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FOREWORD

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

* * * * * * * * *

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

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

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

* * * * * * * * *

The original report was prepared by the Wolf Management Engineering Company, Chicago, Illinois.

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CORRUGATED FIBRE BOXES

INTRODUCTION

The manufacture of corrugated cartons has had a phenomenal growth in the United States. Corrugated cartons are strong, resilient, light, and so inexpensive that many manufacturers use them in great quantities for many products, even some which are quite heavy. This makes for a good market for these very useful shipping containers which are used for 90% to 95% of all packaged freight.

The growth of this business in the United States is shown both volume-wise and dollar-wise below.

Year	Corrugated Fibre Shipments 1000 Sq. Ft.	Value
1942	38,779,300	$ 323,970,800
1943	44,280,600	411,863,600
1944	43,739,200	427,972,000
1945	44,559,000	438,443,900
1946	56,330,400	597,064,100
1947	58,366,900	820,497,300
1948	59,733,100	813,378,000
1949	59,123,800	738,592,400
1950	76,021,900	995,454,100
1951	74,161,800	1,209,475,100
1952	72.172,300	1,108,962,[illegible]00
1953	80,918,600	1,244,191,300

GENERAL ASSUMPTIONS

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

1. All costs are based on 1959 prices in the United States. Labor rates were determined by averaging going rates in plants similar to the proposed plant.

2. Adequate and suitable water, sewage, electricity and transportation facilities are available at the plant site.

3. The plant operates eight hours a day, five days a week, fifty weeks per year.

4. No special provision is made for the training of new personnel. It is assumed that learner's rates are paid in such cases.

5. The following items cannot be estimated realistically:

   a. Land value.
   b. Distribution and selling costs.
   c. In-freight and out-freight.
   d Taxes.

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

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

In view of the inadequacy of supply of corrugated board in many countries, the plant proposed herein is designed to make corrugated board and to convert the board into cartons.

MATERIALS

The materials used in the manufacture of corrugated containers are paperboards such as:

1. Fourdrinier Kraft
2. Cylinder Kraft
3. Semi-chemical
4. Straw Board
5. Bogus

The liners for both the inside and outside are usually of Fourdrinier Kraft or Cyclinder Kraft in weight ranges of 33 to 90 pounds per 1,000 square feet.

For the corrugating medium, any one of the papers shown above would be suitable in weight ranges of 26 to 32 pounds per 1,000 square feet. The liner combinations used in fabricating a container are, of course, governed by the articles the container is designed to carry.

As an example, a 200-pound test container (a board combination that will withstand a bursting test of 200 pounds per square inch in a Mullen's tester) has a size limitation of 75 inches inside dimension (length, plus width, plus depth) and a limitation of the gross weight carried of 65 pounds.

The larger the size and the heavier the weight of the articles to be carried, the more strength the box must have. The bursting strength of combined board is determined by adding the bursting strength of the inner and outer liner plus 30 pounds for the corrugating medium.

The contents to be packed in the container determine the flute to be used. An "A" flute, which provides the greatest cushion, is approximately 3/16 inch high, and the "B" flute approximately 1/8 inch. There is also a "C" flute designed as a substitute for both sizes which will caliper approximately 5/32 inch. A jumbo flute, which is used for inner packing, measures about 1/2 inch.

Unlined Corrugated Paperboard

This product is made in sheets or rolls and in varying widths and lengths. It is manufactured of various kinds of paperboard and in varying thicknesses. It is used for lining, covering, padding, etc., and also to protect glassware, other fragile articles, and articles in glass or earthenware. (See Figure 2)

Single-Faced Corrugated Paperboard

Single-faced corrugated paperboard is made by gluing the corrugated paperboard to the flat liner. It is made of various kinds and grades of paperboard and in varying thicknesses. By gluing the corrugated paperboard to the flat liner, the corrugations are held firm and are prevented from stretching or flattening unless the combined paperboard meets with a considerable amount of pressure.

It may be obtained in rolls, as illustrated in Figire 2, in width desired, in sheets, or in circles or other shapes, from the paperboard manufacturers in the United States. When it is in rolls, the standard length is 250 feet and the standard width 36 inches.

Single-faced corrugated paperboard is used principally for wrapping and for interior packing. Articles of glassware, other fragile articles, and articles in glass and earthenware containers are often enclosed in this paperboard before being packed in the box. It is also used quite extensively by retail stores for wrapping merchandise for local delivery.

Double-Faced Sheets

Figure 2 shows the construction of double-faced corrugated fibreboard. The flat liners are glued to each side of the corrugated member. It is manufactured of various kinds and grades of paperboard and in varying thickness.

The tensile strength of double-faced corrugated fibreboard is greater than that of any other form of board of equal weight. Because of its arch-type construction it gives strength and rigidity to the fibreboard and also serves as a cushion whenever anything comes in contact with it. It may be scored and folded to a right angle without materially lessening its tensile strength.

This double-faced corrugated fibreboard is used for liners, pads, shells, tubes, and partitions for the interior packing of articles requiring such protection. It is used extensively for inner packing for glassware, other fragile articles, and articles in glass or earthenware containers. It has many other uses, such as, for picture backing, wardrobe cabinets, toys, freight car door protection, etc.

Double-Wall Sheets

Double-wall board consists of three flat liners and two corrugated members combined in the following sequence: a flat liner, a corrugated member, a (center) flat liner, a corrugated member, and a flat liner. It is manufactured of various kinds and grades of materials and strength and in varying thicknesses. The protection afforded by double-wall corrugated fibreboard is greater than that of double-faced corrugated fibreboard.

MANUFACTURING UNIT

Manufacturing capacity is referred to in square feet of corrugated board made per month, or by the number of boxes made per month.

The proposed plant, which represents the minimum economic unit for the industry, has a capacity of 6,000,000 square feet per month, equivalent to 450,000 boxes averaging 13.2 square feet each.

DIRECT MATERIALS AND COSTS

Item	Cost per 1000 square feet	Comparative Costs
Inner Liner	$ 2.58	_____
Corrugated Medium	1.66	_____
Outer Liner	2.58	_____
Starch	.20	_____
Finishing Cost	.30	_____
Total:	$ 7.32	_____

Cost per 1,000 boxes = $7.32 x 13.2 sq. ft. = $96.70.

At 450,000 boxes per month, averaging 13.2 sq. ft. each, the monthly material cost would be $43,515.00.
The annual material cost would be $522,180.00.

MANUFACTURING PROCESS

Sheet and Blank Formation

The operations necessary to fabricate a corrugated container center around one machine, the corrugating and combining machine. This is the principal and most expensive piece of equipment found in the container plant. The corrugating machine consists of various individual pieces of equipment, placed in line or tandem to form the integrated unit which makes the corrugated board from mill rolls of paper, finally cutting the board to the required lengths and widths. (See Figures 2A through 11.)

The combinations of machines and the sequence of the corrugating operation are as follows:

Corrugating and Single-Facing Machine

This machine is built to produce corrugated single-faced board in standard rolls up to 250 lineal feet. The sequence of operation in the machine follows: first the inner liner is placed in a mill roll stand, threaded over a pre-heater to make it susceptible to moisture and then into the single facer. The roll of corrugating medium is placed on mill roll stands, threaded over a pre-heater and a series of steam showers and then into the single facer from the opposite side.

The paperboard to be corrugated passes between two fluted rolls that mesh to form the flutes; fingers spaced in the corrugating rolls fluff the sheet from the corrugating rolls where it contacts a transfer roll that applies the adhesive to the tips of the flutes. It is then joined to the inner liner forming what is known as single-faced board. Figure 2A shows a cross-section view of a single-facing corrugator.

Double-Backing

The single-faced board is then conveyed over a bridge to the double-backer where it passes over a transfer roll which applies adhesive to the exposed tips of the flutes.

The outer liner is placed into mill roll stands, threaded over a pre-heater, then into the double-backer where it is joined to the single-faced board to form a three-ply or double-faced board.

The double-backer is in two sections 36 feet long, and is referred to as the heating or drying section and the cooling and pulling section. Since the flexible single-faced paper at the point of entry is reinforced with a second liner (outer), the board is now rigid and can travel only on a horizontal plane. Consequently, the double-backer must be of considerable length to accomplish its purpose.

The double-faced board then travels over a heating plate section conveyed between wide cotton belts which keep the board under a slight pressure and allow time for the adhesive to set.

Slitting and Scoring

As the board leaves the double-backer and belt section, it travels through a slitting and scoring attachment and finally to the cutoff, thus producing sheets trimmed for length and width and scored lengthwise. A three-bar scoring and slitting attachment allows multiple setups for various box-blank sizes with a minimum of machine down-time.

Adhesives

The two most common adhesives used in a corrugator are silicate and starch. The silicate forms a hard bond but has a tendency to form and build up on the equipment, which presents a maintenance problem; whereas starch takes on a powdered form when dry and crumbles under friction. Of the two, most manufacturers prefer the starch.

The forming of the corrugated sheet and the box-blank is now complete, and the fabrication of the container follows.

Printing and Slotting

The corrugated printer-slotter provides the [illegible] of printing, creasing, and slotting the box-blank. The m[illegible]e is hopper fed, permitting high-speed operation. Each bund[illegible] blanks is placed between two adjustable stopper plates; they should be kept even and squared. A kicker, working back and forth under the pile, picks the bottom sheet and pushes it forward to a set of pull rolls. When the forward motion is taken up by the pull rolls, the kicker returns for the next sheet. The pull rolls then convey the sheet blank under the first printing cylinder.

The printing cylinder is of wooden composition marked off in one-inch squares for the aligning of the rubber printing dies so that they will contact the box-blank according to specification. The individual panel dies are mounted beforehand on a fibre sheet. The sheet is then stapled to the wooden cylinder. As the inked surface of the die strikes the sheet, the ink is transferred to the surface of the sheet.

A second set of pull rolls between the first and second printing cylinder keeps a constant pull on the sheet at a constant speed. The first cylinder is used only for the lighter shade of two inks. If the specifications call for only one color, the ink is supplied at the second cylinder.

Ink is worked down to the printing cylinders from the ink fountains; the fountains extend the full width of the machine with a pressure blade at the base resting against the bottom of the fountain roll. The pressure blade can be set by a series of set screws allowing a measured quantity of ink to be carried through as the fountain roll rotates; and through a series of rector rolls, distributor and oscillating rolls, the ink is thoroughly spread over form rolls which contact the dies.

Creasing

The box-blank emerging from the second printing cylinder enters the creasing unit. The creasing unit consists of an upper and lower shaft; the steel wheels in the lower shaft are split blades fastened to semi-steel hubs. These score against a steel collar in the upper shaft, assuring a permanent score for creasing purposes.

Slotting

The slotting unit consists of slotting heads of the interlocking type with bearings five inches long so that they will run without wobbling. A set of lower slotter knife rings make up the female dies. These are removable for regrinding and reversing when one edge is worn. The box-blank passing through the slotting unit is slotted properly to form the flaps.

The box-blanks now printed, trimmed, creased and slotted, drop on a slow moving conveyor belt shingle, then drop on a take-off table where they are piled and attacked for the next operation.

Closing and Taping (Manufacturer's Joint)

The manufacturer's joint is the seam that forms the body of the box. This seam or joint is always on the corner, and the box is folded for taping as shown in Figure 1.

The two most common types of closing the box-blanks are taping and stitching. For more economical operation, taping is used.

Taping Method

The operation is performed in a semi-automatic open-throat taping machine. The box-blanks, in piles, are placed on a roller conveyor and automatic lift which keeps the box-blanks entering the machine at the level of the throat of the taper.

The operator folds the blank over and pushes it forward where pull rolls take over the guidance of the box through the machine. The tape in pre-gummed rolls is pulled over a wetting roll, and is then automatically placed along a vertical corner of the box and cut to length by a trip-operated solenoid valve. The box-blank is then guided along between belts and pressure is applied to set the adhesive. The boxes drop into a counter ejector, set to eject the required number of boxes in stacks along a roller conveyor where they are bundled.

Packaging

The stacks of containers are tied or strapped in bundles of 25 or 50, or whatever may be the most suitable for the size and weight of the bundle.

The tapes used in this operation run from 2 inches to 3 inches in width, the application depending on the size of contents of the container. Some of the tapes available are Kraft paper tape in weights of 40 to 120 pounds, Kraft backed combined with asphalt and sisal fibres, Kraft backed combined with glass fibres, and cloth backed tapes of various weights.

TESTING

Container plants usually have their own testing equipment or employ the services of a commercial testing laboratory. Container and materials testing is simply a method of determining the probable performance of container and materials in use. Scientific machines and instruments have been developed that simulate conditions to which containers and their materials are known to be subjected during transport. Regular testing procedures assure good quality control.

Paper and paperboard reflect changes in atmospheric conditions, so for uniformity, containers to be tested are conditioned for 24 hours at 50 percent relative humidity and 73 degrees Fahrenheit, the standard set by the American Society for Testing Materials.

Tests of containers are: the compression test, revolving drum test, incline impact test, vibration test, drop test, score line tear test, scuffing test, and moisture-proofness test.

To elaborate on a few of the necessary tests:

Compression Test

This test subjects containers to compressive forces similar to those to which they may be subjected while in transit in cars, trucks or warehouses. Each container is tested individually, both top and bottom, and end to end, in a large compression machine which consists of a platform scale over which a power-driven crossbeam is mounted. The container to be tested is placed between two parallel surfaces, one the scale platform, the other the platen under the crossbar. The applied pressure is read on an attached calibrated dial at each increase of 1/10 inch in the deflection or distance that the opposite surfaces of the container are forced together.

Revolving Drum Test

This test subjects the container to treatment closely simulating handling during transportation. The machine used is a 7-foot hexagon drum, in the inside faces of which is a series of baffles which cause the container to fall on various

points in succession as the drum revolves at a constant speed of 2 RPM. The number of falls which the container can withstand before failure is a measure of its serviceability.

Inclined Impact Test

This test simulates the stresses applied to containers in transit, where the vehicles are subjected to sudden starts and stops. It consists of releasing a loaded container mounted on a movable platform dolly which rides on a plane inclined to 10 degrees from the horizontal, and permitting it to strike against a fixed backstop or the bottom of the incline. The magnitude of impact shock is varied by using different release points.

SCRAP

The care and attention devoted to scrap disposal is, to some extent, dependent upon the resale value of trimmings, roll ends, and other scrap. When scrap has a fair resale value, the best practice is to set apart an area where all waste paper can be collected and baled. The trim strips from each side of the slitter at the end of the drying line are fed into flexible suction pipes and conveyed to the baling area. Scrap accumulates very rapidly from the slitter, but most equipment currently furnished includes the suction pipes. Box makers generally consider the cost of scrap to run from 10 to 12 percent of material costs.

CONTAINER DESIGN

Designing a carton that will give the maximu service requires the consideration of many things, such as appearance, weight, price, ease of handling and packaging, and protection to the contents. The carton shown in Figure 1 is an example of good design; dimensions are easily visualized, being approximately 1 foot square by 2 feet long. This box requires 12 square feet of board to make. One thousand boxes, with allowances for folding and 10 percent for scrap, require 1,320 square feet to make.

PLANT LAYOUT

The controlling feature of the layout is the length of the space available for the corrugator. The capacity of the corrugator can be increased if the heating and drying sections are lengthened. The longer these sections are, the greater speed at which the paper board can be passed through. The space allotted to equipment other than the corrugator will vary, depending upon the sizes of boxes to be produced. The equipment listed contemplates a balance of all sizes of boxes; therefore one small and one large printer-slotter have been listed.

The plant layout should be decided upon after the intended output has been determined as to the volume of the principal sizes and types. In the United States, a monthly output of 6 million square feet is considered the minimum economical operating capacity. This would require approximately 50,000 square feet of space as shown in Figure 11.

PLANT SITE

To provide for eventual expansion, the land for the plant site should contain at least 2 1/2 acres. The site should be level, well drained, and should be located as advantageously as possible with respect to transportation, power, water, fuel, sources of markets and labor. The cost of such a site is estimated at $2,000.

BUILDING

One building 120 feet by 420 feet or about 50,000 square feet will be required. The building may be consturcted of any suitable materials. It should be a one-story building, well lighted, heated and ventilated. The estimated cost of the building is $3.50 per square foot of floor space or approximately $175,000.

POWER

The connected load of all motors used will not exceed 120 H.P. The annual cost of power is estimated at $7,400.

WATER

The cost of water for the boiler, production and all other purposes is estimated at $700.

FUEL

The cost of fuel is estimated at $8,000. Consideration should be given to the type of fuel available locally in the procurement of the boiler.

EQUIPMENT REQUIREMENTS

Item	Unit	Estimated	Actual
68-inch Single Facer with either "A", "B", or "C" flute corrugating rolls*	1	$ 16,500	_____
Mill Roll Stands*	3	5,000	_____
Single Preheating Unit*	1	3,300	_____
Duplex Preheating Unit	1	7,000	_____
Bridge and Conveyor	1	4,200	_____
Glue Machine*	1	7,500	_____
Double Facer	1	40,000	_____
Duplex Slitter Scorer	1	6,000	_____
Single Sheet Cut-Off*	1	17,000	_____
Sheet Stacker and Delivery*	1	8,500	_____
25 H.P. Drive for Single Facer	1	5,000	_____
50 H.P. Drive for Double Facer*	1	9,000	_____
2-ton Electric Hoists Mounted on Bridge to load rolls onto stands	4	6,000	_____
Steam System	1	5,000	_____
Total		$ 140,000	_____

* Units of the Corrugating and Combining Machine.

In addition to the corrugating and combining machine, the following equipment will be required:

Item	Unit	Estimated	Actual
38-inch by 78-inch two-color Printer-Slotter, Creaser and Trimmer, Type RPS, including variable drive and 15 H.P. motor	1	$ 33,000	_____
50-inch by 106-inch two color Printer-Slotter, Creaser and Trimmer, Type RPS, including variable drive and 20 H.P. motor	1	37,000	_____
Size 82-inch Slitting and Scoring Machine, including drive and motor	1	3,500	_____
Estimated additional charge for scoring wheels, depending on various boxes to be produced		500	_____
Single Operator, Automatic Taper, including 1 1/2 H.P. drive	1	6,000	_____
Steam Boiler 150 H.P., 200 pound pressure	1	25,000	_____
Starch Equipment	1	6,000	_____
Total		$ 115,000	_____

Total Cost of Machinery and Equipment $255,000.

The equipment cost can be materially reduced by buying used equipment. This can be done at very reasonable prices in the United States, especially in the sizes for 63-inch material.

OTHER EQUIPMENT REQUIREMENTS

Item	Estimated	Actual
Hand Tools	$ 500	
Repair Parts	3,000	
Extra Motors	1,500	
1 Ton Pickup Truck	2,500	
Total	$ 7,500	

OFFICE FURNITURE AND EQUIPMENT

Item	Unit	Unit Cost	Estimated Cost	Actual
Desks	4	$ 150	$ 600	
Chairs	8	50	400	
Filing Cabinets	4	75	300	
Typewriter	1	150	150	
Adding Machine	1	150	150	
Initial Supplies		200	400	
Total			$ 2,000	

DEPRECIATION

Item	Estimated Cost	Years' Life	Estimated per Year	Actual per Year
Building	$ 175,000	20	$ 8,750	
Machinery and Equipment	255,000	15	17,000	
Other Equipment	5,000	10	500	
Office Furniture and Equipment	2,000	10	200	
Pickup Truck	2,500	4	625	
Total			$ 27,075	

LABOR REQUIREMENTS

Direct Labor

Department	Unit	Hourly Rate	Total Cost per Year	Actual Cost per Year
Corrugating				
Corrugator Operator	1	$ 2.00	$ 4,000	_____
Double Backer	1	1.80	3,600	_____
Slitter Operator	1	1.80	3,600	_____
Shafter	1	1.60	3,200	_____
Take-Off Men	3	1.50	9,000	_____
Printer Slotter Pressman	1	2.20	4,400	_____
Knifeman	1	1.70	3,400	_____
Helpers	2	1.50	6,000	_____
Finishing				
Taping Supervisor	1	1.60	3,200	_____
Taping Helpers	8	1.50	24,000	_____
Material Handling	4	1.50	12,000	_____
Warehouse Men	2	1.70	6,800	_____
Maintenance	2	2.00	4,000	_____
Shipping	3	1.50	9,000	_____
Total	31		$ 96,200	_____

Indirect Labor

Description	Unit	Hourly Rate	Total Cost per Year	Actual Cost per Year
Manager	1		$ 10,000	_____
Janitor	1	$ 1.60	3,200	_____
Bookkeeper	1		4,800	_____
Clerks	2	1.60	6,400	_____
Firemen	2	1.80	7,200	_____
Total	7		$ 31,600	_____

SUPPLIES

Item	Estimated	Actual
Lubricants	$ 100	_____
Maintenance	1,000	_____
Spare Parts	5,000	_____
Hand Tools	130	_____
Office Supplies	300	_____
Total	$ 6,530	_____

MANUFACTURING OVERHEAD

Depreciation	$ 27,075	_____
Indirect Labor	31,600	_____
Supplies	6,530	_____
Power	7,400	_____
Water	700	_____
Fuel	8,000	_____
Total	$ 81,305	_____

MANUFACTURING COSTS

Direct Materials	$ 522,180	_____
Direct Labor	96,200	_____
Manufacturing Overhead	81,305	_____
Total	$ 699,685	_____

UNIT COST PER 1,000 BOXES

Annual Cost of Manufacturing $699,685
Annual Production of Boxes $5,400,000

$$\frac{\$\ 699,685}{5,400,000} = \$.13 \text{ per box}$$

Cost per 1,000 Boxes $130

FIXED ASSETS

Item	Estimated	Actual
Land	$ 2,000	
Building	175,000	
Production Equipment and Tools	225,000	
Other Equipment	5,000	
Furniture and Fixtures	2,000	
Pickup Truck	2,500	
Total	$ 411,500	

WORKING CAPITAL

Direct Materials	- 60 days	$ 92,000	
Direct Labor	- 30 days	8,000	
Manufacturing Overhead	- 30 days	6,700	
Reserve Sales Collections	- 30 days	79,000	
Total		$ 185,700	

CAPITAL REQUIREMENTS

Fixed Assets	$ 441,500	
Working Capital	185,700	
Total Capital Required	$ 627,200	

SALES REVENUE

The average size box used in this report for cost purposes requires 13.2 square feet each. The manufacturing cost is $0.13 each. The total boxes produced per year is 5,400,000.

The current selling price for a box of this quality and size is $0.175. Based on this price per box, the annual gross sales would amount to $945,000.

The selling cost is lower than for the average industry since the boxes are sold principally to industry in large orders.

RECAPITULATION OF COSTS, SALES AND PROFITS

	Estimated		Actual
Direct Material	$ 522,180		_____
Direct Labor	96,200		_____
Manufacturing Overhead	81,305		_____
Total Manufacturing Costs		$ 699,685	_____
Interest on Loans	$ 7,000		_____
Insurance	2,000		_____
Advertising	2,400		_____
Legal	1,400		
Auditing	3,000		_____
Unforeseen Expense	20,515		_____
Total Administrative Costs		36,315	_____
Sales, Commissions, Travel, Freight Out, Bad Debts, Discounts and Allowances		64,000	_____
Profit before Taxes		145,000	_____
Total Annual Gross Sales		$ 945,000	_____

BUDGET CONTROL:

A requisition form designed to provide accurate records of procurement and indicate the purpose of procurement with the least amount of time and effort is shown on the following page.

This form has an account number for each type of the various expenditures which the manager will review in detail, monthly or oftener, in order to control his expenses. Some items, such as power and water, are usually under contract and are easily checked by reference to monthly bills. For simplification, items (marked with an asterisk below) are omitted from the purchase requisition. Variations in the labor costs are easily reviewed by examination of the payroll vouchers. The simplified type of control thus provided makes certain that the manager can control expenditures promptly.

Following the requisition form, a sample voucher check is shown. Voucher checks should be used for the payment of all expenditures and the appropriate book account number placed on each voucher.

At the end of each month the manager will receive a statement of all expenditures broken down by budget accounts. If the expenditures exceed the budgeted monthly allowances of any of the accounts, the bookkeeper will furnish the manager with a break-down of all expenditures relative to the budgeted accounts exceeded. All these supporting data can be secured by reference to the purchase requisitions and the check vouchers. This reference will enable the manager to determine what caused the over-expenditure and take corrective action.

If at any time during each month it becomes apparent that expenditures will exceed any of the budget accounts, the bookkeeper will bring this to the attention of the manager for his information and action.

BUDGET CONTROL ACCOUNTS:

Account Number		Monthly Expense	Monthly Budget	Annual Budget	Actual
10	Administrative	$_____	$ 1,150	$ 15,800	$_____
20	Sales	_____	5,416	64,000	_____
30	Direct Materials	_____	43,515	522,180	_____
40	Supplies	_____	544	6,530	_____
51	Power*	_____	616	7,400	_____
52	Water*	_____	58	700	_____
53	Fuel	_____	666	8,000	_____
60	Unforeseen Expense (Reserve Account)	_____	1,870	20,515	_____
71	Direct Labor*	_____	8,016	96,200	_____
72	Indirect Labor*	_____	2,633	31,600	_____
80	Depreciation (Reserve Account)	_____	2,180	27,075	_____

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

PURCHASE REQUISITION	COMPANY NAME	DATE

- ☐ 10 ADMINISTRATION
- ☐ 20 SALES
- ☐ 30 MATERIALS
- ☐ 40 SUPPLIES
- ☐ 50 UTILITIES
- ☐ 60 UNFORESEEN EXPENSE

INDICATE BELOW THE USE OF MATERIALS

- ☐ DIRECT MATERIALS
- ☐ MAINTENANCE MATERIALS
- ☐ MAINTENANCE SERVICES
- ☐ OPERATING SUPPLIES

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

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

R. W. MITCHELL MANUFACTURING COMPANY

1422 BOSWORTH STREET, S. E.

65-22
514

ANYWHERE, U. S. A._____ 19 ___ No. 10000

PAY _____ DOLLARS $ _____

TO THE ORDER OF

R. W. MITCHELL MANUFACTURING COMPANY

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

BY SAMPLE CHECK

VICE PRESIDENT

ACCOUNT NUMBER

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

R. W. MITCHELL MANUFACTURING COMPANY

ENGINEERS

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

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

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

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

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

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

TRAINING

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

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

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

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

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

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

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

SAFETY

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

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

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

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

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

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

SUMMARY

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

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

MATERIALS AND SUPPLIES

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

MARKET FACTORS

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

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

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

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

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

EXPORT MARKETS

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

MARKETING PROBLEMS

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

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

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

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

ECONOMIC FACTORS

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

PERSONNEL

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

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

LAWS AND REGULATIONS

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

FINANCIAL FACTORS

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

FINANCIAL REQUIREMENTS OF THE PROJECT

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

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

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

SHORT TERM BANK CREDITS

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

FINANCIAL PLAN

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

BIBLIOGRAPHY

Textbooks

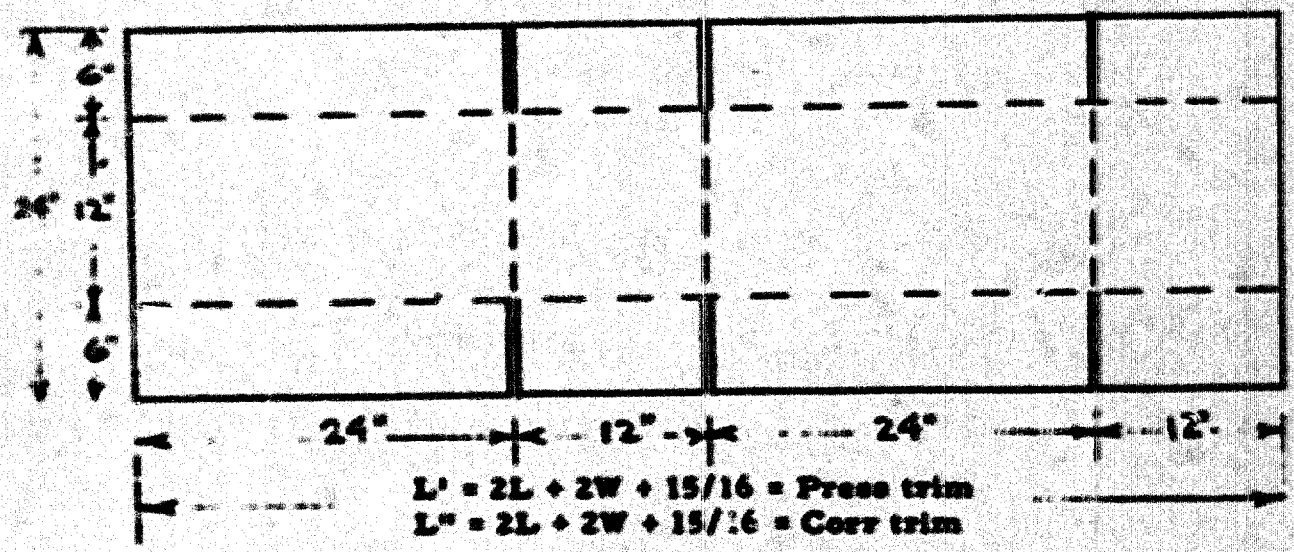
Corrugated and Solid Fiberboard Boxes and Products	Fiber Box Association 224 South Michigan Avenue Chicago 4, Illinois
Manufacture of Fiber Shipping Containers	Board Products Publishing Co. 228 North LaSalle Chicago 1, Illinois

Periodicals

Box Board Containers	Maywood Publishing Company 6 North Michigan Avenue Chicago 2, Illinois
Fiber Containers	Board Products Publishing Co. 228 North LaSalle Chicago 1, Illinois

ABBREVIATIONS

ASME	American Society of Mechanical Engineers
sq ft.	Square feet
RPM	Revolutions per Minute
H.P.	Horsepower
%	Percent
'	Foot or Feet
"	Inch or Inches



Outer laps meet - inner laps at random.
All dimension center to center of creases.
D-L-W are content or inside box dimensions.

<u>Regular slotted container - "A" flute - taped</u>

Approximately 12 square feet for 1 container.
Approximately 1,320 square feet for 1,000 with scrap allowance added.

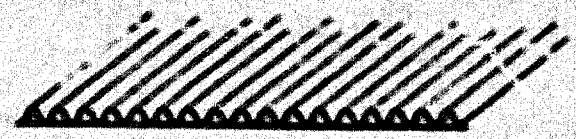
Manufacturer's Joint

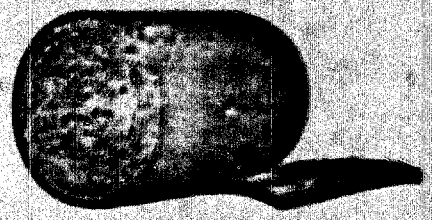
Container folded for taping

FIGURE 1.

UNLINED CORRUGATED PAPERBOARD

SINGLE-FACED CORRUGATED PAPERBOARD

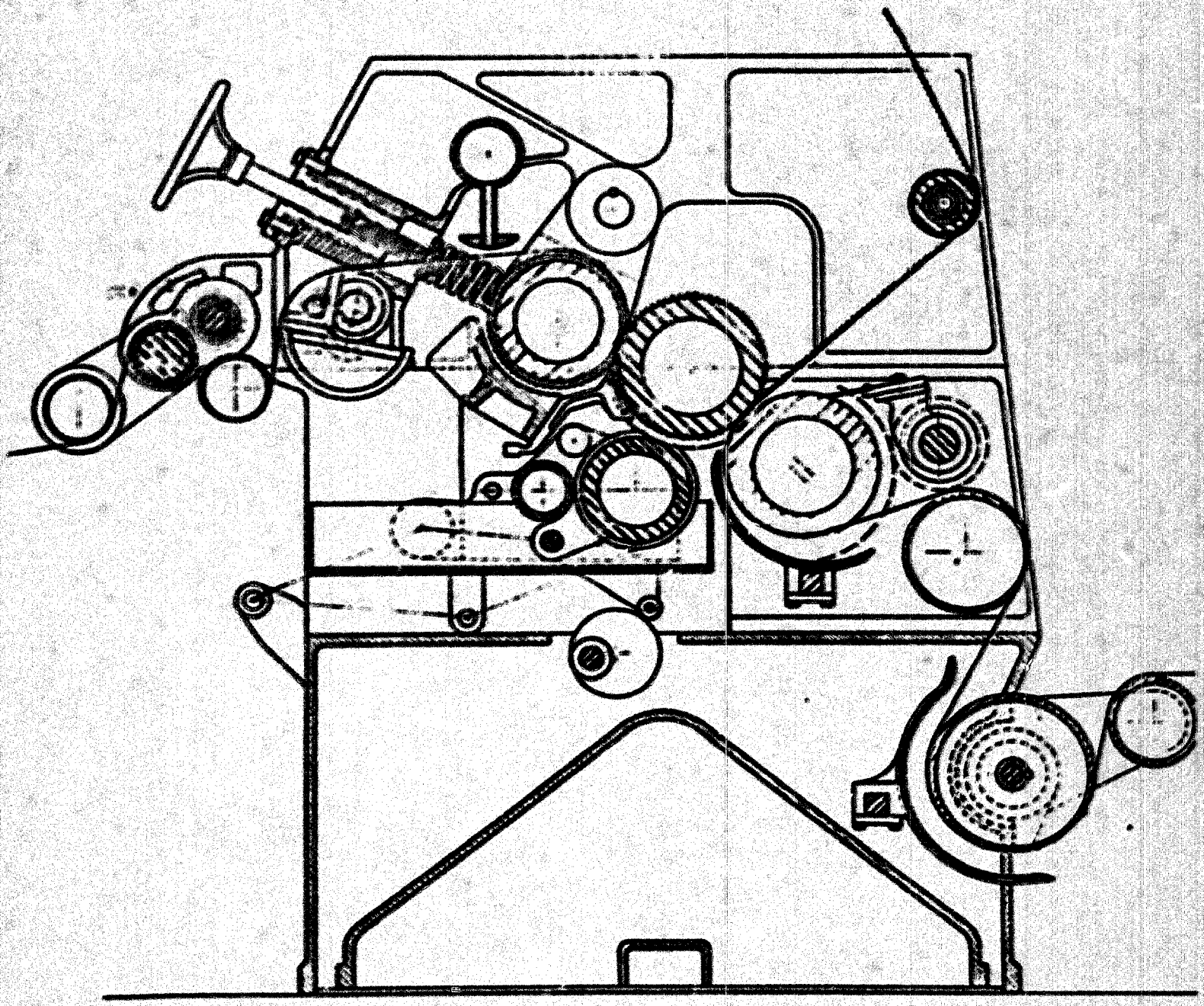




DOUBLE-FACED SHEETS

DOUBLE-WALL SHEETS

FIGURE 2 TYPES OF CORRUGATED PAPERBOARD



SIDE ELEVATION — CROSS SECTION OF
SINGLE FACING CORRUGATOR
FIGURE 2A

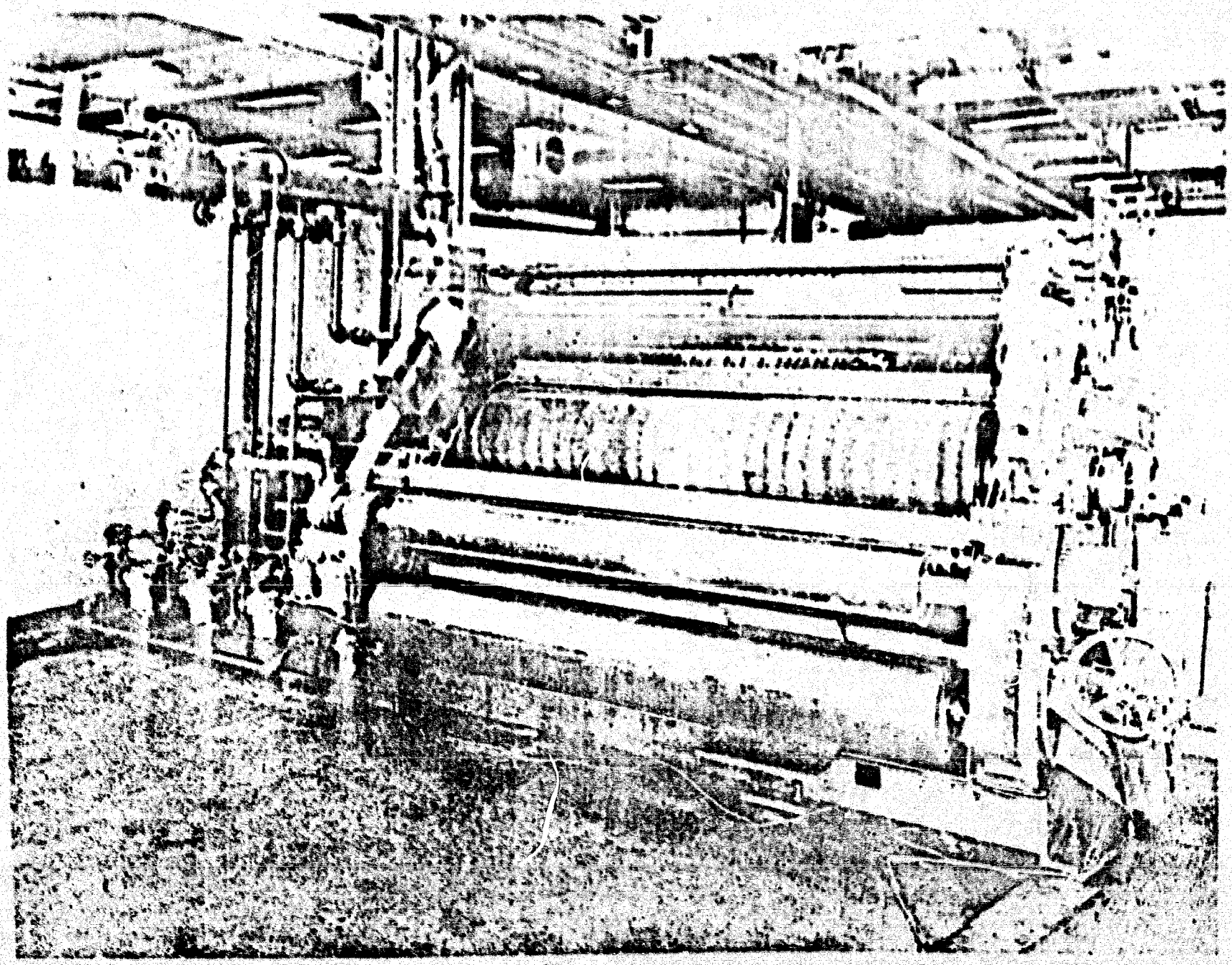


FIGURE 2B - SINGLE FACING CORRUGATING MACHINE (1952)

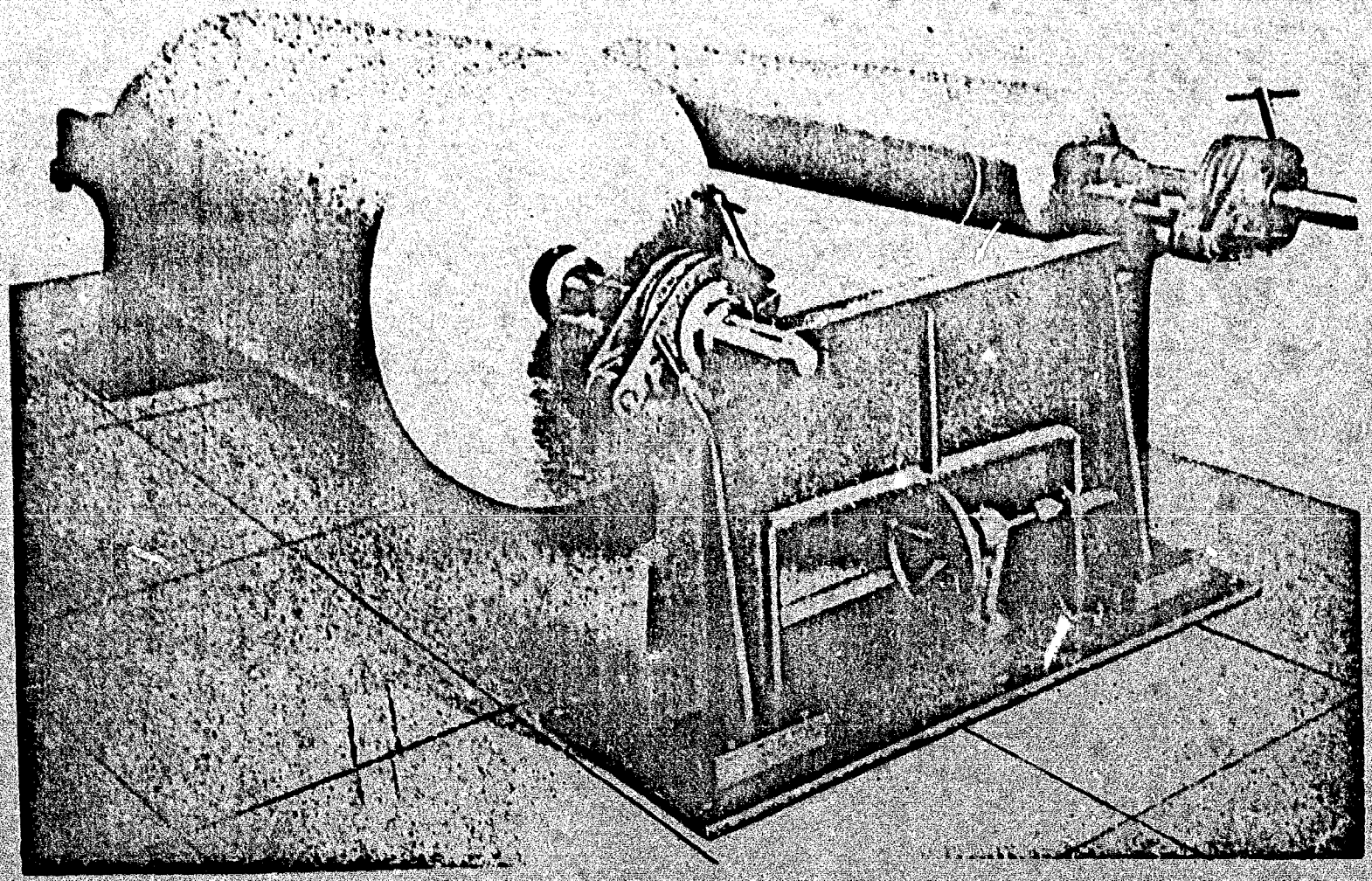


FIGURE 3 - STANDARD MILL ROLL STAND

The preheater consists of a balanced and smoothly turned and ground steel drum, 36" in diameter, mounted on roller bearings having large capacity. It revolves freely by the pull of the paper. The bearings are set in cast iron side frames which are rigidly mounted on a solid, one-piece base plate.

The drum which is heated by steam through a Johnson joint with siphon pipe attachment, conforms to the A.S.M.E. requirements. A ¾ H.P. motor, driving a pinion and gear, controls the swing of a 5" diameter wrap roll. This permits a wide range of the contact of the paper with the hot drum so that the minimum or maximum of moisture can be removed. This adjustable wrap roll is stopped in its extreme positions by two limit switches to prevent over-riding.

A stationary idler roll is located at the lowest point to give maximum surface contact. Both the stationary and adjustable idler rolls are mounted on large capacity ball-bearings.

The maximum wrap-around the drum is more than 8 feet, — the equivalent of four 24" steam chests on the double facer.

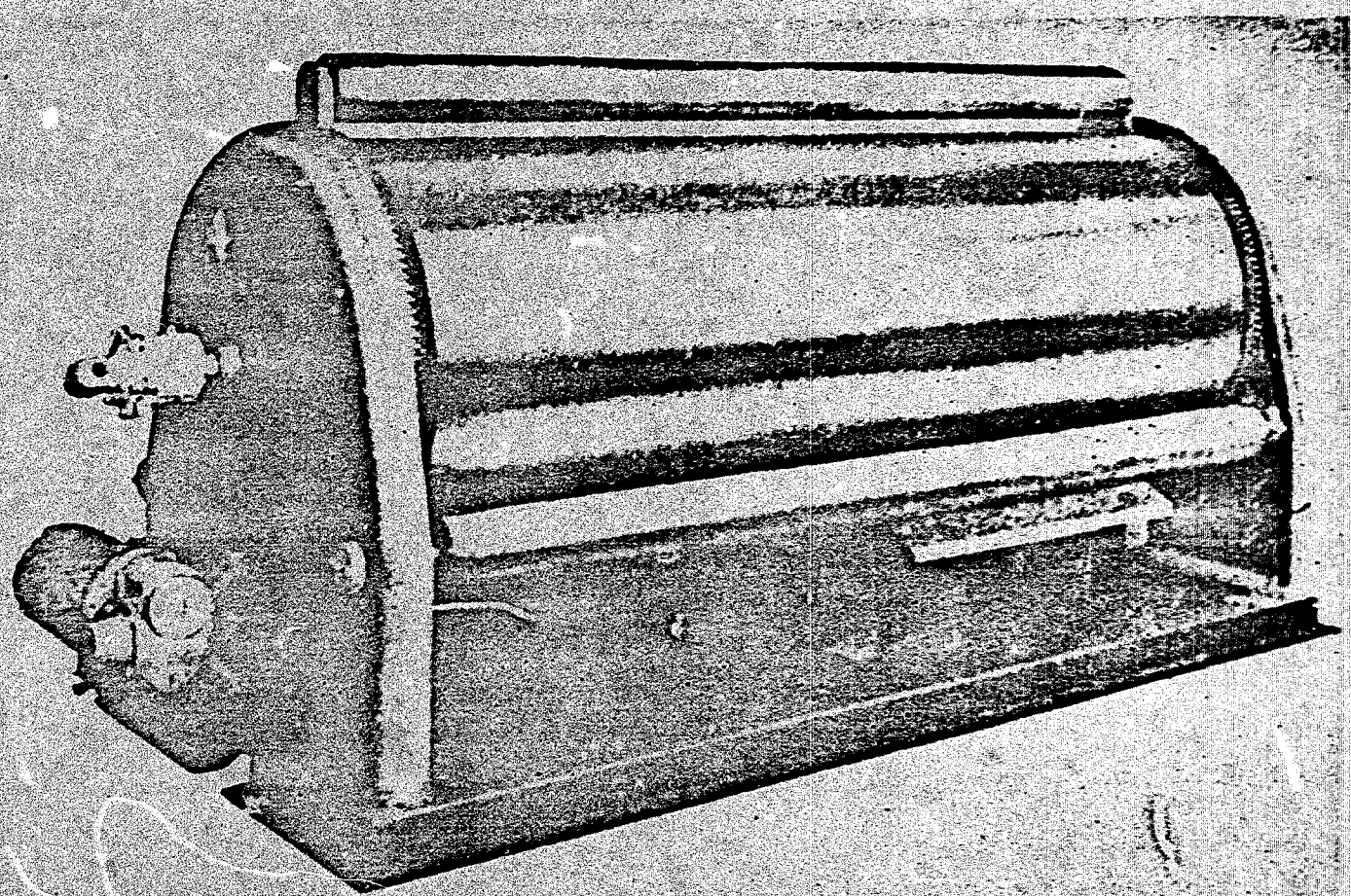
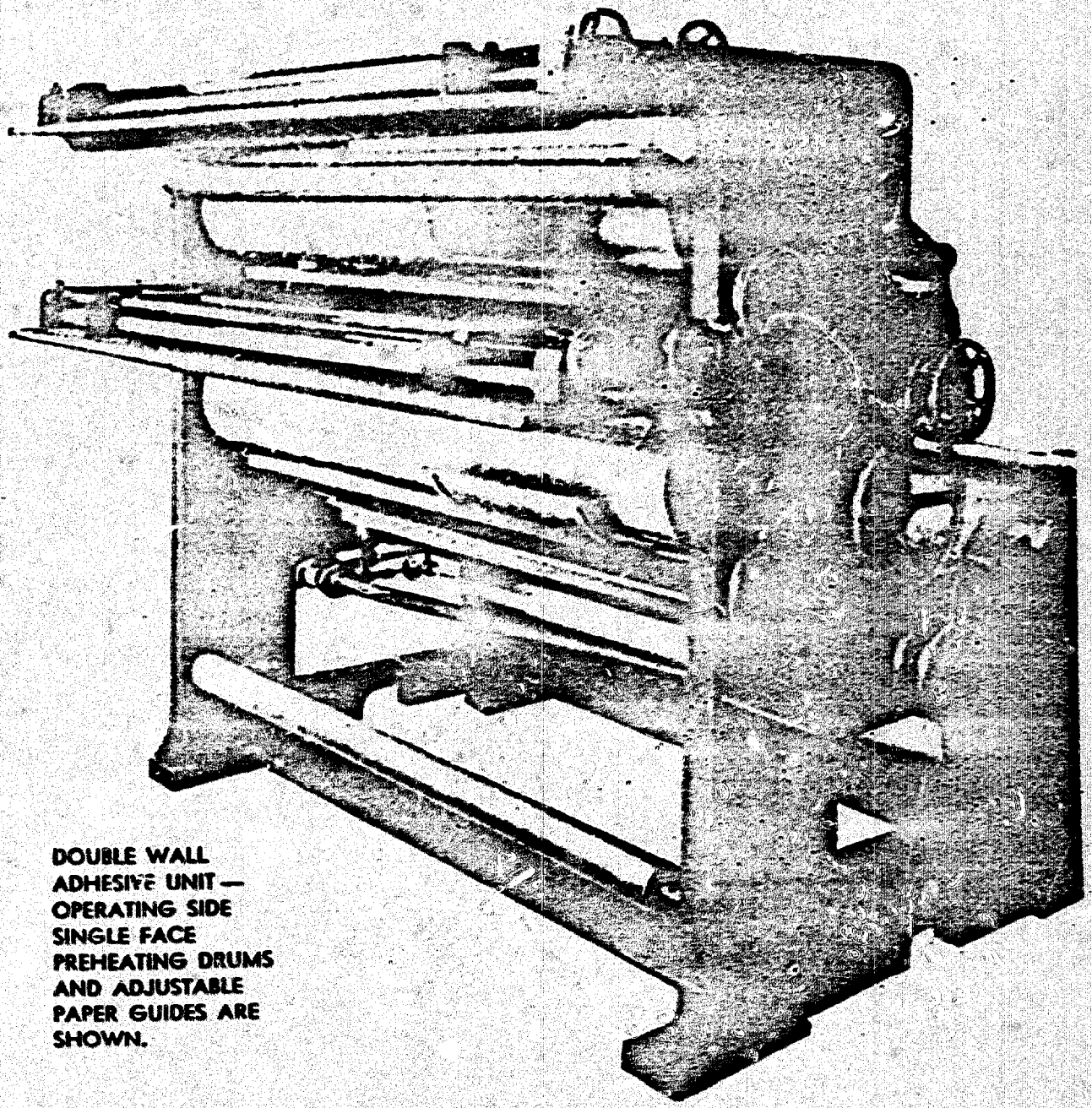


FIGURE 4 - PREHEATING DRUMS



DOUBLE WALL ADHESIVE UNIT — OPERATING SIDE SINGLE FACE PREHEATING DRUMS AND ADJUSTABLE PAPER GUIDES ARE SHOWN.

FIGURE 5

PRECISION SHEET CUT-OFF

SINGLE TYPE

Years of research and much experimental work has gone into the building of sheet cut-offs for corrugating and other board machines.

It is noiseless and smooth running, quickly set and accurate at all speeds. Its accuracy alone makes this machine pay for itself in a short time, as the paper wastage common to other types of cut-offs is greatly reduced. Then too, there is less down time and the speed of the corrugator is increased.

Because this cut-off is completely rotary and because there are far less working parts than found on other knives, maintenance expense and down time are practically nil. The operating mechanism is amazingly simple—a crank, link, four gears, and a variable speeder are the main members.

This cut-off is guaranteed to cut sheets squarely in any length from 25" to 180" with sheet lengths not varying over 1/16" at any speed of the corrugating machine. With the trend toward bigger and bigger boxes, such as furniture and textile containers, the great range of sheet sizes should not be overlooked. These extra long sheets permit the manufacture of large containers in one piece, thus saving extra handling, assembling and taping.

The unit consists essentially of two heavy walled cast iron side housings securely bolted and dowel pinned to a heavy one piece steel platform and they are interlocked by three sturdy cast iron cross braces.

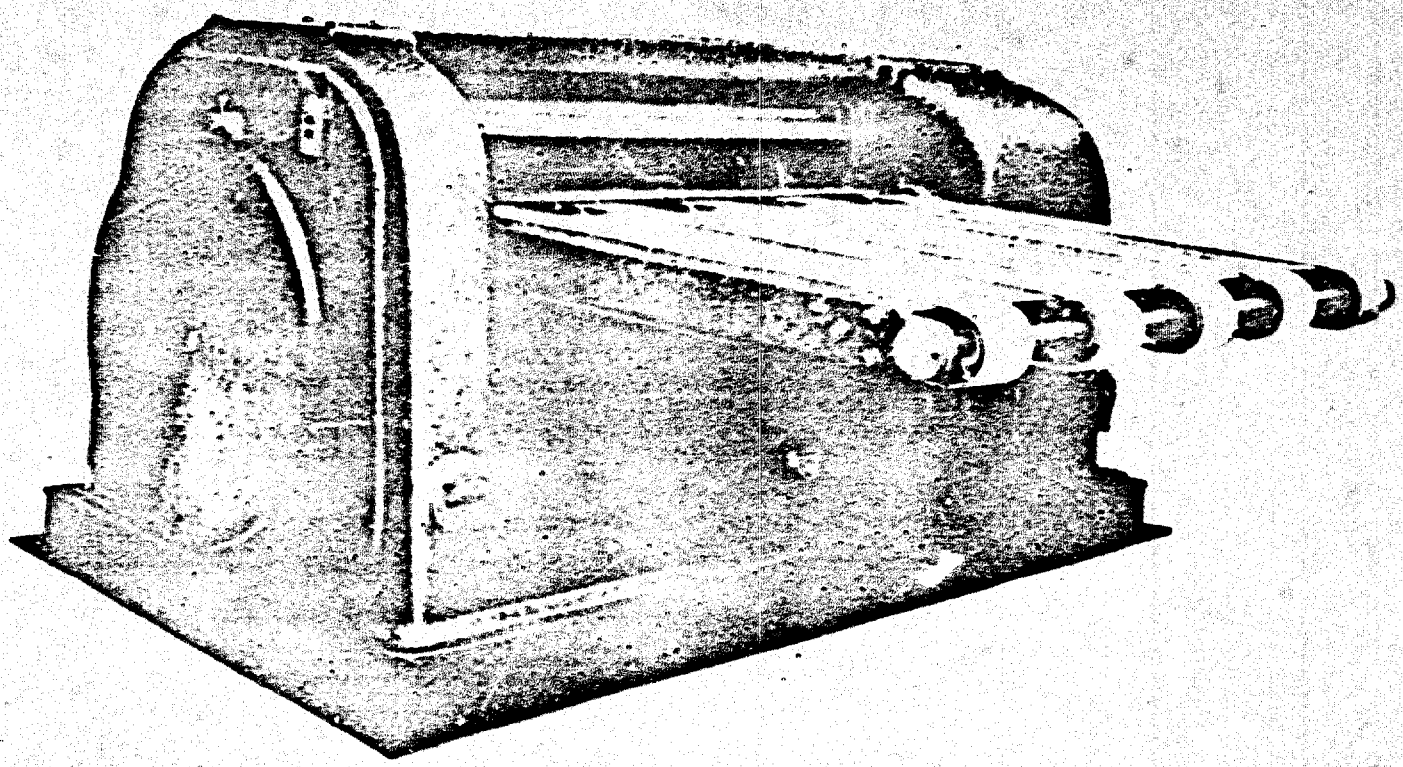


FIGURE 6 - SINGLE CUT-OFF DELIVERY END

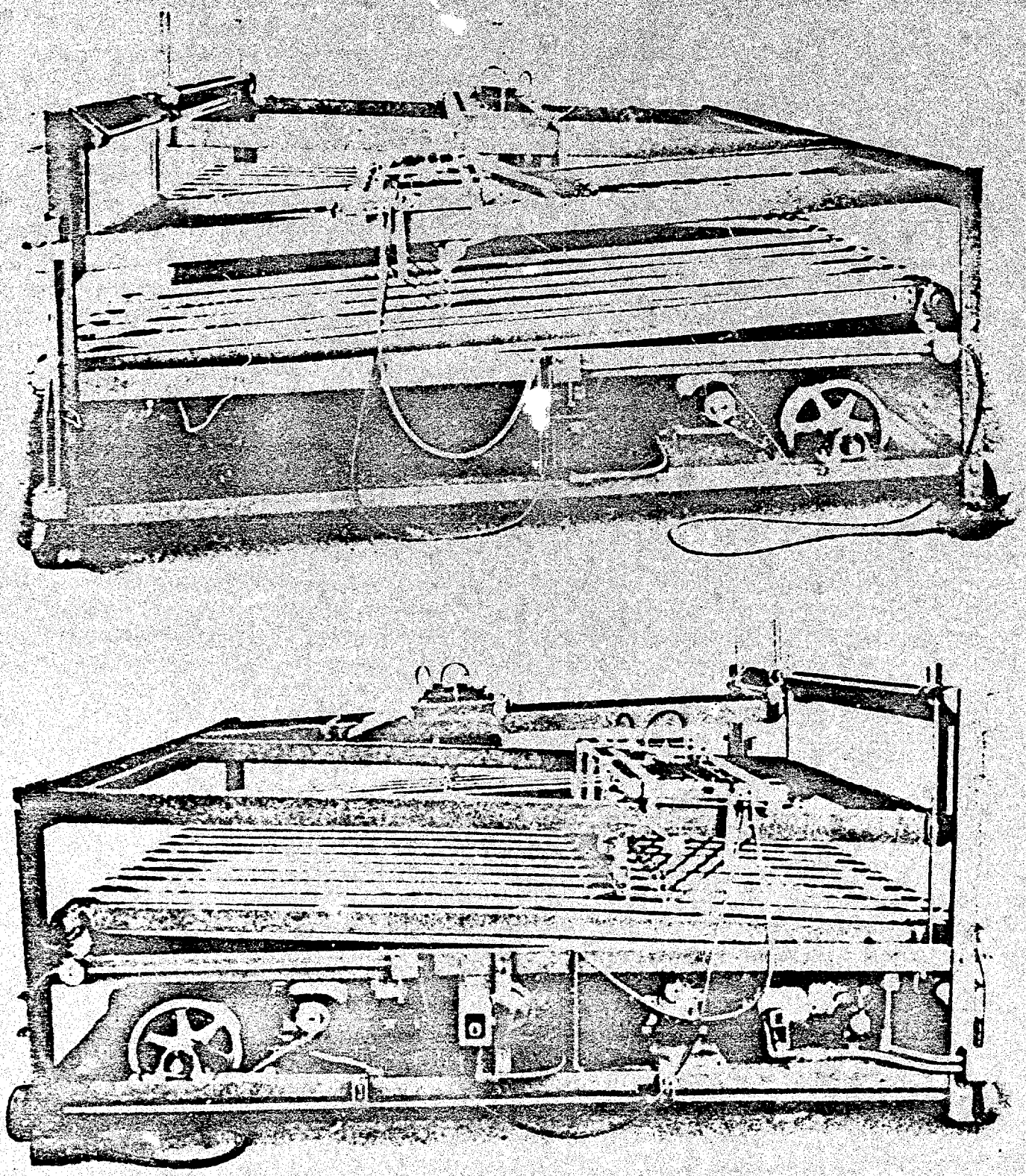


FIGURE 7 - SHEET STACKER

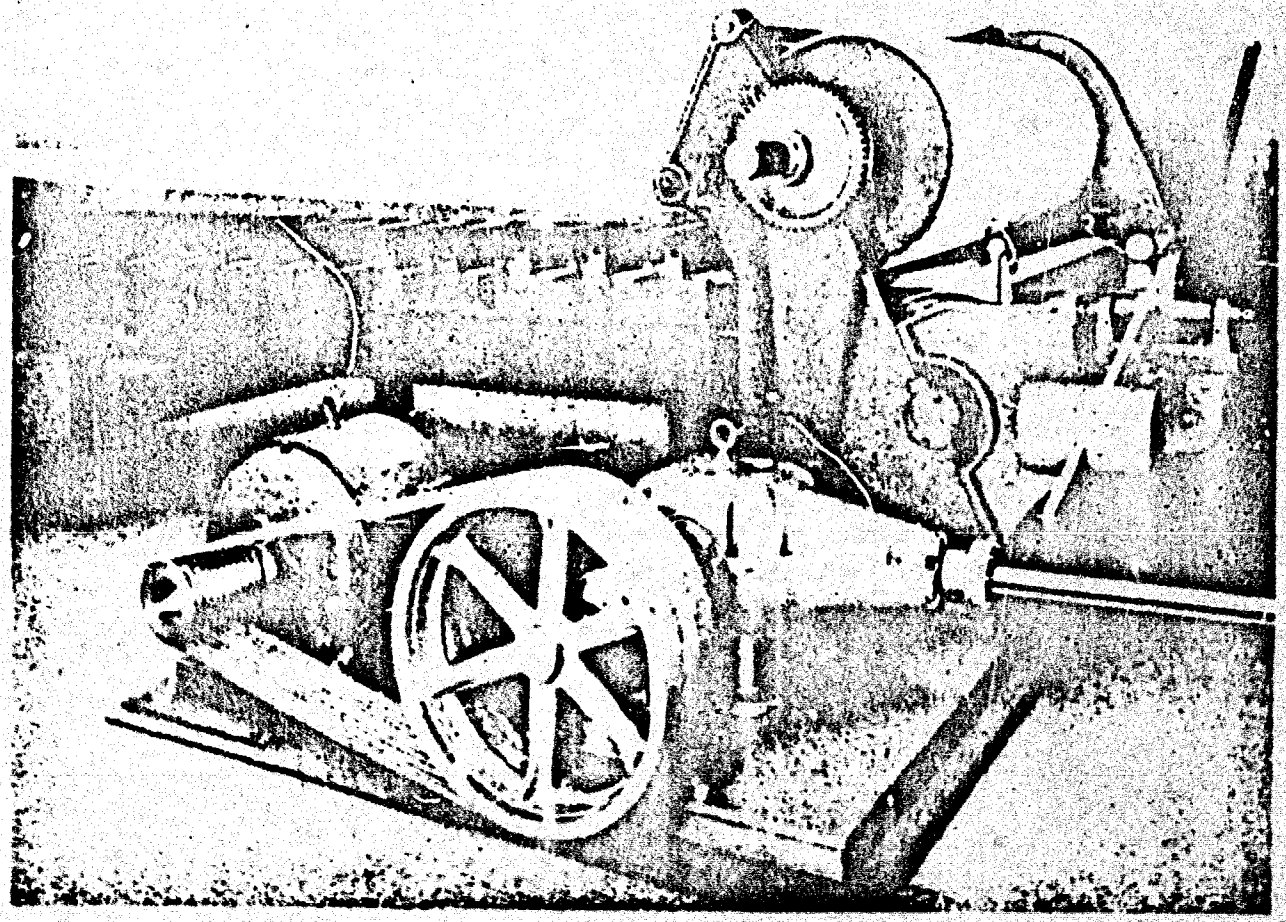


FIGURE 8 - 50 H.P. DRIVE FOR DOUBLE FACER

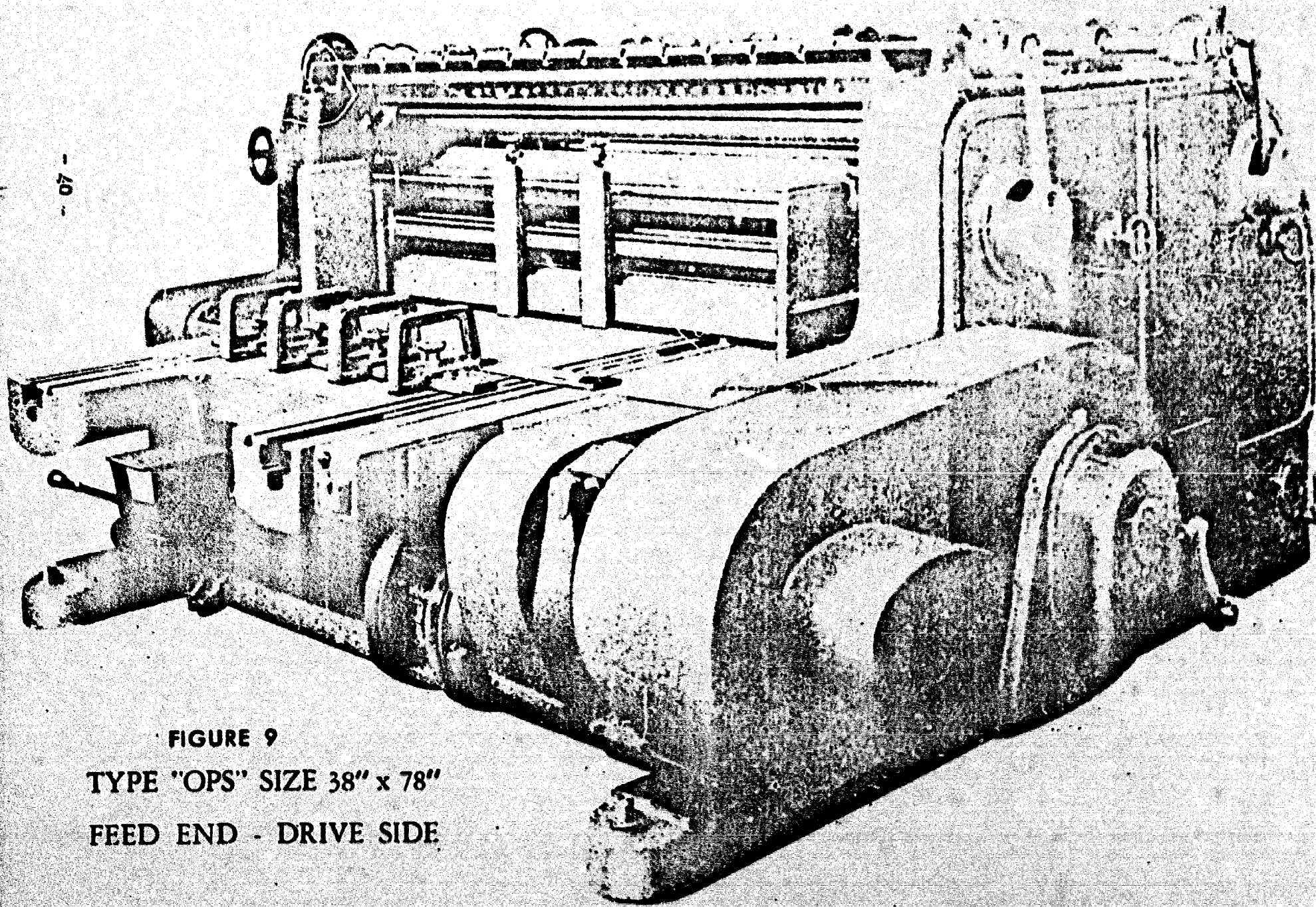


FIGURE 9

TYPE "OPS" SIZE 38" x 78"

FEED END - DRIVE SIDE

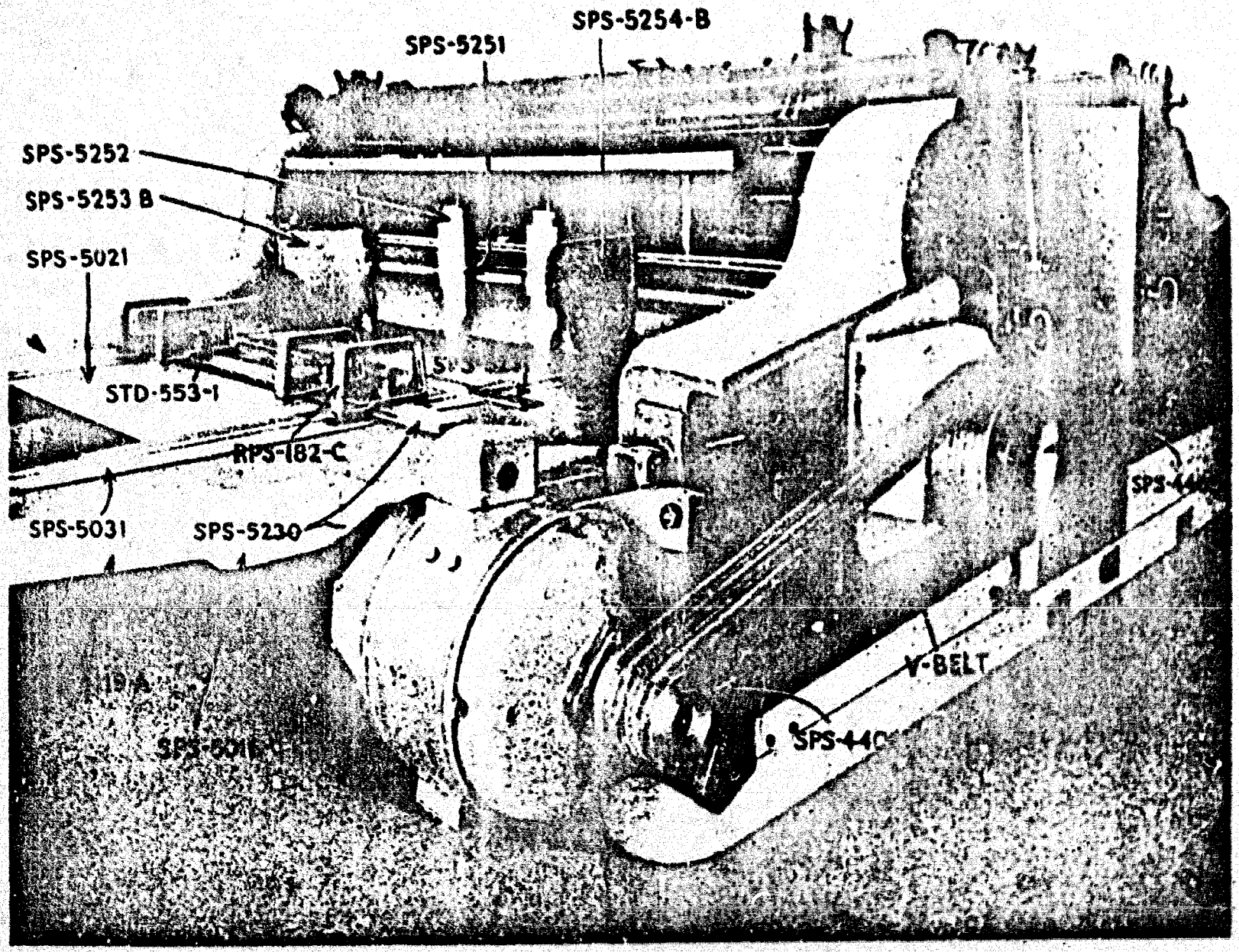
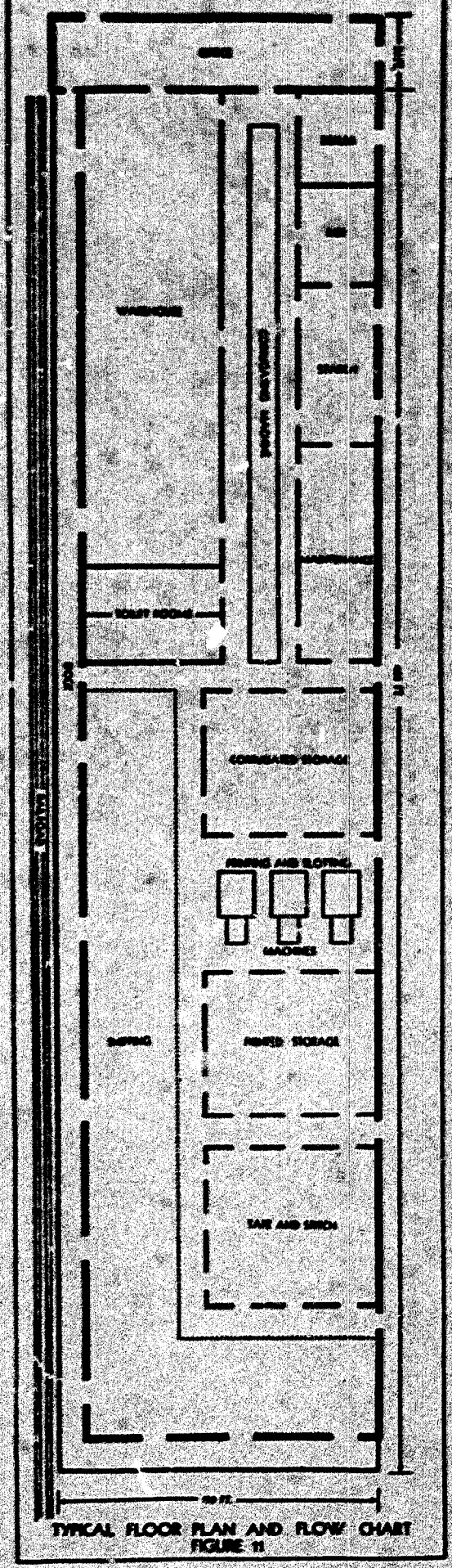


FIGURE 10 - S. P. S. GENERAL VIEW - FEED END - ALL ELECTRIC DRIVE



TYPICAL FLOOR PLAN AND FLOW CHART
FIGURE 11

Best Available Document

SERVICES OF THE INDUSTRIAL TECHNICAL COOPERATIVE PROGRAM

TITLE II - TECHNICAL AIDS FOR OVERSEAS

INDUSTRIAL INFORMATION SERVICE

Provides information regarding:

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

TECHNICAL DIGEST SERVICE

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

TECHNICAL INQUIRY SERVICE

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

TRAINING MATERIALS SERVICE

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

TECHNICAL LITERATURE SERVICE

Provides recommendations and guidance regarding current useful world-wide publications relating to industrial and productivity improvement; distributes carefully selected and representative [illegible] publications of particular value for program use; and facilitates related literature procurement.

U. S. BOOK EXCHANGE SERVICE

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

VISUALS AND NEW MEDIA

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

TECHNICAL FILM SERVICE

Provides guidance and facilitates procurement of U. S. technical and training films for program use; provides representative U. S. technical industrial films and libraries on loan; [illegible] short-term program procurement; and facilitates adaptation of films and [illegible] for program use.

Best Available Document