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NEWSPRINT MACHINES — PAST AND THE PRESENT

Manos Mukherjee & B. Niyogi,
Paper Machinery Division,
Jessop & Co.
Calcutta

The trend World wide in all the Industries today is dictated by shortage of resources, energy conservation and the urge to produce more at minimum cost.

Newsprint Industry is no exception and the first target of the Newsprint manufacturers has been to produce a greater printing surface per ton of paper by lowering the basis weight of Newsprint from 52 gsm to 49 gsm and the trend is to lower in further. Lowering the basis weight from 52 to 49 gsm has given a gain of approx 7% in printing surface per ton of paper. However, this decision of the Newsprint manufacturers has put the paper machinery manufacturers and their equipment to test by demanding the same characteristic or better grade of newspaper at a lower gsm and higher machine speed but at a lower furnish cost.

The quality of Newsprint has, over the years, undergone changes, more so with the increased use of high speed offset presses. To-day the basic requirement of a Newsprint running on a offset is higher pick resistance (less linting) than required earlier by letter press printing machines. this is because of the following three reasons:

a. Offset inks are tackier than letter press inks.
b. Thinner films of ink used produces a greater pull on the paper surface.
c. The resilient offset blanket conforms better than a metal form to the paper's surface. The sheet is in 100% contact with the rolls in the press nip and this intensifies the pull of the ink.

Today in U.S.A., printers using a high speed offset presses would demand a paper having the following specifications:

Basis weight (gsm)	49 ± 1%
Brightness (Tappi)	59 ± 1%
Opacity (%)	96–1.0
Saturation (%)	5 ± .5
Dominant Wave length	581 ± 1
Moisture	8.0 ± 0.5%
Smooth (Sheffliend)	110 ± 10
K & N Absorption.	
Density Top	55 ± 3
Penetration	30 ± 2.

In Addition the sheet should be lint free and non two-sided.

Lowering of the basis weight and more stringent specifications of Newsprint running at a much higher speed in the printing presses made the paper mills try out different combination of furnish. A lower basis weight of sheet reduced the strength properties of the paper in a linear proportion resulting in more running problem in the machine and reduced machine efficiency. To overcome this problem, a higher percentage of chemical furnish was used but this again increased the cost and produced a sheet which was less opaque. Fig. I gives an indication of the effect on sheet properties by varying the % of long fibre. Mills usually have their own furnish combination and there is nothing as a standard furnish in newspring production today.

In order to find what brought in the present day machines it is necessary to look at a typical machine of the early 60's.

The headboxes were air cushioned type with 3 or 5 rectifier rolls for pressure operation. The fourdrinier would be about 20 metres long from breast roll to couch and forming table would have a few grooved rolls immediately after the breast roll followed by table rolls and suction boxes for drainage. A dandy was a standard recommendation for getting a better formation.

The most popular press section was the Beloit "Twinver" press followed by a 3rd press. The first and second presses were suction presses and 3rd press may have been suction or solid since "Venta-Nip" was yet to be introduced.

The dryer section would have 50 drying cylinders and two sweat cylinders with a breaker stack at about 75% down the dryer section.

Twin calenders were supplied each with 4 or 6 rolls followed by the reel.

These type of machines were generally designed for 750 m/min with a normal operating speed of 600 m/min.

At this point it is interesting to analyse what the paper machinery manufacturers selling points were then.

The headbox was changed to a pressurised type headbox from a open type to get away with 3 metres of stock behind the slice lip for a speed of 300 m/min. The slice lip would be a vertical slice lip with micro adjustments at close pitches across the width for precise control of the basis weight profile.

The fourdrinier table was made longer to better handle the increased water load and the initial table rolls were replaced by grooved table rolls to reduce the stock jump retard the drainage of water at the initial stages.

A press with a suction pick up and two nips before a open draw would improve the press runnability at a higher speed. The press design would take care of the broke handling problem at higher speed by dumping the broke into the couch pit.

Instead of going for a large dryer section the total dryerrequirement was broken up into smaller groups to give better control over steam distribution and draw control for better runnability on the machine.

Breaker stack became a must for all Newsprint machines to improve upon sheet smoothness and caliper profile thus reducing the incidence or severity of barring at the calenders.

The single calender stack of 8 or 10 rolls was broken down and the recommendations were for two separate calenders each with 4 or 6 rolls. This gave 6 to 10 nips of relatively low intensity to improve smoothness without too much loss of bulk. In addition, the spilting of the dynamic mass reduces the calender barring problem.

In the middle 60's and thereafter when operating speeds began to creep upto 600 m/min and over, the above concept of machine failed and problems were faced in all areas of paper making, formation, basis weight profile and two sidedness.

The vacuum developed by a rotating table roll was the main dewatering force on a table roll fourdrinier and is proportional to the diameter and speed of rotation. With machine speeds increasing and with wider machines, table roll diameters also had to be increased. With the machine speed increasing and correspondingly the vacuum in the nip, rate of removal of fines from the web increased and in addition to this the release of this high vacuum increased the intensity of the stock jump. Another factor involved was the pressure peak at the incoming nip of the wire and the table roll which disturbed the forming mat both disturbing the formation and also increasing the rate of fines loss on the vacuum side of the table roll.

It was therefore a necessity to develop a more gentle and controlled means of dewatering and hydrofoil was the answer to these problems. The vacuum is greatly reduced but it acted on the paper web for a longer period of time. the drainage forces were gentle which improved the formation but the net volume of water removed was more or equal to that of a table roll depending on the length of the foil blade. Stock jump was also substantially reduced because the vacuum slowly died down. Another feature of the foil was the clean disposal of water removed from the web. Water was drawn to the underside of the wire by the vacuum zone and was removed by the sharp leading edge of the following foil blade. With a table roll, a proportion of the removed water would cling to the surface of the roll and be flung off by centrifulgal action to splash and rewet the underside of the wire. These flashes would disturb the formation of the paper web and wash out fines and filler from the wire side.

This development in the use of foils instead of table rolls allowed the paper machines to make a good paper upto 750 m/min but in late 60's and early 70's when manufacturers were looking for higher speed machines and printers started looking for papers with minimum two sidedness, the basic concept of a foundrinier machine, draining from one side, failed. The paper web had to be drained from both sides and this brought in the concept of twin wires.

Fourdrinier machines at higher speed allowed the stock to skate and floc resulting in poor formation and fibre distribution and drainage from one side only which led to two sideeness and that was not acceptable by the printers. Poor formation required more calendering to get smoothness resulting in lower sheet strength, poor opacity and show thru. Machine direction basis weight variation was also of greater amplitude due to amplification of pressure pulsations on the open wire. In addition to paper making problems, engineers were faced with designing a very long fourdri8nier which increased the building cost substantially.

To overcome the problems with Fourdrinier machine, Beloit Group came up with the "Bel-Baie" type of formers — Fib. 2. In this type of formers the headbox discharges vertically upwards into the wide nip formed between two wires. The wires then pass over a curved slotted shoe of relatively large radius that dictates the drainage pressure. the drainage pressure on a twin wire is equal to the wire tension divided by the radius of curvature. The slotted shoe design allows for two sided drainage. The curved shoe is followed by a low vacuum curved suction box of similar construction. Following this is the couch roll which is wrapped for a large part of its circumference. The couch is fitted with two separate vacuum compartment each designed to operate at a different vaccum. The roll is sufficiently large to replace the conventional flat box section of a standard fourdrinier. This design eliminates the drag and wire wear normally associated with a flat box section. The wire separates on the suction roll and the sheet is carried downwards to the conventional suction pick up arrangement.

This design of twin wire forming has crossed 1000 m/min machine speed and the advantages of this machine design can be listed as follows:

a. Sheet formation between twin wires minimise "two sidedness".
b. Controlled gradual drainage over a longer distance provides "Soft drainage" —Maximum fibre dispersion and sheet uniformity.
c. Low contact pressure of wires against ceramic elements result in minimum wear. Low horse power requirement.
d. Improved basis weight profile and optimum sheet surface characteristics.
e. No apparent limit to speed, highest machine productivity.
f. Excellent printing quality, exceptional press runnability, sheets compatible with newest printing techniques.
g. Proven low linting characteristic for offset printing.

However, upstream of the Fourdrinier is the headbox where the sheet formation is first made and determined. The first problems encountered by the builders was not a paper making but an engineering problem.

Proportional to the square of the machine speed the pressure inside the headbox increased although the absolute pressure is quite low. The inside area or volume is very large which results in large deflections and stresses. The large deflection of the slice body or apron made a difference in the slice opening at the centre and the edges which was sufficient to affect the basis weight profile and the basic sheet characteristic (Fig. 3). To overcome this problem the first approach was to increase the strength of the slice body by combining it with cross machine platform. The better solution was to split the slice body and the apron body into cross machine members and interpose air blocks between them. The air pressure was controlled as a function of the pressure inside the headbox to maintain zero deflection of the slice lip and apron.- (Fig. 4).

The size and cost of this complex headbox was no longer feasible for fast wide machines and further improvement in formation was not possible due to down steam wakes and turbulence set up by rectifier rolls.

In order to meet the growing need of the market, Beloit research department began to work on a better headbox in the 70's (Fig. 5). The Converflo headbox is a hydraulic headbox without any air cushion. The stock enters the rectangular taper header which is designed for 10% recirculation in order to balance the pressure across the width. The stock then flows through a bank of tapered tubes. The tube bank consists of multiple rows of tapered distribution tubes. The tapered tubes reduce the flow velocity at the tube exists allowing the jet to combine more readily in the stilling chamber. The stilling chamber provides space and time for the combination of jets to merge before entering the Converflo element.

The "Converflo" element consists of a drilled plate supporting a series of trailing vanes. Fibre dispersion is obtained by passing the stock through the multiple narrow channels ahead of the slice discharge. These narrow channels breakdown the flow and suppress large scale turbulence. An essential property of narrow channels is that they have a high open area at the discharge end thus avoiding disruptive wakes downstream of trailing vanes.

Quite apart from the improved formation, the construction is greatly simplified. There is a minimum of curved surfaces and the top and bottom of the headbox can be screwed together at close centres across the whole width of the machine thus eliminating the characteristic heavy wall construction of the previous design.

Even though the Converflo headbox came into existence to cater for Fourdrinier machine it has undergone a number of changes leading to the Concept III headbox. Converflo headbox has remained an ideal piece for injecting the stock into the nip formed between the two wires of the Bel-Baie formers. The "Converflo" headbox is solidly mounted between sill beams directing the jet upwards into the nips. these headboxes are provided with all the basic needs of the paper maker —a good cleaning arrangement of the headbox, facility to tilt the headbox thereby allowing to direct the jet on either of the two wires or at the nip, top lip movement in respect to the bottom and temperature compensating arrangement for top and bottom lip.

The fastest newsprint machines in the World had the Twinver press but there have been many improvements over the years. In the earlier design of these presses all the press nips were suction but subsequently with the coming of the Venta Nip concept, the 2nd and 3rd position where changed to Venta nip. Suction Wringer presses were also replaced with Venta-Nip presses. This change over not only reduced the power consumption required for vacuum generation but also gave a higher dryness figure out of the press leading to a safer running of the sheet in the machine. A dryness of 40/41% was expected out of this press after this change over with a loading of 110 kgs/cm at the last nip. Venta-Nip rolls also proved to be mechanically stiffer, could be more easily cambered and produce a more uniform moisture profile across the machine.

With the machine speed inceasing further and crossing the 600 m/min, Twinver press followed by the 3rd press failed to be answer and a new press design had to found out. Two nips before an open draw were not sufficient enough to make Beloit research team came up with the "Tri-Nip" press (Fig. 6) configuration in the year 1969 and even today is the best recommendation for Newsprint machines running up to 1000 m/min. Further higher machine speed than this calls for a 4th press after the Tri-Nip press.

In this "Tri-Nip" press configuration the paper web, after being picked up by the suction pick up, was subjected to double felted pressing at the 1st nip for both symmetrical water removal. The second nip was a suction nip followed by a Venta Nip in the third ni, position.

The main features of this "Tri-Nip" press design can be stated as follows:

1. Suction pick up.
2. Sheet supported between pick up and first press.
3. Three nips before an open draw.
4. First nip is double felted, double vented (Suction top, V.N. bottom) for.
   - A. Two-sided dewatering
   - B. Maximum water removal due to reduced flow path.
   - C. Uniform dewatering to maintain sheet quality and fines distribution.
5. Suction transfer to second nip keeps water away from sheet and felt for minimum reqetting.
6. Transferred plain center roll after second nip to third press (inverted Venta Nip.)
   - A. Minimum rewetting
   - B. No open draws, no blowing or wad damage.
   - C. Reduced centre roll picking (sheet is drier).
7. Broke disposal into separte press pit.
   - A. Down away from sheet run.
   - B. Threading to baby dryer with short draw possible.

In paralled with the machinery development, considerable progress had to be made by felt manufacturers to supply felts that could withstand the higher nip pressures and the wear problem because of the higher speeds of the machine. Higher synthetic content felts came into the market that took care of the wear and better wearing designs gave low resistance to transverse flow of water from the sheet. High synthetic felts however became very stiff and hevy, making felt changing a major problem. To take care of this, machinery manufacturers came up with the "Easy felt" changing frame design.

This frame design includes remover blocks located at strategic points in the press posts and beams to permit felting the inside equipment such as press rolls, felt rolls, saveall pans and shower pans without disturbing them. In the "Tri-Nip" press configuration for a felt change the overhead machine house crane is required for felting only the stretcher rolls of pick up felt and 3rd press felt. this also is not required for the more advanced design of the "Tri-Nip", the "Flip Top Tri-Nip". The longer life of these new felts together with "easy felt" frame designs have let to considerable reduction in diwntime, thus increasing running time and production efficiency.

With wider machines above 8.0 metres the problem arose of designing a suitable suction roll that could take care of the stresses in a "Tri-Nip" press and be suitable in size to be handled for maintenance purposes. The answer to this was the "Tri Vent" press design (Fig. 7) in which the suction roll was subjected to only one nip and the second and third nip was between the centre granite roll and two Venta Nip rolls. this press design required one more Ventex roll compared to a "Tri-Nip" press and therefore carries a higher price tag.

However, due to lower vacuum requirement in the "Tri-Vent" press configuration the operating cost would be less than a "Tri Nip" press configuration.

Increase of machine speed over the years has been steady progress being made in the improvement of conventional means of drying rather than in he development of radically new designs or principles. the objective of all these developments have been to support the sheet to the reel. High machine speeds caused severe sheet instability in the dryer section affecting the machine performance and the justification for going in for higher speeds.

The ideal path of sheet travel between top and bottom dryers is AB and CD (Fig. 8). However, during the early stages of drying when the sheet is relatively wet, the tendency of the sheet is to stick to the drying cylinder. Sheet separation from the cylinder does not take place until the point E. At the bottom cylinder, when the machine is operating at high speed, air is pumped into the wedge created by converging bottom felt and the sheet. This pumping action of the air into the wedge pushes the sheet further away from the approaching bottom cylinder. Here the sheet does not contact the bottom cylinder, until point F. The net effect is that of sheet bulging along with the curved path EF. The effect of sheet adhering to the separating felt instead of following the ideal path is shown in fig.

This longer than ideal sheet gives rise to a general slackness of the web which can then be disturbed by uncontrolled air turbulence.

Turbulence is generated by dryer fabrics, fabric seams, pocket ventilation equipment and rotating cylinder heads and felt rolls.

It has been observed that the problem of sheet futter and wrinkling is less when the sheet reaches 50% bone dry and there is no sheet dryness at which support can be removed without creating some amount of slackness and instability. Some where between 40-50% bone dry is where flutter and wrinkling appears to be the worst in conventional cylinder drying machines and this is where the focus of improvement has been.

The sheet has to be supported from the press to the dryer part and then within the dryer part.

Commonly the sheet support in the draw from the pres part to the dry part is by the use of a transfer box inside the dryer fabric (Fig. 9). This has proved successful and there are many machines operating in the 1000-1200 mpm range with this arrangement.

In case of press designs having a open top design, and needing a very wide dry end post, these transfer boxes cause operational and felting problem (Fig. 10). One method of overcoming this problem is to put the first dryer in between the press post but then this could pose a major maintenance problem if the dryer has to be removed for any purpose. Another method could be to use a very long boxes. Long boxes have difficulties in holding front and back edges. Use of Vacuum inducing coanda air jets at the front and back edges in addition to the conventional air jets at the trailing edges can overcome this problem. this design is successful and operating in a number of machines. (Fig. 11).

Another radical alternative to the above system of holding the web from the press to the dryer is by means of double felted transfer (Fig. 12). This arrangement has the advantage that the distance from the press to the dryer can be large with no operational problems. This system has been successful in both newsprint and heavier grades of paper.

The first attempt to support the sheet within the dryer part was by inserting paper rolls between the top and bottom dryer. This system proved to be a failure. Next came the "Squat" dryer section (Fig. 13) wherein the upper tier of dryers were lowered thuc reducing the unsupported sheet run and the degree of sheet instability. Dryer spacing is usually a compromise of several physical design requirements. The felt roll diameter is determined as a function of machine width, speed and felt tension. The dryer spacing is then determined as a function of maximum felt wrap of the dryers and minimum length of draw between dryers whilst maintaining adequare clearance between felt rolls and dryers. Stability of draw between dryers and adequate area of vapour removal are also important considertions in addition to accessibility at both front and rear sides for quick broke removal.

A number of machines are operating with this design but the disadvantage of this design is that the machine direction spacing must be increased with consequent increases in machine length.

The first radical alternative to the sheet handling problem was the development at Hylte Bruk, Sweden of the serpentine concept (Fig. 14). This immediately gave the opportunity to run newspring upto 1100 mpm. The advantages of this system are;

The **advantages** of this system are :

1. Sheet is supported by the common felt as it passes over both top and bottom dryers thus eliminating the free sheet run between dryers and associated sheet flutter.
2. Sheet flutter reduction has made it possible to run at higher speeds. An increase of 3-5% is not unusual for newsprint machines.
3. It has often been possible to reduce the draw between the last press and dryer section. this lower tension has a favourable influence on total shrinkage and sheet width on the reel.
4. The reduced draw results in less sheet breaks and improved machine efficiency.
5. 5.The felt will wrap the top dryers more which will increase the sheet contact time. It is reasonable to assume that this contributes to improved heat transfer from the top dryers.
6. Less dryer clothing, fewer felt rolls, easier broke removal due to no bottom felt.

The **disadvantages** of this sysem are:

1. Sheet does not contact the bottom dryers. Thus a reduction in drying capacity is possible if the machine is already dryer limited and lost capacity cannot be compensated for elsewhere on the machine.
2. The possibility that the top dryers became wrapped with paper during a sheet break is real and has actually caused the bottom dryers on one machine to be lifted off the base plates.
3. 3. Temperature differences between top and bottom dryers caused by the difference in condensing load can have the effect of bottom dryers running hotter and having a larger diameter unless operated at a lower steam pressures. The bottom dryers will then pull the felt and the resulting load on the pinions have caused gear teeth and journal failures on some machines.
4. Speed limit ocurs when the sheet leaves the felt going round the bottom dryers.

Initial efforts to eliminate the problem of speed limit included the use of blow boxes to induce a vacuum at the ingoing nip of dryers and felt (Fig. 15). Grooves were also put in the bottom dryer to try and maintain a vacuum inside the felt, right round the wrapped zone. Some improvement have been effective in increasing speeds upto 1200 mpm. The problem of this system was the difficulty in maintaining vacuum around the bottom cylinder.

Beloit came up with the "Bel Run" concept as a complete solution to this problem. The bottom cylinders were eliminated and the sheet and felt were turned around vacuum turning rolls (Fig. 16).

This design also eliminates the threading difficulties often experienced with conventional serpentine section where the tail is often not tight against the bottom dryer and in this unstable state will wander and break. Vacuum turning rolls will hold the tail tightly.

Speed limits for this type of felt run has not yet been reached and now is the standard recommendation by Beloit for their newspring machines.

In the calender area there have been some interesting and important developments to assist the paper maker to produce a newspring that is acceptable to the printers.

With the increase of machine speed and width, the size and corresponding weight of the rolls increased. In case of conventional calender, where the dead weight of the rolls applied the nip pressure at the bottom roll, for wide and fast machines, it was found to be far in excess of what was required for paper making purposes. In addition to this, bar marking in the paper become a major problem in case of calenders for wide machines having more than six rolls. This is due to oscillation that develops in the stack of rolls. The vibration is essentially that of a series of masses (the rolls) which are spring connected (the nips) that can oscillate vertically in a vibratory system. The number of frequencies at which such a system can vibrate is the number of masses minus one. For instance, a two roll calender would have only a single vibrating frequency and three roll stack would have two frequencies and a six roll stack fine.

The net result of these high stacks at high speed is a barring or line impression across the machine in the sheet which is an indication of uneven calendering pressure caused by the vertical bouncing of rolls with resultant variation in caliper and smoothness.

To overcome the problem of more than required nip pressure at the bottom roll because of the dead weight of the rolls, method of relieving the nip pressure was developed. This system had the advantage, in addition, to relieving part of the body wight also relieved the over hanging weights of the roll ends, bearing and equipment such as doctors which are mounted on the bearings, thereby overcoming the common problem of reduced caliper on the sheet edges. However, this machinism of nip relieving is limited for conventional intermediate calender rolls because of the inability to hold an even nip across the machine. Bending of the intermediate rolls occur when lifting forces exceed the weight of bearings and housings and end weights of the rolls.

The development of the control crown roll made it possible to change the nip pressure without the need to change the crown of the bottom roll. the combination of the two principles of nip relief and control crown bottom rolls produced the flexibility required for paper making purposes and overcome many of the main problems associated with the weight of large high speed stacks.

At this junction it would be of interest to look at the effect on caliper and smoothness after calendering as a function of the nip pressure applied, the number of nips the sheet passes through and the moisture in the sheet (Fig. 17, 18, 19).

The relationship of nip pressure — caliper in Newspring unlike kraft or fine paper grade is very nearly a straight line. Comparing one nip with three nips at 600 pli and 140°F it is seen that three nips reduced caliper by 0.64 mil. Likewise smoothness improves by 72 points at three nips. When temperature is increased to 200°F, single nip caliper drops by 0.3 mil and three nip caliper drops by 0.2 mil. Also Sheffield smoothness numbers are reduced by 20 points. Increasing the moisture content of the sheet within limits has the effect of reducing caliper and improving smoothness for a given nip pressure.

To solve the problem of conventional calender stack and to have an effective tool in the hands of the paper makers for varying the caliper-finish combination in the early 70's and still is very much in use. In a Versa-Nip calender along with the King roll depending on the requirement, 1,2 or even 4 rolls in a six roll calender could be controlled crown rolls. The difference in capabilities between the versa nip calender and a conventional calender is given in Fig. 20, 21, 22). With a Versa-Nip calender it is possible to operate over a range of nip pressure at each number of nips by applying relieving pressure to the ends of the intermediate controlled crown calender rolls and also adjusting the bending of the King roll to the proper value. Thus for instance it would be possible to run with five nips over a range of pressures from 100 to 600 pli. The controlled crown intermediate rolls are fitted with double shoes. The top shoe is used for nip relieving and the bottom shoe for loading. However, by applying differential pressure to both shoes it is possible to achieve vibration damping during both load or relieve conditions.

With the development of these sophisticated calender stacks Breaker stacks have been dispensed with since surface finish can be controlled and barring eliminated by proper setting of the number and intensity of nips on the calender. 1 to 1½% efficiency have been achieved since break losses during threading and break frequency have reduced.

The improvements discussed are the results of applying engineering technology to the problems of paper making process. In all cases the improved design has been evolved to overcome specific faults or shortcoming in the existing designs when these designs have reached the limit of their capability to perform their functions satisfactorily.

In conjunction with improvements discussed, there has been substantial improvement in other related area like, reel, drive, steam and condensate system but the same could not be accommodated in this paper.

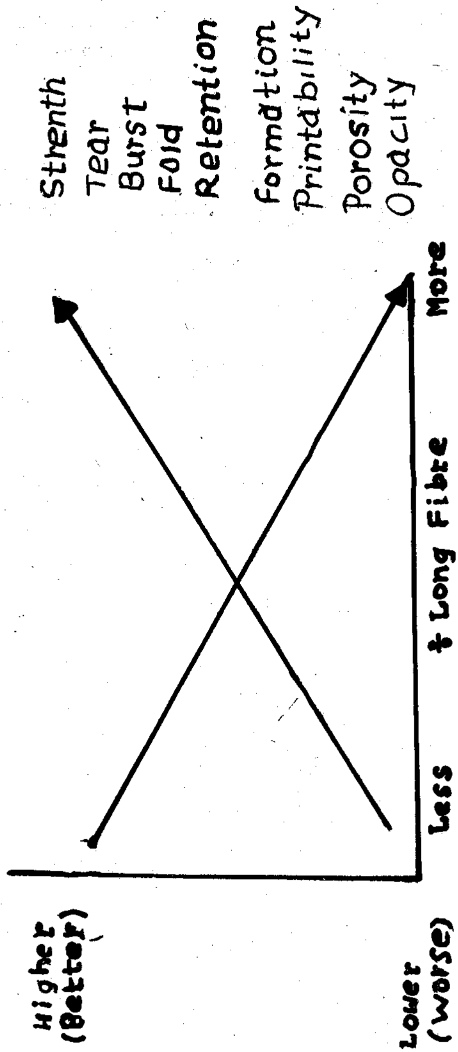


Fig. 1 - Effect of Long Fibre on sheet properties

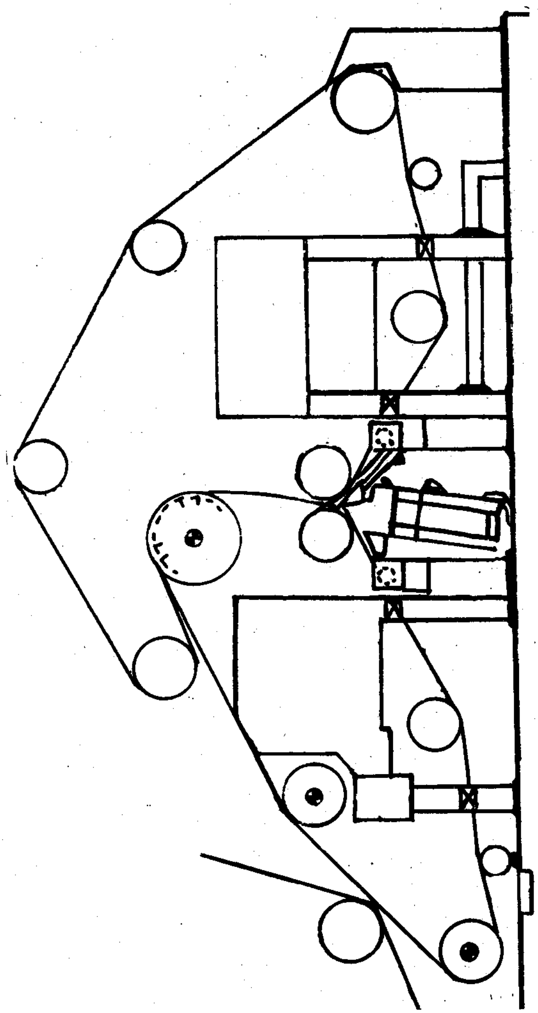


Fig.- 2. Bel-Baie II Former

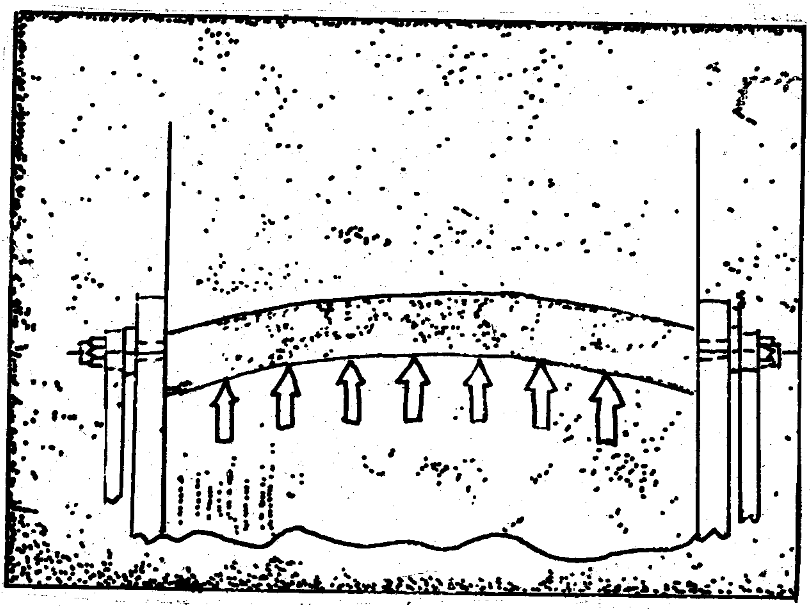


Fig. 3. - Deflection of Slice Lip.

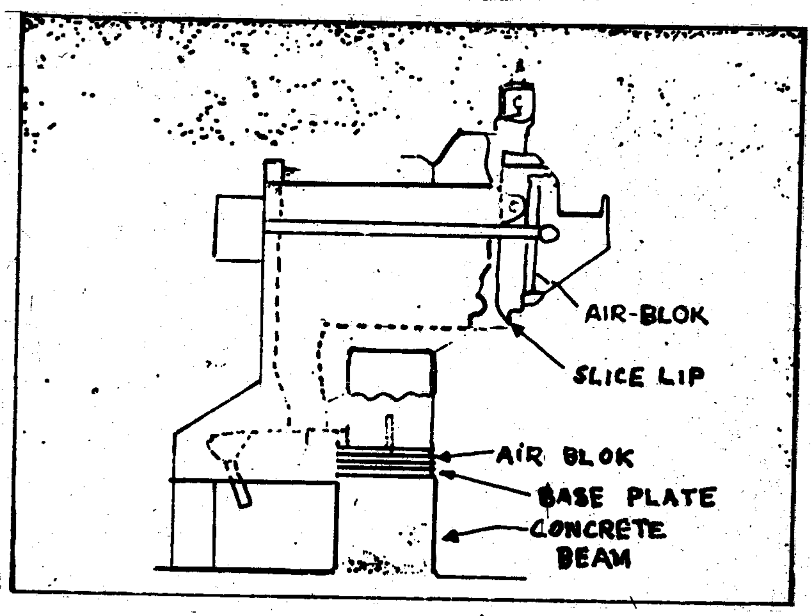


Fig. 4.- Air Blok to control slice lip Deflection

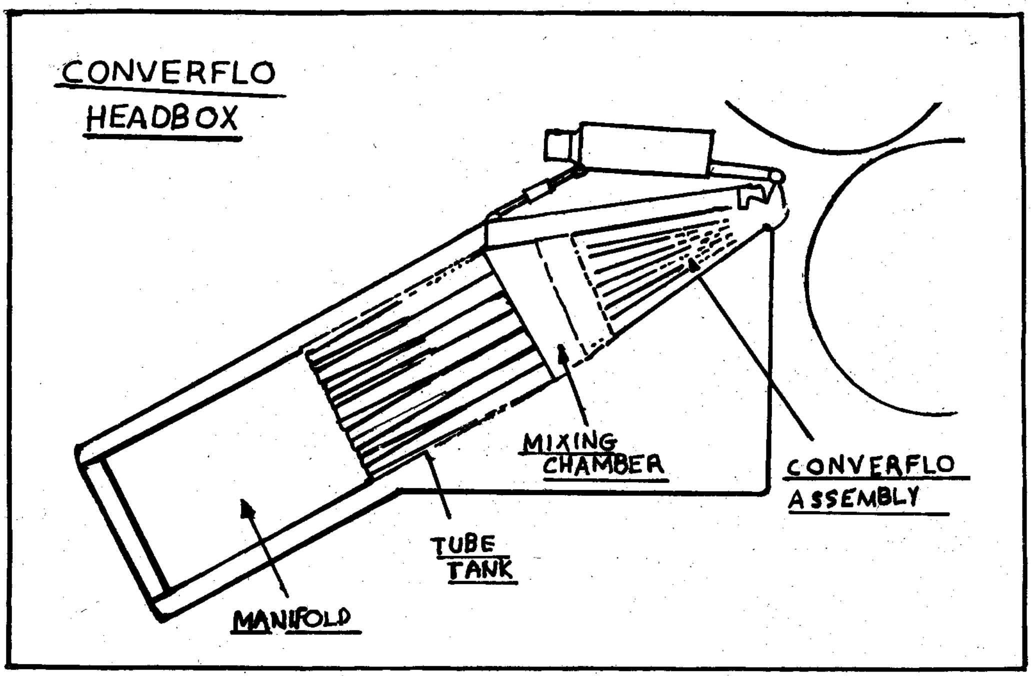


Fig. 5 - Converflo Headbox

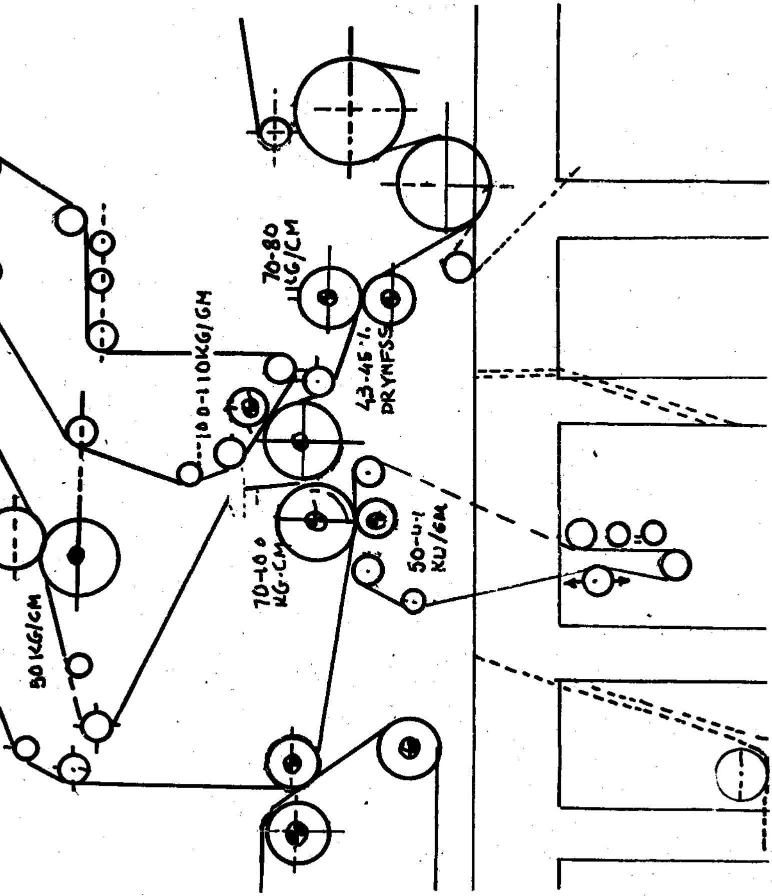
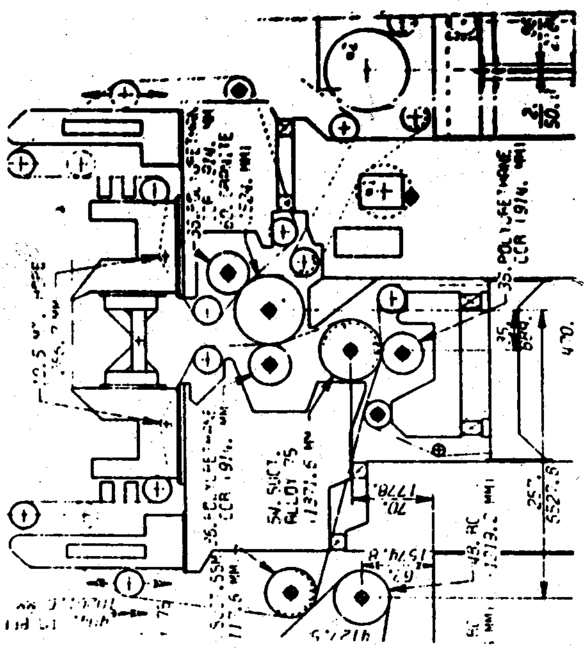


Fig.- 6 - Tri Nip Press



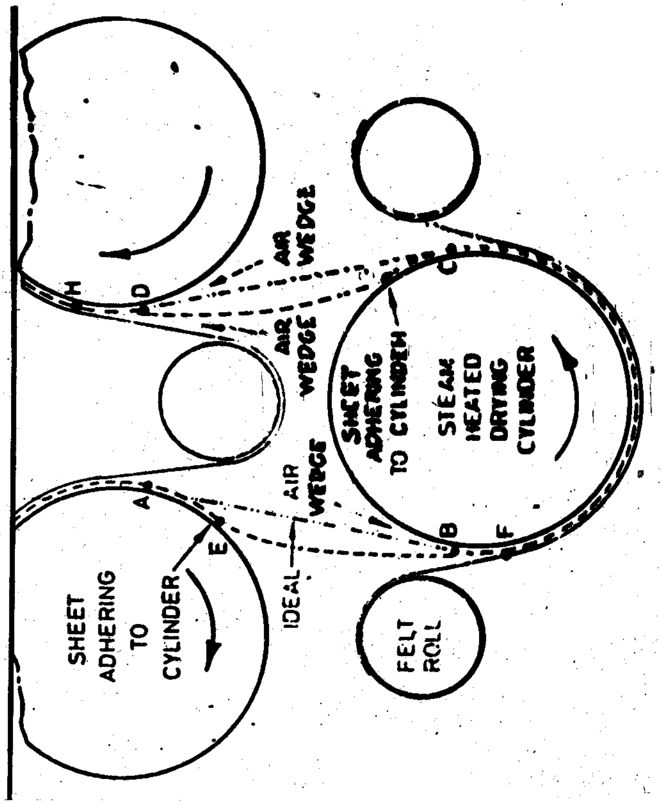


Fig.- 8 - Sheet Release - Off Cylinder

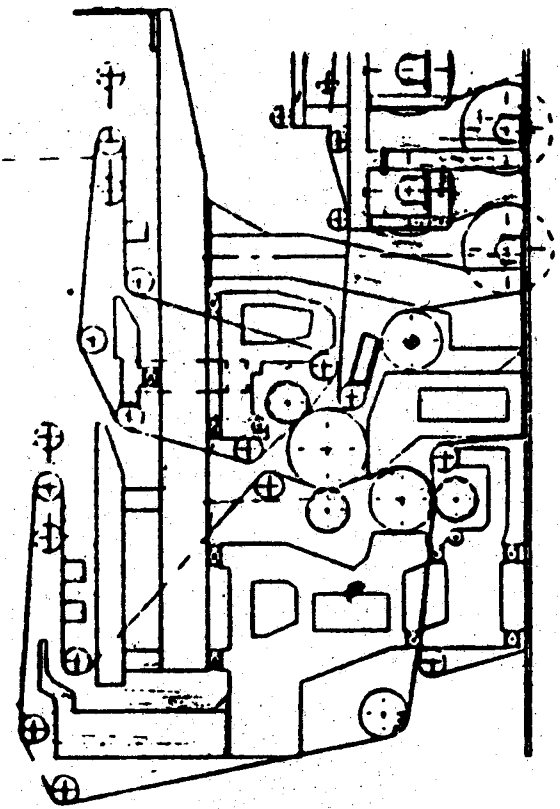


Fig.- 9 - Conventional Transfer Box

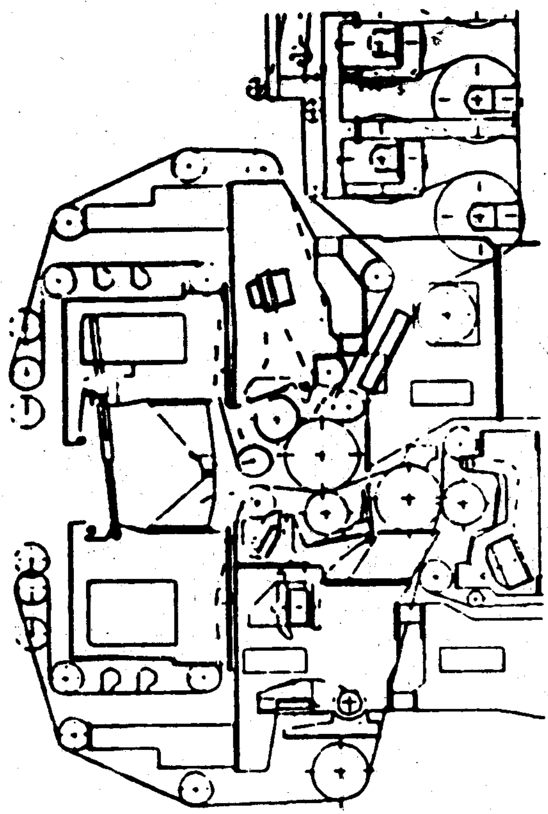


Fig.- 10 - Long Transfer Box on open Top Press

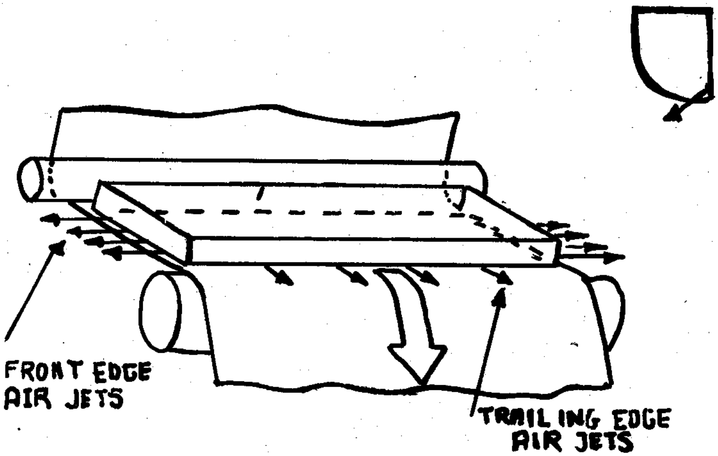


Fig.- 11 - ADDITIONAL AIR JETS FOR LONG TRANSFER BOX

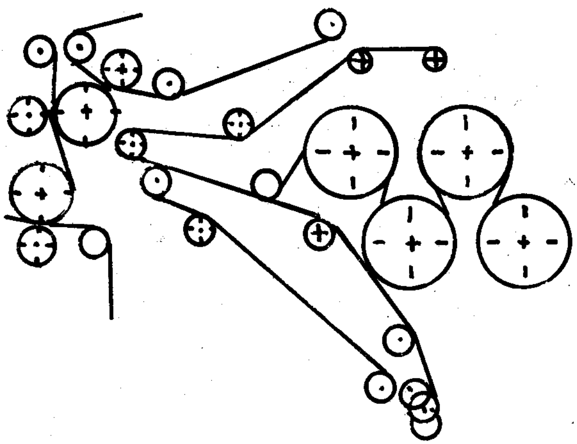


Fig.- 12 - Double Felted Transfer

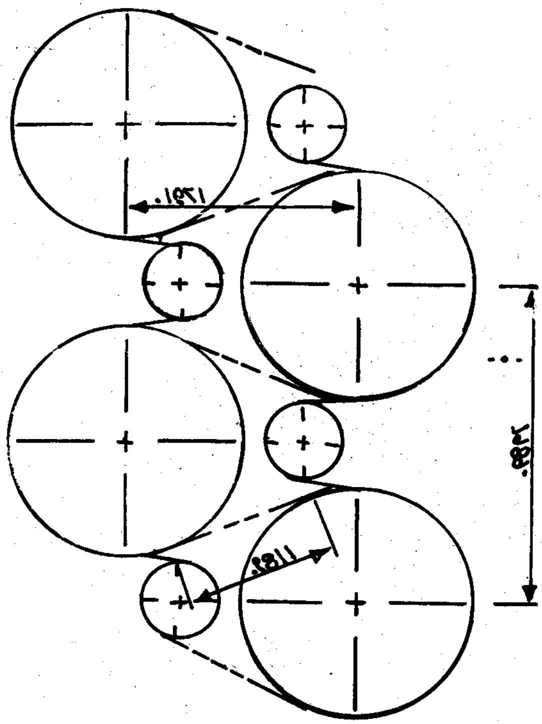


Fig.- 13 - Squat Dryers

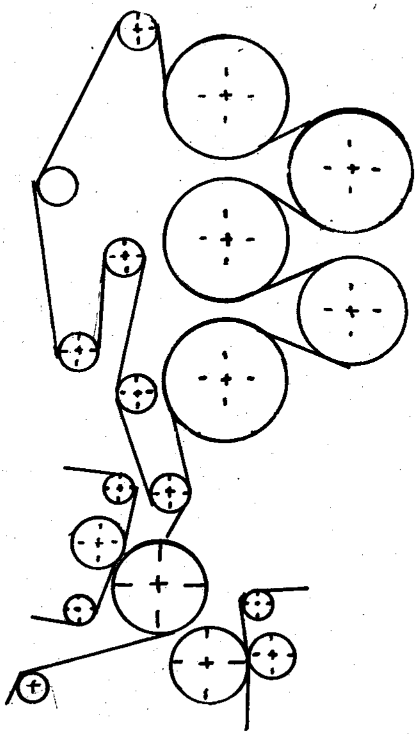


Fig.- 14 - Serpentine Dryers

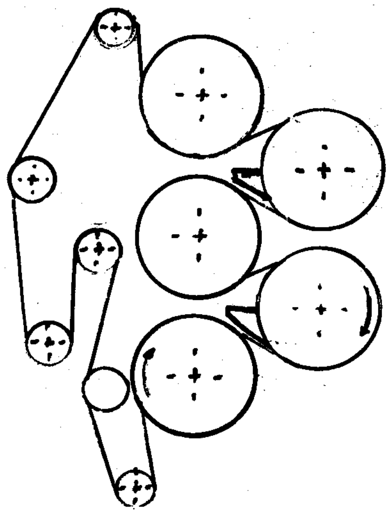


Fig.- 15 - Blow Boxes in Serpentine Dryers

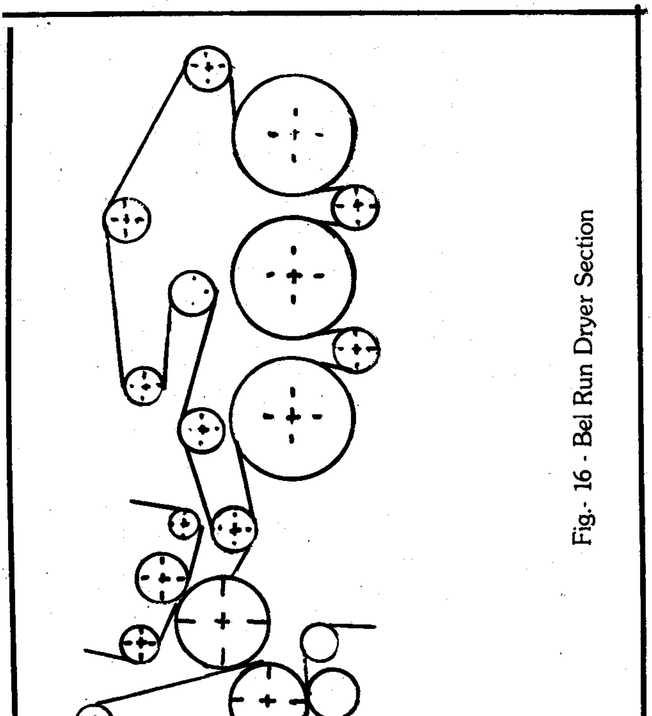
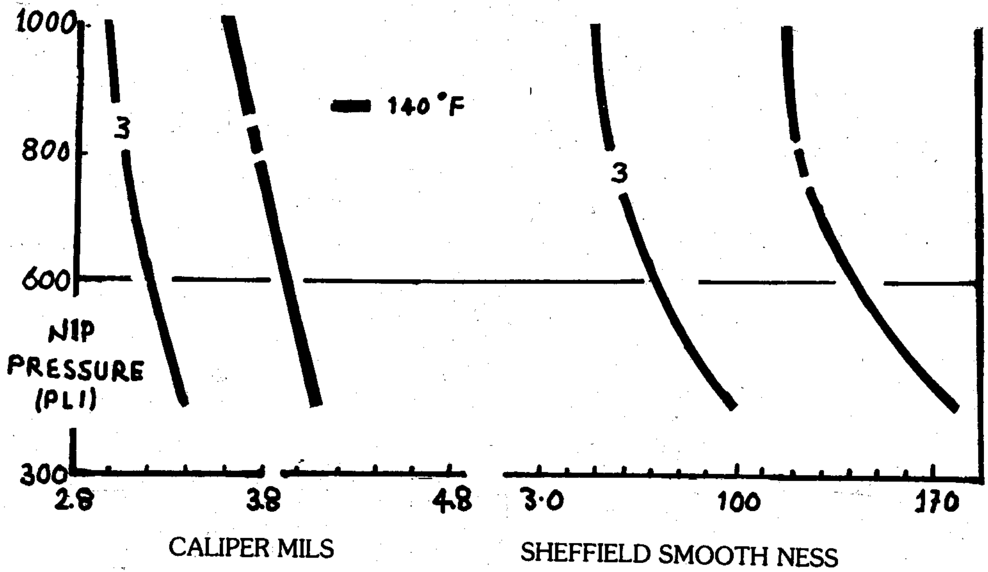
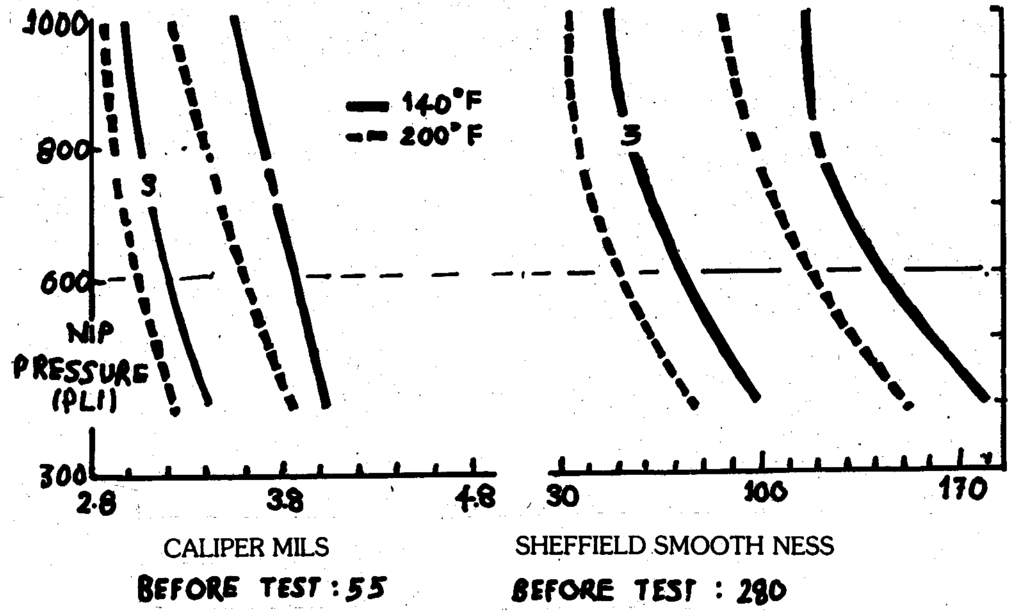


Fig.- 16 - Bel Run Dryer Section



Basis Weight : 32 Lbs. per 3000 Sq. Ft. at 78% Moisture

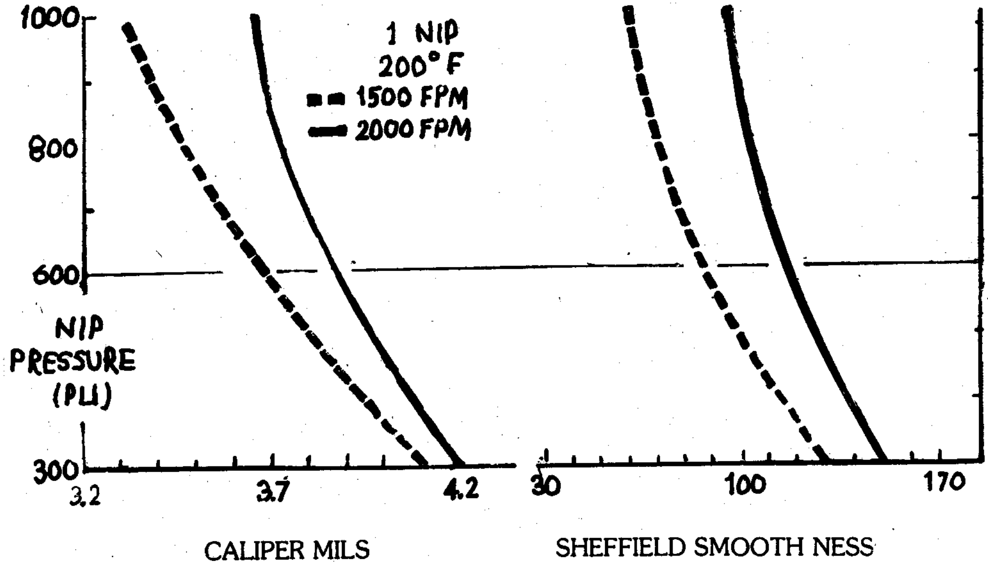
Fig.- 17
Newsprint— Nip Pressure Vs. Caliper and Smoothness
(Numbers on curves are number of Nips)



Basis Weight : 32 Lbs. per 3000 Sq. Ft. at 8% Moisture

Fig.- 18

Newsprint— Nip Pressure Vs. Caliper and smoothness
(Numbers on curves are number of nips)



Basis Weight : 32 Lbs. per 3000 Sq. Ft. at 78% Moisture

Fig.- 19 Newsprint— Nip Pressure Vs. Caliper and smoothness

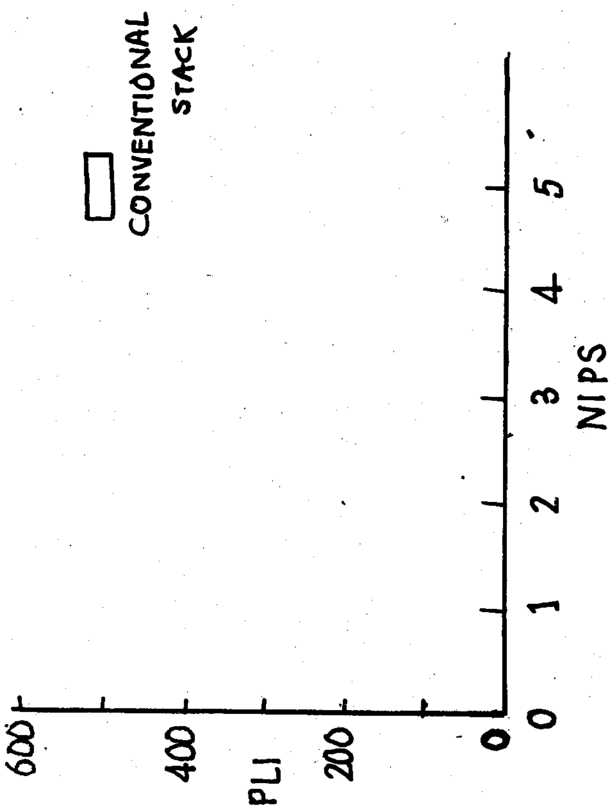


Fig. 20 - Nip Pressures of Calender Stack with Plain King Roll.

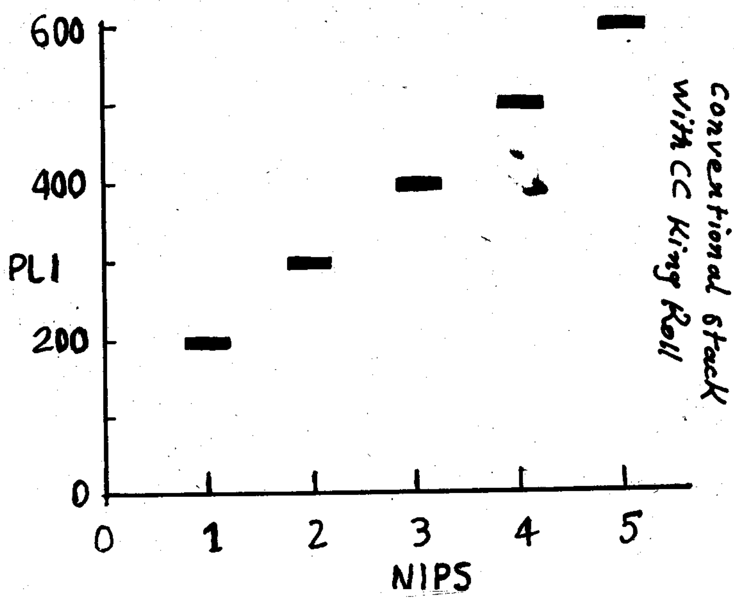


Fig. 21 - Nip Pressures of Calender Stack with controlled Crown King Roll.

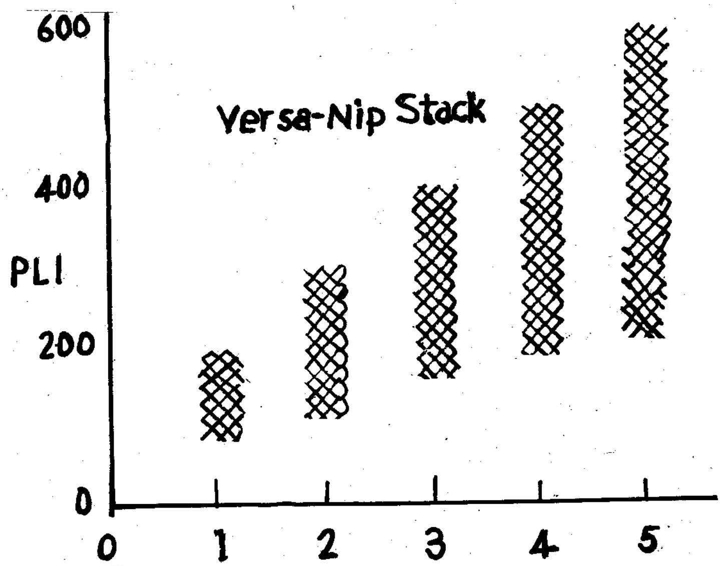


Fig. 22 - Nip Pressure of Versa-Nip Calender Stack.