PLANT REQUIREMENTS FOR MANUFACTURE OF BICYCLE TIRES AND TUBES

DEPARTMENT OF STATE
AGENCY FOR INTERNATIONAL DEVELOPMENT
COMMUNICATIONS RESOURCES DIVISION
Washington 25, 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 Agency for International Development, but merely a citation that is typical in its field.

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

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North Bergen, New Jersey

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Akron, Ohio

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BICYCLE TIRES AND TUBES

INTRODUCTION

The manufacturing plant described in this brochure is designed to produce bicycle tires made of natural rubber at the rate of approximately 500,000 per year. The tires considered here are of the pneumatic type that require an inner tube. This plant is assumed to produce natural rubber tubes at the same rate as the outer casings. Tire size is assumed to be either 26-inch or 28-inch diameter to fit an adult size bicycle.

It is recommended that the tube valve assemblies be purchased in large lots from specialty companies. Valve making machinery is expensive, and has very high production rates. Therefore, its purchase generally is not considered a sound investment for any but the largest manufacturers of pneumatic tires.

GENERAL ASSUMPTIONS

In order to make realistic estimates of annual costs, certain assumptions have been made. They are:

1. That adequate electric power, water, and sanitary facilities are available at the site;
2. That adequate transportation facilities are available for moving in supplies;
3. That there is an existing market large enough to absorb the above production capacity;
4. That all costs for buildings, equipment, materials, labor, and supplies are based on costs current today in the United States.
5. That experienced rubber technicians and the required semi-skilled laborers are available locally, or can be trained economically;

6. That all estimates are based on one 8-hour work shift per day and six days per week;

7. That while general assumptions will be made for each of the following items, for the purposes of completing cost estimates, adjustments should be made in accordance with local conditions:
   a. Freight or other transportation costs,
   b. Sales costs,
   c. Interest on capital, taxes, and insurance,
   d. Value of land required,
   e. Labor costs,
   f. Materials costs.

8. That the product is sold at the site, with the buyer taking delivery at the plant.

MANUFACTURING OPERATIONS

The efficient production of high quality bicycle tires and tubes required a thorough understanding of each step in the manufacturing process, plus a high degree of management skill to fully utilize the plant's labor force. Bicycle tire production is not a continuous flow operation. Many of the plant's personnel must be proficient at more than one task if all workers are to be profitably used for 8 hours per day. Proper scheduling of workers' time and the various steps in manufacture is necessary to maintain a constant daily output of finished tires and tubes. Proper scheduling also is necessary if minimum manufacturing costs are to be realized.

PROCEDURE OF MANUFACTURING

The manufacture of bicycle tires may be outlined as seven primary operations. Each operation may be considered separately from the others. Under the best conditions these operations require varying amounts of time to complete each day, if the output is to remain constant at 1,600 tires and tubes per day. Management effectiveness may be judged in great part by the manner in which the manufacturing operations are integrated and by the reduction of the labor force's non-productive time to a minimum.

The seven primary operations are:

1. Mixing raw rubber.
2. Rubberized fabric and tread production.
3. Bead production.
4. Tire building.
5. Tire curing.
6. Tube production.
7. Inspection and packaging.

Mixing

In the mixing operation, raw natural rubber is compounded with other substances into a homogenous mixture that can be rolled and extruded into slabs. Four types of compounded rubber stock are usually prepared in the manufacture of bicycle tires. These are tread stock, tube stock, coated fabric stock, and bead stock.

The exact composition of these compounded stocks varies with the manufacturer. It is possible to change the wearability of finished tires and tubes, and to change the workability of compounded rubber by making small changes in the proportions of ingredients that are mixed with the raw rubber during the mixing operation.

There are five main compounding ingredients: carbon black, processing oil, zinc oxide, accelerator and vulcanizing agents. A typical batch of tube stock will contain 64% natural rubber, 19% carbon black, 13% processing oil, about 1% vulcanizing agent, and less than 1% of a special accelerator chemical. These percentages will change for tread stock, which will have 53% rubber, 30% carbon black, 13% processing oil, less than 1% of a different type of accelerator chemical, and about 2% each of zinc oxide and vulcanizing agent. Bead stock and coated fabric stock will closely approximate tread stock. Small alterations in the formula are made to increase the stickiness of the coated fabric stock and to increase the toughness of the bead stock. Exact formula will change with the type of processing equipment used, type of raw rubber stock, etc.

Recommendations on formulas for compounded rubber stocks apparently are easy to obtain from established manufacturers. Very little information is considered proprietary in this industry.

The first step in the mixing process is to cut the bales of raw rubber into pieces small enough to be digested by the mixer. Batches of compounded stock weighing from 400 to 450 pounds are normally mixed at one time. The most economical and efficient mixer available today is the internal Banberry type. If open mills are used for mixing the work is very dirty, unpleasant and slow.

After leaving the mixer, each batch of compounded stock is run through a sheeting mill. The sulphur base vulcanizing agent is added to the batch during this process and all of the other ingredients are put into the mixer with the raw rubber. From the sheeting mill the stock goes through a strainer, or type of extruder and is then cut into slabs. These slabs usually measure about 3 by 4 feet, and are one inch or more thick. They are stacked on carts and kept in mixed stock storage until they are needed in subsequent manufacturing operations.

Normally, the mixing operation will have to be kept going continuously during each 8-hour shift to maintain an adequate supply of compounded stock.

Rubberized Fabric and Tread Production

Rubberized fabric and tire tread material are prepared separately, but some of the machinery used is common to both operations. Therefore, in most bicycle tire factories these operations are closely coordinated.

In a plant the size of the one under discussion, two 50- or 60- inch sheeting mills would be the machinery common to both operations.

During the final preparation of tire tread material, tire tread stock is taken from mixed stock storage and passed through the sheeting mills. From the sheeting mills the stock is put through an extruder that holds the material dimensions to a close tolerance. The output sheet from this continuous strip extruder is then cut into the proper lengths. The tread strips are placed on carts and stored until needed in the tire building operation.

First step in the preparation of rubberized fabric, which is used as the backbone or reinforcing ply in bicycle tires, is to heat and dry large rolls of the uncoated fabric. Experience has shown that cotton and a number of synthetic fabrics such as rayon are suitable for this use. However, cotton is still regarded as one of the most satisfactory.

After the fabric has been dried it is stored in a small room in which the temperature and humidity are closely controlled. The exact conditions in this room will vary with the type of fabric. The rolls of fabric are taken out of the storage room just before the calender operation is begun. The calender is a machine with three large rollers that press a thin sheet of sticky rubber into the fabric. If the cloth has not been properly dried, bubbles will appear in the rubberized fabric around any concentration of moisture.

When the calender is operating it requires the continuous output of the two sheeting mills. These mills roll coated fabric stock from mixed stock storage into thin sheets to feed directly into the calender.

The hot strip of coated fabric coming out of the calender is sticky. It must have a sheet of impervious duct material laid on top of it so that it will not stick together as it is rolled into large rolls. These rolls may be allowed to cool, and can be stored under room conditions until they are needed in the tire building operation.

Under normal conditions it will be possible for the calender to turn out the rubberized cloth needed for one day's tire production in a little more than 3 hours. The mills may then be used to feed the tire tread extruder, which will also have to be operated for slightly more than 3 hours to produce the tread material needed for 1,600 tires. It would also be possible for the calender crew to man the bead producing machinery and to prepare the beads needed for one day's use.

The time required to perform each of these three operations will vary due to many circumstances, but ordinarily it would break down into about 3 hours on the calender line, 3 hours on the tire tread line, and two hours on the bead producing line.

Bead Production

The production of beads for the edges of bicycle tires requires two materials. One is copper-plated steel wire, and the other is rubber bead wire stock prepared in the mixing operation.

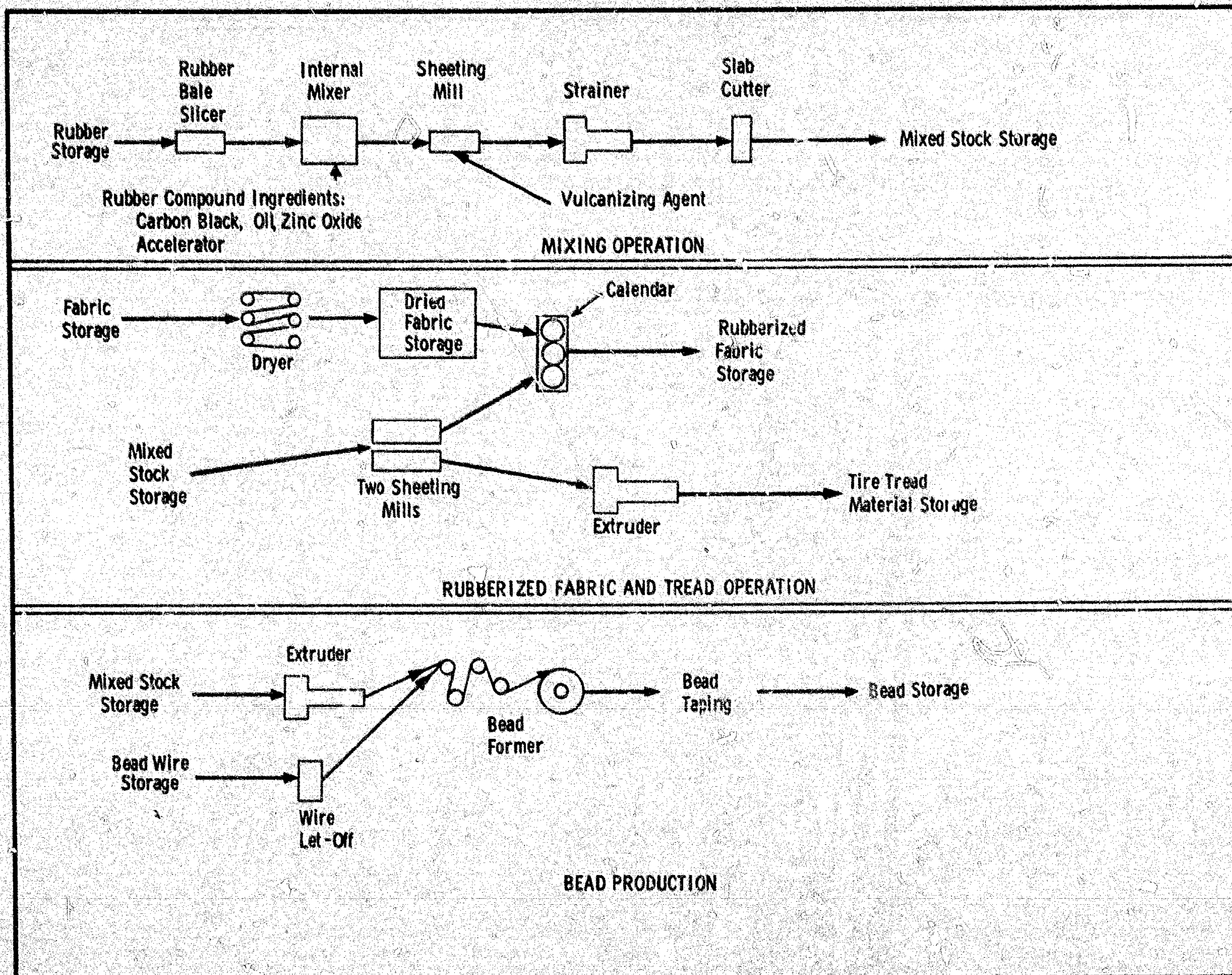
The rubber stock is passed through an extruder and formed into a long narrow strip. This rubber strip and four strands of wire are then fed into a series of rollers and the rubber is pressed around the wire to form a continuous length of bead material.

The bead material is cut into pieces approximately as long as the circumference of a bicycle tire rim. The pieces are bent into hoops and the ends bound together with rubber tape. These finished beads are then stored on small carts until they are needed in the tire building operation.

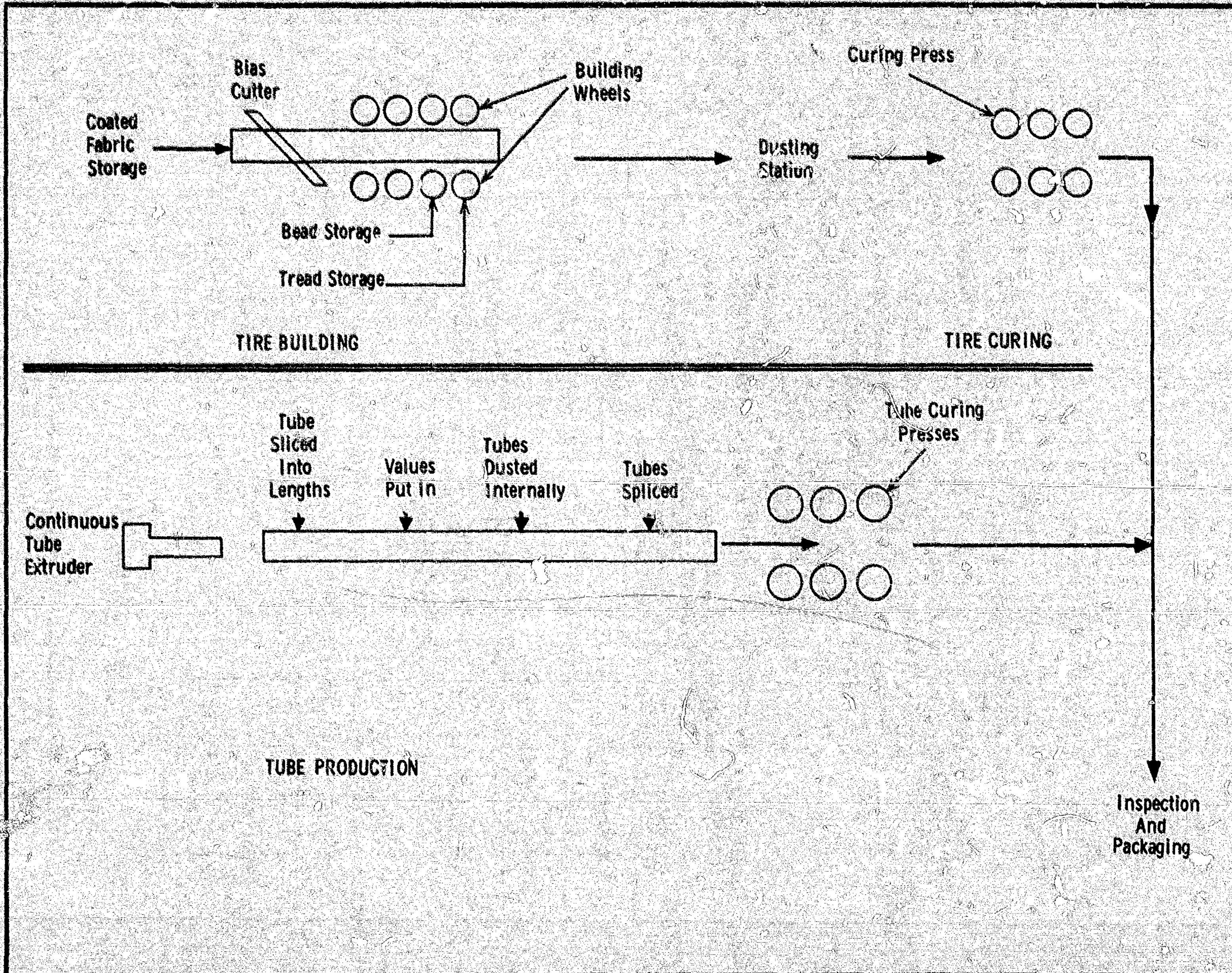
Tire Building

Tire building will be a continuous operation in the manufacturing plant described in this study. Ten to twelve steel building wheels will have to be manned during the entire working day. In this manufacturing step the materials are drawn from coated fabric storage, bead storage, and tread storage.

The large rolls of coated fabric are unrolled onto a long conveyor belt. As the fabric reaches the conveyor a large knife is used to cut the material on the bias. The worker operating this knife also has the task of keeping all of the tire builders supplied with the materials they need. The tire building wheels are located beside the conveyor belt feeding the



Rubber Storage
Rubber Bale Slicer
Internal Mixer
Sheeting Mill
Strainer
Slab Cutter
Mixed Stock Storage
Rubber Compound Ingredients: Carbon Black, Oil, Zinc Oxide Accelerator
Vulcanizing Agent
MIXING OPERATION
Fabric Storage
Dryer
Dried Fabric Storage
Calendar
Rubberized Fabric Storage
Mixed Stock Storage
Two Sheeting Mills
Extruder
Tire Tread Material Storage
RUBBERIZED FABRIC AND TREAD OPERATION
Mixed Stock Storage
Extruder
Bead Former
Bead Taping
Bead Storage
Bead Wire Storage
Wire Let-Off
BEAD PRODUCTION


Bias Cutter
Building Wheels
Curing Press
Coated Fabric Storage
Dusting Station
Bead Storage
Tread Storage
TIRE BUILDING
TIRE CURING
Tube Curing Presses
Tube Sliced Into Lengths
Values Put In
Tubes Dusted Internally
Tubes Spliced
Continuous Tube Extruder
TUBE PRODUCTION
Inspection And Packaging

bias cutter.

The worker at each building wheel must perform his task rapidly. He takes a piece of coated fabric and folds it double along its long axis so that there are two layers or plys to act as a backbone for the tire. The doubled fabric is laid around the building wheel. A piece of tread material is then rolled with a hand roller tightly against the rubberized fabric. Two coated bead wires are then pressed into the edges of the tread material and a solid tire case is formed.

These raw or "green" tire cases are removed from the building wheel by dismantling the wheel, which can be done quickly. The green tires are sent to a single work station where they are dusted with a mixture of mica and soapstone and then hung on pegs to await the curing operation.

Tire Curing

Tire curing or vulcanizing will be a continuous process, and maximum use must be made of the factory's twenty curing presses. It takes only six minutes to vulcanize either a tire or tube with modern equipment. Even though the press operator's task is relatively simple, he must work steadily to service the twenty presses every 6 minutes. To service a press the operator must open it, withdraw the finished tire, clean the mould out with a blast of compressed air, put a green tire into place, and close the press.

Two tire press operators are listed among the factory's workers so that they may relieve each other in servicing the presses. The operator not actively servicing the presses may dust green tires and arrange them so that a supply is kept on the peg by each press.

Tube Production

The exact methods of tube production will vary with the manufacturer. In a modern plant tubes usually are prepared on a small conveyor line. An extruder at the head of the line feeds tube stock from mixed stock storage. A continuous tube of sticky raw rubber is put out by this extruder and carried down the conveyor. A knife is used to cut the tube material into strips that are as long as the circumference of the tire. The cut is made at a 45-degree angle to the long axis of the tube.

A small hole is cut through one side of the tube and the valve is placed in this hole. As these lengths of tube material with valves in place move down the conveyor line they are coated on their inner surfaces with a mica dusting powder. The powder is blown into the insides of the tube with compressed air.

After this procedure the tubes are spliced. The two ends of the length of tube material are rolled together to accomplish this. The green tubes are then sent to the tube presses. The press operator inflates them before they are placed in the press and they remain inflated during the vulcanizing operation.

The presses that vulcanize tubes operate in approximately the same manner as tire presses.

Various degrees of mechanization can be built into the tube production line. The line considered in this report has six men working on the line and one press operator. These six men perform the following tasks; 1 man places the valves, 2 men blow powder into the tubes, and 3 men splicing and feeding the press operator, and one press operator. All of the other operations on the line are automatic.

Inspection and Packaging

The tires and tubes vulcanized in modern presses do not require any buffing or polishing. They are finished products ready for sale.

Inspection of the finished tires is done by eye, and any imperfections on the inner or outer surfaces can be detected readily. Tube inspection consists of the same kind of a check for imperfections in the outer surface, plus a leak check. Leaks are found by inflating the tubes and placing them on a very slow conveyor. If they leak, they will have lost most of their air by the time they reach the end of the conveyor.

Bicycle tires are normally shipped without wrapping. Several tires are bound together with cord and no other covering is required. In this report, it is considered that the tubes will be individually boxed and the cost of these boxes is included in the list of direct material expenses. It would be possible to reduce this expense by 85% if the tubes were wrapped in plain heavy paper for shipment.

PLANT SITE

A plot of ground with about 12,000 square feet of level area will be the smallest size on which the bicycle tire plant described here should be built. The building will occupy about 11,000 square feet. The remaining area will accommodate vehicles for pickup and delivery of materials and finished product.

The plant site must be accessible to electric power, water and sewage facilities. An exceptionally large volume of water will be required.

The site should be convenient to an appropriate transportation terminal, and should be as close to the market area as possible. The cost of the plant site will vary widely according to the location. For this reason, an arbitrary sum of $2,000.00 is used in this report.

BUILDING REQUIREMENTS

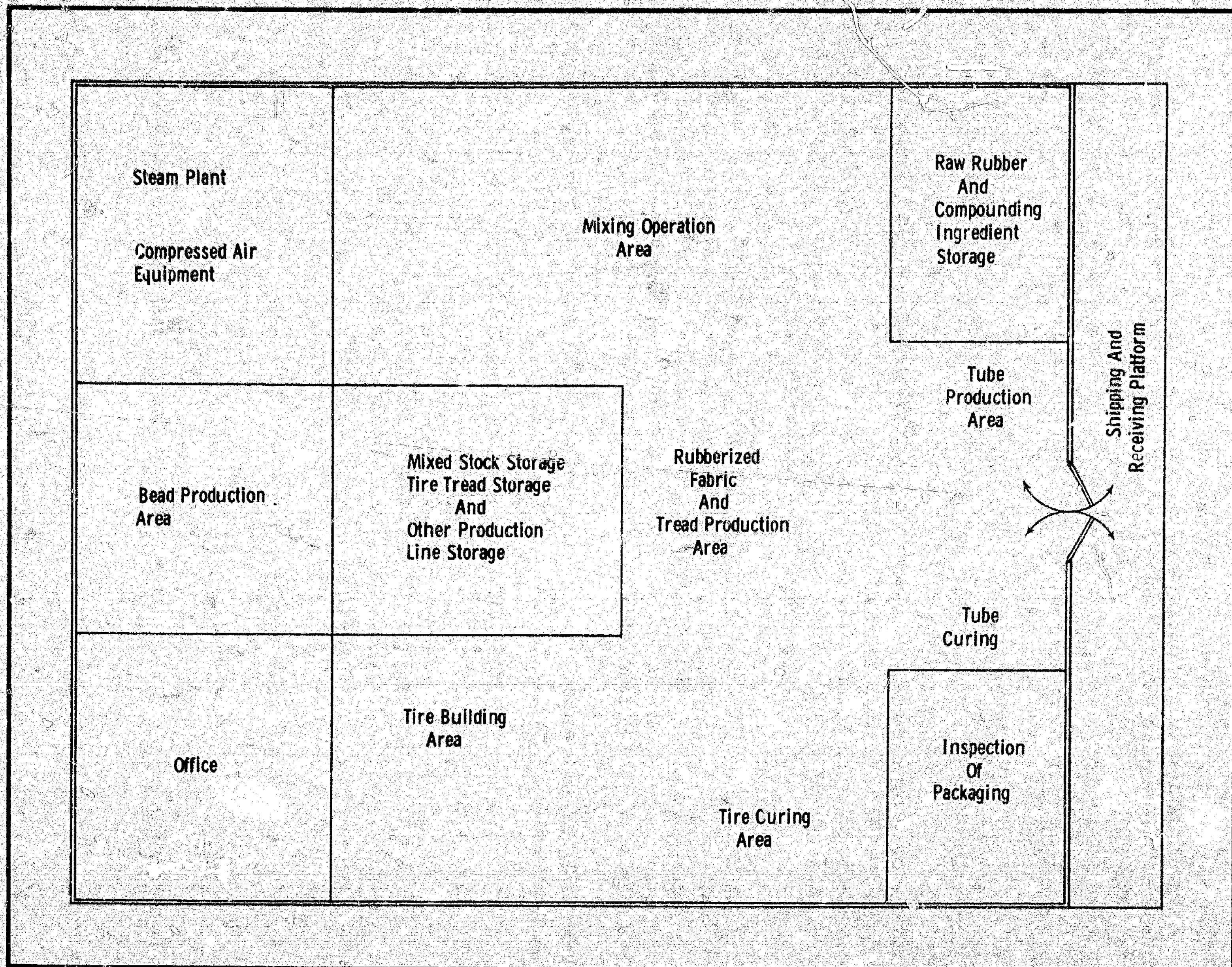
A building with approximately 10,000 square feet of floor space will be needed to produce 1,600 bicycle tires and tubes each day. The size of the building will vary considerably depending on the inventory of raw material and finished stock maintained.

In the United States a building built of cinder blocks or brick would cost about $5.00 per square foot to construct. Ceilings should be about 15 feet high, except in the area of the internal mixer. This cost figure includes plumbing, ventilation, and normal industrial wiring installation. Therefore, the total building cost of the factory area is estimated at $50,000.

In addition to the production area, about 1,000 square feet will be needed for the office and sales functions. This additional floor space will make the total cost of the building about $55,000.

A possible arrangement of facilities in an 11,000 square foot area is shown in figure 2. Specific areas will vary in size depending on the type of equipment installed and the quantities of raw materials and finished product kept on hand. For this reason, no individual sizes have been shown.

Two of the primary considerations leading to the plant layout shown are: (1) production line storage, such as mixed stock storage should be convenient to all of the production operation


Steam Plant
Compressed Air Equipment
Mixing Operation Area
Raw Rubber And Compounding Ingredient Storage
Shipping And Receiving Platform
Tube Production Area
Bead Production Area
Mixed Stock Storage Tire Tread Storage And Other Production Line Storage
Rubberized Fabric And Tread Production Area
Tube Curing
Office
Tire Building Area
Tire Curing Area
Inspection Of Packaging

areas and the stock is stored on small truck and dollies for easy handling; (2) the relatively noisy operations such as the mixing and curing operations are located as far as possible from the office while quiet processes such as bead production and tire building machines are placed close to the office area.

POWER

A dependable supply of electricity is required, and it is assumed that this will be available. Electricity is needed for lighting and for the operation of all of the manufacturing equipment. Standard industrial wiring is adequate. The total annual power requirement is estimated at 790,000 kilowatt-hours. At representative U.S. rates this would make the annual power cost about $22,000.

WATER

A large volume of water is needed at any rubber factory to cool the high temperature machinery that processes the rubber stock. It is estimated that 45,000 gallons of water per day will be needed to cool the mills, extruders, calender, etc. This estimate includes the water used for cleaning equipment, drinking and sanitary purposes. Annual water requirement is predicted to be 14,000,000 gallons, with an annual cost of $5,000.

In many sections of the United States and in many parts of the world the cost of using this amount of water would be considerably higher than this estimate. If a new bicycle tire plant were not located in a region with a plentiful and inexpensive supply of water, it would be wise to consider the purchase of a regenerative water cooling system so that a smaller amount of cooling water might be recycled and thence used again.

It is assumed in this report that cooling water is available and can be used once and then discharged to a sewer.

FUEL

Fuel is required to run the steam plant that provides steam to heat the tire and tube presses and for heating the building. Coal, gas, or oil may be used as this fuel. Costs are estimated at about $5.00 per day for fuel, or $1565.00 per year.

EQUIPMENT LIST

Item	Intended Use	Capacity
Internal Banberry mixer.	Mix raw rubber with compounding chemicals.	Up to 500 lb. batches of compounded rubber.
Rubber slicer.	Slice bales of natural rubber into small pieces.	Bales 3 ft. on a side.
Sheeting mills.	Roll compounded rubber into sheets.	50 - 60 inches wide.
Strainer.	Rough type extruder.	6 - 8 inch.
Slab cutter.	Slice output from extruder into pieces about 1-ft. long.	6 to 8 inch.
Dryer.	Dry fabric.	66 inch.

Calender.	Roll fabric and rubber sheets together to produce rubberized fabric.	66 inch.
Extruder for tire tread material	Close tolerance extruder.	6 inch.
Bead insulating setup.	Produce beads.	28 inch.
Bias cutter.	Cut fabric on the bias.	66 inch.
Building wheels.	Lay up tire components.	28 inch.
Curing moulds (tires).	Vulcanizing treads.	28 inch.
Curing moulds (tubes).	Vulcanizing tubes.	28 inch.
Curing presses (tires).	Ovens to heat the vulcanizing moulds.	Dual presses.
Curing presses (tubes).	Ovens to heat the vulcanizing moulds.	Single presses.
Steam plant.	Provide steam for presses and other uses.	10,000 lb. per day.
Compressed air machine.	Air needed to operate presses.	200 cfm.

MACHINERY AND EQUIPMENT

Internal Banberry Mixer

This type of internal mixer is named for its inventor, and eliminates the strong odors and unpleasant plant conditions that result from mixing raw rubber with chemicals in an open vessel. Large rotating arms in the mixer constantly pull the mass of rubber apart and turn it back together again.

The output from this mixer is a completely homogenous mixture of natural rubber and chemicals. It is known as compounded rubber.

Rubber Slicer

The rubber slicer is a large mechanical knife resembling a guillotine. It is used to cut bales of raw rubber into small pieces that can be handled by the internal mixer.

Sheeting Mills

These mills are used to roll compounded rubber into large sheets that can be fed into forming machines such as extruders, calenders, etc. The sheeting mills perform two important functions in preparing the rubber for the forming machines. First, they roll the rubber into smooth constant-thickness sheets. Second, they thoroughly heat the rubber to a temperature of several hundred degrees so that it can be worked easily.

Strainer

The strainer is a rough type of extruder that takes the compounded rubber output from the Banberry mixer and the sheeting mills that work with it, and extrudes it into a continuous strip 6 to 8 inches wide and about 2 inches thick. The primary purpose of producing this strip is to get the compounded rubber into a form that is easy to store.

Slab Cutter

The slab cutter takes the output strip from the strainer described above and cuts this into lengths about one foot long. These slabs are then stacked on carts and wheeled into the storage area until needed on the production line.

Dryer

The fabric dryer is a machine with heated rollers arranged in two vertical rows. The tire fabric is run between the rollers and heated to completely free it of moisture. After the rolls of fabric have been dried they are placed in a room in which the temperature and humidity are closely controlled. The air in the room is kept as dry as possible and the temperature is kept above 75 degrees F.

Calender

The calender is a large, heavy machine with three large rollers. A continuous strip of hot rubber from a sheeting mill is fed into the calender with a continuous strip of dry cloth, and the two strips are pressed together under great pressure from the three main rollers in the calender. The output from this machine is a strip of rubberized fabric that is rolled up and stored until needed on the tire building line. A strip of impervious duck cloth is placed on top of the sticky rubberized fabric as it comes out of the calender so that it will not stick together as it is rolled up.

Extruder for Tire Tread Material

The tire tread extruder is a high tolerance rubber extruder that holds its continuous output strip to a close thickness and width dimension. An automatic knife working on this machine cuts material for treads into strips of the proper length.

Bead Insulating Setup

In most bicycle tire factories this equipment is put together by the plant engineering staff. It consists of a simple set of squeezing rollers that press four copper-plated steel wires into a narrow strip of compounded rubber. The output strip from these rollers is cut into the proper lengths. These lengths are bent into hoops and the ends bound together by hand. Uncured rubber is used to bind the ends together.

Bias Cutter

The bias cutter is a large table that can be fitted with a knife above it into a conveyor line. Rubberized fabric passing down this line is cut at a 45-degree angle to its centerline by the knife. The knife is suspended on a horizontal rod above the table. This rod is set at the proper cutting angle and the cutting can be accomplished by simply drawing the knife across the table. The knife may be actuated both manually or by motor.

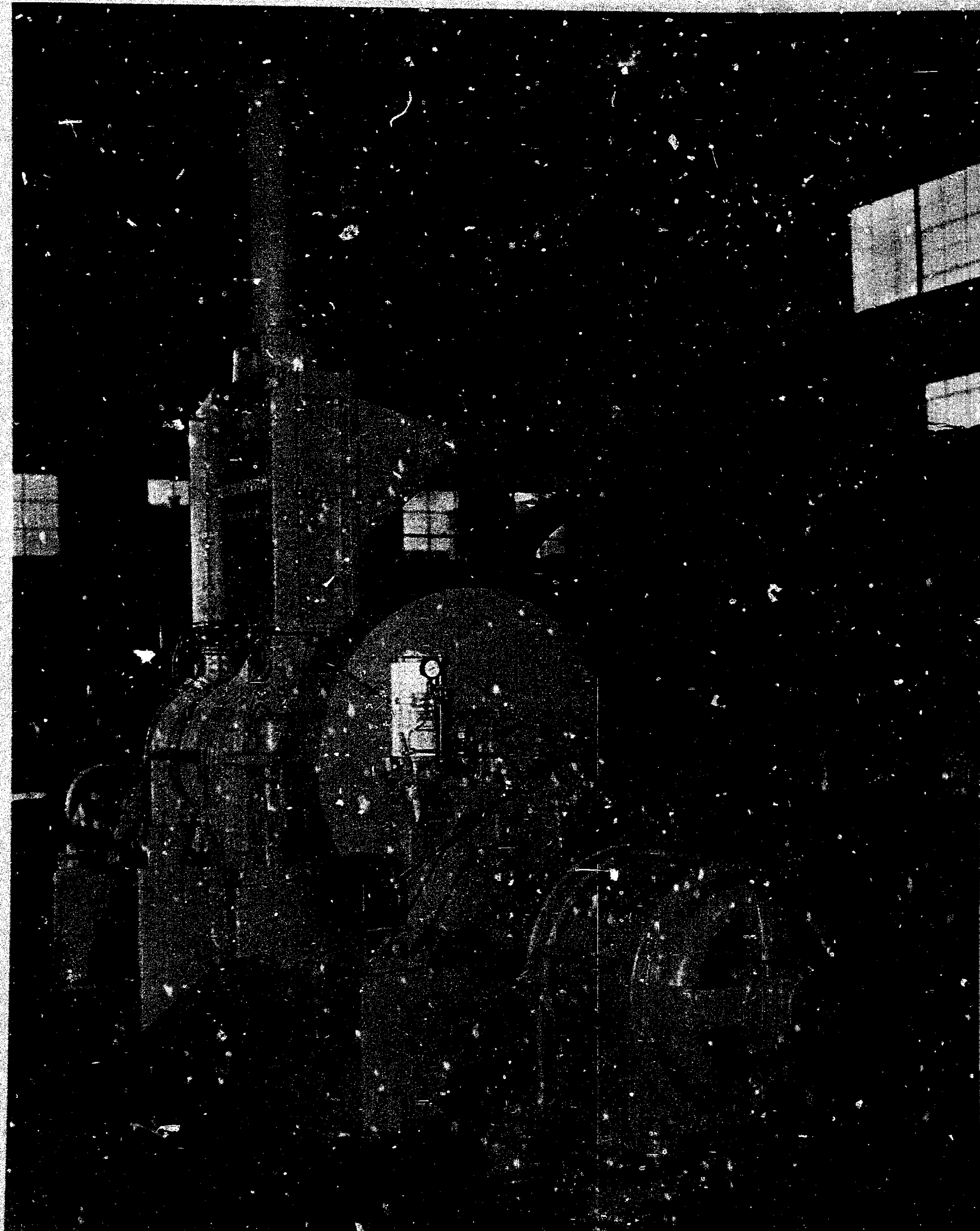


Figure 3. Banberry Mixer

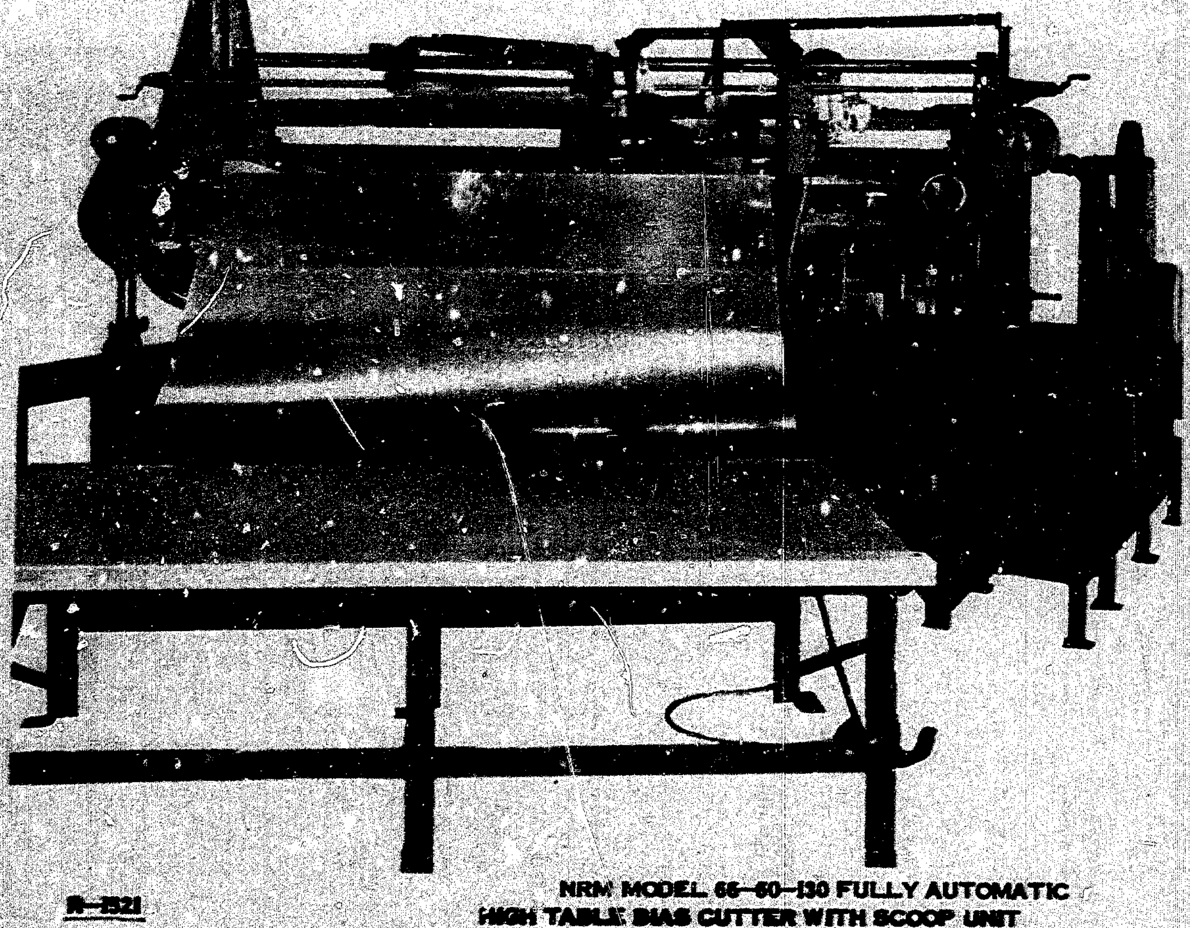


Figure 4. High Table Bias Cutter

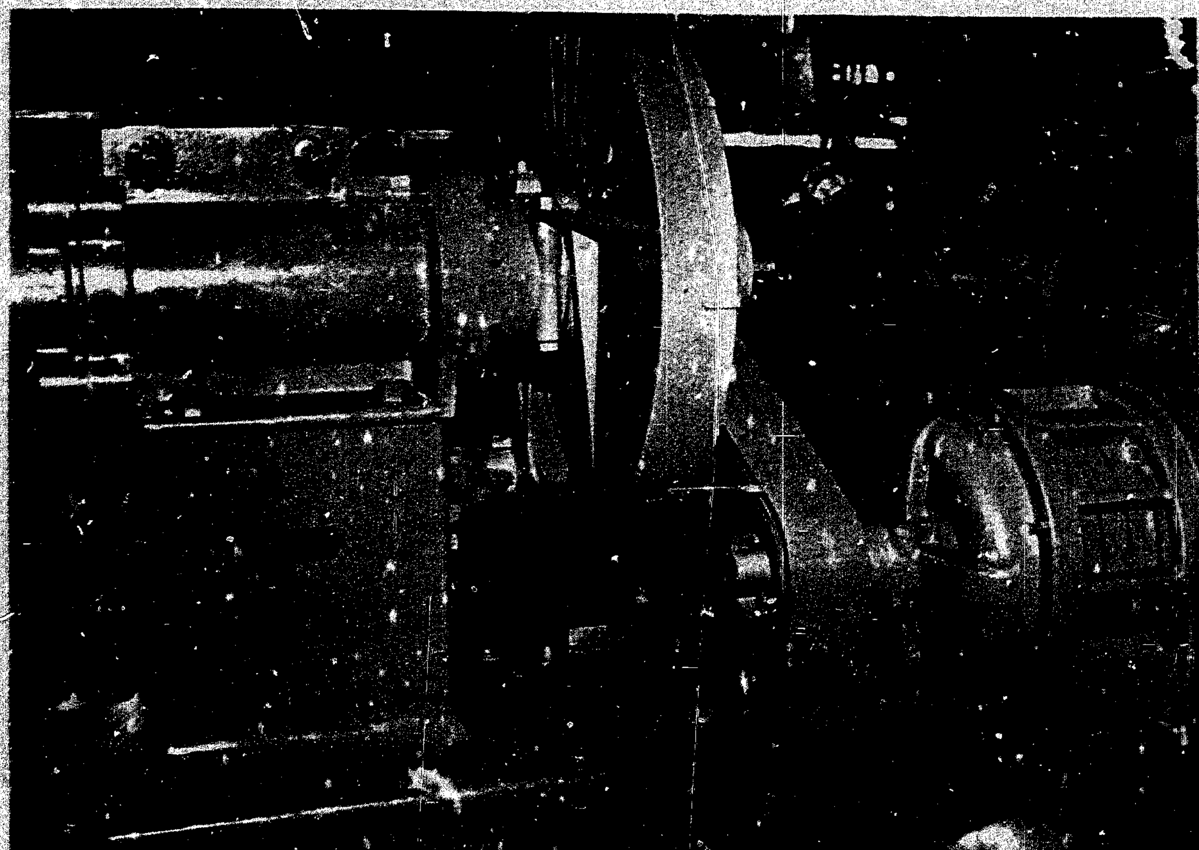


Figure 5. Rubber Extruder

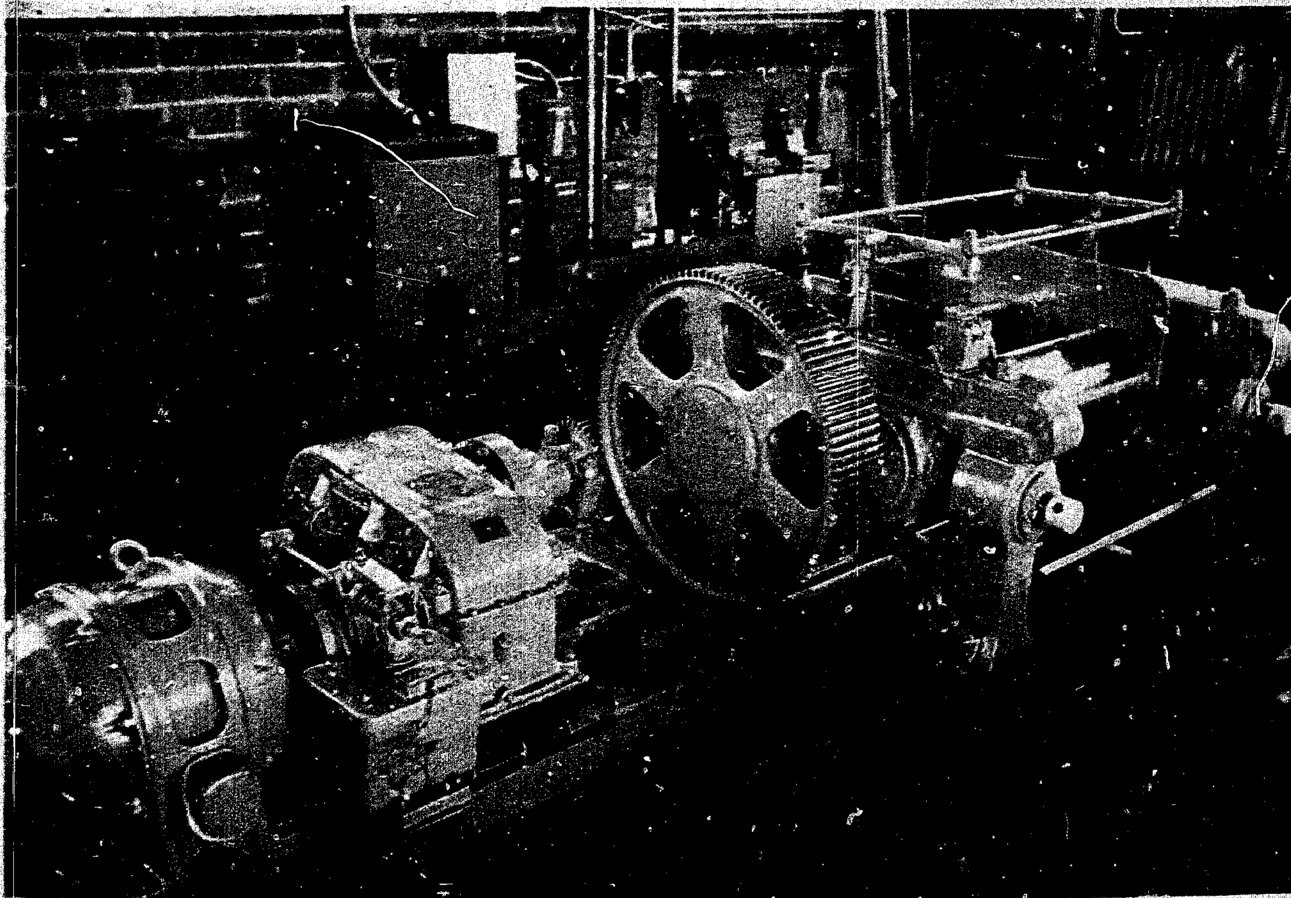


Figure 6. Mill Unit

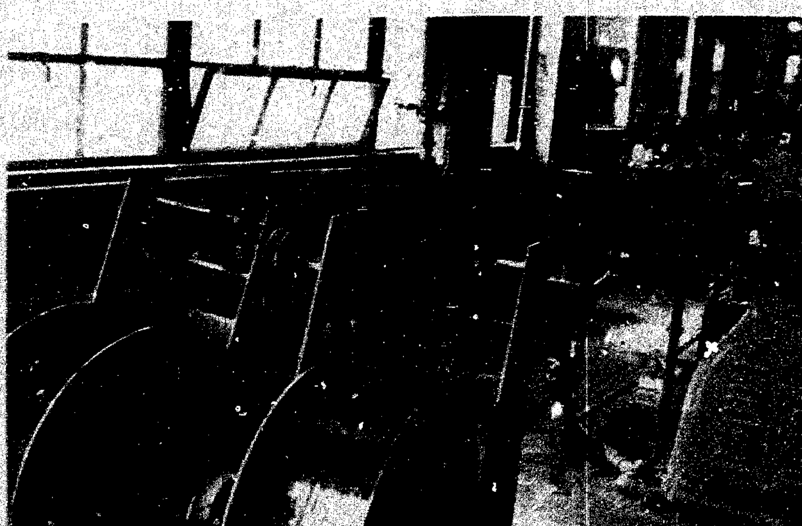


Figure 7. Bead Setup

PRODUCTION EQUIPMENT

Item	No.	Estimated Cost	Actual Cost
Internal Mixer	1	$50,000.00	
Rubber Slicer	1	2,000.00	
Sheeting Mills	3	90,000.00	
Slab Cutter	1	4,000.00	
Strainer	1	15,000.00	
Dryer	1	25,000.00	
Calender	1	50,000.00	
Extruder	3	30,000.00	
Bead Insulating and Winding Set-up	1	1,000.00	
Bias Cutter	1	10,000.00	
Building Wheels	12	3,000.00	
Curing Molds - Tires	20	36,000.00	
Curing Molds - Tubes	20	24,000.00	
Dual Presses for Vulcanizing Tires	10	110,000.00	
Single Presses for Vulcanizing Tubes	20	80,000.00	
Production Line Machinery for Tubes	1	5,000.00	
Steam Production Equipment	1	50,000.00	
Compressed Air Production Equipment	1	2,000.00	
TOTAL Cost of Major Equipment		587,000.00	
Miscellaneous Equipment: such as hand trucks, conveyors etc.		10,000.00	
TOTAL Equipment Cost		$597,000.00	

This tabulation shows the estimated cost for the major equipment needed for a bicycle tire factory producing 1,[illegible]00 tires and tubes per day. A lump sum of $10,000 was used for the cost of miscellaneous equipment that will also be needed. If the factory equipment is purchased on a turnkey basis, through a consulting engineering firm, it can be assumed that the planning and detailed engineering will add 8 to 10% to the total cost.

While the above estimated prices are averages for new equipment, there is a large supply of excellent reconditioned used machinery that is available at prices from 30 to 50 percent below those quoted. Used machinery is available from both rubber machinery manufacturers and companies that make rubber products.

The above production equipment is considered the minimum requirement. Many operations are assumed to be performed by hand. With the listed equipment, for example, it is necessary to package the finished tubes and bundle the finished tires by hand.

A representative list of equipment manufacturers is given in the following. This is not intended to be a complete or recommended listing of companies. Actual selection of the equipment should be made by a professional rubber engineer.

McNeil Machine and Engineering Co.
96 East Crosier Street
Akron, Ohio

Bedford-Bolling Company
3190 East 65th Street
Cleveland, Ohio

Farrell-Birmingham Company
Ansonia, Connecticut

National Rubber Machinery Company
47 West Exchange Street
Akron, Ohio

Continental Machinery Company
261 Broadway
New York, New York

Tire Machinery Corporation of America
1034 Home Avenue
Akron, Ohio

Reliable Rubber & Plastic Machinery Co., Inc.
2008-14 Union Turnpike
North Bergen, New Jersey

P. E. Albert & Son
21 Nottingham Way
Trenton 3, New Jersey

DIRECT MATERIALS COSTS

Item	Pounds per day	Average Cost/lb (cents)	Daily cost	Pounds per year (313 days)	Annual estimated cost	Annual actual cost
Rubber	1,700	27	$459.00	532,100	$143,667.00	
Carbon black	810	8.5	68.85	253,530	21,550.05	
Process oil	400	2.25	9.00	125,200	2,817.00	
Zinc oxide	63	15	9.45	19,719	2,957.85	
Accelerator Type A-tubes	4	125	5.00	1,252	1,565.00	
Accelerator Type B-tires	20	110	22.00	6,260	6,886.00	
Vulcanizing agent	53	2	1.06	16,589	331.78	
Fabric	1000	40	400.00	313,000	125,200.00	
Bead wire	385	15	57.75	120,505	18,075.75	
Tube boxes	1,600	7.5	120.00	500,800	37,560.00	
Valves	1,600	12	192.00	500,800	60,096.00	
			$1,344.11		$420,706.00	

DIRECT LABOR REQUIREMENTS

Skill	Number	Hourly rate	Estimated daily cost (8 hrs.)	Estimated annual cost (2504 hrs.)	Actual annual cost
Mixer Operator	2	$2.00	$32.00	$10,016.00	
Sheeting Mill Operator	3	1.95	46.80	14,648.40	
Calender Operator	5	2.50	100.00	31,300.00	
Tire Press Operator	2	1.95	31.20	9,765.60	
Tire Builder	10	1.60	128.00	40,064.00	
Bias Cutter Operator	1	1.75	14.00	4,382.00	
Tube Line Operators	7	1.80	100.80	31,550.40	
Inspectors & Shipping Packers	2	1.70	27.20	8,513.60	
Helpers 1-Mixing Operation 1-Calender Operation	2	1.50	24.00	7,512.00	
		Total		$157,752.00	

The tabulation above shows the direct labor required to produce 1,600 tires and tubes per day. The hourly wage scale is believed to be about average for the United States tire industry. This relatively small industry follows the wage practices of the majority of the rubber industry, however, and most of the workers are employed under some type of incentive plan. These plans provide the worker with a basic wage that can be increased if the production rate is high.

The number of workers listed above are considered to be the minimum for the factory here considered. It will be necessary for all of the workers to be skilled at their jobs when the plant first begins to operate or it will not be possible to maintain the prescribed production rate.

INDIRECT LABOR REQUIREMENTS

Skill	Number	Estimated annual salary	Actual annual salary
Manager	1	$12,000	
Plant Engineer	1	9,000	
Bookkeeper	1	7,000	
Secretary	1	6,000	
Clerk	1	5,000	
Maintenance Supervisor	1	8,000	
Maintenance Mechanics	2	13,000	
Electrician	1	7,000	
Housekeeper	3	13,500	
	Total	$80,500	

FURNITURE AND FIXTURES

Item	Number	Estimated cost	Actual cost
Desk and Chair Set	5	$375.00	
Filing Cabinet	4	100.00	
Typewriter	2	150.00	
Adding Machine	1	100.00	
General Fixtures	--	200.00	
		$925.00	

SUPPLIES

Item	Estimated annual cost	Actual annual cost
Office Supplies	$500.00	
Plant Supplies		
Cleaning and Housekeeping	1,000.00	
Indirect Expendable Items	200.00	
Equipment Maintenance Supplies	3,000.00	
Total	$4,700.00	

FIXED ASSETS

Item	Estimated cost	Actual cost
Land	$2,000.00	
Building		
Portion chargeable to direct	50,000.00	
Portion chargeable to indirect	5,000.00	
Production Equipment	597,000.00	
Furniture and Fixtures	925.00	
	$654,925.00	

DEPRECIATION

Item	Estimated cost	Estimated life (years)	Estimated annual depreciation	Actual annual depreciation
Direct:				
Building	$50,000.00	25	$2,000.00	
Equipment	597,000.00	10	59,700.00	
			$61,700.00	
Indirect:				
Building	5,000.00	25	200.00	
Furniture and Fixtures	925.00	5	185.00	
			$385.00	
Total			$62,085.00	

MANUFACTURING OVERHEAD

Item	Estimated annual rate	Actual annual rate
Power, Fuel and Water	$28,565.00	
Depreciation	61,700.00	
Supplies	4,200.00	
Employee Fringe Benefits	5,000.00	
Total	$99,465.00	

GENERAL EXPENSES & SELLING COSTS

Item	Estimated annual rate	Actual annual rate
Indirect labor	$80,500.00	
Depreciation	385.00	
Supplies	500.00	
Insurance and real estate taxes	4,000.00	
Selling costs	15,000.00	
	$100,385.00	

TOTAL ANNUAL COSTS

Item	Estimated annual cost	Actual annual cost
Production:		
Direct materials	$420,706.00	
Direct labor	157,752.00	
Manufacturing overhead	99,465.00	
	677,923.00	
General expenses and selling cost	100,385.00	
	$778,308.00	

WORKING CAPITAL

The working capital required will depend upon the ease with which raw materials can be obtained. If the tire factory is located a great distance from the supply source and materials must be purchased in large lots and stockpiled the working capital requirement will be high. The terms of sale of the factory's product can affect the required amount of working capital also.

When raw materials may be purchased readily, it is estimated that a working capital of $127,000.00 would be sufficient to begin production. This constitutes a 60-day coverage of manufacturing plus overhead costs.

CAPITAL REQUIREMENTS

Item	Estimated amount	Actual amount
Fixed Assets	$654,925.00	
Working Capital	127,000.00	
	$781,925.00	

SALES REVENUE

Annual Production (Tires and Tubes)	Sales price	Estimated annual sales	Actual annual sales
500,000	$1.90 per tire and tube set	$950,000.00	

The tabulation above is based on a daily production of 1,600 tires and tubes and 100 per cent sales.

RECAPITULATION OF COSTS, SALES AND PROFITS

Item	Estimated annual costs	Actual annual costs
Sales Revenue	$950,000.00	
Production costs	778,308.00	
Profit before taxes	$171,692.00	

It must be emphasized that this estimate of profit is a rough approximation that should be used only as a starting point in planning a bicycle tire manufacturing operation. When an actual locale is considered, many variations in costs estimates and predicted earnings can be expected.

TRAINING

In some areas skilled workers are available locally. In other areas most of the workers may have to be trained entirely. If ample skilled workers are not available, adequate training would be assured by using one or more of the following methods.

1. If the plant is designed and installed by a competant engineering firm, the contract should be negotiated, if possible, on a turnkey 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, because the new workers would have an opportunity to train on the job under experienced people who were capable of maintaining full quality and quantity production.

2. 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 plant. This would provide training while the plant is being installed.

3. 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 these tasks, and to assist in the training of the organization, even if they must be procured from outside the country. The manager, above all, should have years of experience in this type of business, and be fully qualified in all phases of management, including the training of new and unskilled employees.

SAFETY

The requirement for and the cost of a safety program in any manufacturing plant can be justified on both an economic and a humanitarian basis. Some of the economic reasons are: reduced labor turnover, less machine shutdown time, less repair cost, and less labor time lost.

There is always the possibility of receiving burns and having hands caught in open machinery in a bicycle tire plant. All machinery that can be covered should be equipped with safety guards. However, sheeting mills, calenders, etc. cannot be designed without having some of the rollers exposed. Employees should be constantly cautioned about the danger of getting either hands or clothing caught in these machines.

Safety manuals are usually furnished with each piece of equipment. These should be issued to the operators of the equipment and reviewed at regular intervals. Most critical safety instructions for operators should be displayed on signs near the machines.

Clearly marked aisles for walking personnel and movement of materials should be laid down in the plant. Some provision should be made for a first aid station.

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

SUMMARY

A bicycle tire manufacturing plant, built and operated according to the assumptions made in this study, would be a profitable undertaking.

These 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 the majority of materials and supplies available locally?

2. Is the local material market competitive?

3. Is satisfactory delivery of local materials assured at reasonable prices?

4. What materials and supplies must be imported?

5. Are they available in world markets at competitive prices?

6. Would prompt delivery of imported materials and supplies be assured to that large inventories would not be required?

MARKET FACTORS

1. Is there already a demand for the product?

2. How is demand for the product now satisfied?

3. What is the estimated annual increase in local consumption over the next five years?

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? 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?

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 marketing and distribution facilities for the product exist?

3. What types of organizations will the product be sold to?

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?

PERSONNEL

1. Is there an adequate skilled labor supply near the plant location?

2. Can the problem of training competent management and supervisory personnel be solved?

LAWS AND REGULATIONS

1. Do existing labor laws, government regulations, laws and taxes favor establishment of new business?

FINANCIAL FACTORS

1. Technical advise 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. The time required to liquidate credit sales to customers and bad debts?

d. The period necessary to get the plant into production?

e. Cash required to amortize its principal 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 projects and on working capital requirements?

SHORT TERM BANK CREDITS

1. Has it been possible to make arrangements with local banks to finance short-term 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?

INDUSTRY ORGANIZATIONS

The following professional organizations would be able to supply detailed information pertinent to the establishment of a plant such as the one described in this report.

American Society of Mechanical Engineers, 29 W. 39th St., New York 18, New York
Natural Rubber Bureau, 1108 16th St., N.W., Washington, D.C.
Tire & Rim Association, Inc., 2001 First National Tower, Akron, Ohio
Rubber Export Association, 1185 E. Market St., Akron, Ohio
Rubber Manufacturers Association, 444 Madison Avenue, New York 22, New York
Wheel & Rim Association, 3365 Locust Boulevard, St. Louis, Missouri

ENGINEERS

Primarily three firms in the United States are engaged in the manufacture of bicycle tires and tubes. The most current knowledge of this business is concentrated in these firms.

Carlisle Tire and Rubber Company
Carlisle, Pennsylvania

U. S. Rubber Company
1230 Avenue of the Americas
New York 20, New York

Goodyear Tire and Rubber Company
1144 E. Market Street
Akron, Ohio

It is possible that any of these companies might be engaged to provide engineering assistance in the establishment of a bicycle tire and tube plant outside of the United States.

While consulting and engineering firms in the United States have had little experience in setting up tire factories, many of these firms have had a wide variety of experience in the establishment of factories of all kinds. Three of these firms are listed below, and a more complete list can be obtained through the societies listed in the previous section of this report.

Arthur D. Little, Inc.
1725 Eye Street, N. W.
Washington, D. C.

George Fry & Associates
910 17th Street, N. W.
Washington, D. C.

F. W. McBryde Associates
1314 15th Street, N. W.
Washington, D. C.

The Wellman Engineering Company
113 St. Clair Avenue, N. E.
Cleveland 14, Ohio

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Pneumatic Tires, Henry Clemens Pearson, The India Rubber Publishing Co., 1922, Libary of Congress # TL270.P4

The Cumberland Tire and Tube Co., Adolph Matz and John H. McMichael, Southwestern Publishing Co., Cincinnati 27, Ohio, 1957

Accounting and Costs as Tool of Management for Control and Analysis, Technical Aids Branch, Office of Industrial Resources, International Cooperation, 1959, Washington 25, D. C.

PERIODICALS

Rubber Age, Palmerton Publishing Co., 101 W. 31st Street, New York, New York
Technical News Bulletin, U. S. Bureau of Standards, Washington 25, D. C.
Journal of the American Society of Mechanical Engineers, 29 W. 39th St., New York 18, N.Y.
Tire and Rim Association Yearbook, Tire and Rim Association, Inc., 2001 First National Tower, Akron, Ohio
Rubber Manufacturers Association Yearbook, Rubber Manufacturers Association, 444 Madison Avenue, New York 22, New York
Rubber World, Bill Brothers Publishing Co., Philadelphia, Pennsylvania