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## FOREWORD

The purpose of this report is to present basic information for establishing and operating a small plant to manufacture paint and varnish brushes in a country with a tropical or semi-tropical climate. The information includes general manufacturing methods, plant layout, and costs of materials, equipment, and labor, based on the general assumptions contained in this report.

The plant described is considered to be the economic minimum in size which utilizes suitable equipment and methods. Products are to be simple and varieties limited in order that costs may be kept to a minimum.

As an essential preliminary, potential plant operators must determine whether or not there is a market for the products of this plant. Naturally, they must be willing to assume the risks inherent in any business. The profits shown in the profit and loss statement are illustrative and depend upon market conditions, good management, and local factors.

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

This report is one of a series prepared for the Office of Industrial Resources of the FOREIGN OPERATIONS ADMINISTRATION by the Wolf Management Engineering Company, Chicago, Illinois.

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## TABLE OF CONTENTS

	<u>Page</u>
Introduction	1
General Assumptions	2
The Manufacture of Paint and Varnish Brushes	2
(1) Sterilizing	2
(2) Sizing and Hand Mixing	3
(3) Machine Mixing	3
(4) Butting	3
(5) Brushmaking	3
(6) Vulcanizing	4
(7) Inserting	4
(8) Nailing	4
(9) Beating-Out	4
(10) Stamping	4
(11) Finishing	5
(12) Shipping	5
(13) Inspection	5
Materials and Material Requirements	5
Schematic Flow Chart	5 a
Equipment Requirements	6
Labor Requirements	9
Building Requirements	10
Diagrammatic Layout	10 a
Overhead Rate	11
Unit Cost of Manufacturing	12
Capital Requirements	13
Sales Revenue	14
Projected Profit and Loss	15
Conclusions	16

**PLANT REQUIREMENTS  
FOR MANUFACTURE OF  
PAINT AND VARNISH BRUSHES**

**INTRODUCTION**

Paint and varnish brushes are widely used in the United States by expert painters, the home owners who do their own maintenance work, and by industrial plants for many purposes. Brushes are also used by those who have hobbies such as furniture making, by those who do their own interior decorating and by those who paint automobiles.

That the market is expanding in a healthy manner is borne out by the fact that the sales volume of paint and varnish brushes increased approximately 15% in the five-year period ending in 1952.

Many brush manufacturers confine their production to paint and varnish brushes only, while others produce various types of brushes other than paint and varnish brushes. This study is predicated on establishing a small manufacturing plant, producing, in an eight-hour day, 5,400 good-grade paint and varnish brushes, ranging in size from one inch to six inches. This production level was selected because it represents a small, yet economical and efficient, unit employing 35 to 40 persons, most of whom can be unskilled, as they can be taught the various operations of the trade within a very short time.

It will be found that the capital required is relatively modest in comparison to the potential profits which can be derived from such an enterprise. As manufacturing know-how increases and as profits grow, investment can be made in equipment to produce other types of brushes, such as:

sash brushes  
cement coater brushes  
kalsomine brushes  
patio brushes

These brushes are made on equipment other than that utilized for paint and varnish brushes, and semi-skilled personnel is generally employed.

The types of paint and varnish brushes suggested are those which are sold in the United States by paint, hardware and department stores. The brushes contemplated will be of good quality, made of hog bristles, rubber vulcanized in nickel ferrules, with beech, birch or maple wood handles.

GENERAL ASSUMPTIONS

- (1) Costs are based on 1954 prices in the United States. Labor rates are the same as those found in brush manufacturing areas in the United States.
- (2) Adequate and suitable water, sewage, electrical, and transportation facilities are available at the plant site.
- (3) The plant will operate 22 eight-hour shifts per month.
- (4) Labor saving devices which would increase investment in capital out of proportion to the corresponding reduction of unit costs have not been included in the equipment requirements.
- (5) The necessary raw materials are available in suitable quantity, quality and at the proper prices.
- (6) The market is available or can be readily developed at appropriate cost and the time for starting the proposed enterprise is favorable.

THE MANUFACTURE OF PAINT AND VARNISH BRUSHES

The major steps involved in manufacturing paint and varnish brushes are as follows:

- |                            |                 |
|----------------------------|-----------------|
| (1) Sterilizing            | (8) Nailing     |
| (2) Sizing and Hand Mixing | (9) Beating-out |
| (3) Machine Mixing         | (10) Stamping   |
| (4) Butting                | (11) Finishing  |
| (5) Brushmaking            | (12) Shipping   |
| (6) Vulcanizing            | (13) Inspection |
| (7) Inserting              |                 |

It is recommended that the wooden handles, ferrules, and paint well strips be purchased in the interest of lower unit costs and capital expenditures.

(1) Sterilizing

Upon receipt, the bristles are prepared for sterilizing by making up quarter pound bunches of bristle, held together by a rubber band. The bunches of bristle are then set in metal trays and placed into the sterilizing machine which generates from 15 to 18 pounds of steam. Approximately 150 pounds of bristle can be sterilized in one hour. It is advisable, of course, to take the usual precautions to protect personnel from possible infectious diseases.

**(2) Sizing and Hand Mixing**

Upon removal from the sterilizer, the bristles are laid out on a long wooden table where they are sized for length. The grouped sizes are then made up in one-pound bunches by hand mixing various types or grades of bristles. After hand mixing, the bristles are placed in wooden boxes and stored on steel racks while awaiting machine mixing.

**(3) Machine Mixing**

Bristles are spread by hand in the trough of the mixing machine. This trough is about six feet long, two inches deep and has an adjustable width of from one to seven inches to accommodate the particular length of bristle to be mixed.

The machine electrically agitates the trough of bristles at a rate of 35 movements per minute. The purpose of this machine is to mix the bristles so that a uniform mixture is assured. Ten pounds of bristles can be mixed in one operation, requiring about two minutes.

**(4) Butting**

After machine mixing, the bristles are again bunched by hand and stacked vertically in a stacker, which is attached to an electrical bench vibrator, to butt back or remove the particles of flesh clinging to the butt end of the bristle.

**Note:** One end of the bristles, the "flag" end, is soft and is the end from which paint and/or varnish is applied. The other end, known as the "butt" end, is somewhat harder and is the end which is inserted in the ferrule and rubber vulcanized.

After being butted back, the bristles are again bunched in quarter-pound bunches, tagged as to mixture and size, and placed in a metal box holding one hundred pounds of bristle to the box.

**(5) Brushmaking**

Dependent on the size of brush to be produced, the bristles are weighed and separated into correct amounts for each brush. Weighing is usually done on a one-pound fraction-of-an-ounce, dial counter scale.

The weighed bristles are then placed, butt end first, into the ferrule and a wooden strip is inserted to form the "paint well" within the brush. Using a small wood template to hold the wooden strip and bristles in

place, the bristles are tamped on a 12-inch-square metal surface plate until all the bristles are firmly backed against the wooden strip. The ends are then trimmed to size, and the loose bristles are removed.

#### (6) Vulcanizing

Heated liquid rubber, sufficient to cover the wooden strip inside the ferrule, is poured into the ferrules. The brushes are then placed on a metal tray, each tray holding approximately 500 brushes. The loaded trays are then placed in a vulcanizing oven, which holds 12 trays, and are revolved at five revolutions per minute to bring about even vulcanizing at 140 degrees Fahrenheit. This process usually requires from 10 to 12 hours.

#### (7) Inserting

Upon removal from the vulcanizing oven, a short period of cooling time takes place, after which the brushes are removed to the inserters where the handles are inserted into the ferrule. The assembled brush is then placed into a clinching machine, and the ferrule is clinched to the handle.

#### (8) Nailing

This operation is performed on an automatic nailing machine, and, dependent on the size of the brush, from two to four small nails 1/4 inch long by 1/32 inch in diameter are driven into the wooden handles to hold the ferrules in place.

#### (9) Beating-Out

The beating-out machine has a plate, two feet in diameter with approximately 24 grips, into which the brushes are inserted horizontally, handle end first. The bristles are then sprayed with light machine oil, and the machine is set spinning at approximately 3,500 revolutions per minute. Due to the oil and the whirling motion of the machine, the loose bristles are thrown from the brushes and later removed from the machine for reclaiming.

#### (10) Stamping

The handles of the brushes are stamped as to size, weight and trade name in a machine which is operated by foot control pedal. This machine contains a heating element which keeps the dies hot as the necessary markings are stamped into the handles of the brushes.

**(11) Finishing**

In this operation the brushes are combed by a fine-tooth metal comb; the ferrules and handles are wiped clean, and a paper wrapper is placed over the ferrules and bristles, held fast by a rubber band. The brushes are boxed 12 to a box and set in a portable truck to be removed to the Shipping Department.

**(12) Shipping**

The boxed brushes are checked for accuracy of count by the Shipping Clerk who then seals the ends of the box. The boxes are crated and prepared for shipment to destination.

**(13) Inspection**

The brushes are checked from time to time by a person having a thorough knowledge of all operations.

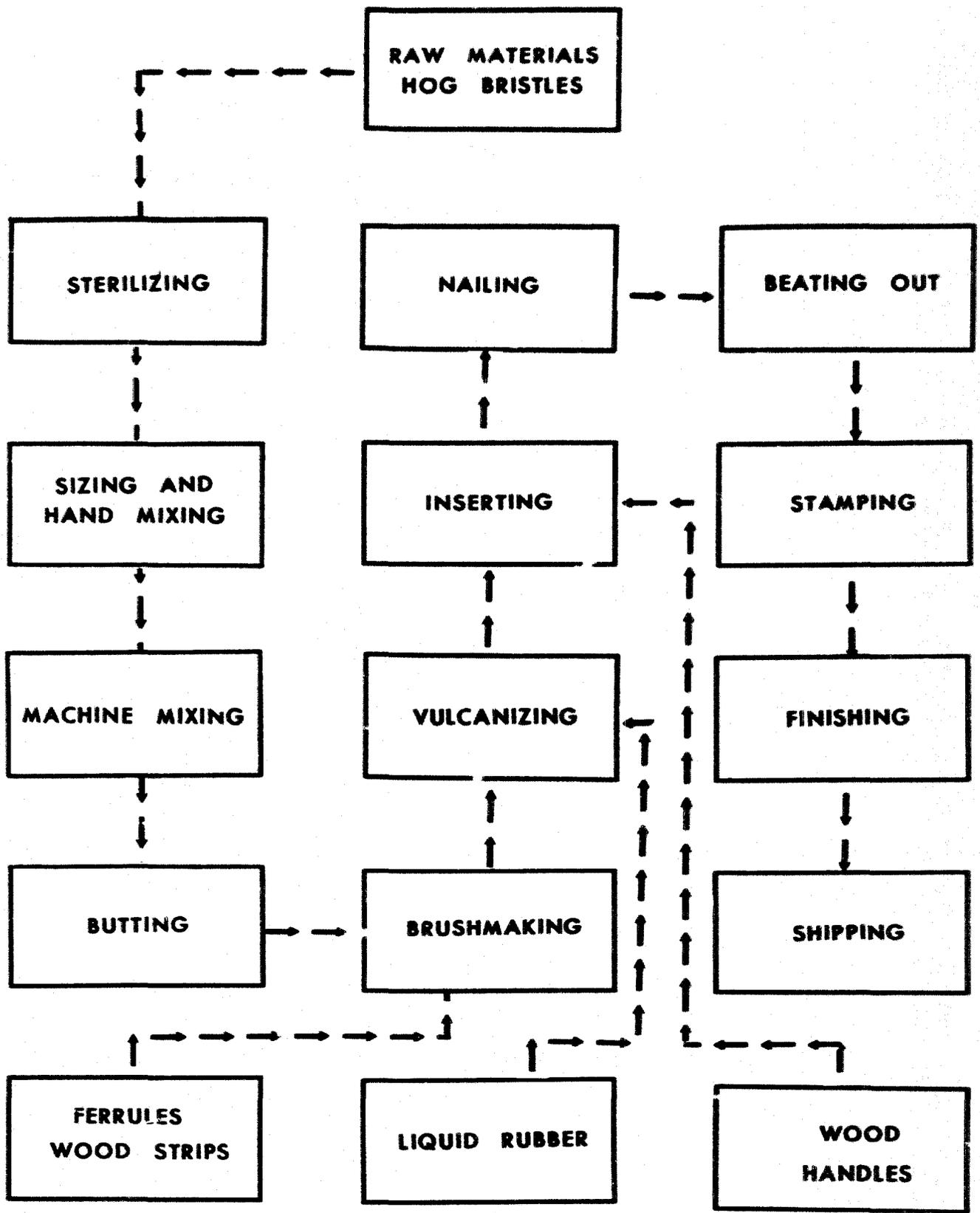
A schematic flow chart is shown on the following page.

**MATERIALS AND MATERIAL REQUIREMENTS**

Bristles are of three types: (1) soft bristle which comes from China and Korea; (2) medium bristle which comes from Formosa and India; and (3) hard bristle from Argentina (except when government restrictions are in effect). Size of bristles range from 1-1/2 inches to 6 inches in length. A good quality brush usually contains a mixture of 60% soft bristle, 35% medium bristle, and 5% hard bristle.

Most shipments are received in boxes containing 100 pounds of bristle. While the bristles from the principal areas of supply will vary in price, the material costs herein presented have been averaged at \$3.00 per 100 brushes.

The costs of materials for one month's output of 118,800 brushes, in the sizes and amounts as shown in the table under SALES REVENUE, are as follows:



SCHMATIC FLOW CHART

<u>Material</u>	<u>Cost Per Brush</u>	<u>Estimated Material Cost</u>	<u>Actual Material Cost</u>
Bristles	\$ 0.03	\$ 3,564.00	_____
Wooden handles	0.02	2,376.00	_____
Ferrules	0.01	1,188.00	_____
Misc. Items (Vulcanizing rubber, paint well strips, nails, tags, tape, paper cartons, fibre boxes)	0.0025	297.00	_____
<b>Total Material Cost:</b>	<b>\$ 0.0625</b>	<b>\$ 7,425.00</b>	_____

The bristles used in this example came from Formosa, the prices being as follows:

Black:	\$30.00 per hundred pounds
Brown:	36.00 per hundred pounds
Silver	55.00 per hundred pounds

The weights of bristles used in brushes of typical size are:

1-inch brush	11/16 ounces (3-inch)
3-inch brush	2-1/4 ounces (3-inch)
6-inch brush	4-1/2 ounces (3-inch)

### EQUIPMENT REQUIREMENTS

Paint and varnish brushes are made with highly standardized equipment most of which is used throughout the industry. The following equipment will be found in most paint and varnish brush manufacturing plants in the United States.

<u>Departmental Equipment</u>	<u>Cost</u>	<u>Comparable Local Figures</u>
<u>Raw Material Storage</u>		
Steel Storage Racks (10)	\$ 1,200	_____
Wooden Bristle Boxes (homemade)(50)	100	_____
Hand Truck	250	_____
	<u>1,550</u>	_____

Comparable  
Local Figures

Cost

Sterilizing Department

Sterilizing Machines (150 lbs. capacity)(2)	3,000
Metal Trays (10)	50
Table Scale	50
Work Table (homemade)	175
	<u>3,275</u>

_____
_____
_____
_____
_____

Sizing and Hand Mixing Department

Work Table (homemade)	175
Sizing Racks (homemade) (10)	20
Wood Bristle Boxes (homemade)	20
Table Scale	50
	<u>265</u>

_____
_____
_____
_____
_____

Machine Mixing Department

Mixing Machines (2)	7,000
Tables (homemade) (2)	20
	<u>7,020</u>

_____
_____
_____

Butting Department

Work Table (homemade)	175
Electric Table Vibrator	100
Table Scale	50
Metal Bristle Boxes (50)	500
Steel Storage Racks (10)	1,200
	<u>2,025</u>

_____
_____
_____
_____
_____
_____

Brushmaking

Work Benches (homemade) (16)	400
Table Scales (16)	800
Surface Plates (16)	16
Shears (16)	48
	<u>1,264</u>

_____
_____
_____
_____
_____

Vulcanizing

Vulcanizing Ovens (2)	4,000
Metal Trays (12)	120
Liquid Rubber Dispensers (2)	100
	<u>4,220</u>

_____
_____
_____
_____

Inserting

Six Shelve Portable Trucks (5)	250
Clinching Machine	1,200
Bench (homemade)	25
	<u>1,475</u>

_____
_____
_____
_____

	<u>Cost</u>	<u>Comparable Local Figures</u>
<u>Nailing Department</u>		
Nailing Machines (2)	700	_____
Benches (homemade) (2)	50	_____
	<u>750</u>	_____
<u>Beating-Out Department</u>		
Beating-Out Machines, including blower systems (2)	5,000	_____
Oil Sprayer	150	_____
Portable Trucks, six shelves (5)	250	_____
	<u>5,400</u>	_____
<u>Stamping Department</u>		
Platform Scale	500	_____
Crating Equipment	250	_____
Tape Dispenser	5	_____
Hand Truck	250	_____
	<u>1,005</u>	_____
Total Production Equipment:	\$ 28,249	_____
<u>Misc. Tools and Equipment, Shop Supplies, etc.</u>	1,500	_____
<u>Office Equipment</u>		
Desks, chairs, typewriter, files, office supplies, etc.	1,500	_____
Total Cost of Equipment:	\$ 31,249	_____
	_____	_____

LABOR REQUIREMENTS

In general, the necessary skills can be taught to the general run of factory workers in comparatively short time by a limited number of informed key persons.

Occupation	<u>Direct Labor</u>		Total Hourly Rate	Comparable Local Figures
	Personnel Required	Average Hourly Rate		
Material Handler	1	\$ 1.35	\$ 1.35	_____
Sterilizer	1	1.55	1.55	_____
Sizer and Hand Mixer	1	1.62	1.62	_____
Mixing Machine Operators	2	1.68	3.36	_____
Buttbacker	1	1.52	1.52	_____
Brushmakers	15	1.46	21.90	_____
Vulcanizers	2	1.58	3.16	_____
Insertter	1	1.40	1.40	_____
Nailer	1	1.40	1.40	_____
Beaters	2	1.57	3.14	_____
Stamper	1	1.50	1.50	_____
Finishers	2	1.38	2.76	_____
Shipper and Receiver	1	1.62	1.62	_____
Inspector	1	1.70	1.70	_____
	<u>32</u>		<u>\$ 47.98</u>	_____

Total monthly cost of Direct Labor

\$47.98 X 8 hours X 22 days = \$ 8,444.48

Indirect Labor

	Monthly Rate	Comparable Local Figures
Superintendent	\$ 500	_____
Clerk	200	_____
Mechanic	320	_____
Janitor	200	_____
<b>Total:</b>	<b>\$ 1,220</b>	_____

The duties of the indirect group are as follows:

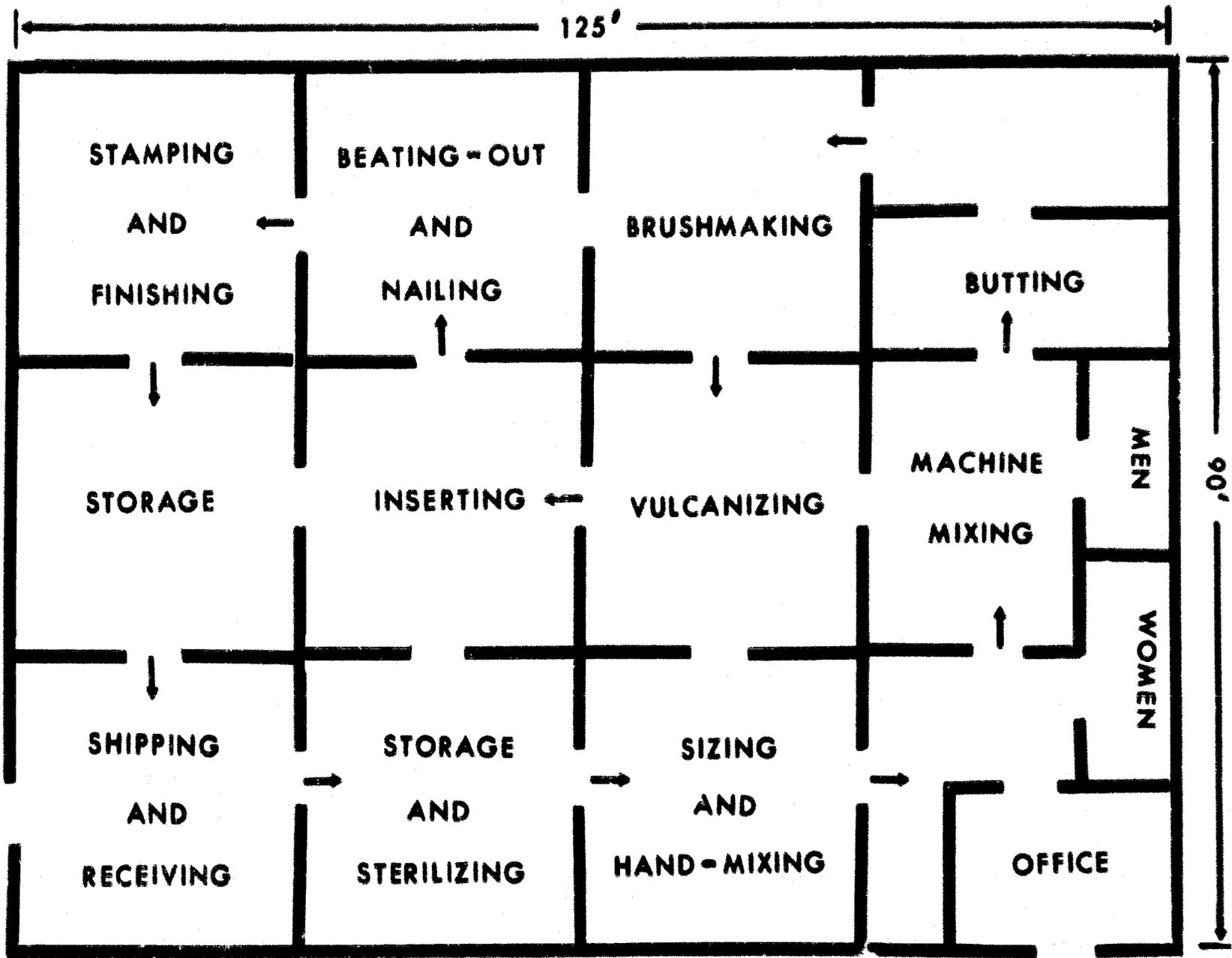
- (a) **Superintendent:** one who has a thorough knowledge of the industry, can train the personnel and who can operate the plant economically and efficiently.
- (b) **General Office Clerk:** one who has some knowledge of bookkeeping, billing and general office procedures.
- (c) **A mechanic or all around maintenance man** who would be responsible for general machine maintenance, electrical and carpentry work; also able to make minor repairs to the building, both inside and outside.
- (d) **A combination clean-up man and janitor** to keep the premises, both inside and outside, in orderly condition.

#### BUILDING REQUIREMENTS

A one-story, fireproof structure, having a minimum height of 15 feet would be excellent; however, a less expensive structure would be adequate, depending on local conditions.

The total area required is approximately 11,250 square feet. At \$3.50 per square foot, the building could be erected for \$39,375.00, including sanitary facilities. This, of course, would vary greatly in different localities due to many factors.

A schematic diagram of a suitable floor plan follows.



DIAGRAMMATIC LAYOUT

SCALE 1/16" = 1'

102

OVERHEAD RATE

Depreciation

(Assuming no scrap value)

Item	Years Life	Estimated Cost	Annual Depreciation	Comparable Local Figures
Building	20	\$ 39,375.00	1,968.70	_____
Production Equipment	10	28,249.00	2,825.00	_____
Misc. Tools, etc.	5	1,500.00	300.00	_____
Office Equipment	10	1,500.00	150.00	_____
Total:		70,624.00	5,243.70	_____

Estimated Monthly Depreciation =  $\frac{\$5,243.70}{12}$  = \$436.70

Comparable Local Figure = \_\_\_\_\_ = \_\_\_\_\_  
12

Overhead Expenses (per month)

	Estimated	Comparable Local Figures
Depreciation	\$ 436.70	_____
Indirect Labor	1,220.00	_____
Power, Fuel, Water, etc.	300.00	_____
Indirect Materials, and Office Supplies	150.00	_____
Insurance, Interest, Taxes	-	_____
Total Overhead Expenses:	\$ 2,106.70	_____

Estimated Overhead Rate =  $\frac{\$2,106.70}{5,632 \text{ Direct Labor Hours}}$  = \$0.374 Per Direct Labor Hour

Comparable Local Figure = \_\_\_\_\_ = \_\_\_\_\_ Per Direct Labor Hour

UNIT COST OF MANUFACTURING

	<u>Cost Per 100 Brushes</u>	
	<u>Estimated</u>	<u>Actual Local Figures</u>
<u>Direct Labor</u>		
$\frac{\$8,444.48 \text{ (page 9)}}{118,800 \text{ brushes per month (page 5)}}$ =	\$ 7.11	_____
<u>Materials</u>		
$\frac{\$7,425 \text{ (page 6)}}{118,800}$ =	6.25	_____
<u>Overhead</u>		
$\frac{\$2,106 \text{ (p. 11)}}{118,800}$ =	1.77	_____
<b>Total Cost Per 100 Brushes:</b>	<b>\$ 15.13</b>	_____
	=====	=====

# CAPITAL REQUIREMENTS

-13-

## Working Capital

	<u>Estimated</u>	<u>Comparable Local Figures</u>
Direct material inventory (60 days)	\$ 14,850	_____
Work-in-process (2 days)	675	_____
Finished Goods (2 days)	675	_____
Total Inventory:	\$ 16,200	_____

## Operating Expenses

Direct Labor	\$ 8,444.	_____
Indirect Labor	1,220	_____
Power, Fuel, Water	300	_____
Indirect Materials, Office Supplies	150	_____
Total Operating Expenses: (1 month)	\$ 10,114	_____

Total Working Capital: \$ 26,314 \_\_\_\_\_

## Fixed Assets

Land	-	_____
Building	\$ 39,375	_____
Production Equipment	28,249	_____
Misc. Tools	1,500	_____
Office Equipment	1,500	_____
	\$ 70,624	_____

## Total Capital Requirements

Working Capital	\$ 26,314	_____
Fixed Assets	70,624	_____
Reserves (organizational expense, surveys, accounts receivable, necessary operating reserves)	33,062	_____
Total Capital Requirements:	\$ 130,000	_____
	=====	=====

**SALES REVENUE**

Size of Brushes (inches)	Percent of 118,800 Produced Per Month	Total Made in Sizes Per Month	Selling Price Per Brush	Revenue from Brushes Per Size	Comparable Local Revenue Per Size
1	3	3,564	\$ 0.14	\$ 498.96	_____
2	17	20,196	0.20	4,039.20	_____
2-1/2	12	14,256	0.23	3,278.88	_____
3	30	35,640	0.26	9,266.40	_____
3-1/2	15	17,820	0.30	5,346.00	_____
4	14	16,632	0.38	6,320.16	_____
5	6	7,128	0.48	3,421.44	_____
6	3	<u>3,564</u>	0.59	<u>2,102.76</u>	_____
Total:		<u>118,800</u>		<u>\$ 34,273.80</u>	_____

**Total Potential Annual Revenue**

**\$34,273.80 X 12 months = \$411,285.60**

Assuming, at the outset, that production and sales average 50% of full potential for the first three months, the first year's sales will be:

	\$34,273.80 X 50% X 3 months	=	\$ 51,410.70	_____
Plus	\$34,273.80 X 9 months	=	<u>308,464.20</u>	_____
Total Sales Revenue, First Year:		\$	<u>359,874.90</u>	_____

-15-

PROJECTED PROFIT AND LOSS

	<u>Estimated</u>	<u>Actual</u>
Gross Sales	\$ 359,874.90	_____
Less: Returns and Allowances	874.90	_____
Net Sales	<u>359,000.00</u>	_____
Less: Cost of Manufacturing (12 months overhead and direct labor, 10-1/2 months material)	<u>204,576.66</u>	_____
Gross Profit on Sales	<u>154,423.34</u>	_____
Less: Distribution Expense		
Commissions )	_____	
Advertising )	_____	
Out Freight ) 25% of	_____	
Warehousing ) Sales	_____	
Other )	_____	
Total Distribution Expense	<u>89,968.50</u>	_____
Operating Profit	<u>64,454.84</u>	_____
Less: Administrative Expense (6% of Sales)	<u>21,592.44</u>	_____
Net Profit (before taxes, interest, insurance and other undetermined expenses)	<u>\$ 42,862.40</u>	_____
	<u>_____</u>	<u>_____</u>

## CONCLUSIONS

The manufacture of paint and varnish brushes is sufficiently profitable to justify the establishment of an enterprise for this purpose in any situation in which the important factors of the market, raw material supply and available labor are not less favorable, in their net result, than is set forth in this study.

Anyone contemplating such an enterprise would be well advised to carefully determine all the vital facts before making any commitments.

Two factors are especially important: (1) The market - is it readily available or can it be developed quickly at reasonable cost? (2) The raw materials - can they be had in the proper quality, at economically sound prices, and in sufficient quantity?

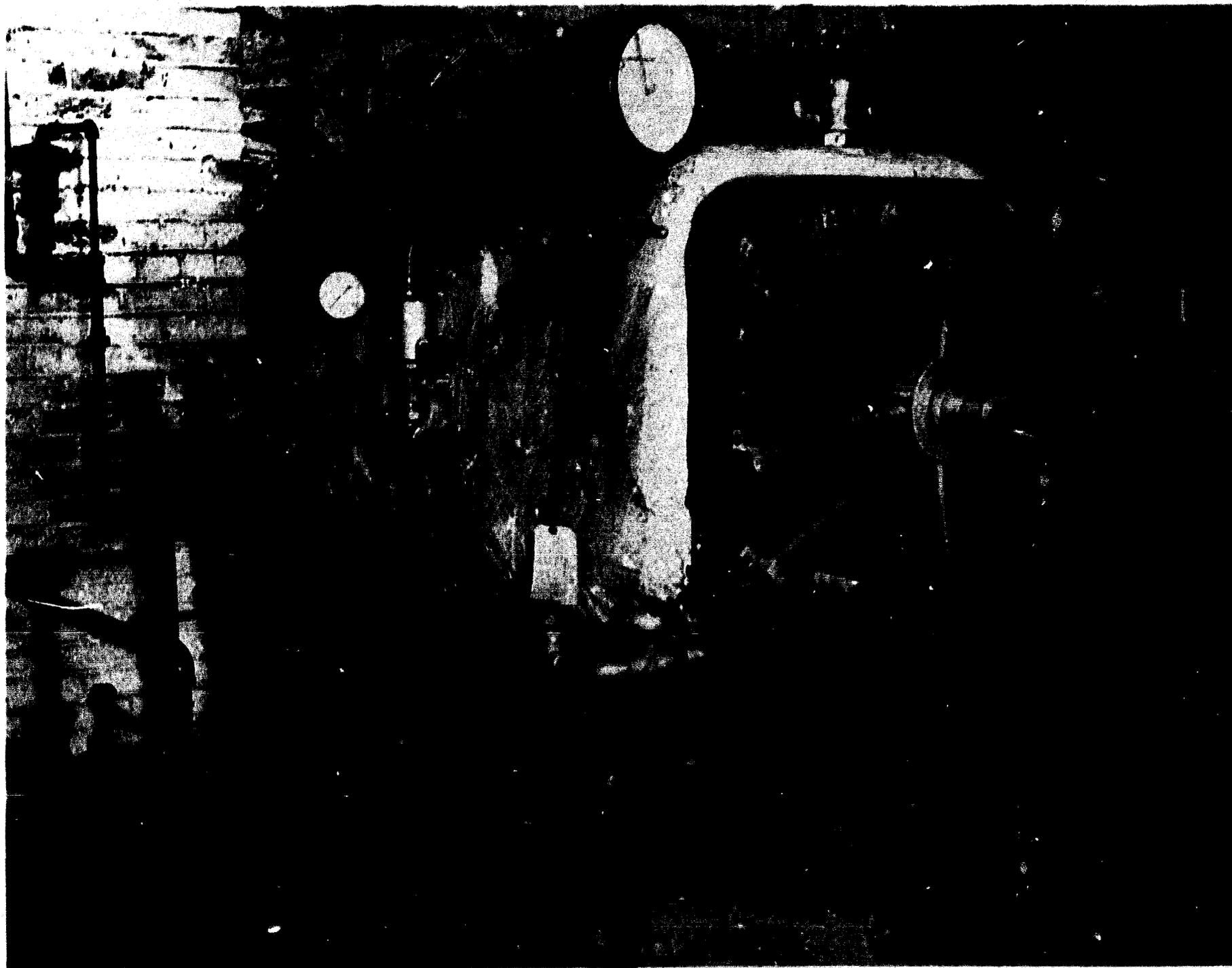
A considerable increase in production volume could be gained by working two or three shifts.

In determining the rate of return on investment, it is necessary, of course, to include all costs not now known, such as taxes, insurance, and interest.

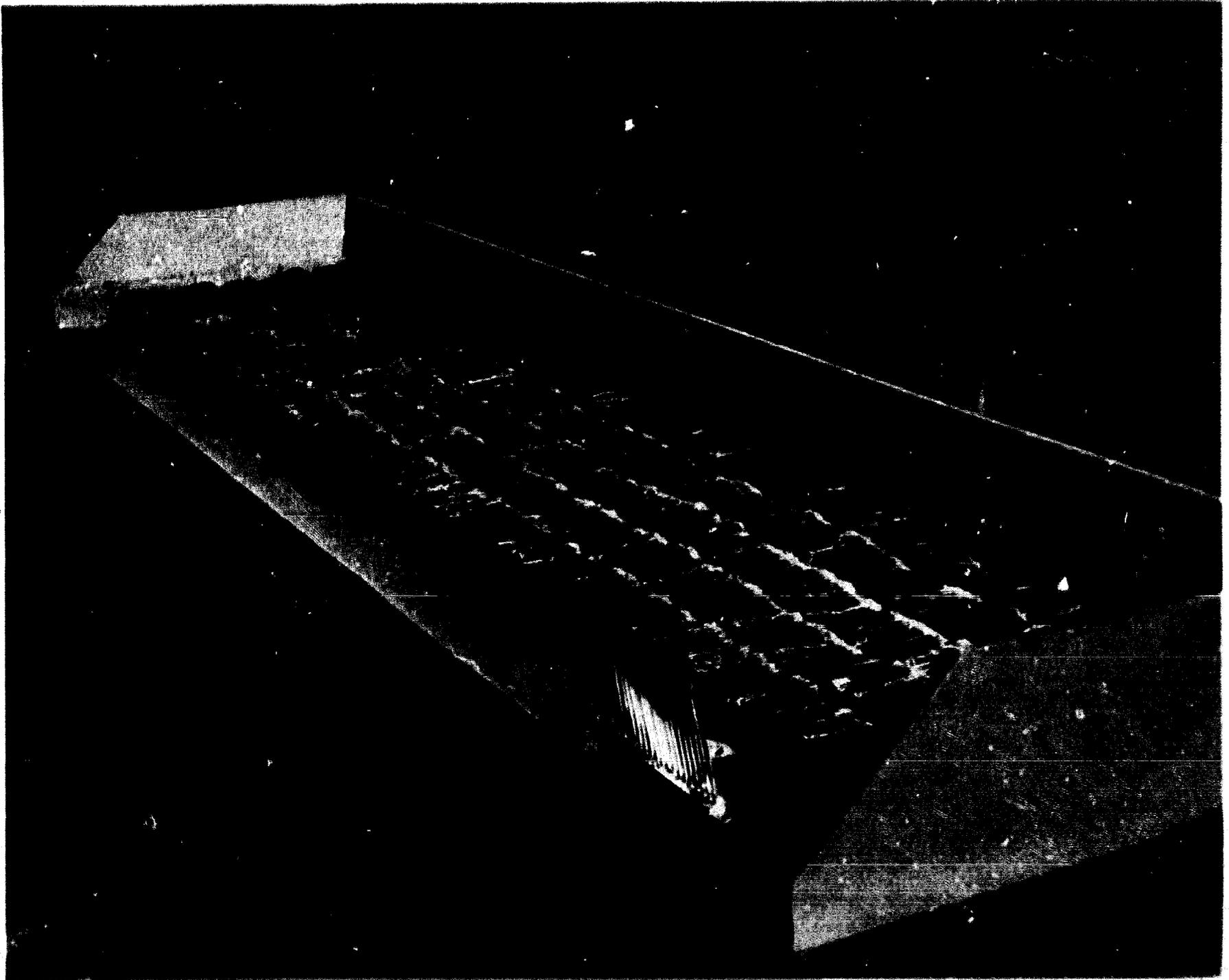
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FIGURE 1 VARIOUS SIZES OF FINISHED PAINT OR VARNISH BRUSHES.



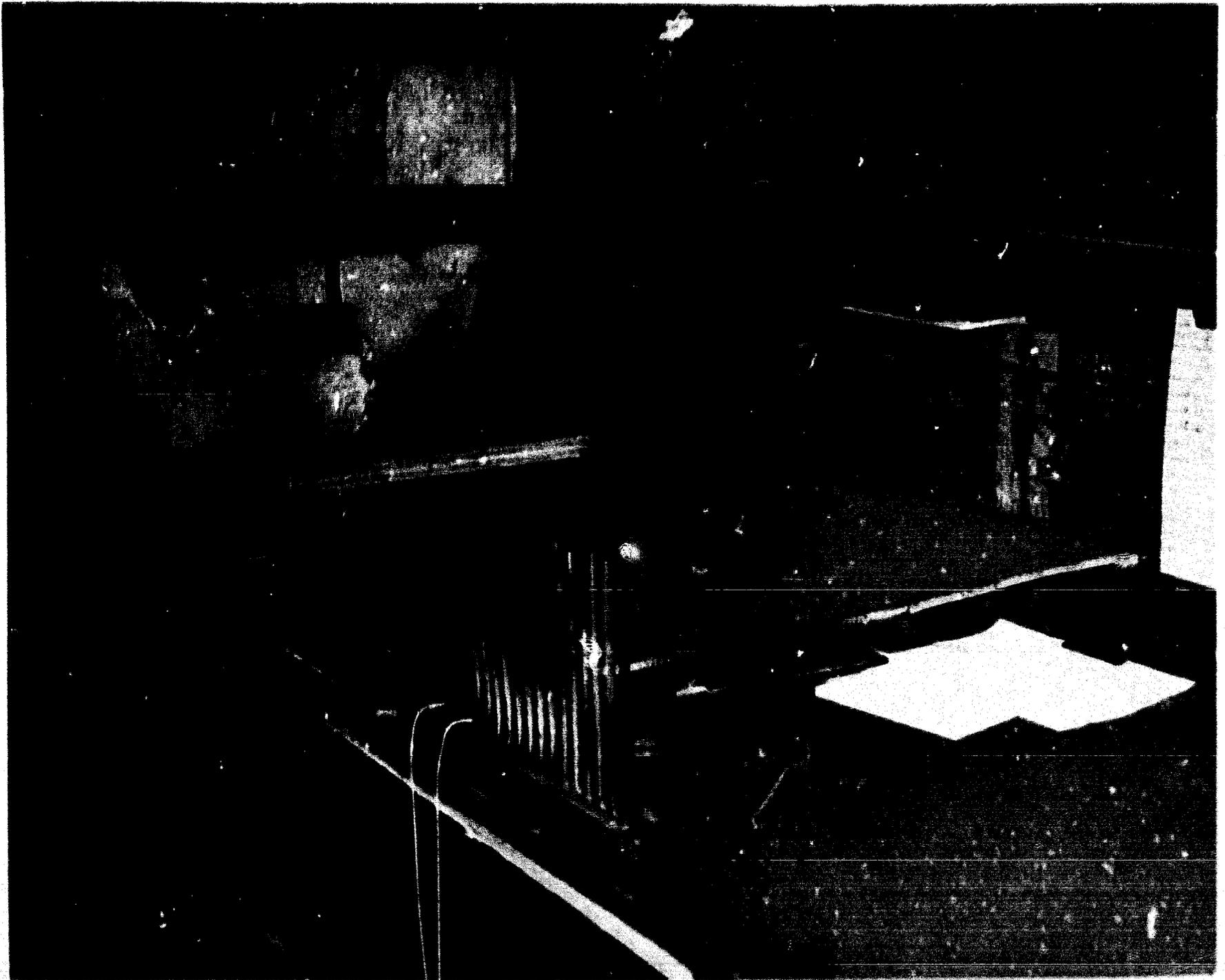
**FIGURE 2 STERILIZING MACHINE GENERATES 15 TO 18 POUNDS OF STEAM AND STERILIZES APPROXIMATELY 150 POUNDS OF HOG BRISTLE PER HOUR. ONE MAN OPERATES TWO MACHINES.**



**FIGURE 3 SIZING AND HAND-MIXING. BRISTLES ARE LAID OUT ACCORDING TO GRADE AND SIZE, THEN HAND-MIXED BY USING THE COMB SHOWN ON EXTREME END OF WORK BENCH.**



FIGURE 4 MACHINE-MIXING. TROUGH HOLDING BRISTLES IS DIRECTLY UNDER WOOD TRAY TOP CENTER.



**FIGURE 5 BUTTING. HERE BRISTLES ARE HELD BY HAND ON BENCH VIBRATOR. IN MOST BUTTING - BACK OPERATIONS BRISTLES ARE PLACED IN A STACKER AND SET ON AUTOMATIC VIBRATOR WHILE OPERATOR PREPARES NEXT BATCH.**

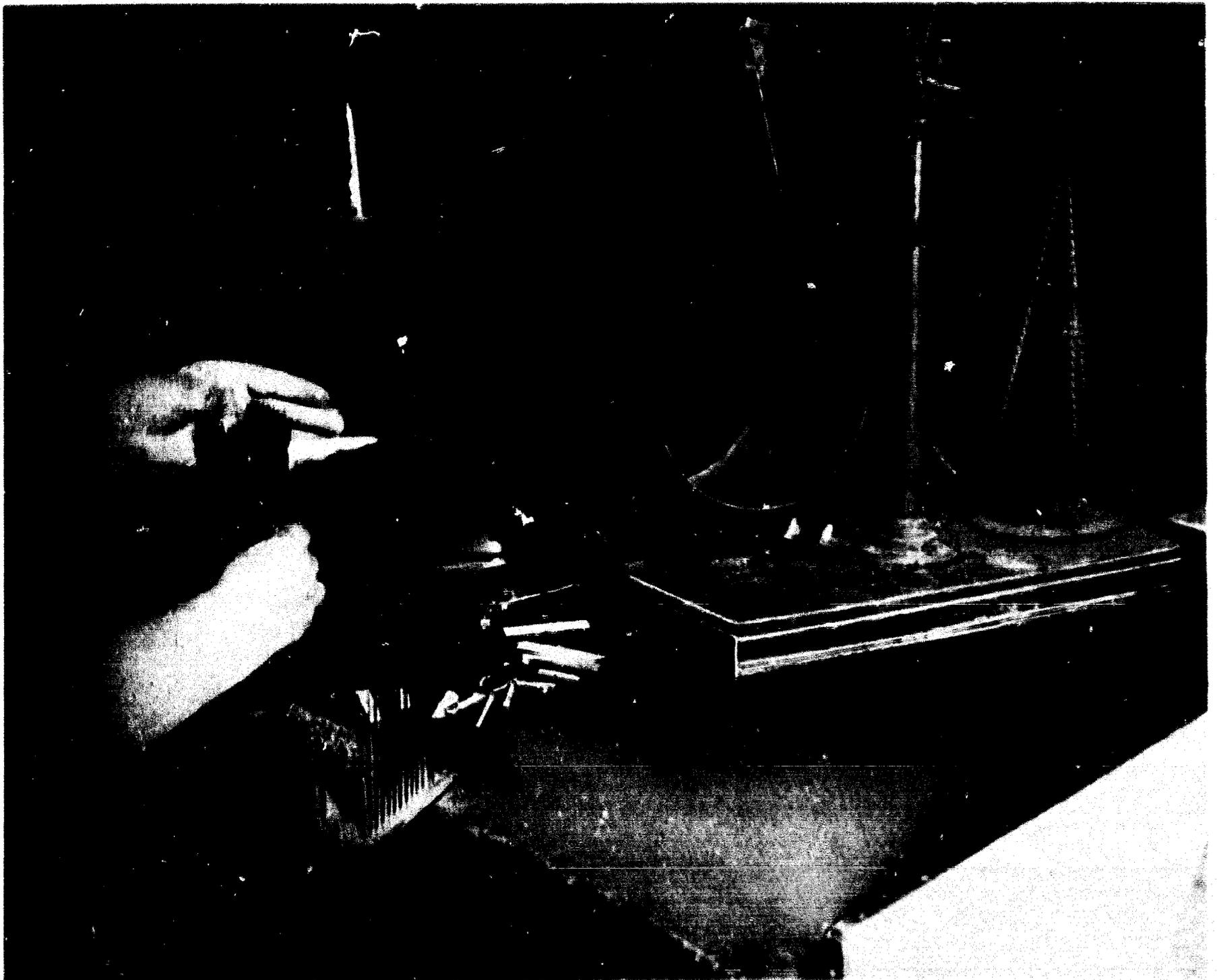


FIGURE 6 BRUSHMAKER PLACING BRISTLES IN FERRULE. A SCALE WITH WEIGHTS IS USED INSTEAD OF DIAL SCALE. WOOD STRIPS FOR THE PAINT WELL ARE ON OPERATOR'S RIGHT, BRISTLE PILE ON LEFT.

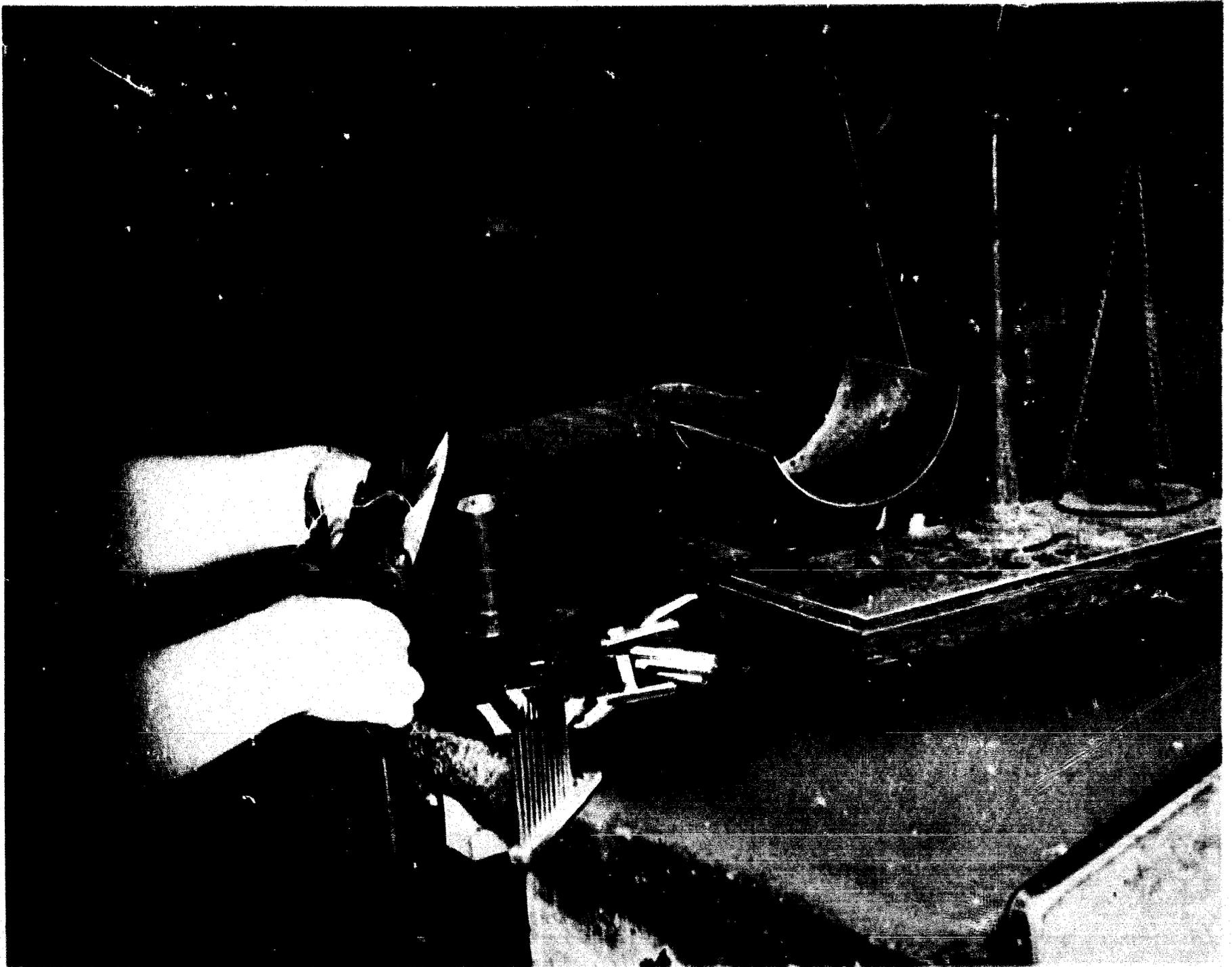


FIGURE 7 TRIMMING. BRUSHMAKER TRIMS THE ENDS OF EACH BRUSH.

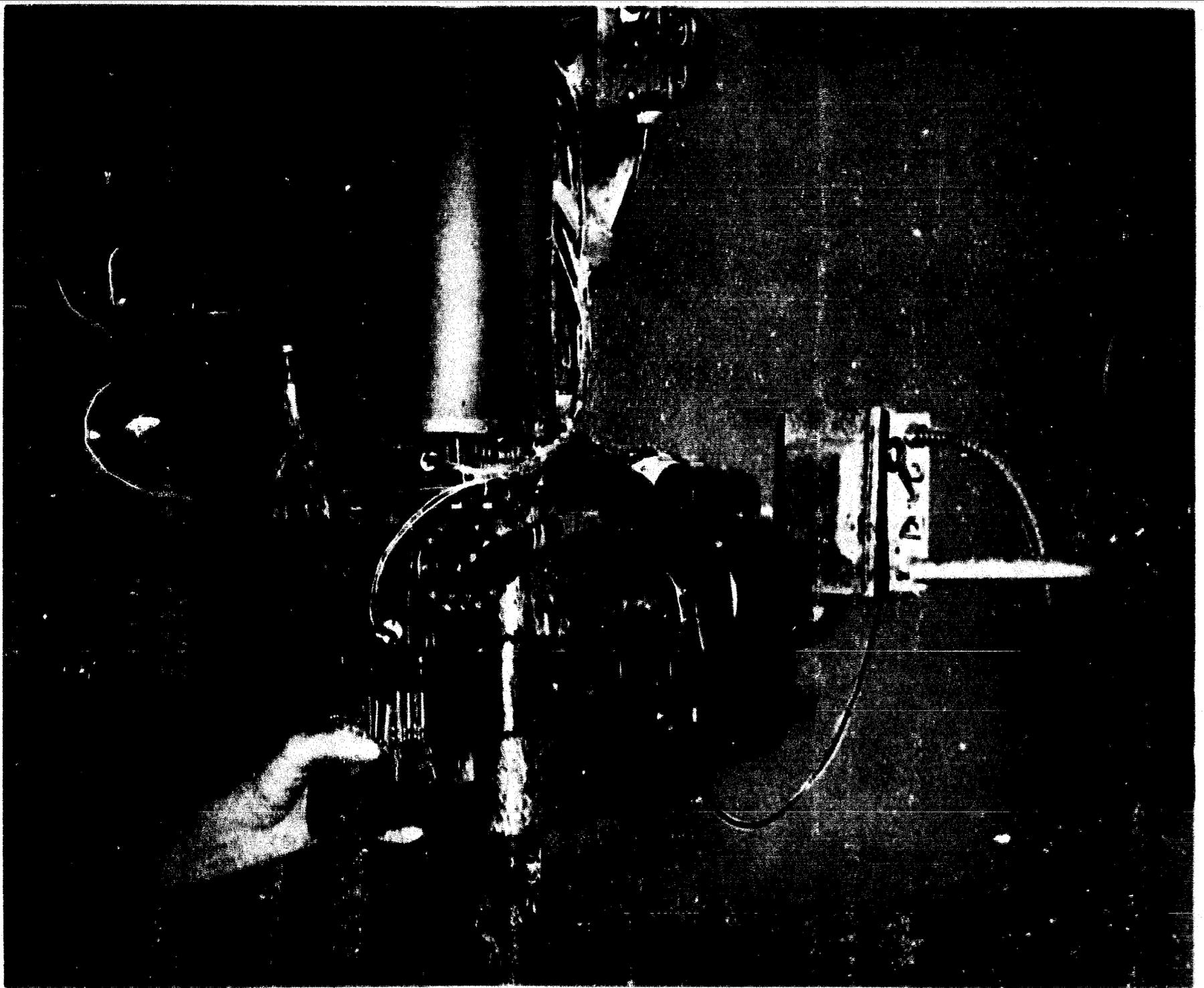


FIGURE 8 HEATED LIQUID RUBBER FLOWS FROM CONTAINER INTO THE FERRULE OF EACH BRUSH.

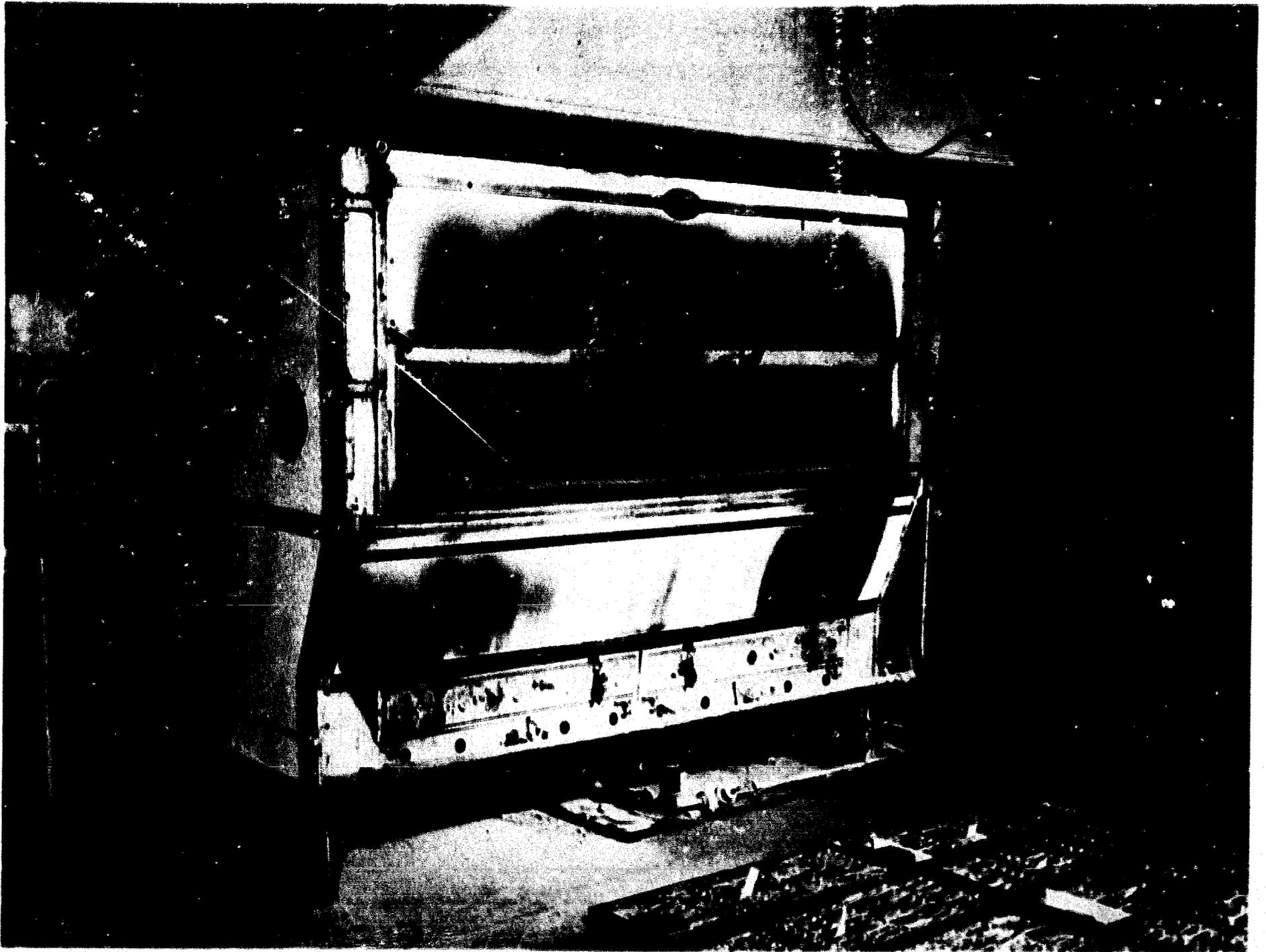
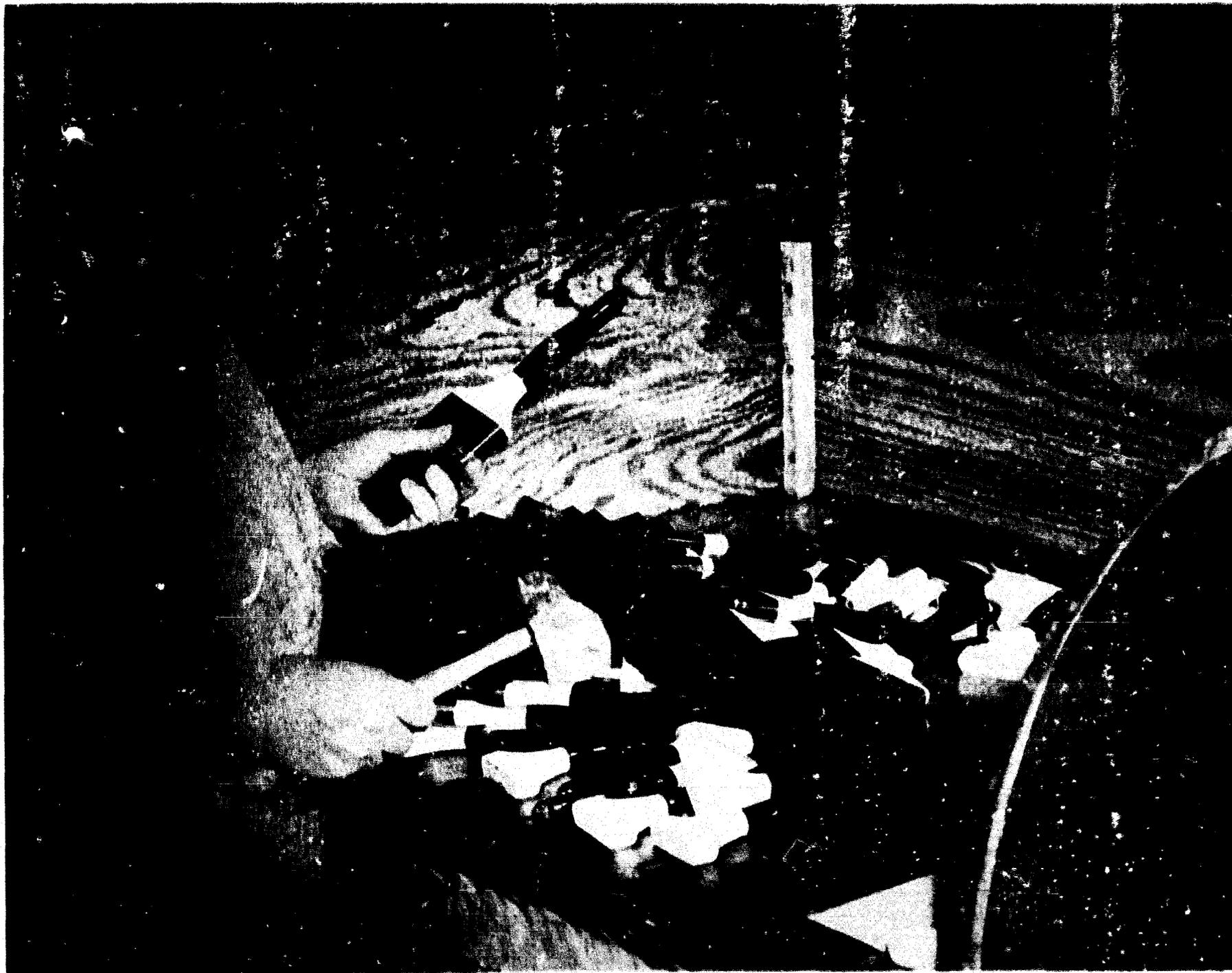
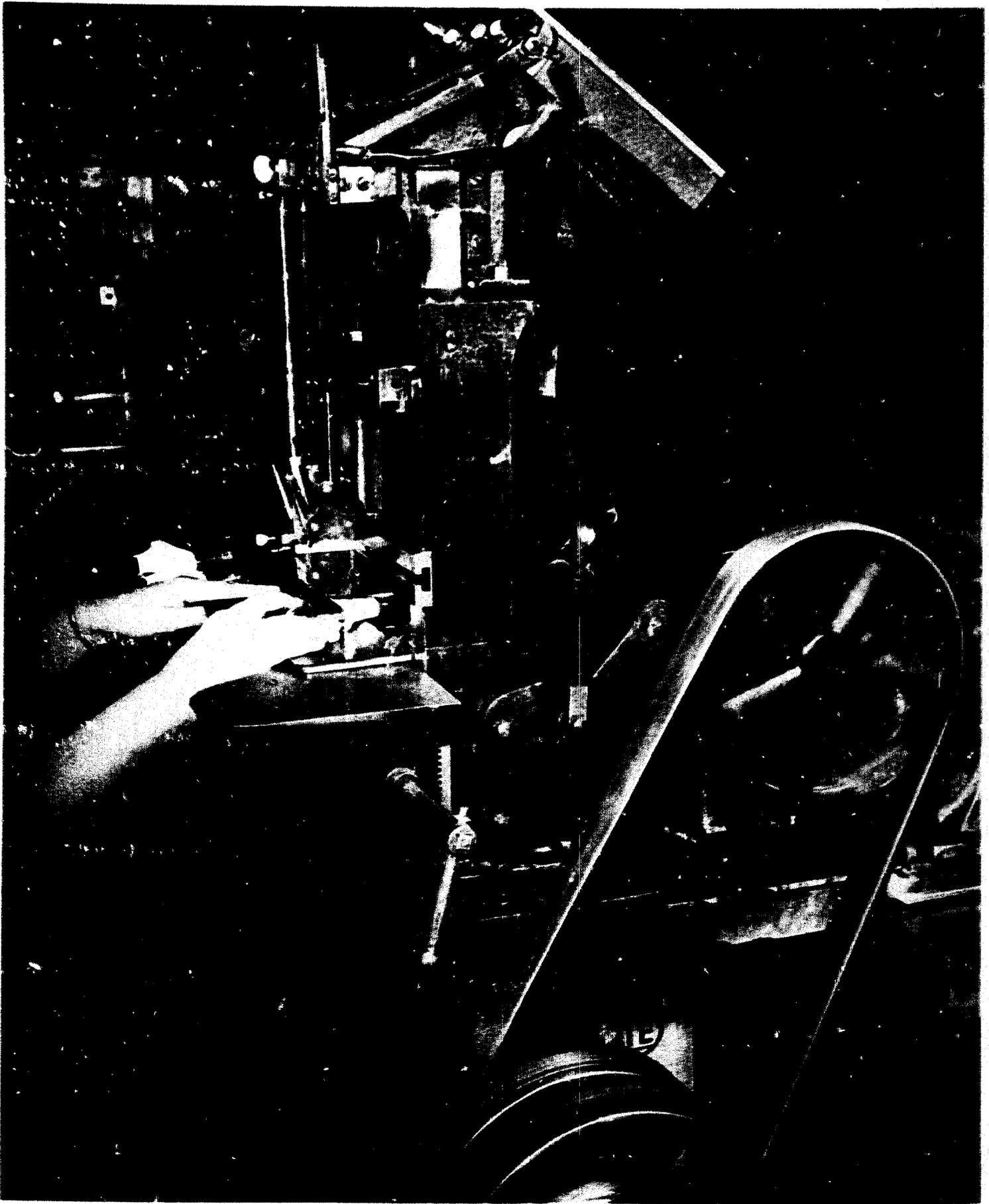


FIGURE 9 VULCANIZING OVEN AND TRAYS OF VARIOUS SIZE BRUSHES READY FOR OVEN. ONE OVEN CAN VULCANIZE 6,000 BRUSHES IN A 10- TO 12-HOUR PERIOD.



**FIGURE 10** INSERTING HANDLE. AFTER HANDLE IS TAPPED IN, THE FERRULE IS CLINCHED TO THE HANDLE ON A SMALL CLINCHING MACHINE



**FIGURE 11 NAILING. OPERATOR SETTING BRUSH IN AUTOMATIC NAILING MACHINE WHERE TWO NAILS WILL BE INSERTED TO FASTEN FERRULE TO HANDLE**

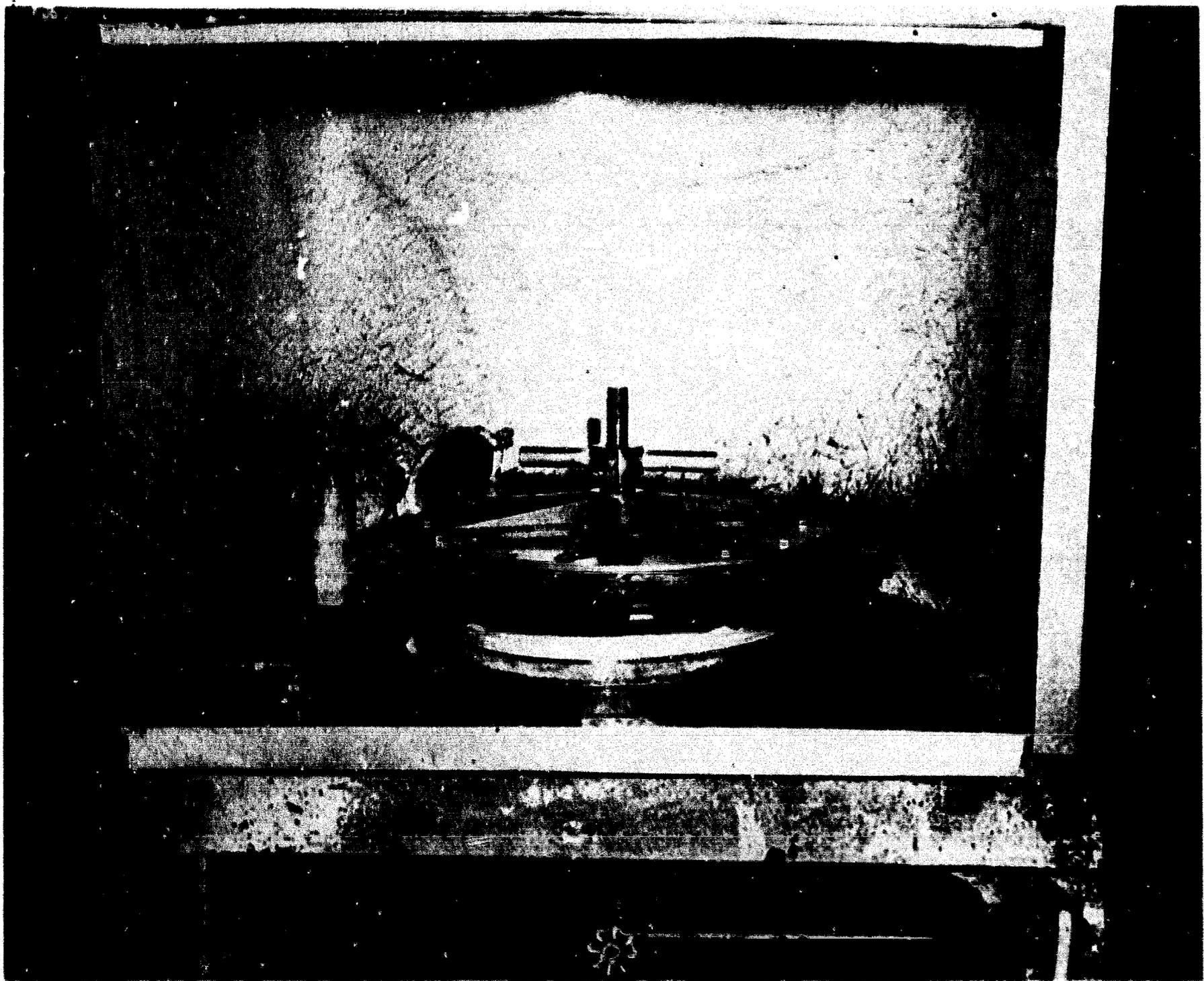
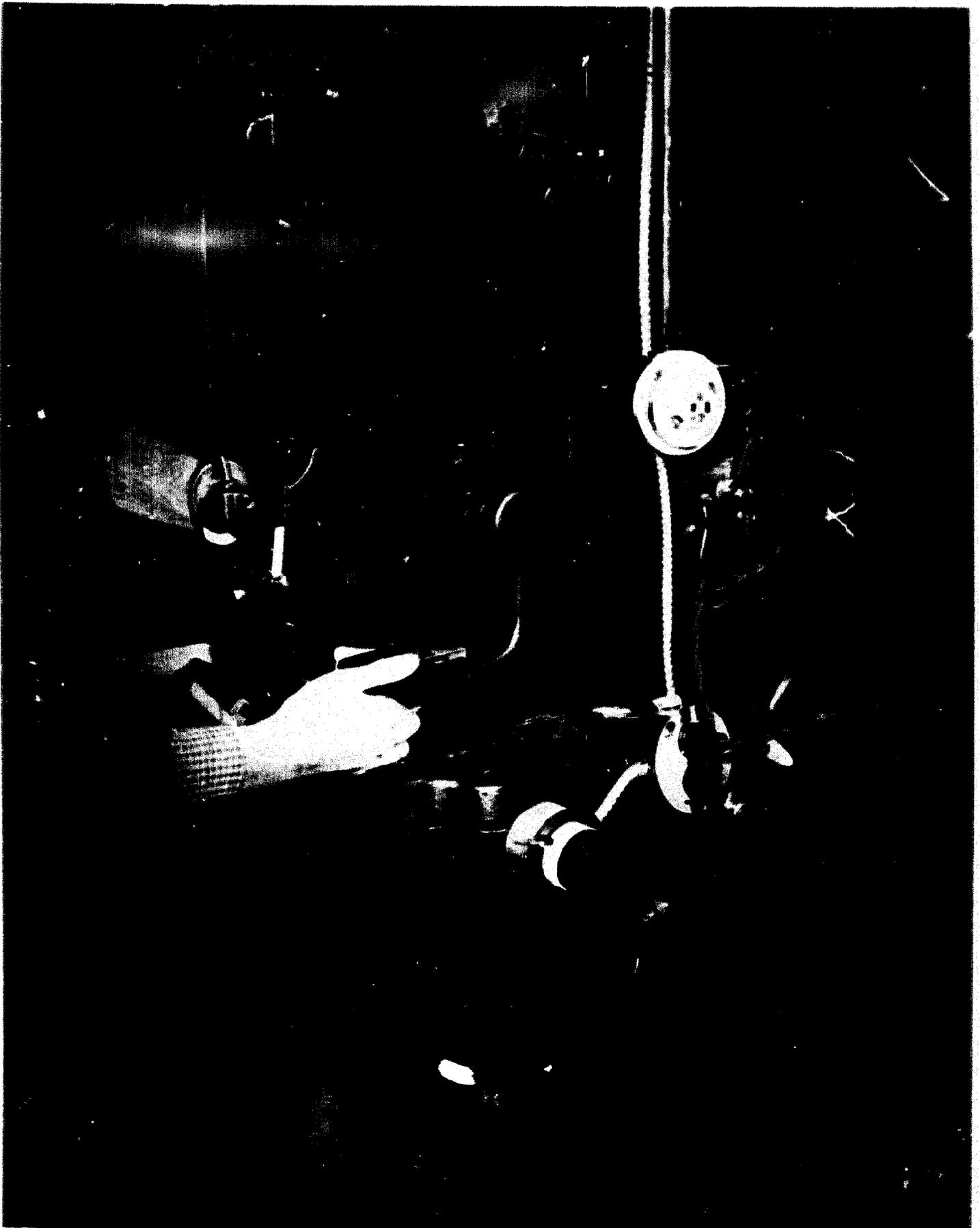


FIGURE 12 BEATING-OUT. BRUSHES IN PLACE IN MACHINE. LOOSE BRISTLE IS RELEASED BY THE WHIRLING MOTION



**FIGURE 13 STAMPING. SIZE AND MAKE ARE MACHINE-STAMPED ON THE HANDLE.**

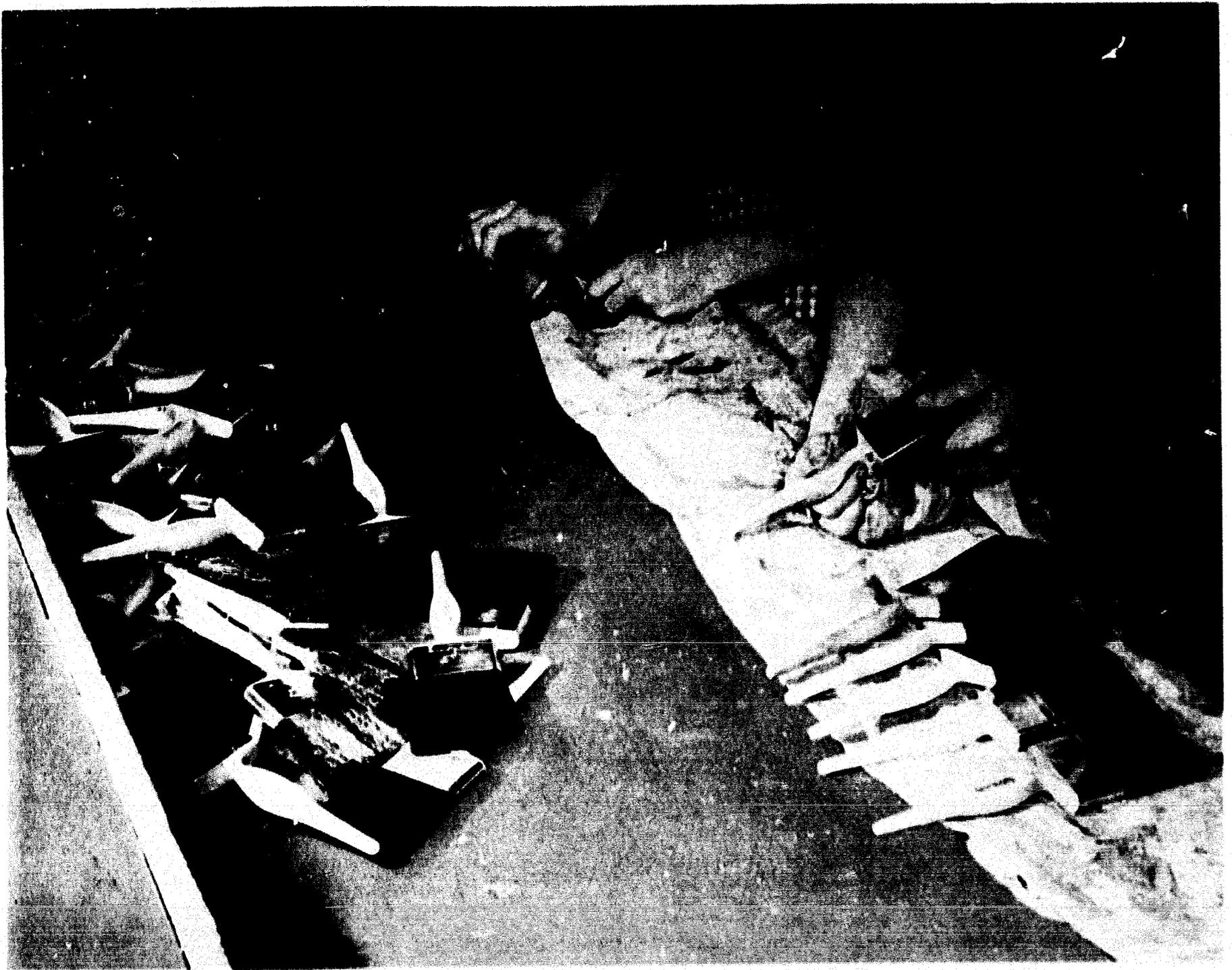


FIGURE 14 FINISHING. BRUSH IS CLEANED AND COMBED.



FIGURE 15 BRUSHES ARE WRAPPED WITH HANDLE EXPOSED, AND PACKED A DOZEN TO THE BOX.