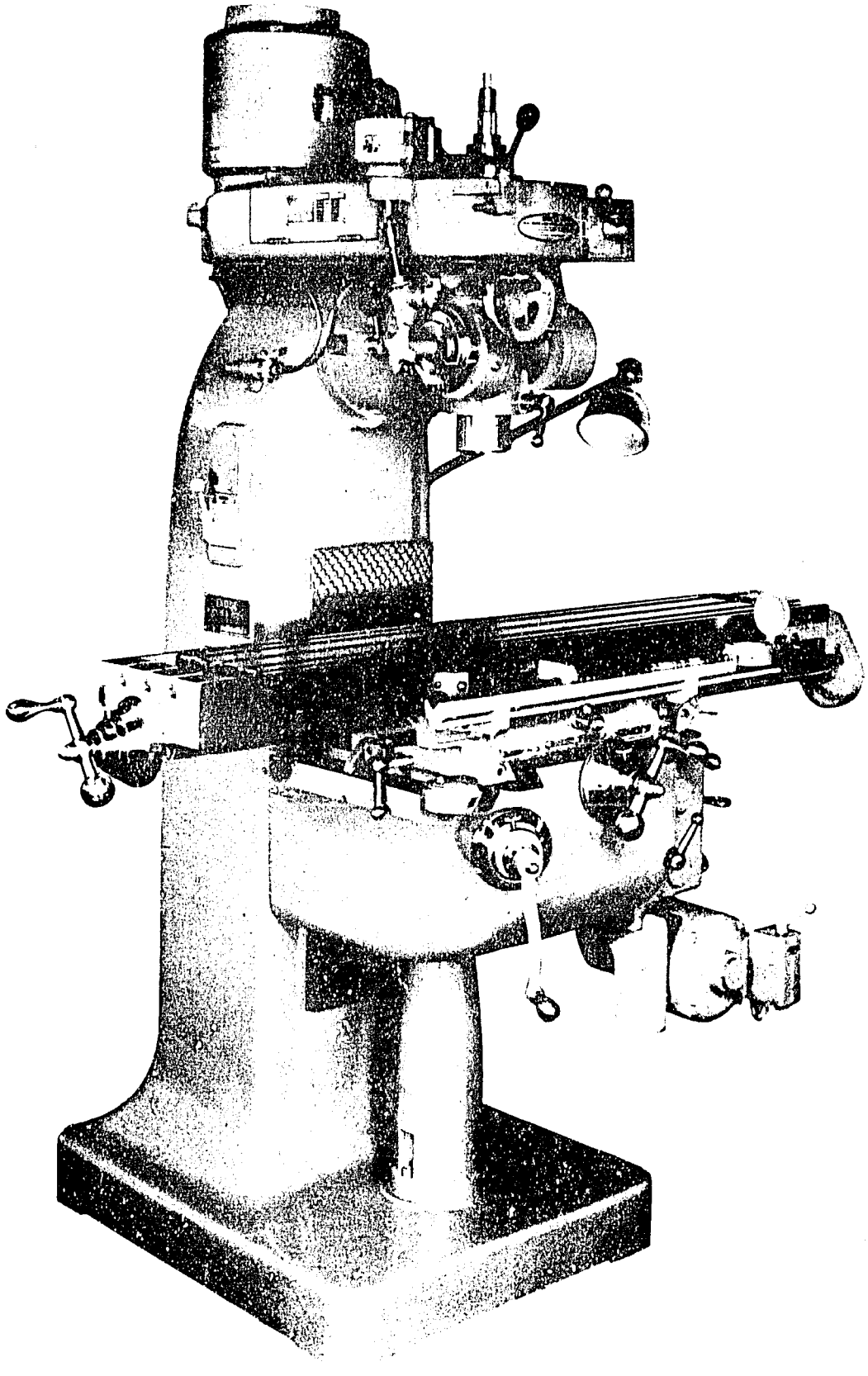
The capacity of this plant is 48 bicycles per 8-hour working day. Production capacity could be increased by working longer hours or by using extra shifts, as shown below:

Shifts per day	Hours per shift	Units per day
1	8	48
1	10	60
2	8	96
2	10	120
3	8	144

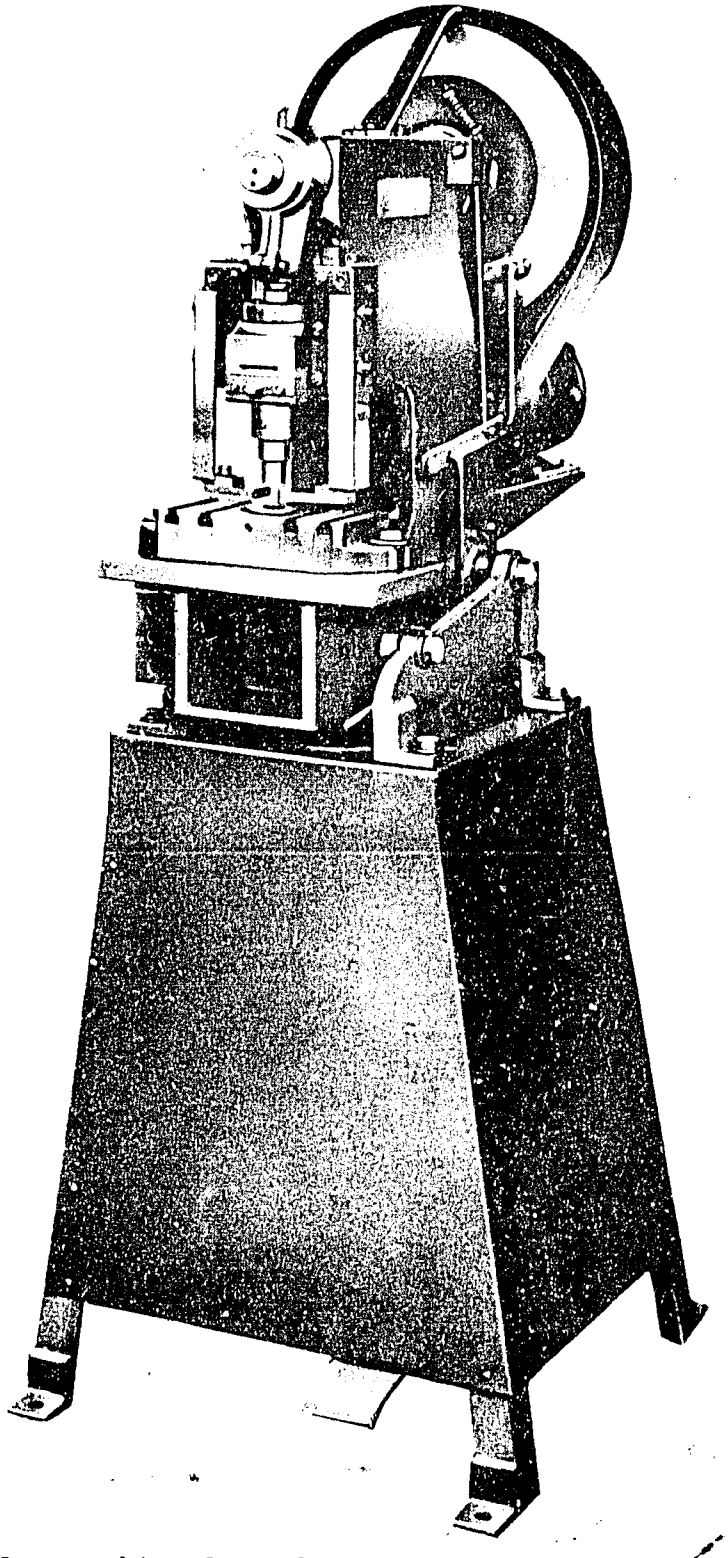
Some additional working capital would be required if production is substantially increased. No additional equipment or increase in capital investment is required for a production of 144 units per day, if the plant is operated in accordance with the above hours per shift and shifts per day.



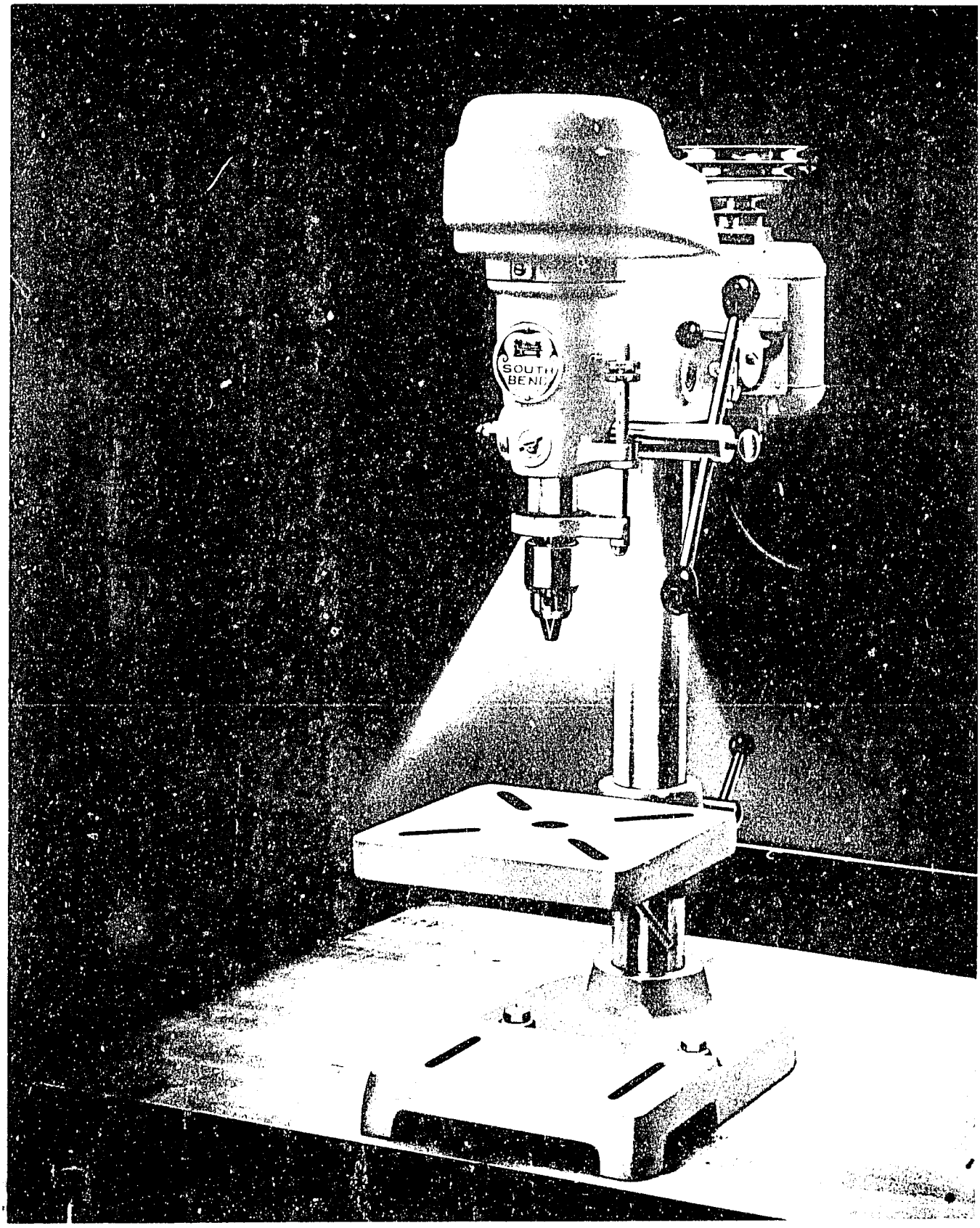
Metal bandsaw for cutting tubing



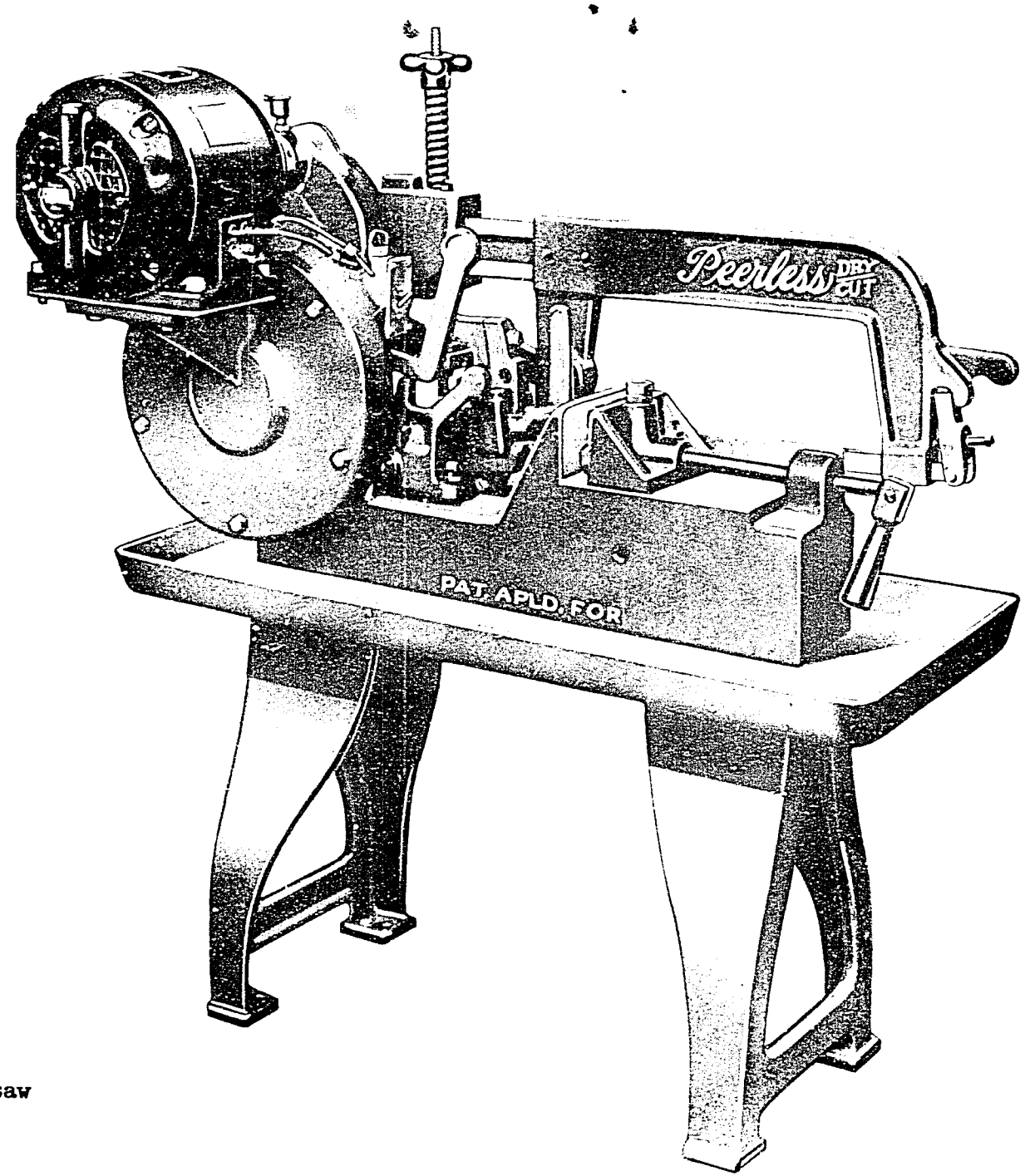
Milling machine for milling tubing



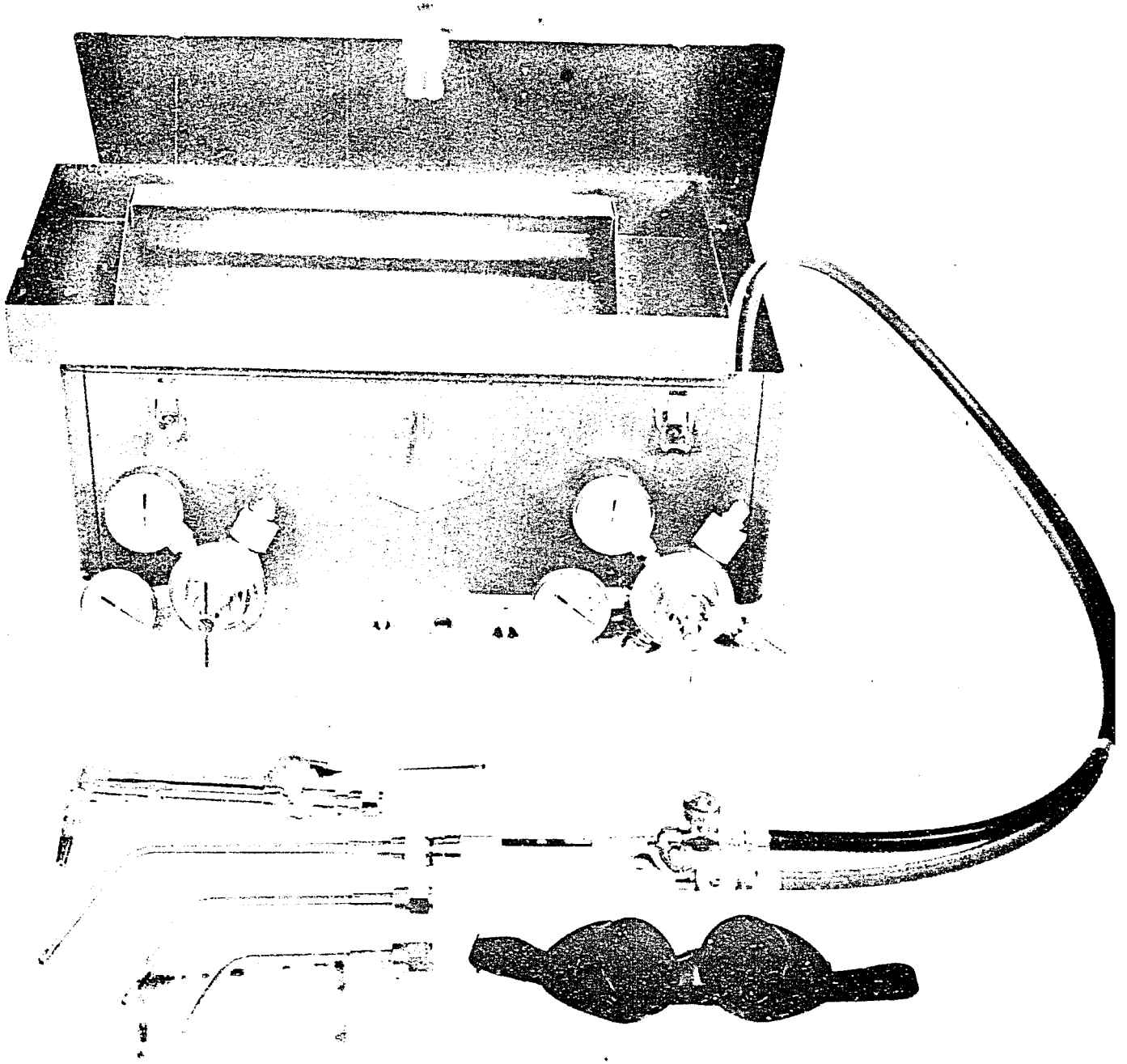
Punch press for punching frame lugs



Drill press for all drilling operations

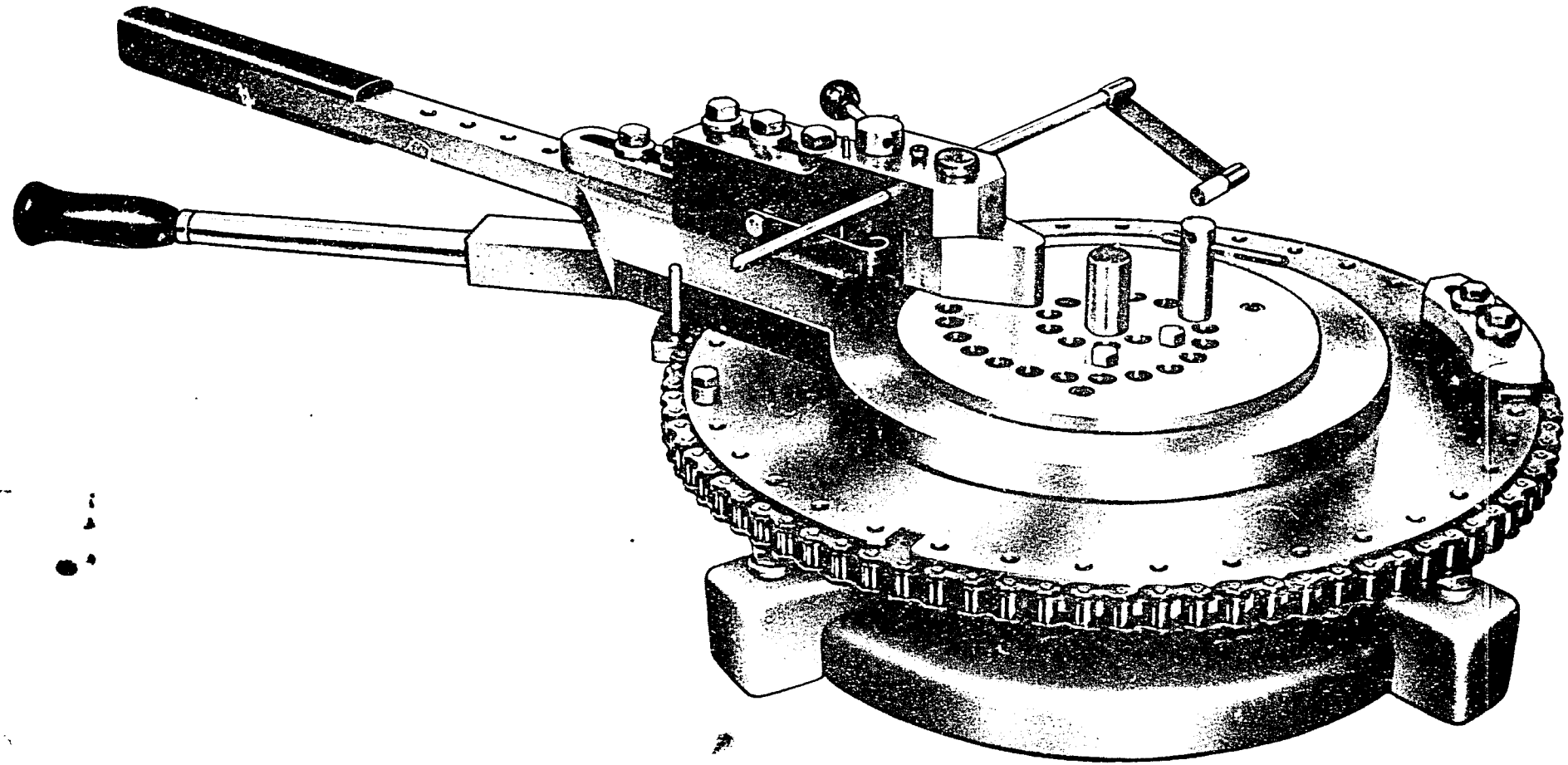


Power hacksaw



Welding kit

Spray booth



Bender for bending tubing and bars

PLANT SITE

A site of level, well-drained land, about 200 feet square, will be desirable. The site should be as advantageously located as practicable with respect to transportation facilities, power, water, fuel, sources of labor, and markets. The estimated cost of the required land is $1,000.

BUILDING

One building 100 feet by 40 feet, or 4,000 square feet, will provide enough space for office, storage, production, shipping, and some expansion. The building may be constructed of any substantial materials. It should be a one story building, well lighted, heated and ventilated. A steam boiler should be installed to provide steam for production uses as well as for heating the plant. The estimated cost of the building with a small steam boiler or generator installed is $24,000.

POWER

A dependable supply of electricity is required for the operation of a bicycle plant. The estimates in this brochure do not include provision for an electrical generating unit, but are made on the assumption that the electricity will be purchased from an outside source. A diesel engine-driven generator would be practicable however, and if the electricity from the local source is not satisfactory as to price, dependability, or uniformity of voltage delivered, provisions should be made for the generation of the electricity needed in the plant.

The connected load of all motors used will not exceed 40 horsepower. Since all of these motors are not operated at the same time, nor at full capacity, the peak demand will probably be 25 horsepower. The estimated annual cost of electricity is $800.

FUEL

A small boiler is needed to provide the hot water for the degreasing process, for cleaning and heating. The estimated annual cost of all the fuel required for these purposes is $400.

TRUCK

A one-ton pick-up truck will be needed for carrying materials and supplies and for local deliveries. The estimated cost is $2,400.

WATER

Very little water is required in the manufacturing process. That is principally for the degreasing and cleaning. Water must be available for fire protection, sanitary facilities, for heating and drinking purposes. The estimated annual cost of water is $100.

DIRECT MATERIALS

It would not be practicable to manufacture, in a small bicycle plant, all the parts required to produce a bicycle. The capital investment would be prohibitive. Moreover, some of the parts used can be purchased more cheaply than they can be produced in small quantities. It is recommended that only the frame, seat post and frame lugs be machined at the plant initially. After the plant is operating efficiently and producing 48 bicycles per day, additional parts should be produced at the plant. For this purpose a careful study of all parts purchased should be made to determine the selection of parts which can be best adapted to plant production and, in addition, will provide the greatest reduction in cost of parts. It is recommended that consideration be given to producing the following parts after the organization is fully trained and ready for additional machinery and assembly work:

kick stand	front wheel axle	spokes
steering post	fender braces	seat
steering post bracket	handle bars	pedals

Some of the parts can always be purchased for less cost than they can be manufactured in small quantities. These include such items as rear hub, rims, sprocket, spoke nipples, bolts, nuts, washers, cones, bearings, and pedal crank forgings.

MATERIALS TO BE MACHINED INITIALLY

TUBING

Tubing length in inches	Diameter in inches	Wall thickness in inches	Estimated cost	Actual cost
34	1/2	1/16	$ .1428	$____
40	3/4	1/16	.1948	____
64	1	1/16	.3530	____
6	1 1/2	3/32	.0706	____
3	2 1/4	3/32	.0508	____
TOTAL COST OF TUBING PER BICYCLE			$ .8120	$____

The tubing will be purchased in random lengths and fabricated at the plant. Allowing 10 per cent waste would make the total cost of tubing per bicycle . . . . . $ .90

SEAT POST

Length in inches	Diamter in inches	Estimated cost	Actual cost
10	3/4	$ .08	$____

REAR FRAME LUGS

Material	Dimensions in inches	Estimated cost	Actual cost
Carbon steel	1/8 X 4 1/2 X 3	$ .04	$____

TOTAL COST OF DIRECT MATERIAL TO BE MACHINED INITIALLY . . . . . $ 1.02

PURCHASED PARTS

Number		Estimated cost	Actual cost
1	chain guard	$ .35	$____
1	steel roller chain	.52	____
1 pr.	handle bar grips	.20	____
1 pr.	pedals, chrome	.50	____
1	saddle	1.38	____
1	kickstand	.28	____
1 set	fenders (front and rear) with braces	.90	____
1	fork	1.15	____
1	crank and parts, complete	1.40	____
1	handle bar stem, chrome	.68	____
1	handle bar, chrome	.62	____
1	front hub, chrome	.76	____
1 set	2 tires, 2 tubes and rim tape	3.50	____
1	coaster brake hub, chrome (36 spokes)	3.50	____
72	spokes, chrome	.81	____
2	rims, chrome	1.24	____
1	reflector	.04	____
1	name plate	.05	____
	bolts, nuts, washers, screws	.04	____
TOTAL ESTIMATED COST OF PURCHASED PARTS		$ 17.92	$____

ESTIMATED COST OF DIRECT MATERIAL, PURCHASED PARTS AND CARTON PER BICYCLE

	Estimated cost	Actual cost
Shipping carton	$ .75	$____
Total estimated cost of purchased parts	17.92	____
Tubing material	.90	____
Seat post material	.08	____
Rear frame lugs material	.04	____
TOTAL ESTIMATED COST OF DIRECT MATERIAL, PURCHASED PARTS AND CARTON, PER BICYCLE	$ 19.69	$____
TOTAL ANNUAL COST OF ALL DIRECT MATERIALS FOR 12,000 BICYCLES	$236,280.00	$____

SUPPLIES

It is important to have on hand a complete set of replacements for the most vulnerable parts of the operating equipment. These and other essential supplies listed below should be replaced whenever a carefully determined minimum is reached.

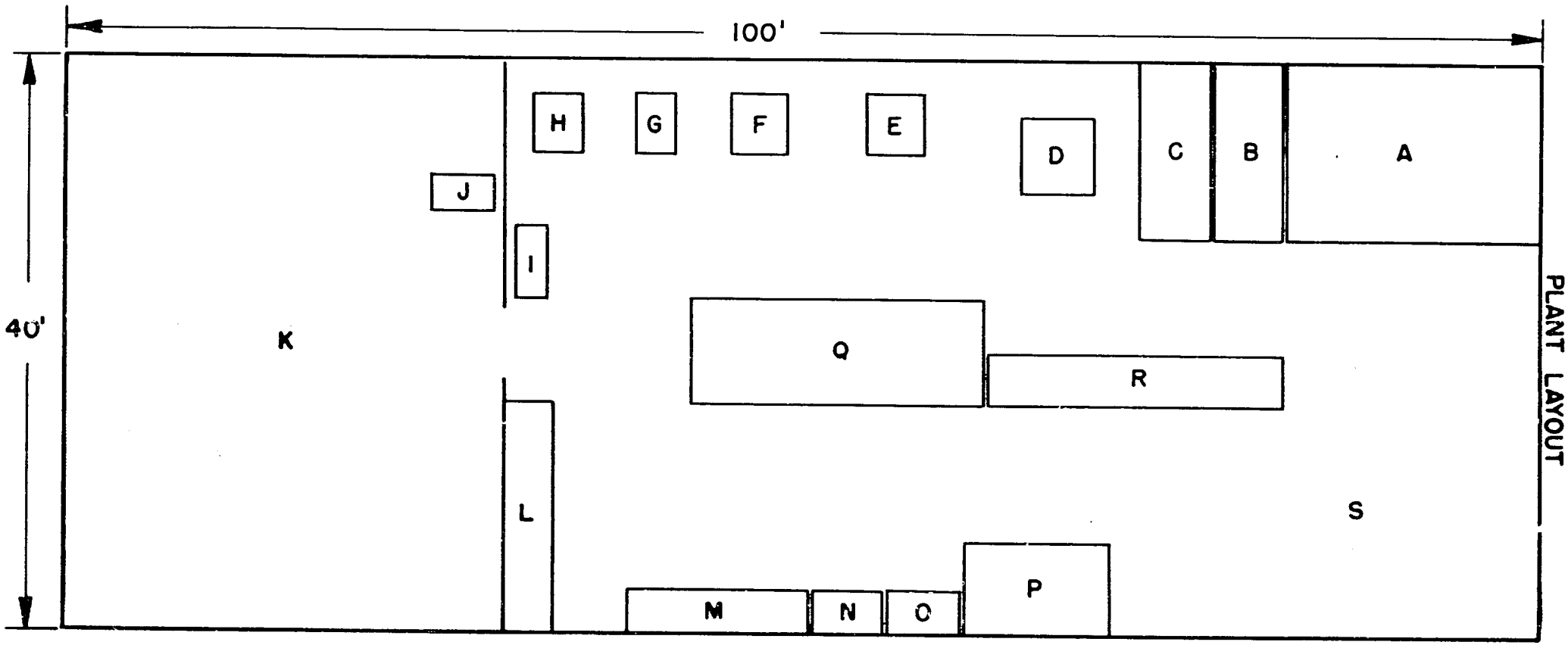
	ANNUAL COST	
	Estimated	Actual
Welding rods	$ 1,000	$____
Acetylene gas	2,200	____
Oxygen	2,700	____
Enamel	2,350	____
Grinding, polishing and cutting tools	300	____
Caustic soda, hand tools and all other supplies	300	____
TOTAL ESTIMATED ANNUAL COST OF SUPPLIES . . .	$ 8,850	$____

EQUIPMENT REQUIREMENTS

Quantity		Estimated Cost	Actual Cost
1	Bench grinder	$ 200	$_____
1	Hacksaw, power driven	300	_____
1	Bench drill press	170	_____
1	Metal band saw	375	_____
1	Verticle milling machine	1,500	_____
1	Punch press	505	_____
1	Bender	275	_____
2	Flexible tube grinders and polishers	741	_____
2	Electric drills	94	_____
2	Welding kits complete with goggles, hose, wrenches, lighters, welding tips, cutting attachments, welding handles, and regulators	190	_____
1	Complete spray booth with two complete sets of hose, guns, and one compressor	1,750	_____
2	Degreasing vats, complete	300	_____
	Fixtures, forms, dies and benches	2,800	_____
4	Vices and hand tools	300	_____
	Band saws, drills and cutting tools	500	_____
	Electric motors, wiring, switches and installation costs	2,000	_____
TOTAL ESTIMATED COST OF EQUIPMENT		$12,000	$_____

DEPRECIATION OF FIXED ASSETS

	Estimated Cost	Years	Annual Depreciation
Building	$24,000	20	$ 1,200
Machinery and equipment	12,000	15	800
Office equipment	1,000	10	100
Truck	2,400	4	600
TOTAL ANNUAL DEPRECIATION			$ 2,700



A. Office
B. Rest room - Women
C. Rest room - Men
D. Bandsaw
E. Milling machine
F. Punch press
G. Drill press
H. Bench grinder
I. Bender
J. Power hacksaw
K. Stock room
L. Welding
M. Grind & polish
N. Degrease
O. Rinse
P. Enamel
Q. Wheel assembly
R. Final assembly
S. Shipping & Storage

FLOW SHEET

TUBING

Stockroom to bandsaw for cutting to length. All tubing is cut on the bandsaw. After leaving the bandsaw, the tubing is routed to the following machines, as required:

End Milling
Punch Press
Drilling
Bender

FRAME LUGS

Only two operations are required: punch and burr.

SEAT POSTS

Cut to length in stockroom, milled, then bent in bender.

WELDING

Tubing and frame lugs assembled and welded into complete frame, then ground and polished.

ENAMEL

All parts that are enameled are sent to spray booth where they are degreased and sprayed with one coat of primer and one coat of enamel.

WHEELS

All wheel parts are sent from the storeroom to the wheel assembly bench where they are assembled complete and the tires inflated with air.

FINAL ASSEMBLY

All parts and subassemblies are sent to final assembly where the bicycle is assembled complete, inspected, and placed in a shipping carton.

PERSONNEL REQUIREMENTS

INDIRECT LABOR

Office	Persons Needed	Hourly Rate	Annual Cost Estimated Cost	Annual Cost Actual Cost
Manager	1	$	$ 8,000	$_____
The manager with the help of a bookkeeper in the office, will take care of all administrative duties, including procurement, and will inspect the finished bicycles.				
Bookkeeper	1		3,000	_____
Secretary	1		2,400	_____
Truck driver	1		2,000	_____
The truck driver will also attend to janitor services.				
TOTAL INDIRECT LABOR	4		$15,400	$_____

DIRECT LABOR

Plant

Machinist*	1	$ 1.50	$ 3,000	$_____
Machinist helper	1	1.00	2,000	_____
Welders*	2	1.50	6,000	_____
Polishers (frame)	2	1.00	4,000	_____
Enamel and degrease*	1	1.50	3,000	_____
Assembly men (wheel and tire)	6	1.00	12,000	_____
Assembly men (final)	4	1.00	8,000	_____
Stock men	2	1.00	4,000	_____
TOTAL DIRECT LABOR	19		$42,000	$_____

*Key men

SAFETY

First aid kits and supplies should be readily available. One complete kit should be kept in the manager's office so that he can take immediate action in the case of accident. Special kits should be kept close to the welding and degreasing operations. The bookkeeper should also be made responsible for routine checking of the first aid kits to make sure that any supplies which have been used are replaced.

Special provision should be made for the treatment of burns. These are likely to occur where hot caustic is used for degreasing and hot water is used for cleaning. They also are likely to occur where welding is being done.

Because of the welding operations, special care should be taken to cope with the fire hazard. Fire extinguishers should be available and fire drills should be conducted about once a month to train the employees regarding the responsibility of each one in case of fire.

The manager should make frequent inspections to look for, and correct, fire hazards, accident hazards, and unsafe practices. He should be familiar with first aid treatments and any action required in case of fire or accidents. The manager should take some specific action at least once each month to bring to the attention of each employee the importance of safety precautions and intelligent first aid.

Some machines have safety appliances and the manager should see that these are in good operating condition and that the operator is using them.

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

ANNUAL OPERATING COST

DIRECT OPERATING COST

	Estimated Cost	Actual Cost
Materials, component parts and cartons	$236,280	$_____
Accessories	30,000	_____
Direct labor	42,000	_____
TOTAL DIRECT OPERATING COST	$308,280	$_____

INDIRECT OPERATING COST

	Estimated Cost	Actual Cost
Labor	$ 15,400	$_____
Supplies	8,850	_____
Power	800	_____
Water	100	_____
Fuel	400	_____
Freight - in	2,200	_____
TOTAL INDIRECT OPERATING COST	$ 27,750	$_____
TOTAL ANNUAL OPERATING COST	$336,030	$_____

WORKING CAPITAL REQUIREMENTS

Because most materials and supplies will require considerable time for delivery, about 3 months working capital, or 25 per cent of the annual cost of materials, accessories and supplies will be required.

TOTAL WORKING CAPITAL	$ 66,600	$_____

FIXED ASSETS

	Estimated Cost	Actual Cost
Land	$ 1,000	$_____
Building	24,000	_____
Machinery and equipment	12,000	_____
Office equipment	1,000	_____
Truck	2,400	_____
TOTAL FIXED ASSETS	$ 40,400	$_____

CAPITAL REQUIREMENTS

Fixed assets	$ 40,400	$_____
Working capital	66,600	_____
TOTAL WORKING CAPITAL REQUIRED	$107,000	$_____

RECAPITULATION OF COSTS, SALES AND PROFITS

	Estimated Cost	Actual Cost
Total annual operating cost	$336,020	$_____
Depreciation	2,700	_____
Interest on loans	1,500	_____
Insurance	250	_____
Legal and auditing	1,000	_____
Unforeseen	5,920	_____
TOTAL OPERATING AND BURDEN COST	$347,400	$_____
Sales cost, including delivery	30,000	_____
Profit before taxes	66,600	_____
TOTAL ANNUAL SALES	$444,000	$_____

SALES

RETAIL DEALERS PROFIT

It is recommended that sales be made direct to the retailers rather than through a distributor. If this is done, the manufacturer can allow the retailer a greater margin than would be possible if the sales were made through a wholesaler. Because of this extra profit to the retailer, he will make a greater effort to increase the sales of the products of this plant.

The total estimated cost, including sales cost and profit, of one 26-inch bicycle produced in this plant is $32. A bicycle of this standard of quality should sell for $50, retail, which would give the retailer a profit of $18 on each bicycle sold, or more than 50 per cent of the amount he would pay for the bicycle. He would make a higher profit on the accessories and spare parts he would sell.

SALE OF ACCESSORIES AND SPARE PARTS

In addition to the sale of bicycles, there will be a large volume of accessories and spare parts sold. The accessories will be purchased packed, ready for reshipment.

The principal accessories would include such items as:

luggage carrier	balancer
basket	chain lock
mirror	rim lock
headlight	fender flaps
headlight battery	tire pump
horn	generator set
bell	siren
flash light	speedometer
saddle bags	tools

In addition, there will be sales of regular spare parts. The estimated annual sale of spare parts and accessories is $60,000, or about 16 per cent of the total receipts from the sale of bicycles. Since there is no labor to be performed on these accessories except handling and shipping, the profit on these sales will amount to about one third, or $20,000.

TOTAL ANNUAL SALES

Total annual sales of 12,000 bicycles at $32 each	$384,000
Total annual sales of accessories and spare parts	60,000
TOTAL ANNUAL SALES	$444,000

BUDGET CONTROL

A requisition form, page 26, is designed to provide accurate records and control of costs, both direct and indirect, with the least amount of time and effort.

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, water, fuel, are usually under contract and are easily checked by reference to monthly bills. For simplification such items (marked with an asterisk on the attached list) are omitted from the purchase requisition. Variations in the labor costs are easily reviewed by examination of the payroll. The simplified type of control thus provided makes certain that the manager can control expenditures promptly.

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 on any of the accounts, the bookkeeper will furnish the manager with a breakdown of all expenditures relative to the budgeted accounts exceeded. All these supporting data can be secured by reference to the purchase requisitions. 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 Expenditures	Monthly Budget	Annual Budget
10	Administration	$_____	$ 454	$ 5,450
20	Sales	_____	2,500	30,000
30	Welding rods	_____	83	1,000
31	Acetylene gas	_____	184	2,200
32	Oxygen	_____	225	2,700
33	Enamel	_____	196	2,350
34	Tools	_____	50	600
35	Purchased parts	_____	17,920	215,040
36	Cartons	_____	750	9,000
37	Tubing	_____	900	10,800
38	Lugs and posts	_____	120	1,440
39	Accessories	_____	2,500	30,000
40	Unforeseen expense	_____	493	5,920
*50	Indirect payroll	_____	1,283	15,400
*51	Direct payroll	_____	3,500	42,000
60	Freight in	_____	184	2,200
*70	Fuel, water, power	_____	108	1,300
		$_____	$31,400	$377,400

Note: Number 10 includes legal, insurance, interest and depreciation.

PURCHASE REQUISITION	BICYCLE PLANT	DATE:

INDICATE BELOW THE DEPARTMENT OR PROJECT IN WHICH THE MATERIAL WILL BE USED

( ) 10 ADMINISTRATION	( ) 32 OXYGEN	( ) 36 CARTONS
( ) 20	( ) 33 ENAMEL	( ) 37 TUBINGS
( ) 30	( ) 34 TOOLS	( ) 38 LUGS AND POSTS
( ) 31	( ) 35 PURCHASED PARTS	( ) 39 ACCESSORIES

INDICATE BELOW THE USE OF MATERIALS:
( ) 40 UNFORESEEN EXPENSE
( ) 60 FREIGHT IN

SPECIAL PROJECT:

NUMBER:

TITLE:

DESCRIPTION:

PLEASE ORDER THE FOLLOWING MATERIALS OR SERVICES

DELIVERY WANTED:

QUAN.	DESCRIPTION	UNIT	TOTAL	

QUOTES FROM		REQUISITION BY:	
		APPROVED BY:	
ORDER PLACED WITH		ORDER NO.	ORDER DATE

SUMMARY

A small bicycle plant built and operated to make bicycles according to the assumptions made in this brochure, 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 bicycle plant. Among the necessary determinations to be made are those with respect to the following items:

SALES

Will the potential annual sales amount to at least $444,000?

COSTS

After revising the estimates of cost and earnings shown in the brochure so they conform to actual local costs, where it is proposed to build the plant, will a profitable operation be indicated?

COMPETITION

Is there potential competition which will reduce the revenues below a profitable level, either by lowering prices or by reducing the volume of sales?

ORGANIZATION

Is there reasonable assurance that experienced men will be available for management and other key posts to initiate operations? Will suitable trainees be available for the permanent organization? The men in the key posts should be trained in advance of the initial operations of the plant.

A small bicycle plant, such as described in this brochure, when installed and operating, will serve as a good nucleus for a much larger industry when a larger plant is justified. The transition can be made by gradual growth.

Additional sizes and grades of bicycles can be manufactured and sold when the volume of sales would justify such expansion. The manufacture of children's tricycles would offer another possibility of expansion. The manufacture of motorcycles is a natural development from bicycle manufacture. From these to the making of small powered scooters is a reasonable advance to expect.

The same plant equipment could be used in the manufacture of wheel-chairs and some items of furniture, using welded tubing.

Since the manufacturing equipment, including the welding and enameling equipment, are standard items in many manufacturing plants, it is quite probable that the plant will develop a variety of products in response to local demand.

REFERENCES

BIBLIOGRAPHY

Bicycle manufacturing as a complete and independent process, has not been the subject of any recently published volume that would be of particular value in the establishment and operation of a small bicycle plant in a foreign country. An informative discussion of the history of the development of the bicycle, its important characteristics and some information on its manufacture is to be found in the Encyclopedia Brittanica.

The important manufacturing processes, other than assembling, included in the plant described herein are machining, including milling, punching, drilling, cutting, grinding and polishing, welding and enameling.

The machining processes are described in all standard textbooks and handbooks on machine shop practices. The welding and enamelling are also described in such books, but special details not described there will vary according to the source of supply and the nature of materials and equipment used. Suppliers will furnish adequate instructions for each.

Other references are as follows:

Mechanical Engineers' Handbook - Kent.
John Wiley and Sons, Incorporated
440 4th Avenue
New York 16, New York

Plant Engineering Handbook - W. Stantiar.
McGraw-Hill Book Company
330 West 42nd Street
New York 18, New York

Jigs and Fixtures for Mass Production.
Pitman Publishing Corporation
2 - 6 West 45th Street
New York 19, New York

Manufacturing Equipment and Processes - C. W. Lytle, et al.
International Textbook Company
1001 Wyoming Avenue
Scranton 9, Pennsylvania

Manufacturing Processes - N. L. Begeman.
John Wiley and Sons, Incorporated
440 4th Avenue
New York 16, New York

REFERENCES

PERIODICALS

Product Engineering	McGraw Hill Book Company, Incorporated 330 West 42nd Street New York 26, New York
Machine Design	Penton Publishing Company Penton Building Cleveland 13, Ohio

ENGINEERS

The services of professional engineers are desirable in the design of a bicycle plant, even though the proposed plant is small. A correct design is one that 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 in 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, D. C.

SUPPLIERS

This constitutes a partial list of suppliers of bicycle parts, subassemblies and accessories taken from the Thomas Register. The names of additional suppliers can be secured by reference to that volume, and other directories and trade publications.

BEARINGS

Wald Manufacturing Company
Maysville, Kentucky

The Perry Fay Company
1200 Perry Street
Elyria, Ohio

McLean Manufacturing Company
1442 East Davis
Arlington Heights, Illinois

Indus Corporation
1817 Madison Avenue
indianapolis, Indiana

Hartford Steel Ball Company, Incorporate
Hartford, Connecticut

BELLS

Star Brothers Bell Corporation
Summit Street
East Hampton, Connecticut

CHAINS

Acme Chain Corporation
425 Dwight Street
Holyoke, Massachusetts

COASTER BRAKES AND FRONT HUB

New Departure Division of General Motors
1955 Thomas
Bristol, Connecticut

Murray Ohio Manufacturing Company
1100 East 152nd Street
Cleveland, Ohio

CONTROLS

Stevens Adamson Manufacturing Company
257 Ridgeway Avenue
Aurora, Illinois

Shakespeare Products Company
Kalamazoo, Michigan

ENAMEL

E. I. duPont de Nemours and Company
Wilmington 98, Delaware

FENDERS

Elrae Pressed Metals, Incorporated
Sycamore and Grey Trail
Buffalo, New York

McCulley Metal Products, Incorporated
45 Latchworth
Buffalo, New York

FINISHING EQUIPMENT

DeVilbiss Company
300 Phillips Avenue
Toledo 1, Ohio

HANDLE BAR GRIPS

The Ohio Rubber Company
99 Ben Hur Avenue
Willoughby, Ohio

HANDLE BARS, PEDAL ARMS

Michigan Machining Company
East Detroit, Michigan

MUDGUARDS AND FORKS

Acklin Stamping Division of
Tecumseh Products Company
1926 Nebraska Avenue
Toledo, Ohio

NUTS

National Bolt and Nut Company
Myrtle Avenue and Broadway
Brooklyn, New York

PARTS

The Iseli Swiss Screw Machine Company
Greystone Road
Terryville, Connecticut

Northern Metal Products Company
West Grand Avenue
Franklin Park, Illinois

M. & S. Manufacturing Company
East Main and Railroad
Hudson, Michigan

Kalamazoo Stamping and Die Company
1850 Halmer Avenue
Kalamazoo, Michigan

Ashtabula Bow and Socket Company
4210 Ann Avenue
Ashtabula, Ohio

PUMPS

Peters and Russell, Incorporated
503 West Liberty
Springfield, Ohio

REFLECTORS AND MOUNTINGS

Dare Products, Incorporated
Betterly at Reynolds
Battle Creek, Michigan

RIMS

Williams Steel Wheel and Rim Company, Incorporated
1201 Burrstone Road
Utica, New York

SADDLE POSTS

Superior Plating Works
4690 West Palmer
Chicago, Illinois

SPOKES, NIPPLES, HANDLE BARS AND SPROCKETS

The Torrington Company
1000 Clark Street
Torrington, Connecticut

STANDS

Reflector - Hardware Corporation
2235 South Western Avenue
Chicago, Illinois

TIRES

United States Rubber Company
1230 Avenue of the Americas
New York 20, New York

TUBING

Republic Steel Corporation
Republic Building
Cleveland 1, Ohio

WASHERS

Freemay Washers and Stamping Company
Post Office Box 1756
Cleveland, Ohio

WELDING

Southern Oxygen Company
15 West 57th Street
New York 19, New York

WIRE FOR SPOKES

Wickwire Spencer Steel Division
The Colorado Fuel and Iron Corporation
575 Madison Avenue
New York, New York

WRENCHES

Apso Mossberg Company
10 Lamb
Attleboro, Massachusetts

TECHNICAL INQUIRY SERVICE REPORTS

Information relating to establishment of a manufacturing plant has been furnished by the Technical Inquiry Service in the following reports:

CHEMICAL AND RELATED PRODUCTS

Fermentation Ethyl Alcohol
Furfural
Laundry and Milled Toilet Soap
Pharmaceutical Products
Potash
Salicylic Acid
Small Fertilizer Plant
Sulphuric Acid
Vinyl Floor Tiles

FOOD PROCESSING

Candy and Confectionary
Carob Molasses
Crude Olive Oil
Dehydrated Molasses
Fish Meal
Fish and Shrimp Processing
Ice Cream
Molasses
Orange Juice
Rice
Rice Bran Oil
Salted Peanuts
Slaughtering and Meat Packing Plant
Soybean Processing
Starch
Unfermented Grape Juice
Wheat Flour
Wheat Milling

NOTE: Additional plant requirements data have also been published in longer plant operations and plant requirements reports, for industries listed in the Technical Aids Branch "Industrial Reports and Publications" bulletins.

METALS

Aluminum Architectural Specialties
Bicycles
Coil Springs
Copper Tubing
Copper Wire - Drawing and Insulating
Fluorescent Lamp Ballast
Fractional and Small Horsepower Electric Motors and Direct Starters for Squirrel-Cage Motors
Galvanized Steel Pipe
Latch Needles
Manganese
Metal Spinning
Mineral Wool
Ornamental Ironwork
Porcelain Enamelware
Primary Hardware
Radios
Recovery of Zinc
Rice Paddy Cultivators
Shallow Well Hand Pumps
Small Steel Melting Plant
Small Steel Rolling Mill
Split Gib-Head Keys and Solid Taper Pins
Stainless Steel Utensils
Storage Bins
Surgical Instruments
Tungsten Carbides
Wire Products

MISCELLANEOUS

Adhesive Tape
Automobile Batteries
Block Ice Making
Dry Cleaning
Souvenirs and Small Jewelry

RUBBER AND LEATHER

Camelback
Children's Shoes
Men's Dress Shoes
Rubber Cement
Rubber Floor Tiles
Rubber Soling
Rubberized Fabric
Small Leather Tannery
Tire Cord Bonding
V-Belts
Women's Shoes

TEXTILES

Cotton Crochet and Knitting Yarns
Cotton Yarn
Hooked Rugs
Jute Yarn
Nylon Hosiery
Surgical Cotton
Wool Scouring
Woolen Yarn
Worsted Yarns

STONE, CLAY AND GLASS

Asphalt Floor Tiles
Cement
Chalk Whiting

WOOD AND PAPER

Brooms
Boxes and Shooks
Creosoted Wood Products
Flush Doors
Hardwood Parquet Flooring
Lead Pencils
Paper Bags
Plywood
Refrigerated Walk-In Coolers
Sensitized Papers
Wood Wastes