Paper Machines—Today and Tomorrow

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"The author surveys and explores the spectacular panoramic scene giving an idea of what has been, what is and what is going to be new and novel in the field of Paper Machines, where the Development trend knows no bounds, where the size has grown to that of a Giant and expected to grow to that of a monster by 1970."

I. Fourdrinier and Formers :

Due to increasing exploding population, increasing literacy growing consciousness for more readership, increasing gusto tempo of industrialisation, the demand for paper/Newsprint is growing more and more, which in turn is making the Machinery manufacturers to make Paper Machines bigger and bigger with speeds higher and higher, with advances and developments in each section, the research going on round the clock in the research centres of the Machinery manufacturers and R and D centres of the Paper Mills.

The Paper Machine since its technological development towards 18th century end though basically same but has changed a lot, is changing and will change, is a marvel of ingenuity, versatility and the development. Trend of this refinement changes knows no bounds. There is expected a very big revolution and the machinery manufacturers. Researchers and the Paper Mills have already joined hands for bringing that. By 1970 we can expect some thing uncanny and unexpected, new and novel.

The Fourdrinier has its own usefulness and it is not very possible that it may be scrapped, it has involved billions of Dollars Rupees all these years and the expectation of more billions still there because of New Mills and expansion of the existing Mills. Scrapping a fourdrinier for a New Former would be very costly. The coming years are expected to be years of exciting and interesting developments. The other Paper Machines which are expected to make appearance on the scene are :

Twinverform	Beloit Corp.
Rotoformer	Sandy Hill Corp.
Inverform	Development of St. Anne's Board Mill Co., Ltd., Bristol, England
Vertiforma	Black Clawson Co.
Time Twin Wire Twinformer**	Pulp, Paper Research Institute of Canada

Inverform and vertiforma have eliminated the inherent/principal limitation in the fourdrinier that is the free surface of the web which tends to become unstable at increasing speeds.

Major and real break-through in forming is expected to be achieved within another 9-10 years. As yet no commercial installation of vertiforma is there in a Paper Mill but pilot plant studies show it to be a strong contender among the 2 wire Paper Machines.

Twinver-form at KC : Twinver form is essentially a modified Inverform unit.

Last September first and revolutionary Twinverform started at Kimberly-Clark Corp., Niagara, Visconsin, (U.S.A.) and is in full continuous production with excellent results. This is the result of 6 years of work by "Beloit" on the 2 wire forming of Paper. Because of this installation and start up Beloit has pushed the Paper Industry into Jet age and the speed barrier that exists on open wire formaion seems to have fallen. The Twinverform enables the Paper Industry to have a wet end that is not limited in speeds upto at least 3,000 fpm and besides reduces and eliminates the normal, classic headaches and troubles as :

—Spout Jet control.

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**Recently P.P.R.I.C. has develeped a new and unique Paper Machine—"Papru-former" which is approaching the point of commercial application.

—Wire marking.

—Two-sidedness.

—Stock jump instabilities.

—Drainage limitations.

Before conversion to Twinverform of No. 4 it was operating at 1,600 fpm. Beloit has attained in its pilot plant speeds of 2,700 fpm and the fastest commercially operating speed on raw stock coating grades been 2,100 fpm with regular speed run being 1,750-1,850 fpm with an out put of 180 tpd. Attaining of still higher speeds at K-C has not been possible due to speed limitations on the super-calender. It is predicted that if formation improved at higher speeds then forming of light weight book or News at 3,000 fpm. looks entirely feasible and within reach in the very near future. For higher speeds and higher production K-C is making changes in the Drive and also adding a reeler ahead of the stack to improve super-calender's efficiency.

Twinver form is much shorter than the conventional fourdrinier (i.e. lesser than $\frac{1}{2}$ of present length) and during designing the Paper Machine width would pose no problems. On a new machine or a complete rebuild of an existing wet end obviously it would be possible to shorten the wire section to less than one half of present lengths.

In Twinverform both the wires are changed at the same time and the time taken for the wire changes is about 10 hours. Wire mesh does not make any quality difference and there is no reason for using the same mesh on top and bottom wires.

Beloit feels that Twinverform is insensitive to speed, would make excellent Newsprint and promises huge potential for other volume grades including tissue. Beloit has sold other Twinverform to St. Francisville Paper Co., Ltd., Louisiana, U.S.A.—a joint venture of Time Inc. and Crown Zeller—bach Corp., and is expected to be in operation by mid-summer.

Various gains from Twinverform :

*— Outstanding sheet quality (both sides equally receptive to printing and coating).

*— Significant improvement in formation control even with higher consistencies (0.9-1.2) as against 0.6-0.7 in conventional Fourdriniers.

— Less of wire marking.

— Uniform distribution of fines and fibres.

— Less two-sidedness in brightness, color and ash distribution.

— Fewer bursts.

— More uniform quality from run to run.

The Twinverform appears to be an immediate ready answer to one of the industry's most pressing problems—elimination of 2-sidedness and has added or introduced a new dimension in paper making.

"New Tissue Former in operation at KC—, Memphis, Tenn :—"

Very recently K-C Corp., also put into operation a rebuilt Paper Machine employing a 'revolutionary' new forming process and producing fine, high quality tissue at speeds much faster than ever before attained on a Tissue Machine. Trial runs have been successful and the new former is capable of producing 40,000 tons/year of light weight, high grade material for use in the production of facial, toilet tissue, 2 ply paper towels, sanitary products. Mr. J. C. Wollwage says that the machine is capable of operating at speeds approaching 5000 fpm and hopes to reach this speed range this year.

Scotts New Former :

Recently Scott Paper Co., got long-awaited patent on part (forming roll portion of the machine-patents on flow spreading device/diffuser are still pending) of their new "Former System" installed on No. 8 machine at Mobile, Ala. The system utilizing a 4 ft. dia roll, flow spreading device and a diffuser replaces the conventional headbox and 35 ft. Fourdrinier Section and can produce 200 in. wide tissue at 4000 fpm speeds. The system eliminates Table/dandy/wire stretch rolls, wire guides and

*These gains mean a major advance in gaining speed and quality in one step.

showers resulting in a saving of initial new machine costs and approx. $3,000 for each wire replacement 10 to 15 times a year. The roll uses a wire with about the same life as a regular fourdrinier wire but it costs only $750 and takes much less time and labour to replace.

The system gives—

— More consistent paper quality by reduction of the Quantity of reprocessable paper.

— Reduction of Power requirements, installation costs, maintenance costs (because of fewer moving parts).

— Improved operating control

Periformer is the latest and the new entrant on the **Former Scene** and M/s. KMW, Karlstad, Sweden are the brains behind it. In this former there is one wire and one yanker drying surface. The most important factor of the Periformer is the constant pressure in the forming zone to prevent secondary bows and the sheet is formed as well as dried in the yankee dryer. The use of low consistency furnish and high turbulence results in very fine sheet formation at exceedingly high speeds of upto 5000 fpm. The tension of the wire gives constant pressure on the forming zone between the cylinder and the wire and the fibre alignment in the sheet is controlled by the jet wire speed ratio.

Canadian International Paper Co., Three Rivers, Quebec (which would be having the 2nd widest machine at Gatinue in he World that is 382″ wide ; the world record being 388″ wide machine for Catawba Newsprint Co., Catawba, S. C. U.S.A.) is putting up Black clawson vertiforma (certical formation machine') and this is the most exciting news and development. The vertiforma has run experimentally over 3000 fpm. **Papriformer** (PPRIC) is nearing the commercial reality and bond newsprint have been tested on the pilot plant. An agreement in principle has been reached whereby Dominion Engineering and KMW will be the sole licensees for the sale and manufacture of the Papriformer (a predecessor machine)—the demon.

Recently Canadian Pulp and Paper Research Institute's Member Co., has asked Dominion Engineering for a proposal to supply the Paperiformer for replacing the wet end of a 234 in. wide newsprint machine and this would be used for experimentation and would be a standby. The same Company is planning a new mill and may be then ordering the first commercially Paperiformer for operation in 12-18 months. The PPRIC anticipates commercial designs for speeds 4,000 to 5,000 fpm, newsprint has been formed at the prototype machine at speed of 4,000 fpm and bond (sulfite) at 3,000 fpm and dewatered to a solids content sufficient for vacuum transfer and formation strength, printing quality are very close to that of commercial fourdrinier paper webs are non 2-sided, symmetrical in their thickness, direction and show low wire marks. Sheet fibre orientation can be varied over a wide range by varying the Jet to wire speed ratio.

The Paperiformer seems to meet the requirements of the ideal web and the **specifications** of the **ideal former** which are :

° Uniform fibre distribution on the plane of the sheet
° Symmetry in the thickness direction
° Controlled fibre orientation
° Smooth surface.

Other **qualifications** of an **ideal former** are :

— Should occupy less space than the fourdrinier
— Should be more productive than fourdrinier
— Should lend itself to easy, safe and precise control of operating conditions and product quality.
— Should be lower in total capital and operating costs than that of fourdrinier.

II Machine screening :

Screening system for machines with high speeds, bigger widths need be a very perfect/tight one delivering A-1 type of furnish for improved efficiency, better run and a quality product and Higher revenue. The earlier and old type of Bird screens at Paper Machine has been supplanted by the Pressure screens thereby eliminating showers, dirt catching, slime growing surfaces and a big aeration of Pulp. Today the Pressure screens are either used in series with centrifugal cleaners or some times alone.

III. Head Boxes:

Pressurized head boxes of various makes/ designs are now available in the market and those incorporate flow characteristics on fuller understanding of modern hydrodynamics principles. These headboxes today are working satisfactorily ensuring good sheet formation and standing the test of maximum wire width—350 inches and maximum speeds (i.e. 3,000—3,200 f.p.m. in case of Newsprint and 4,000—5,280 f.p.m. in case of Tissue Machines) by delivering the stock on to the wire.

— Uniformly dispersed
— Uniformly distributed across the Machine
— At a stable Jet velocity

and avoiding eliminating stagnation, cross current, Turbulence (large scale),flocculation and slime growth — all undesirables. These modern headboxes of today are not very big, clumsy and unmanageable, but are more compact and provide a short path, lesser stock volume and decreased retention. The rectifier rolls in all the passages provide small scale or micro-turbulence to prevent flocculation. The slice in most common use is the vertical lip. The significance of the Head Box performance assumes special, bigger importance with the increasing machine widths, speeds and closer quality requirements of the end product.

IV. Widths & Speeds:

Earlier the tendency had been to restrict the machine width to 300 inches or less but the recent years have witnessed a real and a dramatic breakthrough and now there are many machines on stream with wire width more than 300 inches and here **world record** is **346 inches — the maximum/ largest width at Rothesay Newsprint Mill, East St. John, New Brunswisk, Canada.** There is every likelyhood of wire widths touching new Heights 400-450 inches and there is no room for imagining that the machines of the future will be narrower. Till very recently International Paper Co., has placed an order for their New Mill at Vicksburg, Miss, with Beloit Corporation for a 375 inches wire width liner board machine and this is the world record in Paper Machine width. The 1,300 rpm liner board mill of St. Regis may even have still wider width. A recent order for Newsprint machine with wire width 355 inches and a speed of 3,500 fpm has been placed with J. M. Voith GmbH, by Holmens Bruks Och Fabriks AB, Sweden. The delivery has been scheduled for 1967 and the **Paper Machine is the world's largest Newsprint Machine surpassing Rothesay's in Canada.**

In machine speeds even the Trends have been sky-rocketing and now many paper machines especially Newsprint are running as high as 3,000-3,200 f.p.m. and many others are planned to be built. Tissue machines are already operating at 4,000 f.p.m. or over and the first world record of 4,000 f.p.m. was established by Georfia Pacific Corp., U.S.A. At present 4,000 fpm Tissue machines are in operation at — G.A. Serlachius Oy. Manttaa, Finland, E.B. Eddy, U.S.A. Another tissue with designed top speed of 5,280 fpm (a mile a minute) went into production at Crown Zellerbeach's Mill at Wauna-Oregon (U.S.A.) towards 1965 end. 3,000 fpm would be low speed for Paper Machine in 1970—when many machines would be making Paper at or over 5,000 fpm. Even speeds of 6,000 fpm are believed to be attainable and predicted for the near future may be 4-5 years.

Within the next 4-5 years tissue and wadding grades are expected to be made at 6,000 fpm — already speeds of 4,000-5,000 fpm are realities and within the next 10 years the speeds would touch a new horizon — 8,000 fpm. These better forming methods around which is centring lot of interest, research and development and the newer drying techniques would prove this prediction in the future.

The major factor in High speed paper machine operation is the Mechanical perfection — balance, vibration, speed control, ability of transferring the wet web from the Fourdrinier wire to the presses without much strain/stress.

Till now no serious impediments/problems have been encountered with the very wide and very high speed machine either structurally or in getting uniformity across the width in pressing and drying. Fourdrinier wire length of 130-140 ft. is not considered to be the limit in these days of High speed machine operation and the wire length has touched a new height of over 150 ft. at Rothesay Paper Corpn., Canada.

Following table gives an overall account of the biggest Mills in wire width, speed, length, etc., etc.

No.	Company	Wire width (inches)	Speed (Machine) f.p.m.	Length ft.	Production t.p.d	Builder/Start-up
1.	International Paper Co., Pine Bluff ; Arkansas	301	2500	141' 2"	375	Beloit Corp., U.S.A.
2.	Cartiere Burgo, Torino:Italy (Mantova Mill)	304	3000		350 - 400	Beloit, Italia
3.	Macmilllan Bloedel Ltd., Port Alberni B. C. Canada (No. 5 Newsprint machine)	324	2500/3000	154'	500 - 550	Dominion Engg. works
4.	Union Paper Corp , At Hattiesburg, Miss. Mill at Montgomery, Ala, (U S A.)	328	—		800 kraft liner board	Start up in the 2nd quarter of 1967.
5.	Coosa River Newsprint Machine (No. 3)	336	2500	146' 4"	400	Beloit Corp.
6.	Cox Newsprint Inc., Augusta, Georgia, (U.S.A.)	338	3000	155' 7"	425	Beloit Corp./1966.
7.	Svenska Cellulose AB, Sundsvall, Sweden —at Ortviken Paper Mill.	338	3000		450	Start up 1967 Fall (Beloit Corp.)
8.	Macmillan Bloedel United I.C.. Pinehill, Ala.	338	—	206'	900 (Liner board)	Black Clawson Co. (Operation June/68)
9.	Greak Lakes, Fort William, Ontario, Canada.	342	2250	117' 2"	475	Blaek Clawson.
10.	Rothesay Paper Corp. East Saint John, N. B. Canada.	346	3000	Over 150'	475	Beloit, Walwsley Corp.
11.	Holmens Bruks Och Fabrics AB. Hallstavik—Sweden.	355	3500	Over 150	475 — 555	J. M. Voith Start up 1967 end.
12.	Catawba Newsprint Co., Catawba, S. C. U.S.A.	388 (trim 360")	3000	175	180,000 T/Yr.	Start-up early 1969
13.	A. Ahlstrom Oy Warkaus, Finland.	326"	3000	137.3	Over 400	J. M. Voith
14.	Mackmillan Blodel, Powell River, B. C. Canada.	324"	3000	—	160,000 T/Yr.	Starting Apr. 1967
15.	Kymmeae Ab, Voikka Mill Finland.	313"	3250	—	Over 100,000 T/Yr.	Valmet Oy, Finland. Starting 1969
16.	Canadian International Paper Co. Gatineau, Que, Canada.	382" (360" Trim)	3000	—	180,020 T/Yr.	Dec. 1968 Start-up. Beloit Corp.
17.	Catawba Newsprint Co., Catawba, S. C. U.S.A.	388"	3000	175'	180,000 T/Yr.	(Start-up Late 1968).

World Records :

** At Macmillan Bloedel Ltd., Port Alberni, B.C., Canada, No. 5 Newsprint Machine surpassed 500 tonnes per day—single Newsprint Machine production mark and is a world record.

* In September, 1966, Rothesay Paper Corporation St. John, N.B., Canada established

world record with average of 453 tonnes per day from a single newsprint machine and made a history.

V. Dryer Cylinders and Drying :

It is very possible that when Machine speeds touch new heights, Drying of paper may become a major bottle-neck/hurdle. The recent years have witnessed much of Research, Development work, solving, tackling of problems at the wet-end and allied aspects but many signs pinpoint to increasing interest in the Dry-end study.

In the past 10 years, very few new machines have been built with other than 60 inches diameter.

Dryer Cylinders : Dryer Cylinder diameters have normally come to stay at 60-inches but now this barrier is cracking and breaking down and the new additions are 72-inches diameter and would be put up at MacMillan Bloedel Untied, Inc. Liner-board Machine stated to come into operation in June 1968 and also Union Camp Corp., (U.S.A.) 6-ft. Paper Dryers (length 383 $\frac{3}{4}$"—weight 47,700 lbs.) are also being installed at International Paper Co., Southern Kraft Division, Vieksburg, Miss. U.S.A. and also at Catawba Newsprint Co., Catawba. S. C. (U.S.A.) Future may see 84-in. and 86-in. dryers which the High speeds would demand and dictate. (Some notable exceptions to 60-inch diameter being cylinder machines and some of these have had the large diameter driers.) Mr. O. B. Witworth in his very interesting Paper "Large diameter dryers.....where can they lead"? (Pulp and Paper ; Feb. 21, 1966 ; P.44-47 after considering the Dryer Section geometry proves and advocates the case and desirability of larger diameter dryers (72", 84", 96" because of the unignorable benefits, advantages especially at higher speeds and says further that the trend for these large diameter dryers is there and well established and where this would lead is anybody's guess.

The 6 ft. (72-inches) diameter dryers provide :

— Greater pocket area.

— More effective wrap angle.

— Better heat transfer.

— Shorter/lesser overall length of Dryer Section (Because of the fewer dryers)

— Greater, Better speeds and efficiency of Faster/Wider paper machines—would be monsters of tomorrow.

Drying :

For top speeds of 5000 fpm and above addition of 140-150 wt. to the length of the Dryer section for increasing the drying capacity seems to be uneconomical and awkward. Here again the matters are not silent and new and revolutionary methods of drying are being probed and following are the various innovations attracting the good amount of interest attention and are expected to open up a new era in Drying :

C-Dryer (C-compact).

B-Dryer (Fitchburg Paper Co., Fitchburg, Mass (U.S.A.) or "Dieletic Drying."

" Through Drying ". (This method is being experimentally tested at Pulp and Paper Research Institute, Canada and consists in blowing of Hot Air through the Web).

" Fluidized bed Drying ' : This was originally developed at British Paper and Board Industry Research Association and further research is in progress. Recently Shairley Developments Ltd., Manchester, (U.K.) has announced an agreement with the B.P., B.I.R.A., Kenley, Surrey for collaborating in the development of Fluid Bed, Drying systems for the Paper/Board Industry. Recently at SPCA's Annual meet a New Fluidized—bed Drying technique has been mentioned/ described which uses fluidized ber of sand to dry Horizontally supported sheet which increases drying rates 10-15 times compared to the vertical fluidized-bed arrangement.

Infra Red Drying has been tried at Lydall/ Foulds Div. Colonial Board Co., Manchester, CONN. Here 2 Dryers (First having 43 Infra Red Burners and the 2nd 36 each rated at over 360,000 Btu/Hr. Here 2 units ares tructurally framed and mounted vertically, facing each other just before the Drum Dryer Section. The board passes through the Dryer at a distance of about 2.5-3 inches from the burners and is subjected to infra red energy waves from both sides and the surface temperature is raised and the migration of water Molecules starts. Because of this preheating the Drum Dryers can

evaporate water much more rapidly resulting in increased speeds and production.

Maxifier Direct Contact Burner Drying is a new/ recent development from Australia.

It has been invented/developed, by the Gas and Fuel Corporation of Victoria, Australia and is being manufactured under license by M/s. Green Bank 1ngineering Co., Ltd., Blackburn, (U.K.).

The original unit has been installed at the Melbourne Mill of Australian Paper Manufacturer's Ltd., on No. 1 Board making machine and has been tested, proved under running conditions for over 12 months and surpassed all expectations. Maxifier unit is a direct flame Gas Dryer and is located between the Last Press and the First Drying Cylinder. The sheet passes through the flame (which is of a very high intensity) but because the sheet is in contact with the flame for a limited period and has a High percentage water content when leaving the burner the temperature of Paper/ Board remains at a safe limit. The high Intensity drying unit has achieved better than 3% water removal in 14" of Travel and has increased substantially the production from 5-17% (average being 12%). It can be incorporated in the existing machines and offers unlimited scope where additional Drying is required and machine space restricted. This ingenious invention to become one of the most successful methods of Drying Paper for many years.

The thermal intensity of the Maxifier unit is 4,00,000 BTU/Sq. ft./Hr. as against 6,000-22,000 Btu/Sq ft./Hr. for electric Rediant heaters and 30,000 Btu/Sq. f.t./Hr. for Gas Radiant Heaters.

The exhaust gas of the Maxifier unit can either be discharged into the atmosphere or could be utilised in High velocity Air cap or high velocity for steam removal from the Cylinder pockets or for vapour absorption purpose in a ventilating hood.

High Velocity Drying: High velocity dryer has also found some application in the existing dryer sections and offers another way of increasing the drying capacity of an existing dryer section without any major rebuilding or changes.

Blow Rolls: Various blowing rolls (Madeleine, Heimback and Pocket ventilation (PV) have appeared on the scene and these have eliminated the need of Felt Dryers—increased the drying capacity helped in making the Dryer Sections shorter and less expensive—increased the production by 10-15%—improved the moisture Profile and sheet quality—increased sheet moisture (meaning a corresponding reduction in fibre—decided/definite economic advantage.)—have further eliminated the need for return and feeny Dryers and these mean a reduction in investment in New machines and accessories—increased the felt life—done away with the equipment for blowing hot air under, into the dryer part meaning saving on these Heaters/Power.

Shirley Development Ltd.'s recent release makes a comparison of fluidized bed dryer with other drying systems and makes the following conclusions :

(1) A 7¼ ft. high fluidized bed (over-all cost $84,000) is equivalent in evaporating capacity to 5.6 drying cylinders (over-all cost $156,800).

(2) Total cost figures show that, with modern efficient drying cylinders and large turbines supplying low-cost extraction steam, cylinder-dryer give the lowest running cost but occupy the most space.

(3) With steam costs nearer the average, fluidized bed dryers are competitive with cylinder dryers and may even be considerably cheaper.

(4) Fluidized bed dryers have lower capital and running costs than high velocity air dryers.

(5) Calculation of total cost shows that fuel costs. The major factor on cost/hr. basis, amounts to (1) $30.24/hr. for a fluidized bed ; (2) $23.24/hr. for cylinders (using high efficiency steam and generating electric power) ; and (3) $34.12/hr. for capped cylinders.

(6) A cost comparison under U.S. conditions shows that cost per 1,000 lbs. water evaporation is (1) $1.63 for a conventional cylinder ; (2) $1.91 for high velocity air ; (3) $2.15-$2.34 for infrared drying ; and (4) $1.47 for fluidized bed drying.

(7) Comparative drying rates in lbs./hr. per sq. ft. are : (1) 2.0 for conventional cylinders ; (2) 20 for high velocity air ; (3) 18.32 lbs. for infrared ; and (4) 29 for fluidized bed.

The economy and efficiency of fluidized bed drying is well established but it has still to be adopted to practical paper making and one immediate question that comes to the fore is of how to cope with a sheet break and rathered through a hot fluidized bed.

Actually paper drying appears to be in a state of flux with more interest/research than at any previous time and the future would certainly see the development of New and improved drying methods — musts for the Monsters of tomorrow.

Hoods : Totally enclosed hoods have been another great relief and have given the advantages :

— reduced exhaust and supply volume :

— reduced steam consumption and pressure ;

— increased Drying efficiency ;

— improved/better moisture profile at reel ;

— improved machine efficiency/overall production ;

— improved working conditions.

Recently Midland — Ross Corp., U.S.A. announced a new/major break-through in " wet-end ventilation " — totally enclosed fourdrinier by putting in the market New Ross Fourdrinier wire hood and exhaust system. This is a totally enclosed insulated hood which covers not only the wire section but the head box too. The benefits are tremendous and very many and would be a great help at future top speeds of 5,000 f.p.m.

— Higher stock temperatures and increased drainage rates and increased production ultimately

— More uniform wire temperature resulting in improved wire life.

— Cleaner final product,

— Extra protection against wire damage,

— Marked reduction in fourdrinier area noise levels — really big bonus.

— Improved machine room comfort.

— Reduced mill ventilation and ventilation equipment requirements.

Dryer Felts :

Needled Dryer Felts and Plastic Dryer Fabrics have been another point of relief in the Drying section — Better life meaning fewer fabric changes, lesser Downtime, Increased speed and production and reduced costs.

* **Needled Dryer Felts** have given improved drying and improved felts life and can be constructed more open without a loss of strength.

** **Plastic Dryer Fabrics** because of their more open area and non-absorbent properties permit more readily and uniformly the escape of Moisture from the sheet and have increased the Drying capacity 10-15%. Other advantages of these open mesh synthetic Dryer fabrics are : No guiding problems. Completely flat fabric. No. seam troubles. Excellent runnability. Speed increases (100 f.p.m.) Improved moisture profile across the sheet. Less Wrinkling of the sheet during its passage through the dryers. (No cockle, curl or wrinkle at the seam or elsewhere).

— No marking either from the dryer screen or the caliper seam.

— Negligible time lag for the fabric to stabilize its drying capacity after a wet-end break or a start-up after a shut-down resulting in minimum amount of off product of inferior quality paper.

— Can withstand much greater abuse than the conventional dryer felts.

— Easy washability by air, water, steam, detergents, mild chemicals.

— Cleaner dryer cylinders — lesser down time for maintenance.

— Fewer/lesser customer complaints.

VIII. **Breaker Stack :**

At Breaker Stack the two Nickel chilled iron rolls perform preliminary calendering on paper while it is still partially wet, this in turn compacts the paper lesser than had the same operation been performed on dry paper by the calender. This would result in bulkier and better printing sheet. Experience has shown that the perliminary calendering at the Breaker Stack is more useful/preferable because of fewer Nips required and markedly decreased tendency towards " barring ". Besides it also permits more/better moisture in the final roll without blackening which would be there if all the calendering had to be done only on dry paper. Because of all these merits — Lower Caliper, improved calendering/gloss, improved drying and better percentage of H_2O in the final roll, it would form a part and parcel of the future/New High Speed machine installations.

IX. **Pressing/Presses :**

In the press section Pick-up's Universal adoption at the High speeds has made possible/easy the transfer of the wet sheet from the wire to the Felt where it is in its weakest condition and the incidence of wet end break is there and maximum. The suction pickup has been real boon and has a host of advantages and has extended the margin of operational safety.

Pressing at the very high speeds for optimum water removal may be another bottleneck, but here even the Research and development guns have not been silent but have been focussed for better/improved water removal efficiency. New and Novel techniques have been developed with the result that now we have :

Grooved Press (Dominion)
Fabric Press (Mead) Fabric Press has been installed on 50-60 machines in Europe.

Venta-Nip Press (Beloit) So successful has been the venta Nip Press that over 100 applications had been made in the first year after its introduction and till now more than 150 installations range from Tissue to Pulp on machines travelling from 100 fpm to 2,500 fpm and with nip loads spreading from bare nip Loading to 1,000 pLi.

Appleton Sleeve Development or the Fabric Sleeve Press.
Divided Press.

High Intensity Press (Black Clawson Co) or Hi-I-Press. 12 Hi-I units are being installed.

Installation at Welser Papierfabrik GmbH, Wels, Austria of a "High Instensity Press" has helped boost production some 10%. According to Mr. S. H. Gooley (Chief Engineer, Paper Machine Division, Black Clawson Co. (USA) — Water removal efficiency has increased 2-3% — moisture profile is more even following the 2nd reverse press position — and steam consumption has been reduced and the installation cost is Low.

Installation of Hi-I Press at Thilmany's Pulp Paper Co., Kaukauna, U.S.A. for experimental evaluation showed good water removal without shadow marking or crushing at 1,200 fpm. speeds and 120" trim machine making 15.5 — 50 Kraft specialities.

Yet another installation of Hi-I-Press has been on the No. 5 machine in the 2nd press position of H.C.H. Sieger Mill in Zulpich, Germany, producing 9-point corrugating/wrapping grades — weight range being 19-31 lbs/100 sq. ft. An immediate dryness value increase of 4-5% after Hi-I-Press was got corresponding to a speed increase of 50 fpm (on 27 lb. wrapping grades) and a 10% increase on the machine drainage speed with a 6 tpd weight output increase. The wet streaks previously apparent on the machine are no more there and besides the moisture profile has improved.

The successful results, have led to a repeat order with Black Clawson Int. Ltd., London for installation for Hi-I-Press on either 1st or 3rd press position of the same machine.

Black Clawson spokesman suggests that with the installation of a 2nd Hi-I-Press it may be possible to remove one of the presses thereby replacing it with dryers and increasing machine's speed/production ultimately.

The use of "Controlled Crown rolls" in the press section has also got off the ground resulting in improved/uniform moisture content across the sheet eliminating the necessity of overdrying portions of the sheet to dry up wet streaks. First installation of Accra Nip on presses was made on a kraft liner board Machine at International Paper Co., Gardiner, Ore. The Mills installations seem to be slow as compared to the amount of publicity given to the Calender control.

There has been also a revolution in the wet Press Felts and the needled Felts are the newest development and are finding increasing use resulting in even and better dewatering — a must/essential for high speeds of tomorrow. The needled felts have given better finish, eliminated hair sheeding, shadow marking require less down time for washing and suction presses remain cleaner, fill up less and are more resistant to heavy loading.

X. Table Rolls:

At Table rolls a considerable amount of water removal takes place. The rate of water removal is roughly fortunately proportional to the speed as otherwise High speeds of today would have been impossible. Drainage on the Paper Machine's wire section is just some thing like milking a cow or a buffalo a spurt coming out at each roll — and less with each succeeding roll.

At speeds of 2,600-2,700 fpm., excessive suction is created at Table Rolls because of complete vacuum conditions, which gives rise to spouting interfering further with good sheet formation — a must for Higher machine speeds. The machine apparently reaches its limits of usefulness at speeds nearing 3,000 fpm. Again at top speeds the instability of the free surface of the fibre suspension on the wire becomes more and more critical.

It is very possible that the days of the Table Rolls are numbered and their demise would be gradual now with the mush-rooming use of "Foils" and their substitution is the recent/major trend. High speed machines of future may not use Table Rolls but will go in for the foils because of a broad spectrum of advantages:

— Allow a positive, gentle, much better control of Drainage by decreasing the angle which the Hydrofoils form with the Wire.

— Multiply the drainage points 3-5 times in place of one table roll, giving better/faster sheet formation.

— Eliminate pressure ridges, wire sag, snap back, reduce culls and result in better sheet formation, and improved sheet quality.

— Give better support of the forming medium.

— Give better Fines/Filler retention, reduced sheet and sidedness, reduction of stock pump disturbances and consequent improved sheet formation leading to stronger wet webs — Lesser Press and dryer breaks another count of production increase (Stock jump a nuisance on many machines in the speed range 1,200-2,000 fpm).

— Permit shorter wire lengths or space conservation because of their close placement. Wire length increase has both financial/physical implications or shorter forming area no longer a bottle-neck to increased production.

— Permit use of finer forming medium — Lesser wire mark. — Lower maintenance.

— Increased dewatering would mean — increased speed (50 — 350 fpm) — Reduced Heard Box consistency — Drier sheet off couch.

Reduced Suction Boxes vacuum meaning decreased — Forming medium wear — suction box cover wear — Drag — Power requirements — wire mark — Fines loss.

— Additional refining — Increased production — Better returns.

— Permit savings in Machine, Building and wire costs.

— Permit also wire change time reduction to one half.

— Allow making of heavier sheets because of enough water removal capacity.

— Permit reduction of Stock Temperatures — A money saving/corrosion avoiding count.

Foils can be used under the wire in place of or adjunct to Table Rolls and have given overall operating economy and help in sheet formation technique beyond Table Rolls limitations and have altered substantially the present concepts of wire length and formation time at High speeds. We have many machines today running completely on "Foils" which have changed the operating economies because of speed increases/quality gains. At one such machine the Headbox stock operating consistency has increased from 1.5 to 2.0% whereas wire life has jumped up from 17 days (with table rolls) to 97 days (with Foils). Hydrofoils are not a cure-all but an additional/ useful tool and their handling requires special care and knowledge.

The only shortcoming with the Foils is that it does not eliminate the problems caused by the instability of the free surface. At very high speeds especially the large diameter Table rolls increase the disruptive forces. Recently **Mount Hope Machinery Co.,** have put on the market small diamete — (Non-debecting) — Table Rolls and especially recommended these for Higher speeds. They claim :

— Lesser "Fines" put out

— Better sheet formation

— Increased Fourdrinier wire life

— Lesser vacuum at high speeds.

Variable-bow (Non-deflecting) Table Rolls :

Recently International Paper Co., Pine Bluff, Ark., (U.S.A.) installed Table rolls of 6″ diameter with pre-stressed tension Member in Hollow Core (Mount Hope Machinery Co.) and the results have been excellent. Improvement in sheet formation at top speeds, reduction in pinholes, reduced vibration, easy wire pull and reduced "Jump" and Top surface spatter, reduced vacuum area between wire and rolls, increased drainage through utilization of more rolls and increased wire life.

PVC Covered Table Rolls :

Table rolls having rubber or Polyster resin covers have been in use all along. Hard PVC covered rolls have just made appearance on the scene in Japan and have improved the Paper Machine operation and have been developed by the TOKYO ROLL CO., Ltd., Tokyo, Japan after years of Research and experimentation. These special Hard Polyvinyl Chloride Covered Rolls have the following characteristics/benefits and come to be very highly reputed by major Paper Manufacturers in Japan :

— Are lighter and allow the wire travel smoothly.

— High abrasion resistance (Accuracy of the rolls is maintained over a long period of stable operation).

— High chemical resistance (No pits, scales form on the surface even after a long operation).

— High Mechanical Accuracy.

— Faster Water drainage.

— No changes in Paper basis weight due to uneven wear of Roll surfaces.

— No web streaks resulting from uneven pressure from table rolls.

— Pitch/Paper stack do not adhere much to PVC Paper rolls.

Besides these Table Rolls even PVC covered rolls perform well on Felt rolls, worn rolls, grooved rolls, Paper rolls, etc. As of April, 1965 about 2,500 rolls were in operation at various Mills all over the country (Japan).

Wet Suction Boxes :

Recently Axel Johnson & Co., Inc., I Belmont Ave., Bala-Cynwyd, Pa. (American Distributors of KMW pulp and paper mill equipment) has put in the market "wet suction boxes" (high drainage capacity) which replace the conventional table rolls in the modern high speed paper machines with speeds upto 3,500 fpm and above and claim to permit :

(A) — Lower head box consistencies

— Higher machines speeds.

— Shorter wire sections or increased drainage capacity of existing wire sections within the same overall dimensions.

— Lesser capital costs and can be fitted without any major rebuilt into the existing machines.

and give :

(B) — Better and improved formation

— Increased retention of fillers and fines

— Reduced wire mark

— Improved basis weight stability

— Improved paper quality.

XI. **Suction Box Covers :**

Here specially at very very high speeds of Paper Machine the importance of Suction Box covers still assumes a greater importance. End-of-Grain Maple (wax impregnated) Suction Box covers have dominated the scene and still continue to be used but a new world has emerged again over here and now the market is flooded with a number of different makes such as : Robalit, Rokide, KT Selicon. Carbide. Tungestun Carbide, Teflon SPK Oxide, Gramics, Blyvon, LFT-4, Hypalox, Huylife, Gatke, Aluminium Oxide (Gramic), Hi-fax 1900, Hlex-2000, Somalife W (Somar Mfg. Co., Japan) Stainless Steel, etc., we have to take our hats off to the Modern Research and competitive prodding, which has placed before us, these Suction Box covers which have very many merits/advantages :

— Extremely low co-efficient of friction (0.07-0.09 as compared to 0.2-0.3 for end of Grain Maple) which permits a tighter wire in the forming length area and tighter wire reduces the ability of the wire to follow the periphery of the rapidly, revolving table rolls and this then reduces the spouting effect.

— High wear/Corrosion/Abrasion/Thermal resistance (Temperature upto 212°F).

— Slashed or no maintenance and rare resurfacing.

— No rewetting — can be stored Dry.

— No plugging (No imbedding of Grinder Grit/ Foreign matter into the cover surface . Mirror smooth surface.

— No pitch and slime development and easy washing.

— Elimination of all time oscillation/Oscillation equipment.

— Increased fourdriner wire life 50-60% (Rupee or dollar savings on Wires .

— Reduced Drag Load — decreased consumption of Power at couch 20-30% (Upper Fourdrinier Reserve Power).

— Better Vacuum at Suction Boxes.

— improved drainage/better sheet formation.

— Downtime touching a New Minimum (Less frequent wire changes).

— Greater Operating efficiency via Higher Machine Speeds and increased production, saving in labour, reduced maintenance etc.

— Low operating costs, and Higher profits.

— Easy adaptability.

These New covers are finding an ever increasing use and the operating results are more than stisfactory and promising and the High Speed Machines of future may only have these and no Mample-End-Grain. These covers would pay for themselves in less than a year or so.

World's largest Paper Machine — (Balanced speed 3,000 ft./mt.) at Rothesay Paper Corpn., Canada, has 7 Suction Boxes (15% wide) — 4 having " End Grain Maple " covers and 3 " Hypalox " Oxide Ceramic covers (Feldmüble A.G.).

XII. **Calender :**

Calendering process is physical and reflects only the intrinsic elements in the web and and calendering action being the function of — Applied Pressure, Plastic Flow, Temperature and Speed. The nip pressure across the whole width need be uniform for attaining a uniform sheet. Normal/Standard procedure has been to crown the King roll for compensating from the rolls deflection and the crown depending upon the number of Nips.

Calender design has changed from the "A" Frame to "open side" Type. The selective variation of the crown/and the necessity of getting uniform Nip Pressures has resulted in the Recent developments — Accra Nip and Swinmming Roll.

Accra Nip Machine Calender depends on the Mechanical Flexture of the bottom roll — the basic action being the positive or Negative Loading of an optimum crowned king roll by means of load bearing on the extended roll journals.

Swimming Roll utilizes Hydraulic Pressures to Flex the bottom roll and has had overwhelming success and is a major development.

The outstanding advantage of the open side calender is the pin joint on which the calender roll bearing pivots and this provides a fixed alignment of the calender rolls and a straight Nip line.

Crown Compensating Rolls permit better control of the reel. At spruce falls, German swimming rolls are used as Crown compensating rolls and the mill is putting the rolls on 2 more machines for a total of 5 machines. On the No. 3 machine running standard Newsprint at 2,100 fpm. the Swimming rolls have been advantageous in building the reel. This machine reported as worst on rejects in the mill has had every pound of paper accepted since the installation. Stack changes have been simplified because there was no large mass of metal in the King roll to warm up.

At Saulte Ste. Marie, Abitibi has a Swimming roll in the bottom position in every stack — they are making a wide range of products and their crown compensating rolls are said to be making changes easier. The problem of edge pinching has been tackled. The rolls have been also credited with improving moisture content.

At Great Northern Paper Co. Millinocket, Me., they had once crown compensating roll on No. 2 Light Weight Machine and intend a total of 5.

At Southwest Forests' Snowflake Ariz Mill also a crown compensating roll has been used on the Beloit machine supported by a shoe and controlled by oil pressure. This roll has eliminated maintenance problems and is running with no doctors on intermediate rolls nor is there any further need for using pads.

At Fitchburg Paper Co. (A Division of Litton Industries Inc.) "Swimming Rolls" numbering 8 have been installed and advantages cited are: Reduction in number of rolls required in machine calenders; ability to change grades quickly; cut in roll grinding costs of over 50%; better product. Installation of Swimming roll in No. 1 Stack has cut the Calender nips from 8 to 1. No. 7 Machine is operating with 2 rolls instead of original 4. Installation of Swimming rolls on No. 2, 5 and 6 machines has dispensed with the necessity of 2 rolls running bare on top of Queen roll for compensating for King roll crown and has made possible running any combination of rolls and still maintaining uniform Nip pressure by making a simple adjustment of Hydraulic pressure within the roll.

(Swimming Roll is a trade mark for the controlled deflection roll developed by Edward Kusters of Krefeld, West Germany).

The increasing Machine speeds and widths have also increased the diameter of the calender stack rolls and this has made difficult achievement of — the Number of Nips — Limited the total pressure and reduction of Caliper to Proper/desired limits. This problem has been solublized by having 2 stacks with lesser number of rolls or by providing Nip relief devices. The big machine (Newsprint) at Rothesay Paper Corpn. is having 2 open side desngn calender stacks having 4 rolls each with provision for addition of Extra rolls in the future.

"Chattering" of rolls becomes a problem especially on High Speed machines. The calender stack with 4 rolls helps combat the problem — as fewer the rolls, the lesser the chattering.

XIII. **Pope Reel:**

On most of the Modern/High Speed Machines the Pope Reel has been supplemented by the horizontal sliding reel. This improved design has many advantages:

— Allows for a controllable, constant pressure between Reel drum and paper roll, with better and more uniform winding of the Paper on the rell bar.

— Allows reels to be built upto bigger diameters, providing set off the winder from a single roll of the reel.

XIV. Winder :

Here there have not been major changes in the Winder design. On Newsprint machines the winding speeds have shot upto 7,500 ft/mt. The riding roll has a separate Drive and the unwind stand is supplied with regenerative braking. This allows the big Jumbo rolls to be motored quickly upto speed besides allowing for programming of the winding sequence with controlled acceleration and accurate Tension Control.

Handling of the winder shaft has been made easy by the use of Mechanical shaft puller or air-motor operated shaft puller. Widest/Giant 332″ winder at present in operation in U.S.A. is at Cox Newsprint Inc., built by Beloit Eastern Corporation, Downingtown, Pa and rewinds 96″ parent rolls into 42″ shipping rolls at 7,000 fpm.

XV. Computer Control :

The need and the trend for automatic control of Paper Machine variables which are 430 in number arises with the increasing speeds. The computer control of the paper machine earlier did not meet with much of success. But now the computer control has proved to be quite a big success handling about 187 variables at Mead Corpn., U.S.A. This success is stirring a new interest and it is very fervently hoped that the future would see the Giant and Monster Paper Machine computer controlled completely.

Very recently, Mead Corpn., Kingsport, Tenn. (U.S.A.) put into operation its new 2,000 fpm. 200 tpd. Beloit machine which can be billed as the **" first Paper Machine in the world to have computer controls included in its original design ".** The computer is similar to that in operation at Chillicothe mill Ohio., (U.S.A.) and very unusually problem free start-up had been experienced because of intensive training on computer controls. Main benefits of computer control are uniformity of quality and production efficiency.

XVI. High Consistency Refining (HCR) :

High Consistency Refining — 30% or above is a very new and novel development and would open up new vistas by cutting down the conventional white water system of the Paper Machine and may effect a major and drastic change in the design thereby eliminating the necessity of a white water system. This would be a big must at Top speeds of 4,000-5,000 or above.

This HCR has many facts and versatility — and aims at avoiding of shortening of Fibre or fibre damage/cutting, preserves the fibre length with fibre contact rather than Metal on fibre, (Fibre to fibre contact results in better/improved flexibility, improved interwearing/bonding properties, higher shrinkage potential) — absence of fines and fibre debris. HCR fibres are Long, bent, twisted and bruised, have many fine and thick fibrills sticking out from fibre surfaces and have large filmy sheets peeled away from fibre walls as against short, rigid, straight and smooth surfaced conventional fibres.

HCR has added new dimensions and promises :

— Higher freenesses, better drainage permitting better/faster speeds and Higher production Rates (3 — 15%) due to fewer breaks and no loss in quality of paper.

— Mullen/Tensile at least equal to the conventional refining (depending on stock type).

— Tear equal or greater than the conventional Tear.

— Stretch increases — upto 100% higher than the usual.

— Rupture energy — upto 100% higher than the conventional.

— Little or No increase in fines fraction.

— Lesser strength loss during machine drying.

— At a given freeness — some paper strength properties are upto 100% improved over papers from conventionally refined pulps.

— Lower manufacturing costs — by replacing 5-25% of Chemical pulp with Groundwood or other filler pulp and giving besides 5-20% less reject paper.

— Replacement of High cost Chemical Pulp with Low cost Groundwood not only gives lesser furnish cost but another bonus Better formation and printing quality and helps in establishing a lower basis weight.

— Better strength/toughness of HCR pulp means better printing, pressroom runnability and higher Tear, Strength and Toughness.

— Lower capital costs and long term operating costs.

HCR is going to be especially suitable for 2 areas obviously for developing new/improved products and for filler pulps where it allows a more extensive use by providing a stranger/better matrix their envolopment.

HCR had been developed at Crown Zellerbach and has been patented and many paper mills are in the process of installing equipment for making use of this process in their various grades.

HCR pulp tonnage at Crown Zellerbach is about 1,000 tpd more than 15% of the corporate total according to the latest reports. With proper combination of NCR (30% and more) and conventional refining (1.0 — 5.0%) many outstanding improvements have been got in the laboratory at CZ and it is believed that these Laboratory results would be translated into full commercial use. Dr. W. G. Meyer says that this HCR-NR (normal refining) gives pulp with better strength than either process itself.

XVII. **Photography/Television :**

Visual observation/examination of the various working conditions and high speed phenomena which would be occurring on the Fourdrinier especially when speeds shoot up would be difficult to carry and it would be impossible to check with naked eye. High speed Photography/Flash Light Stroboscopy would be very useful sides. Mr. Jasper Mardon has pursued the use of Photography in Paper Making and says that it is a very useful tool and has been neglected in the past and further stresses that one company could have saved thousands of dollars and solved the problem in 20 minutes.

Television (close sircuit) can provide pictures and inspection of web operations and would give a clear view of paper operations.

XVIII. **High Speed Essentials :**

Following are the basic criteria which need integration into the paper machine and for meeting the modern operating requirements :

— Uniform dispersion of stock.

— Symmetrical drainage in the forming area.
— Complete retention.

— Controlled fibre orientation.

— High consistency stock — a big must at Skyrocketing Machine speeds of 4,000-5,000 fpm and above.

The two wire formers have met with few of the above essentials/criteria as these give symmetrical drainage, controlled fibre orientation (by increasing turbulence of the fibre suspension on the wire and increasing the difference in speed of stock flow and the wire) and are able to use High consistency stock.

Uniform dispersion and complete retention — the nuts are under study, experimentation and the future may see these goals also attained.

Fourdrinier has been perfected to the possible extent but still there are some short-comings and its end is not going to come soon and it will live because of its being the only machine that is practical for installation and use in the developing countries where still much of growth of paper industry has to take place in the years to come when lack of Technical know-how and capital/prohibits installation of High, instrumented and sophisticated machines.

XIX. **Mr. Bovnotn's view of relating cost/daily output to selling price/ton of output of a Machine :**

In view of the rising/shooting costs of Men/ Materials and Machines, a Machine's successful and economic operation is a big must and the choice

of width and the speed are the most dominating and permanent factors. Mr. R. T. Boynton in his paper "The specification of successful paper machines" (18th Annual Conference, Appita-April 1964) mentions the procedure of shortening the time required for specifying and ordering a New Large output Paper Machine, cutting down the expenditure involved and avoiding Big errors in Machine design which may be hazardous in the long run and lists therein the following critical points which have to be taken care of :

— Cost of building a Paper Machine today is no more expensive when related to logical base than at any other time in the period (1922-1962) examined.

— Speeds rise at a greater pace than the Machine widths. We should be more and more liberal/optimistic on speed increases and conservation on width inccreases.

— Modern Paper Machine Designs are bigger/better value for money than the older designs.

— Whether a proposed design would be commercially economical/successful, it would be desirable to establish a cost/output relation for each type of Paper Machine and that is possible and this could serve as a yardstick and a guide.

The last decade has brought to the fore a multitude of changes/innoviations in paper making equipment and process and this long tale of development has been due to the surmounting of one obstacle/trouble after another for meeting the demand of Higher quality, lower cost and greater/increased tonnage through better efficiency/increased automating/improved techniques/higher speeds and greater widths. Paper Manufacturers, Equipment Manufacturers, Machine clothing and Chemical suppliers contribution towards this development is really remarkable/laudable. A number of new processes and devices are in the developing stage and are an assurance of the maintenance of the rate of progress at the present excellent/High level. In short the pace of the progress of the Paper Machine development can be said to be astounding and unbelievable and the future would reveal most of the hidden secrets and make us avail of the resulting fruits.

XX. What would the Paper Machine of future be ?

The author predicts that the Paper Machine of the future would be running at 5,000 fpm and above and be not antiquated machines having been speeded up or renovated but machines employing the modern/and ultra modern innovations — the fruit of research and development from the Headbox to the Winder and everything in between and built up with uptodate Technology and know-how and ridding us of costly and ugly variables now plaguing the process and high automation, heavy instrumentation and ornamentation would be playing a dominating role.

Years ahead would also see many formers in operation because of the active/mounting and ever increasing interest in High speed paper forming (i.e. 3,200 fpm and above) and those formers would be eliminating the instability of stock on the Fourdrinier Wire because of mechanical hydraulic and windage effects which become apparent in open wire formation especially at speeds approaching 3,000 f.p.m. The replacement of the Fourdriniers with the formers is ultimately going to happen, though it may take some more time.

Acknowledgement :

I would like to thank Shri P. S. Kothari, Managing Director, The National Newsprint & Paper Mills Ltd., Nepanagar (M.P.) for permission to publish this paper.