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THE DREO PILOT PAPER MACHINE.(U)
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DEPARTMENT OF NATIONAL DEFENCE
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DEFENCE RESEARCH ESTABLISHMENT OTTAWA

TECHNICAL NOTE NO. 80-3

THE DREO PILOT PAPER MACHINE

by

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ABSTRACT

The DREO experimental paper machine is a versatile apparatus designed for handling wood, synthetic and glass fibers for the production of detector and aerosol filter papers.

It consists of five sections - stock preparation, forming, press, dryer and windup whose components are described in some detail.

RÉSUMÉ

La machine à papier expérimentale du CRDO est une machine à usages multiples conçue pour la fabrication de papier filtre à aérosol et de papier détecteur, et pouvant utiliser des fibres de bois ou de verre ainsi que des fibres synthétiques.

Les cinq sections, préparation de la pâte, table de fabrication, presse, sécherie et enrouleuse sont décrites avec plus ou moins de détails dans cette présente note technique.

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INTRODUCTION

This report describes an experimental paper machine installed at DREO to investigate the preparation of special papers for defence purposes. For some time before the installation, DREO had been concerned with two types of paper and the machine was designed specifically to process these particular papers and at the same time to offer considerable versatility for the possible preparation of other papers. The two types were detector papers for liquid chemical warfare agents and aerosol filter papers. Detector papers have a conventional wood pulp base to which small amounts of one or more dyestuffs or pigments are added. Aerosol filter papers are based on sub-micron glass fibers usually combined with relatively coarse fibers of Vinyon HH* and rayon and are used in protective masks and collective protectors to remove toxic particles, either liquid or solid.

For several years experimental papers had been prepared at DREO using a Williams 8-inch-square sheet-mold in conjunction with a Valley 1½-lb laboratory beater. Trial runs were made on small machines rented on a daily basis from Industrial Cellulose Research Ltd., at Hawkesbury, Ontario and from Howard Smith Paper Mills (now Domtar) at Cornwall, Ontario (1,2).

When it was decided to install an 18-inch experimental machine at DREO, a machine based on one designed by Noble and Wood Machine Co., Hoosick Falls, N.Y. was selected. It was constructed in Ottawa by The Alexander Fleck Limited through an agreement existing between the two companies. The main changes to the original design consisted of widening the machine from 8 in. to 18 in., the provision of an inclined-wire forming box in addition to the flat-wire headbox and the addition of extra dryers. The inclined wire was added to enable very dilute suspensions of glass and synthetic fibers to be handled for preparation of filter paper. It was modelled after one for preparing Textrils using Fibrids (3).

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* Fibers Division of FMC Corporation

Except for a few early runs, this forming box was used for wood-pulp detector-paper as well as for synthetic-fiber filter papers.

Although provision was made in the frame, a wet press and calender stack were not installed initially. About two years after receiving the machine, a press section containing a single plain press and a smoothing press was installed. This press section was designed and fabricated at DREO. A calender has not yet been installed.

Since it was expected that operations would be mostly on a batch basis with numerous formula changes, a Noble and Wood 25-lb Hollander-type beater was selected for stock preparation. This also was assembled in Ottawa by The Alexander Fleck Limited.

Many modification, and additions have been made to the machine and auxiliary equipment since beginning operations but usually no attempt has been made in the report to distinguish between original equipment and DREO changes. The machine and its operation are described as of about the end of 1977. A general description is given first, followed by further details. Papermaking terms and processes mentioned in the report are not explained in detail since these are fully described in the literature (4,5).

GENERAL LAYOUT AND OPERATION

General layout of equipment and material flows is given in Figure 1.

Fibers were dispersed in water and prepared for paper making in the beater. From the beater they were pumped to one of the two stock chests where they were diluted to the desired consistency. Chemicals, dyes or pigments could be added either to the beater or to the stock chests.

From the chests, stock was pumped at a controlled flow rate to one of the headboxes. On the way it was diluted with recycled white water pumped at a controlled flow rate from the white-water chest.

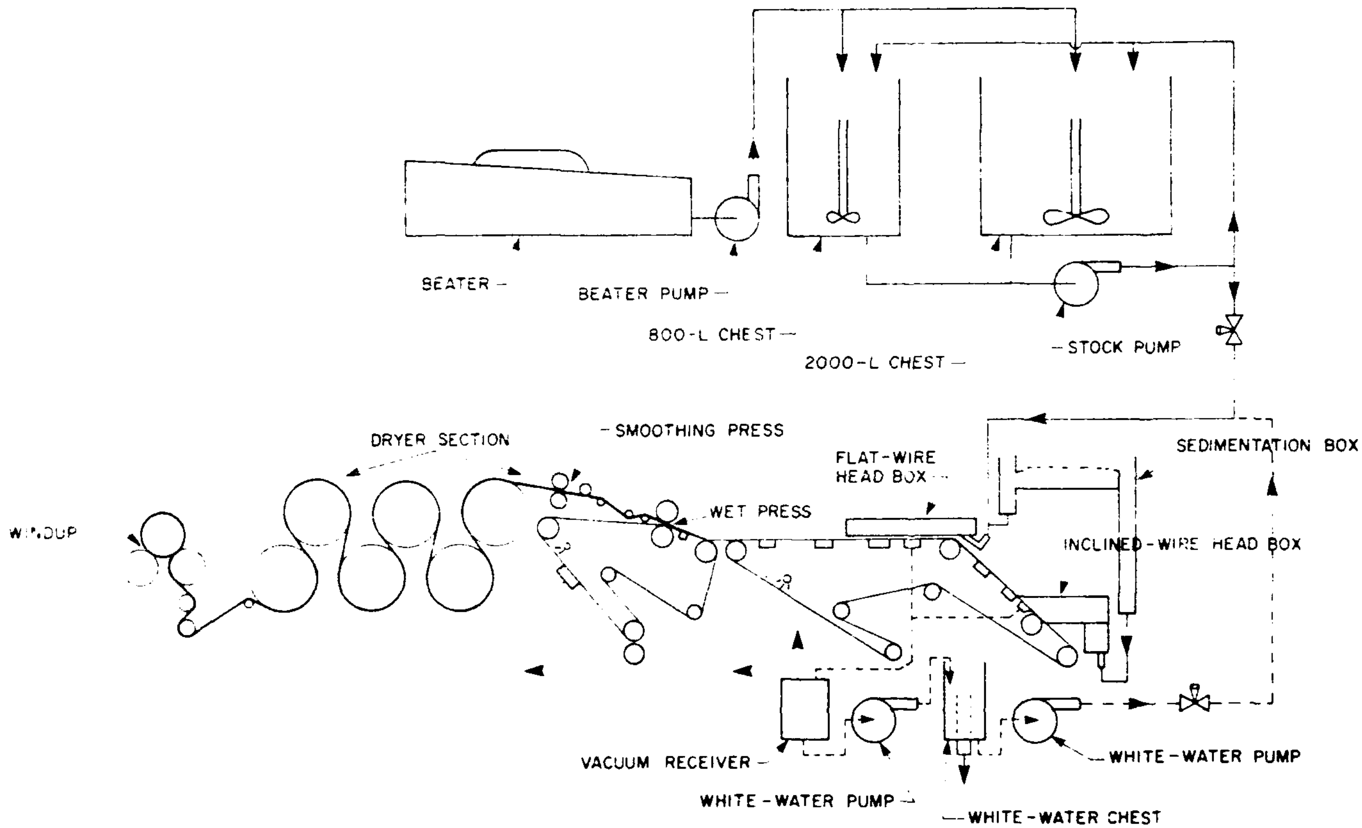


Figure 1. Flow diagram for experimental paper machine and auxiliary equipment.

When the inclined-wire box was used, furnish was passed through a sedimentation box to remove glass beads and dirt before forming the paper. Baffles and an agitator in the forming box kept the fibers in suspension and as well smoothed the flow. The sheet was formed on the moving wire by gravity drainage and then by suction through the wire.

When the flat-wire box was used, furnish entered a pond formed by a dam. In the pond were baffles to distribute the flow and an agitator to maintain suspension. Downstream were two movable barriers, either or both of which could be used as slices. As with the other box the sheet was formed by gravity drainage through the wire followed by suction if desired.

With either forming method, suction boxes further down the wire consolidated the sheet and removed additional water.

At the end of the wire there was a short draw as the sheet transferred to the felt which carried it through the wet-press nip. After it left the nip it passed over a series of small idler rolls to convey it to the smoothing press. After passing the smoothing press there was another short draw before the paper entered the drying section.

The dryer consisted of six drying rolls enclosed in a cabinet with windowed doors at the front and openings at the ends for the paper to enter and leave. The rolls were heated by circulating air through an electric heater located in the bottom portion of the cabinet. An endless chain within the dryer cabinet was used to carry the start-up tail through the dryer.

The dried paper was guided by two adjustable steering rolls to the two windup rolls where it was wound around a core resting in the valley between the rolls.

Maximum wire speed was approximately 3 m/min (10 ft/min) but the usual operating speed was in the neighborhood of 1.5 m/min; this speed enabled us to provide sufficient paper for testing without excessive use of fiber. At 1.5 m/min the production rate of an 80-g/m^2 paper is about 3.3 kg/h (7.2 lb/h).

White water collected by gravity drainage and suction was used to dilute the incoming stock. Excess white water was discarded. Wire shower water and water used for trim squirts were not combined with white water. White water was never used for stock preparation.

The photographs included illustrate various portions of the equipment and will be referred to specifically in the succeeding sections of the report.

DETAILS OF EQUIPMENT

STOCK PREPARATION

The equipment for stock preparation consisted of a beater, beater pump and two stock chests with a single stock pump.

The beater was a Noble and Wood 25-lb Hollander type and is shown in Figure 2. The tub was of cast iron and was set in a concrete base which also formed the sloping floor. It was 200 cm long by 86 cm wide with a channel 32 cm wide coated with an epoxy resin. The roll, which was 38 cm in diameter and 30 cm wide, was fitted with thirty-eight ¼-in. stainless-steel bars. It rotated at 460 rpm to give a speed of 550 m/min over the bed plate. This was a single-angle type with ten ¼-in. stainless-steel bars held in place by cypress blocks.

The roll was carried on a frame whose arms pivoted on supports on the outside of the tub. Through a system of levers a sliding counter weight was used to vary the downward force on the roll. This load could be caried from zero to nearly the full weight of the roll. Minimum clearance between the roll and bed plate was adjustable by a screw (see Figure 2) carrying a scale calibrated in thousandths of an inch. There was a dash pot to damp motion of the roll. The roll could be lifted clear of the bed plate and locked in this position.

The usual charge to the beater was 9 kg of wood pulp at a consistency of about 3.5% and the beating time varied, depending on the freeness desired, between 20 and 30 min with nearly full load on the roll and 0.025-0.035 in. clearance. With glass or synthetics the charge was usually 1.8 kg of fiber in 180 L of water. The roll was lifted and beating time was 10 min.

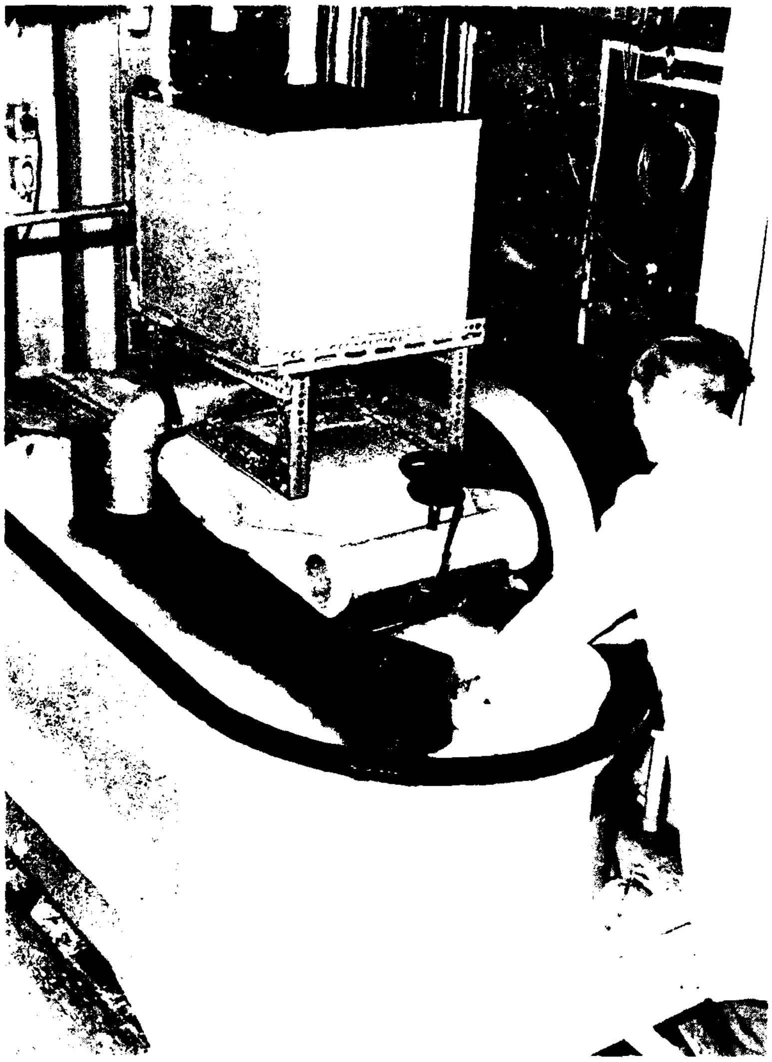


Figure 2. Photograph of operator adding a sheet of wood pulp to the beater.

It was found that when wood pulp was allowed to circulate in the beater while consistency and freeness measurements were made, the freeness continued to drop even though the roll was lifted. When the roll was stopped with a full charge the stock overflowed. To correct this problem an auxiliary tank of sheet metal was installed over the beater. When beating was to be interrupted about 50 L of stock was pumped to this tank before the roll was stopped. This stock was later returned through an opening in the bottom of the tank when beating was resumed or was completed.

The pump used to transfer stock from the beater to the chests was a 1 in. [illegible] Model 6400 of bronze construction with a neoprene impeller, driven with a V-belt at 730 rpm by a 3/4-hp motor. It was rated [illegible] gpm against a 20-ft head.

STOCK CHESTS

One of the chests was a 2000-L (440-gal) flat-bottomed tank of glass-fiber-reinforced plastic (diameter 140 cm, height 135 cm). It had an outlet in the bottom about half-way between the center and the circumference. It was fitted with four stainless-steel baffles 11.5 cm wide set out 5 cm from the wall and angled 45° against the direction of flow from the stirrer. Volume was marked on the wall at 5-gal intervals.

A 3/4-hp Lightnin variable-speed mixer with a 32-mm-diameter shaft and a 290-mm propeller with stabilizing ring was mounted above the center of the tank so that the propeller was about 15 cm from the bottom. Since inadequate mixing accompanied by much splashing occurred when the stock level fell to the vicinity of the impeller, a supplementary impeller was installed. A sliding collar carrying two blades which reached to about 2.5 cm from the bottom of the tank was fitted over the shaft. Normally this was feathered at the top of the shaft but when the stock level fell to about 375-400 L it was lowered to the top of the main impeller where a slot in the collar locked with a key on top of the impeller. This allowed adequate mixing (at a low speed) to below 100 L.

To prevent a vortex forming around the outlet with the consequent variation in stock concentration and composition, a removable manifold was inserted into the tank outlet. It was made from a 1.5-in. copper tee and short lengths of pipe with 38-mm holes cut in the sides so that stock was collected through seven separate ports.

The other chest was used only for smaller batches or for preparing stock for transfer to the larger one. It was a stainless-steel tank 90 cm in diameter with 120-cm vertical walls above a conical bottom 30 cm deep at the center where there was an outlet of 2-in. pipe. Its capacity was 800 L. Inside were three baffles of 5-cm stainless-steel strips mounted at an angle of 45^{o} against the flow from the impeller so that the trailing edge was 5 cm from the wall. A scale, with marks at 2-gal intervals, was painted on the vertical wall of the tank. Stirring was done by two impellers mounted on a 25-mm stainless-steel shaft driven by a Chemineer Process Agitator with a Graham Magnapack ½-hp variable-speed drive. Maximum speed was 1800 rpm. The tank outlet was fitted with a removable tee made of 2-in. copper pipe with a leg of the tee fitting in the outlet. The cross-piece was 36 cm long and had four 50-mm holes in the sides.

In the stock chests, the fibers were diluted to a convenient consistency of about 1% for wood pulp and 0.4% for filter paper stocks. Chemicals such as size, wet-strength resin, alum and pigments were added just before adjusting to final volume.

The pump used to transfer stock from the chests to the machine was a Jabsco Model 777F-12 with a high-pressure impeller driven at speeds varying from 375 to 975 rpm by a 1-hp drive.

FORMING SECTION

The forming, press, drying and windup sections were all mounted on a single base of 4 × 4 in. H beams welded together and fitted with levelling screws.

Figure 3 is a general view of the forming section with the inclined-wire forming box at the right and flat-wire headbox in the center of the picture. The wire course that is shown in Figures 1 and 3 could be used for either headbox or a shorter wire, by-passing the inclined section, could be used for the flat-wire box. Except for a few initial trials, the wire course shown was always used. Starting with the lower breast roll the wire extended upward about 1 m at an angle of 45^{o} to a drive roll (behind the post), then horizontally about 1.5 m to the couch roll, which was also driven, then down at an angle through a shower box, around an idler, a tension roll and a steering roll and then back to the lower breast roll. All equipment for the forming section was cantilevered from a 2.4-m-long tooling plate of 1-in. aluminum and another plate of ½-in. aluminum 30 cm behind the first. This simplified changing wires and removing pans and covers.

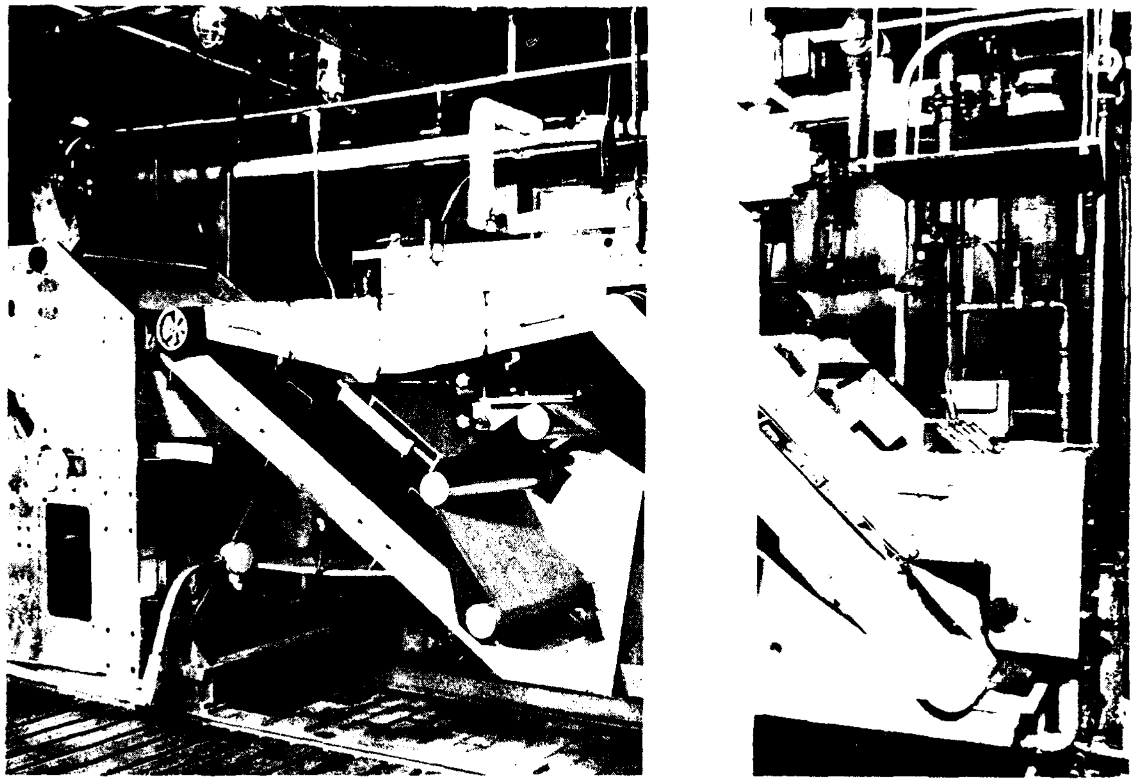


Figure 3. General view of the forming section of the machine showing the inclined-wire forming box at the right and the flat-wire headbox on the flat portion of the wire just to the left of the vertical column. The wire showers are under the sloped cover to the left and the wire tension roll and guide roll are below the flat-wire headbox. The rolls of the forming section are all cantilivered to allow wires to be changed. The aluminum panel at the very left is the start of the press section.

The four driven rolls (upper breast roll, couch roll, lower breast roll and a forming roll just at the lip of the inclined-wire forming box) were 127 mm (5 in.) in diameter and were of rubber-covered stainless steel. They were supported by Teflon-lined bearings on 76-mm (3-in.) hollow shafts. The other three rolls were 89-mm (3.5-in.) stainless-steel sleeves mounted on 76-mm (3-in.) shafts extending through the tooling plate. The steering roll was mounted on the lower of two ½-in. steel plates. These plates were fastened together by a single bolt on which the lower plate pivoted to change the angle between the roll and the wire. An air cylinder attached to this plate was activated through micro switches and solenoids by a small curved plate riding the inside edge of the wire. The tension roll was mounted on the lower of two interlocking plates and was moved in or out manually by turning a hand-wheel on a threaded bolt between the two plates.

The wires were originally 80/60 mesh phosphor bronze 48.3 (19 in.) wide; the longer wires were 625 cm long and the shorter ones 435 cm. In 1976, the longer bronze wire was replaced with one of 78/52 mesh polyester filament. Wires were supported on the table section by suction boxes and foils. There were three positions on the inclined portion of the wire that could be used for either a suction box or a foil and there were nine on the flat portion. Usually three suction boxes were used, one on the inclined portion and two near the end of the flat portion. The first box on the flat portion was used to provide vacuum drainage for the flat-wire headbox.

Mounted at the end of the flat-wire headbox were two wide-angle flat-spray nozzles to trim the edges of the sheet. Also at this point was a travelling squirt that could be positioned near the front of the sheet to cut a tail for threading through the machine at start-up. This squirt was then moved to the rear, gradually widening the sheet to the full width of the wire.

The wire shower had two banks of flat-jet nozzles for a total of 20, each rated at 0.4 US gpm at 40 psig. A removable cover confined the splash from the sprays.

Inclined-Wire Forming Box

The headbox used with the inclined wire is shown in operation in Figure 4. Before reaching the headbox stock flowed through the settling pond mounted over it. This served to remove glass beads of tears that were presented in the glass fibers and which, if allowed into filter paper, often resulted in pin holes. It was also used with detector paper stock

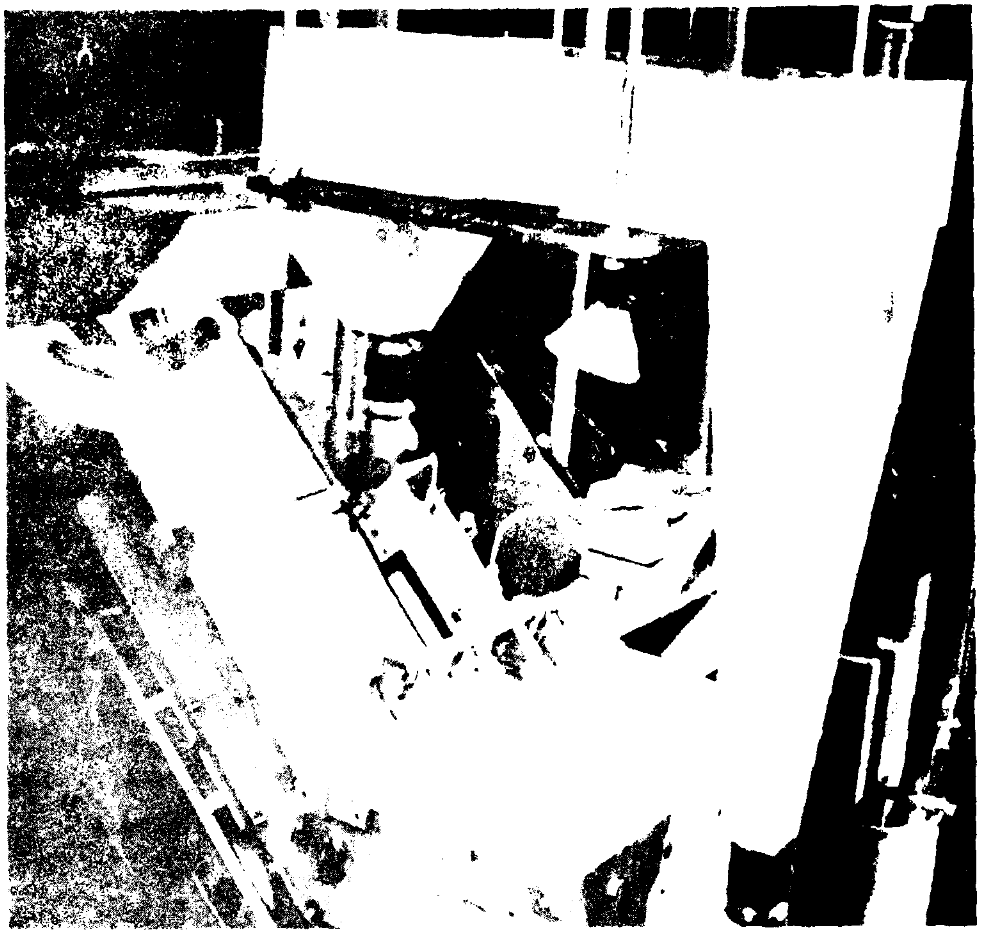


Figure 4. The inclined-wire forming box in operation with gravity settling chamber above it. The wire is moving up the incline to the left. The hexagonal mixer is directly below the bracket holding the five spray nozzles for reducing foam.

to remove dirt. This settling pond was made of acrylic plastic and was 60 cm long, 45 cm wide and 15 cm deep. Four 4-cm baffles across the bottom 13 cm apart provided quiet zones. Entrance to the pond was through a riser similar to the one described below for the headbox. Stock flowed over a weir which maintained the liquid depth of about 10 cm, into a 5-cm-wide downcomer that narrowed from the full width of the pond to fit a 2-in. pipe entrance to the headbox. An adjustable restriction just above the headbox entrance allowed the downcomer to be kept partly filled with stock to allow escape of entrained air. This settling chamber was not in place when the photograph for Figure 3 was taken.

The inner wall of the forming box was of ½-in.-thick stainless steel and the remainder of ¼-in. except where the original walls were extended upward with ½-in. acrylic plastic. The pond formed was 46 cm wide by 38 cm long by a maximum of 18 cm deep. The floor of the box was covered with a sheet of 0.005-in. Mylar from near the entrance of about 3 mm along the wire. The Mylar met the wire just above its contact with the 5-in. forming roll. The location of the edge of the Mylar with respect to the roll was very critical.

The sides of the box extended upward along the wire for 58 cm and this portion carried the deckles. There were 0.5-cm-thick rubber strips 5 cm wide and 30 cm long held in place by stainless-steel strips bolted to the sides. The lower ends extended far enough along the floor of the box to seal the sides at the junction of pond and wire. They also served to anchor the edges of the Mylar apron on the wire.

Stock entered the forming box at the bottom through a fan-shaped flow distributer of 1/8-in. acrylic plastic inserted inside the 5-cm-wide entrance channel. Baffles of 1-in.-diameter acrylic bars spread out the flow from the stock pipe at the bottom to the full width of the pond at the top. Baffle plates of 1/8-in. acrylic were used to smooth the flow within the forming box. To reduce foam, five nozzles were mounted to spray the stock just after it passed the first baffle. Each of these nozzles gave a fine spray through an orifice 0.020 in. in diameter and had a rated flow of 1.5 US gal/h at 40 psig.

The stock was kept in suspension by a 5-cm hexagonal Teflon bar that extended across the pond 6 cm ahead of the wire. The shaft of this bar protruded through the wall and was driven by a gear belt from a reversible variable-speed motor. The mixer was usually operated at about 250 rpm but its maximum speed was 740 rpm. On the floor under the agitator was a strip of 3/4-in. half-round plastic with the flat side down.

As close as possible to the forming roll and ahead of the other vacuum boxes was a suction box which was mostly below the level of stock in the forming box. Water removed by this suction box was collected in a vacuum receiver and transferred to the white-water chest (see Figure 1). Vacuum was supplied by a Nash Hytor pump and regulated by an air bleed to the pump. In practice, the white-water flow and vacuum were adjusted to hold the liquid level between 9 and 13 cm regardless of stock flow. A separate vacuum pump was used for the suction boxes along the wire. Water removed at these boxes was not collected but discharged through the vacuum pump to the drain.

Flat-Wire Headbox

The sides of the flat-wire headbox were of ¼-in. stainless-steel plate while the end was of ½-in. plate. The overall length of the box was 90 cm, the width 45 cm and the depth 10 cm. The pond was formed behind a barrier (Figure 5) made of movable Teflon strips and sloped at an angle of 45°. It could be used either as a dam or a slice. Flow was smoothed by two baffles and agitation was provided by a bar fitted with slanted Teflon discs and driven by a reversible adjustable-speed motor with the same speed range as the mixer in the inclined-wire forming box. An apron of 0.010-in. Mylar extended from under the foot of the barrier 5 cm along the wire to the front edge of the suction box. Two other slices of stainless-steel sheet were provided downstream. These could be adjusted both horizontally and vertically and five set screws along the lower edge allowed adjustment of the profile.

When the flat-wire headbox was not to be used it was lifted half an inch above the wire by a turnbuckle on a rod from the ceiling.

Suction Boxes

The suction boxes were 5 cm deep and 10 cm wide. The plastic surface (NAEPO 10Z) in contact with the wire was 9.5 cm wide and the original covers had six rows of 9.5-mm holes with each row staggered one hole diameter from the previous row. Later, these covers were replaced with ones of Teflon and instead of holes, several slots either 3 mm or 6 mm wide were provided. Slots that were not desired were plugged with strips of rubber. The use of slots was particularly beneficial for the suction box just at the forming roll where the first row of holes sometimes caused machine direction streaks in the paper.

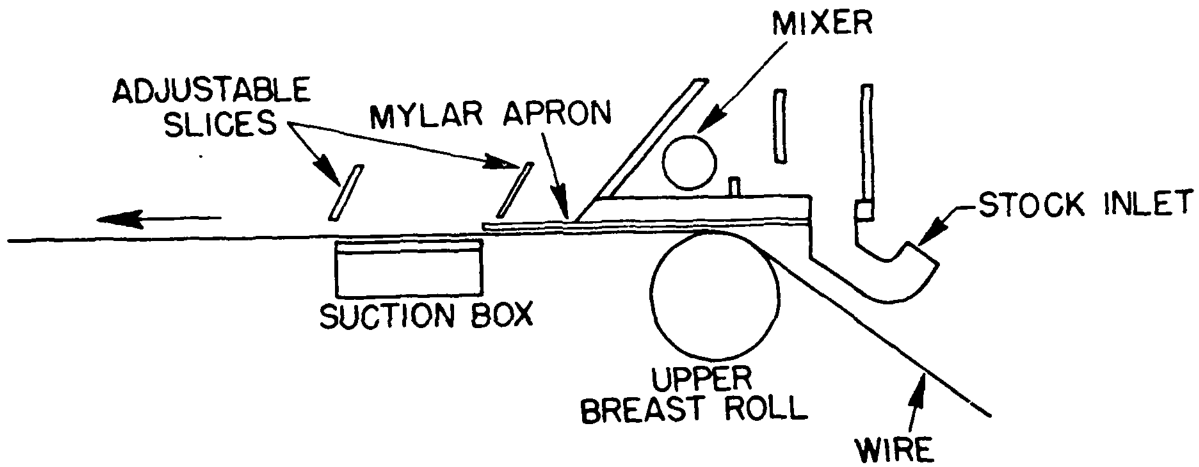


Figure 5. Details of flat-wire headbox.

The foils were of NAEPO plastic and were 12 mm thick and 44 mm deep. The top of each foil was bevelled so that when it was flat against the wire the foil angled downward in the direction of wire travel. These foils were for support only, as at the machine speed available they removed little or no water.

PRESS SECTION

The press section, which was designed and made at DREO, is illustrated in Figure 6. It consisted of a wet press and a smoothing press with attendant apparatus.

The wet press had two 127-mm (5-in.) stainless-steel rolls mounted one above the other with the top roll offset slightly toward the forming section. The lower roll was mounted in a fixed position between the side walls but the upper one was mounted on a frame that rotated on bearings in the walls enabling it to be raised clear of the felt or pressed down on it by an air cylinder. A doctor blade riding the top of the upper roll prevented buildup of fiber picked off the web.

This press arrangement worked well for a press felt of an open weave but there was not sufficient drainage when a thicker, denser felt was used. For this felt, a small suction box with two 1.6-mm slots was installed 15 cm ahead of the nip to suck out air from between the web and the felt. Both the box and an idler roll between it and the nip could be adjusted to vary the angle of approach of the felt to the nip. With the open felt, water pressed from the wet web drained through the felt and was collected and measured but with the thicker felt all the water was absorbed by the felt.

Between the wet-press nip and the smoothing press were five idlers to carry the paper to the smoothing press without its contacting the felt.

The smoothing press was mounted above the end felt roll and at a slight angle so that the paper went straight through the nip and approached the top of the first dryer roll at a tangent. The press consisted of two 87.4-mm stainless-steel rolls with the top roll lifted or loaded by an air cylinder at each end.

After carrying the web through the press, the felt travelled horizontally to a 127-mm (5-in.) roll and then turned downward under a cleaning shower and over a suction box to a pair of drive rolls. The shower was a bank of six nozzles which produced a spray of interlocking hollow cones. Water consumption measured by a rotameter in the supply line was about 60 L/h. The suction box (similar to the ones along the wire) was to remove the water picked up by the felt from the showers as well as that absorbed from the paper at the wet press. It and the one ahead of the nip were connected to a vacuum system which drew the water to an overhead tank from which it flowed down a vacuum leg to a drain at machine level where it could be measured, if desired. The felt drive was formed by two rolls mounted vertically with the top one driven and the lower one positioned by air cylinders. This drive was not required when detector paper was being made as the pressure at the wet press was high enough to move the felt but it was used to drive the felt and carry a web through the press section with little or no wet pressing.

From the drive the felt went around a manually operated (rack and pinion) tightening roll to the steering roll, which was also manually operated, and then up around the breast roll to the nip. The tightening roll and the steering roll were 76-mm (3-in.) stainless steel.

Solids content of detector paper was increased from about 20% to 38% by 38% by the wet press. At a production rate of 3.3 kg/h, 7.8 kg/h of water was removed.

DRYING SECTION

The cabinet in which the paper was dried was an insulated box about 1.8 m long, 1.1 m wide and 2.1 m high. Center-opening doors with double panel windows made up the front. There was a horizontal partition separating the drying chamber from the heaters (Figure 7) and a vertical partition forming a plenum behind the dryers and heater unit. Fifteen finned electric resistance heaters rose from the floor of the cabinet in the mouth of an 80-cm-by-40-cm opening leading to a fan mounted in the plenum. Each heater was rated at 2.5 kW at 550 volts for a total of 37.5 kW.

In operation, air was drawn from the drying chamber through an opening in the horizontal partition, across the heaters, then discharged by the fan into the plenum and out through slotted pipes 115 mm in diameter projecting from the inner wall to the front of the dryer drums. These pipes could be rotated so as to direct the hot air in any desired direction and the slots were provided with six movable covers so that the air profile could be altered from front to back. There were two of these pipes inside each of the six dryers and ten others in the spaces between the dryers. The latter were distributed so that most of the air

Figure [illegible]. Wet-press section of the paper machine showing the [illegible] press rolls in the background. Air pressure regulators for the press and for felt driving rolls are at the [illegible]. The handwheels are for adjusting the felt steering [illegible], [illegible] the felt and for adjusting the roll [illegible] the [illegible] into the smoothing press.

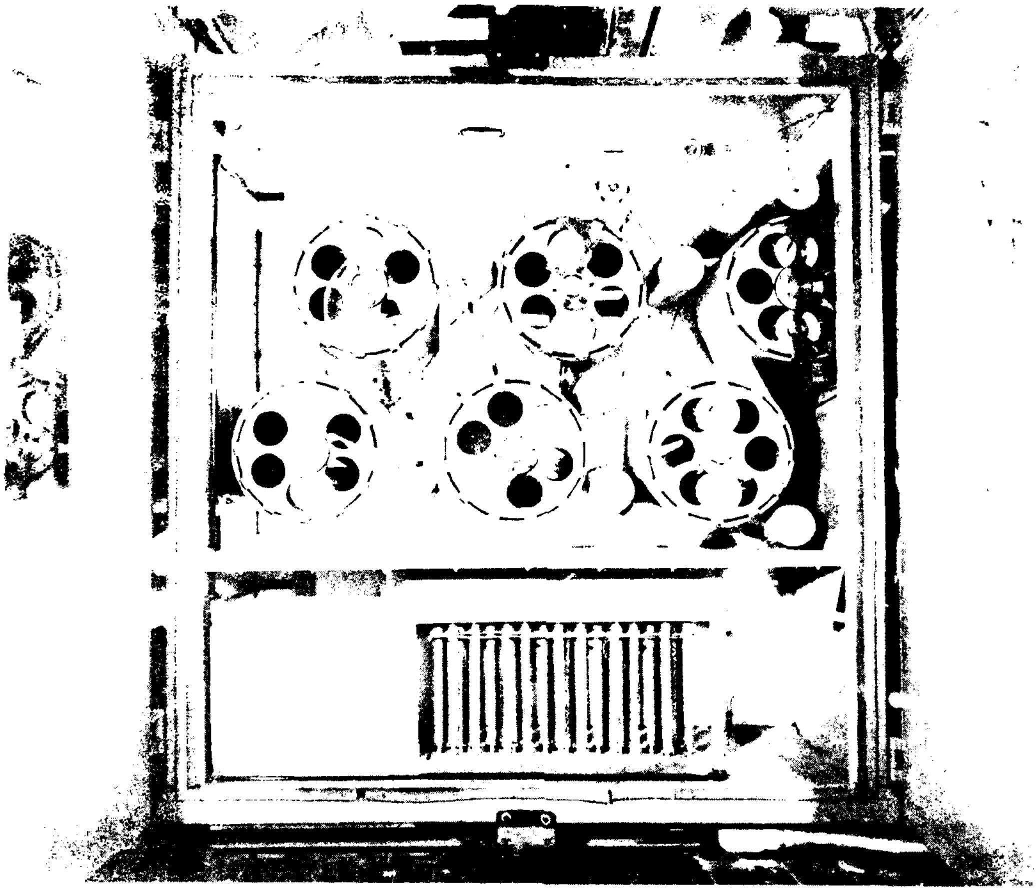


Figure 7.

Dryer cabinet showing the six dryer rolls with electric heater below them. The plenum chamber and air blower are behind the heater and dryers. There is an opening in the tray below the dryers to allow air to pass through to the heater.

could be concentrated on the entering wet web. An adjustable louvre on the wet-end side of the cabinet and a duct with an adjustable vane from the top allowed the amount of make-up air to be controlled.

The dryer drums were cylinders of ½-in. stainless steel 483 mm deep and 406 mm (16-in.) in diameter. They were open at the rear and welded at the front to 3/4-in. steel discs perforated with six 95-mm holes. These discs were attached to 51-mm (2-in.) shafts extending through the rear walls.

The drums were mounted in two horizontal banks of three with the centerlines approximately 46 cm apart. The centers of the drums in each row were about 60 cm apart with the centers of those in the bottom row offset about 20 cm in the direction of travel. The first dryer was placed so that its shell projected through an opening in the wall and was flush with the outer surface of the cabinet.

A contact thermocouple was mounted on the rear wall behind each drum so that the tip was in continuous contact with the surface of the drum just at the rear edge. Another thermocouple in the flow space behind the cabinet led to an indicating controller that governed the power input to the heaters and thus the cabinet air temperature.

An endless sash chain located at the front edge of the dryers followed the path of the paper from No. 2 dryer through to No. 6 and then back to No. 2. In starting the machine, a 5-to-10-cm-wide tail was attached to the chain which carried it through the dryer to where it could be reached by hand through the opening at the end of the cabinet. With this device, the dryer doors needed to be open only briefly when threading a new sheet through the dryer.

On its path from dryer No. 3 to 4, and from dryer 5 to 6 the paper slid over slightly curved, polished stainless-steel plates. These helped to smooth out wrinkles and cockles. Between dryers 4 and 5 it was threaded between a set of four 25-mm (1-in.) rolls that served the same purpose. These devices are not shown in Figure 7. A 25-mm (1-in.) roll just inside the top of the exit kept the paper in contact with roll No. 6 for a longer period, reducing the draw to the windup. This also helped to reduce wrinkling.

WINDUP SECTION

From the dryer cabinet the paper passed over a fluorescent light where formation could be observed, then upward around two steering rolls of stainless steel and between two 254-mm (10-in.) windup rolls to a core riding between these rolls, Figure 8. This core, usually a 102-mm (4-in.) paperboard tube with 13-mm (½-in.) walls, was fitted with a shaft by metal cones squeezed into the ends and locked to the shaft. The ends of the shaft had ball bearings that bore on end plates mounted on the frame to prevent horizontal movement. The two windup rolls were coated with a grit-containing paint to prevent slippage.

DRIVE

The drive motor was a 3/4-hp General Electric shunt-wound dc gear-motor with step-down ratio of 37.3 to 1 giving a top speed of 46 rpm. Speed was varied by a control at the panel. The motor was mounted at the rear of the wire frame underneath the couch roll and drove all sections of the machine by means of belts, chains, etc. at the back of the machine. A sprocket mounted on the outer end of the drive pulley drove a small generator whose output was indicated as ft/min on a meter mounted on the main panel. The motor and some of the power transmission equipment can be seen in Figure 9.

The two upper wire rolls were driven from the motor by pulleys using a 76-mm-wide gear belt and initially only these two rolls were driven. Later, sprockets and a chain operating from the upper breast roll were added to drive the two rolls on the inclined portion of the wire.

Power was taken from a geared pulley on the couch-roll shaft to drive another pulley on a speed adjuster whose output shaft drove the felt drive roll. A geared pulley on this shaft drove a matching pulley on the shaft of the lower roll at the press nip. The speed adjuster had two shafts on which were mounted truncated cones in opposing directions connected by a flat belt. This belt could be positioned by a manually operated guide to vary the speed of the output shaft. The ratio between felt speed and the wire speed could be varied from 0.98 to 1.18.

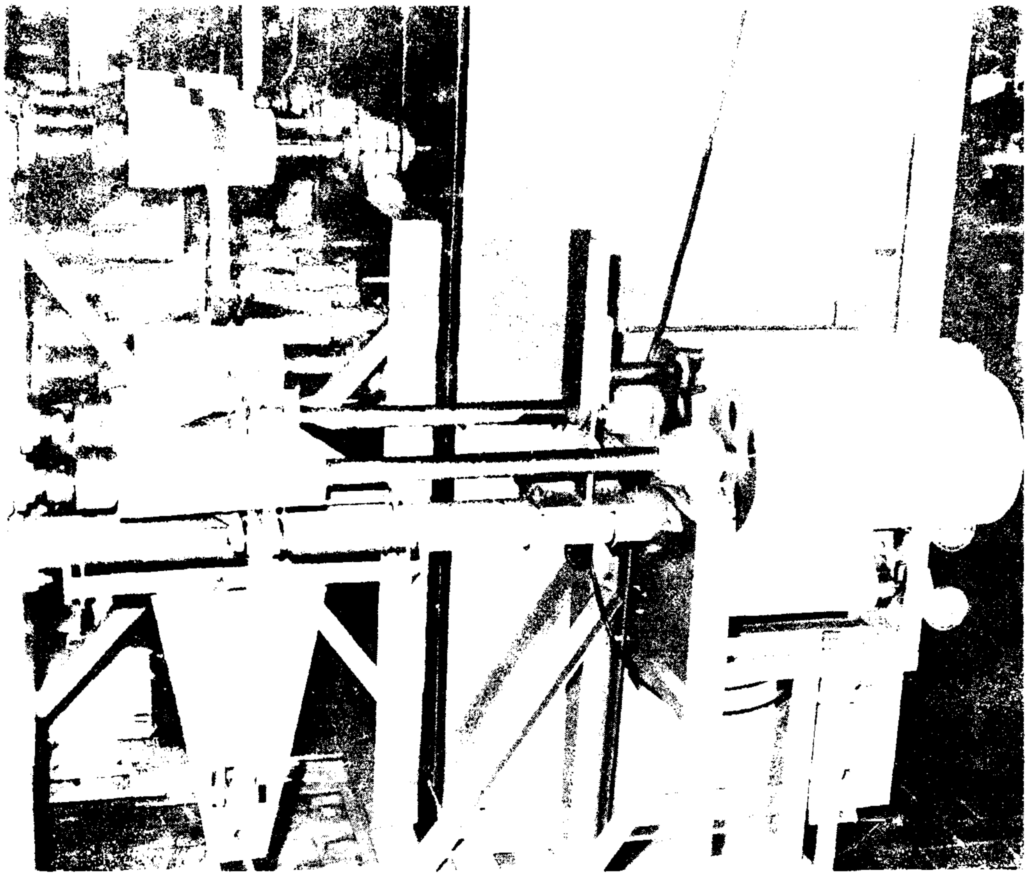
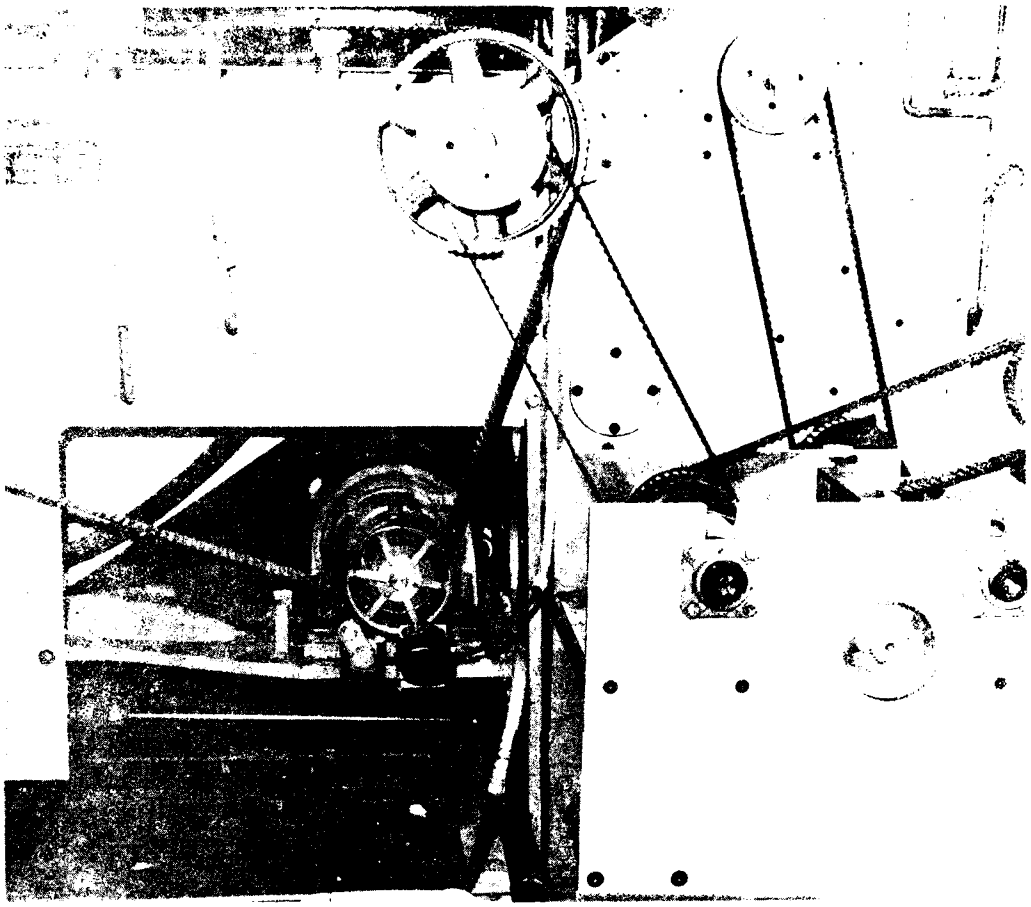


Figure [illegible]. End of drying cabinet showing winding rolls and the [illegible] and belt for the paper and winding section. One of the [illegible] steering rolls can be seen below the winding rolls. In this photograph winding of paper on the core has just been started.



[illegible] [illegible] motor for the machine showing the [illegible] [illegible] the other rolls of the forming [illegible]. [illegible] right of the motor is a double-cone speed changer [illegible] with a belt to another speed changer [illegible]. The small device on the gear on the [illegible] connected to an indicator on the [illegible].

A geared pulley mounted on the input shaft of the wet-press speed changer drove the input shaft of a second changer which is not visible in Figure 9. This changer drove the dryer and windup sections. The smoothing press was driven by a chain from the first dryer so that the surface speeds of the two were equal.

The shafts of the dryer drums extended through the rear of the cabinet (see Figure 8) to truncated cones 305 mm (12-in.) long and 165 mm in diameter at the cabinet end and 178 mm in diameter at the other end. These cones could be positioned along the shafts so the speed of each individual drum could be adjusted. The windup rolls had a similar arrangement and were driven by the same belt. However, they had a separate frame (Figure 8) and their cones were 102 mm × 121 mm × 318 mm long. Crowned idlers could be moved along their supports to position the endless belt that drove the cones. They could also be rotated on their shafts to change the degree of wrap of the belt around the cones. Mounted on the frame for the windup rolls was a hinged plate carrying an idler around which the belt passed. There was a threaded bar on this plate for adjusting the tension on the belt.

INSTRUMENTS AND CONTROLS

The controls were located between the machine and the chests (Figure 10). On the face of the main electrical panel were switch buttons for the machine drive and for all the pumps and mixers. In addition there were the machine speed potentiometer and speed indicator, a Boston Gear Ratiotrol for the headbox agitators and an ammeter for the beater motor. Contained inside were the switches, motor starters, fuses, etc. for the various motors and the half-wave silicone controlled rectifier (SCR) for the drive motor. A small fan blew ambient air directly on the controller to prevent a gradual rise in temperature from heat accumulating in the cabinet. Previously this temperature increase had caused a drift in machine speed.

Mounted beside the main panel was the temperature controller for the drying cabinet. This was a 550-V, 50-Amp. apparatus assembled by Mechron Engineering using a Rubicon SCR power controller mounted on top of the control box. On the face of the box was a General Electric proportional temperature-indicator-controller with automatic reset, a voltmeter, the power selector switch and resets for the blower and the heaters. The power selector switch had 12 positions which in sequence connected power to the dryer fan, the temperature controller, the SCR power controller, then directly to two of the heaters in parallel and finally individually to seven heaters. The temperature controller

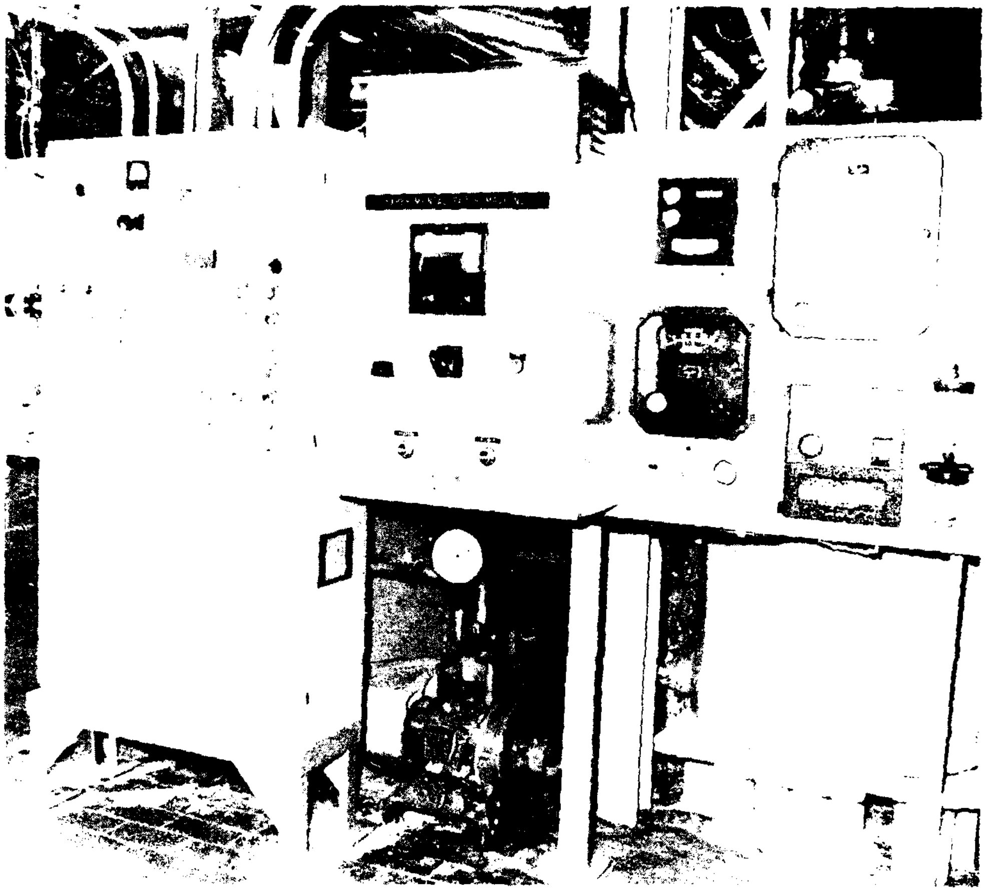


Figure 10. Instrument control panel for the paper machine and auxiliary equipment. The cabinet at the left contains the motor starters and protection devices. The smaller one to its right contains the air heater controller. Pneumatic control instruments which are described in the text are at the extreme right. The pump on the floor is the stock feed pump.

through the SCR unit regulated the voltage applied to five heaters and this voltage was indicated by the voltmeter on the panel. Thus a portion of the power to the air heater was fixed and a portion was regulated. In practice, the voltmeter indicated when the amount of fixed heat was too little or too much and the selector switch was turned accordingly. With this system, the air temperature was controlled very precisely.

Beside the temperature control unit was a panel for pneumatic control instruments. There was a liquid-level indicating controller that operated a valve regulating the flow of white water from the vacuum receiver to the white-water tank (Figure 1). Liquid level was sensed by a bubbler system with a differential pressure transmitter. Also on the panel were the indicating vacuum controller for the vacuum receiver and flow controllers for stock from the chests and white water recycle. For measuring stock flow, a differential pressure transmitter with a range of 300 in. of water was used with devices specially made to give suitable pressure drops without retaining fibers, especially the long Vinyon fibers used for filter paper. Several devices were made to cover the range of flow rates that were used. They consisted of unions of 1-in. pipe, reducers and then appropriate lengths of copper tubing. They were calibrated with water and equations derived for each device. A water purge prevented stock from entering the differential pressure transmitter. Transmitter output was recorded on a circular chart and stock flow was regulated with a ½-in. Saunders diaphragm valve. The white-water flow control system consisted of an orifice plate in a 2-in. line, a differential pressure transmitter with a range of 50 in. of water, an indicating controller and a suitable valve. The orifices were calibrated with water and a scale multiplier derived for each one. All of the controllers had automatic reset except for the vacuum controller.

HANDSHEET PREPARATION

To evaluate paper ingredients and formulas, handsheets were made using a 1½-lb Valley beater in conjunction with a 8-in.-square Williams handsheet mold. This mold was fitted with an extra deck to accommodate the dilute suspensions necessary with synthetic and glass fibers. Stirring was done with a paddle rather than the conventional perforated plate since the long fibers failed to drain through the plate cleanly. The wire used was usually 150 × 150 mesh.

White water from the mold was caught in a tank on the floor below and recycled for each sheet. Seven sheets were made and discarded to allow the white water to come to equilibrium.

Couching and pressing procedures followed closely those given in Standard Method C4 of the Canadian Pulp and Paper Association (CPPA) and T-205 of the Technical Association of the Pulp and Paper Industry (Tappi).

Wood-pulp handsheets were dried on either a hot-plate-type dryer at 100-130°C, or where pigment content made a lower temperature necessary, in a laboratory oven at 60-80°C. The sheets were left on the lower press plates during drying. Filter papers were removed from the press plates and placed wire side down on the Teflon-coated plate of the dryer and covered with a sheet of glass cloth before the dryer cover was lowered in order to prevent them from sticking or tearing when the cover was raised.

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13 ABSTRACT (U)

The DREO experimental paper machine is a versatile apparatus designed for handling wood, synthetic and glass fibers for the production of detector and aerosol filter papers.

It consists of five sections - stock preparation, forming, press, dryer and windup whose components are described in some detail.

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