Application of Recent Innovations for Modernisation of Existing Paper Machines

R. P. Bhargava*
M. B. Kapoor**

The developments in the paper machine designs have been quite remarkable in the last decade. Attempts to make more paper from a given width of the paper machine have resulted in development of equipment and methods by which a very substantial increase has been obtained in production per unit width of the paper machine. This has been achieved by increasing the speed of the machine which has necessitated incorporation of improved equipment in the wet end, dryer and constant parts of the paper machines. Modern paper machine making ordinary grades of writing and printing paper can run upto a speed of 1500/2000 ft. per minute against an average speed of about 400 ft. per minute about 25 years back.

The first fourdrinier paper machine in India was put in the year 1875 and till 1936 the development was slow and production in the country till then was well below 30,000 tonnes per annum. It was during the period 1936 to 1939 that the paper industry in India took a stride and considerable development took place during these years. During the war period there was hardly any improvement in the productive capacity. There was again a very rapid increase in production in the post war period and during the various Five Year Plans the paper industrv grew considerably and now the installed capacity is about 6,000,000 tonnes per annum.

Most of the paper machines installed during the period 1875 to 1935 are still working with the exception of a few machines which have been discarded by some of the mills. Paper Machines installed during the years 1936 to 1952 are all working till this day. The older machines and even machines installed just before war for obvious reason could not have the benefit of the modern techniques. Their speed was limited to about 400/500 ft. per minute. The machines installed after the year 1952 have incorporated some of the modern techniques but it cannot be said that they have all the modern equipment which have been developed till this date.

The older machines installed in India afford a very fruitful field for improvement and for increase in the speeds to achieve more production. It may be pointed out here that immediately after war re-building of the old machines was attempted with great success in most of the paper making countries in Europe. The advantages of re-building of the old machines are obvious. The capital investment per tonne of inceased production is very much lower than the installation of the completely new machine. In most cases the old machines afforded the scope of installation of modern equipment and improved techniques to increase production to as much as 100%.

Attempt has been made in this paper to point out certain aspects of re-building of existing machines to get the benefit of increased exchange expenditure. The rebuilding of the paper machine in India is a very fruitful field of investment and wherever it has been attempted, it has given considerable benefit to the mill concerned.

The rebuilding of a particular paper machine requires a very close knowledge of working condition, type of equipment available, market conditions, etc. No preconceived plan or ideas can be applied to any particular plant. However it can be said that generally the press part modifications gives the best returns on investment and the drier part modifications the minimum return. The constant part modifications follow the requirements of paper machine modification on wire, press and drier parts. It is true that it is possible to calculate with reasonable accuracy the capacities of various parts of the paper machine and the rebuilding deisgned for various points based on such calculations and experience gained by the operators and manufacturers of paper machine manufacture. However, experience has shown that it is a good plan to rebuild a paper machine in stages, progressively removing the bottlenecks at various points as they present themselves, until the desired results are obtained.

The first step in rebuilding an old machine is the determination of the product to be manufactured, the range of substance desired

* General Manager, Star Paper Mills Ltd.
** Paper Maker —do—

and any special qualities to be made. Having determined the above characteristics the important parts of the paper machine can be broadly fixed, and the maximum production which can be achieved, determined. Depending on the maximum production which can be achieved and the product any quality desired, various parts of the machine have to be determined and designed. At this stage, however, the economy of rebuilding has to be carefully studied as the modification to be carried out and the results likely to be attained by various modifications have to be balanced against results obtained. It may be found that modification of wire part while allowing higher speeds may not result in increased production unless press and or drier part is modified. The capital investment of modifications of press part may attain increased production to a considerable extent, and drier part will most certainly improve it. The various advantages achieved have to be balanced against capital required. The modification of wire part, on the other hand, is governed by the increased speed possible, depending on the capacity of the press and drying section. An attempt has been made to discuss some items involved in rebuilding of the old machines to achieve better results and increased production at economic costs.

Fan Pump

When speeding up the machine or even when contemplating improvement information of the sheet at the current or higher speed it may be found necessary to instal a higher capacity fan pump to obtain lower flow box consistency which in turn may necessitate installation of larger number of centrifugal cleaners, change in pipe line diameter and lay out etc. If the space for a second fan pump is available, the lay out can conveniently be modified with excellent resultes as suggested in figure 1, which is incidentally the prevalent practice in most of the Swedish Mills today. The change will enable retention of the existing equipment and minimum of change in the lay out for the improved results sought. It is assumed that the machine being considered for renovation has already been equiped with the centrifugal cleaners for its present production and speed.

Figure 1

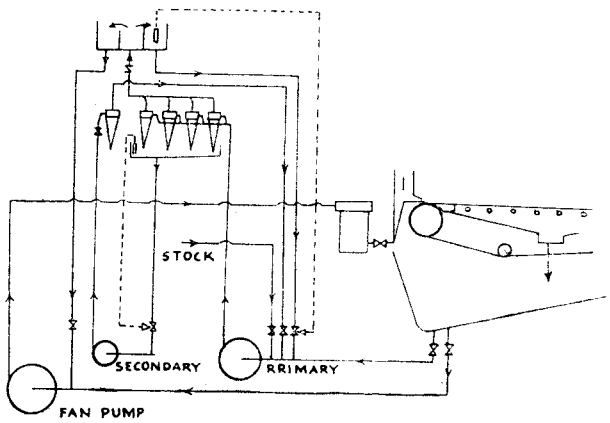


FIGURE 1

Improvement in the quality of the product can be further brought about by equipping the centrifugal cleaners with eductors or vacuum evacuation system for evacuation air from the process which is claimed to minimise air bells and clots from the sheet with resultant improvement in sheet formation.

Screens

Screening capacity is generally considered to be limiting factors on most of the old machines and even on comparatively newer installations where inward or outward flow horizental, vibrating screens have been installed. Some improvements on existing screens can usually be obtained by increasing the shower pressure or by widening the screen plate slot if danger from enhanced dirt is not feared. By bleeding and recirculation of the incoming stock to a secondary flat screen, definite improvement can be expected. However, most of the old machines are cramped for space and if lengthening of the existing wire part is considered essential for higher speeds then the only way out is generaly to extend the wire towards the breast end, which entails, mill short of space can take advantage of pressure screens under the circumstances as these screens virtually require very little space and can even safely be installed off the centre of the machine if required. Of course, for the satisfactory working of these screens also, it is necessary to bleed off the tailings to a secondary screen. However, in case of Kraft and certain other qualities where the cleanliness of

the sheet is rather secondary in nature, the tailings can safely be taken to the machine hogpit provided the broke thickner is of ample size to take care of the extra volume. Cost of installation and operation of a Secondary screen can be avoided in this manner. It will not be out of place to mention that the pressure screen has superceded the conventional screens now and most of the new mahine installation have these units installled ahead of the fourdrinier.

Flow Boxes

With the trend for higher speeds and demand for more uniform sheet profile, caliper etc. search for newer designs continue as in spite of all the efforts, perfect box has yet to be produced. However, lately much attention has been paid to the multitube entry flow box which seems to be giving fairly satisfactory results on the open as well as the closed air cushioned flow boxes. On slow speed the conventional diverging 'V' type design gave reasonably satisfactory results but as the speeds increased, various ideas and designs were tried with certain degree of success till the attention was finally focussed round the multitube entry flow boxes. The reason for the general acceptance appears to be the self cleaning action in the small diameter pipes due to very high velocity and the convenience of obtaining uniform fiber dispersion acros the machine without resorting to diverging flow passages. Though, it is still customary to instal the open box on the slow and medium speed machines where stock velocity is obtained by the static head within the box itself, but preference is now-a-days being given to close air cushioned boxes even on slow speed machines on account of simplicity of design, ease of cleaning and greater possibility of attaining uniform fiber dispersion and sheet profile. Whatever may be the choice for any particular need emphasis should be on accessibility for cleaning, simplicity of design, freedom of dead areas, convenience of attaining uniform fiber dispersion and uniform profile of sheet.

Wire Part

In a number of cases where the increase in speed contemplated is rather moderate, much can be done to retain the existing wire part by incorporating recent innovations such as drainage foils, wet boxes or even adding extra flat vacuum boxes for increased drainage at higher speed. However, if it may become absolutely necessary to replace the fourdrinier part completely either due to a big jump in speed desired or due to critical limits of table and other wire carrying rolls already attaining, than the run out or the cantilever type wire part may be considered for installation. Mainly, the reasons for prefering a cantiliver or the run out type wire part is in the desire to avoid disturbing alignment and the balance of the various heavy rolls and the ease and saving in wire changing time etc. However, besides, machanical limitations the critarian for roughly establishing whether the existing wire length would suffice at the higher speeds is to check the stock consistency at the current speed at various points on the fourdrinier and use discretion for consistencies expected at higher speeds desired. Generally, if the consistency at present speeds and grades at the end of the making table is 2 to 3%; after the boxes 10 to 12% and sheet leaving the couch 18 to 20%, incorporating some of the recent renovations as mentioned above may be found satisfactory to enable the machine to be speeded up by 25 to 40% of its current speed.

DRAINAGE FOILS & WET BOXES

Drainage Foils—Drainage foils have been developed to promote drainage on the fourdrinier and 3 to 4 foil elements may occupy the space of one table roll whereas each of these elements has the drainage capacity nearly equivalent to a table roll but with lower suction intensity. 4 to 8 of these foils may be installed in a drainage unit followed by a deflector. Further development with regards to the foil is the adjustable angle type foil which enable some control on the amount of drainage on the wire. The angle is rather critical and is adjustable between 2 to 5° the greater the angle, the higher the drainage.

Wet boxes—Wet boxes are more or less indentical to the foil units excepting that suction is induced by a fan or drop legs, whichever may be convenient. As the name implies these boxes are applied to the wire part at the point where fibres are still in a mobile

state. Where a fan is used to induce the suction, the drainage and consequently the formation of the sheet is delicately controlled. A combination of the drainage foil and wet boxes will usually enable the Paper Maker to obtain better sheet formation and higher production by running his machine at some what lower head box consistency yet at higher speed. Introduction of several stationary objects in the wire part does promote frictional wear on the wire but the problem is not considered to be serious in view of some of the excellent tops with low co-efficient of friction available to us such as 'Teflon', 'Robalit', 'Micarta' etc.

sive. On the run out or the cantilever type of fourdrinier there is no difficulty in installing the drainage accessories as the problem of man handling and consequently the disturbance in adjustment and alignment, which can be critical, does not arise. However, on the conventional non-renovable type of fourdrinier where all the inside rolls and boxes have to be removed and replaced at the time of wire change, fessibility of installing the equipment is questionable.

Vacuum Boxes : An increase in number of vacuum boxes is usually required with the increased machine speed. On existing machines

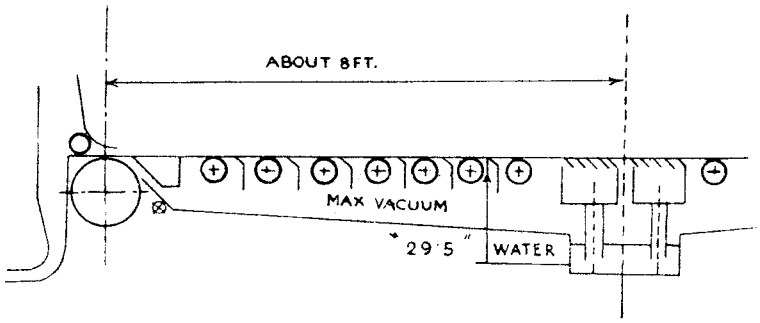


FIGURE - 2

Apart from the increased drainage characteristics of drainage foils and wet boxes further claims such as (a) less two sideness (b) higher retention of filler (c) freedom from pin holes (d) better sheet formation etc. are made for these accessories. In the first instance, the claims may appear to be somewhat superfluous but when considering the gentle action of the foils in comparison to the table rolls, the soundness of the concept is quite comprehen-

it is usually possible to provide for one or two extra boxes by raising the suction couch to the flat box level and transferring the wire guide to the third return roll position. Same result can be obtained by providing an extension piece to the existing flat box frame and cutting off a portion of table rail but in view of very reliable pneumatic and hydraulic wire guide available, extension of vacuum box zone towards the breast and is hardly justifiable.

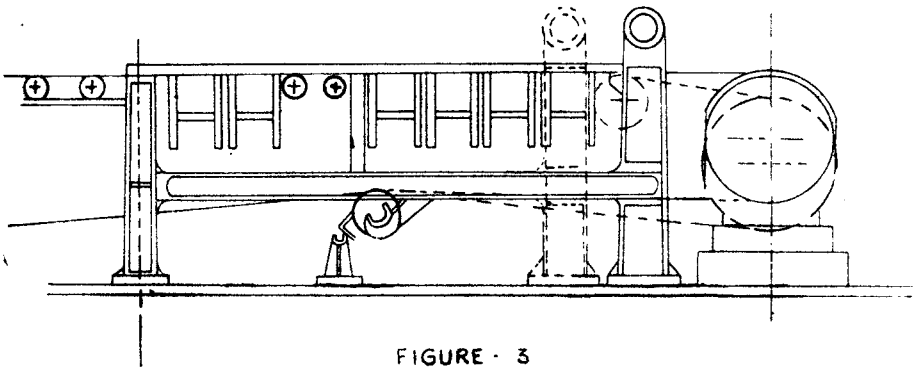


FIGURE - 3

In order to minimise power load and wire wear, consistent efforts have been made over the years to find a suitable "TOP" material which has a low co-efficient of frication, smooth surface uneffected by grit, white water and chemical additives. The most common "TOP" in use is wax impregnated end on grain maple, but several plastic and rubber tops are also available. The latest in the field appears to be K. T. SILICON CARBIDE but is rather expensive though is reported to be giving excellent results on high speed newsprint machines.

There have been several successful attempts to do away with stationary vacuum boxes by replacing with rotary units like Rotabelts and Rovac. A recent attempt by a French Machinery manufacturer has resulted in a design with three rotating rolls with side seals. The equipment has been reported to be giving satisfactory results on slow-speed narrow machines. However, preference is still given to the conventional stationary vacuum boxes unless a particular machine is plagued with some serious abrasion problem not overcome by switching over to some suitable box "TOP" available.

Suction couch and Baggallay box

There are some old machines still running without suction couch, but it is now invariably the practice on newer installations to provide this equipment. However, for increased speeds and where suction couch is in existence it is generally found satisfactory to increase the vacuum pump capacity either by speeding up the pump if possible or replacing it with a bigger pump unit rather than modifying the couch itself. The air displacement capacity of the vacuum can safely be increased by installing a second pump parallel to the existing one and connecting both pumps to a common suction header. The machinery suppliers' recommendations are generally acceptable in this respect.

To consolidate and deliver the sheet from the couch to the first press at some what lower moisture content, it is customary now to instal a large diameter lump-breaker roll on the couch. Old machines in particular can get the benefit of this roll and minimise press breaks on speeding up. Self Skinner Roll composition has greatly reduced the hazard of operating a lump breaker roll as the picking trouble experienced on conventional roll covers with subsequent damage to wires is the thing of the past now. The density of the rubber cover is still a controversial point but it is not advisable to use too soft a cover as it sits into the couch holes damaging the wire. With the Top roll on the couch, the sheet is claimed to leave couch approximately 1% dryer to the press.

On the older machines where the couch press is still in use Baggallay Box can be used with advantage to replace the troublesome jacket. The efficiency of the box is claimed to be practically equal to the comparatively expensive suction couch which is the standard equipment on all modern machines now.

The Baggallay Box in construction, is a two compartment unit with the compartment nearest the breast having a suction zone and made wider to facilitate water removal by vacuum at 15″-20″ Hg from the wet web. The compartment following is narrower and is provided with air supply at 30 p. s. i. for blowing the sheet. The suck and blow box is provided with a low co-efficient of friction "TOP" and does not seriously affect wirelife. When installing on old fourdrinier utilising the existing bottom couch it is normally found necessary to rubber cover the drive roll to prevent slippage of the wire.

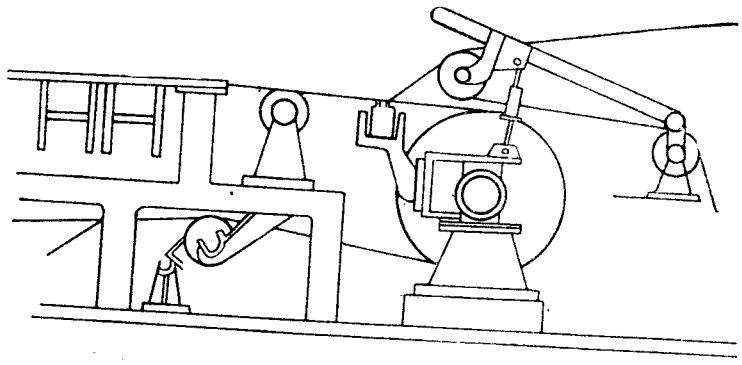


FIGURE-4

The advantages claimed for the Baggallay Box are (a) Low initial investment (b) Automatic sheet transfer to press (c) elimination of couch marks and (d) no trouble with blocked performations.

For conventional machines running around 400 f. p. m. and manufacturing paper from 40 GSM upward it appears to be an ideal substitute for the comparatively expensive suction couch.

Press Part

While considering the renovation of the existing machines it is extremely important that money be spent in equipment which requires minimum of initial expenditure and recurring cost but with maximum yield both in terms of profit as well as the quality of the product. Press part of a paper machine is generally considered to be the ideal filed where extremely fruitful results can be obtained if the spehere is throughly explored and advantage taken of the recent innovations for improvements.

The standard practice on most of the medium and medium fast machines till recently was to provide a first straight through suction press, a second straight through plain or suction press and a third reversing plain press. The arrangement was generally considered to be satisfactory for most of the machines till it was realised that each additional percent of water removed at the presses would result in about 4 percent reduction of water to be evaporated by the driers. A very vivid picture of the economy expected can be visualised by comparing operating efficiency of a 100 inches trim. Fourdrinier with sheet at different solid contents leaving the presses and manufacturing M. F. papers at the rate of one ton per hour with a constant evapration rate of 1.8 lbs/sq. ft/hour at the dryers.

Table 1

Sheet Drynes after presses	Water to be evaporated lb/lb. paper	Hourly evaporation of water	Dryer Surface area required	Number of 5' Dia. cylinders required	Steam required per pound of paper	Steam required per ton of paper	Steam required in tonnes per day for a production of 24 tons paper
32%	2.0	4480	2489 sq. ft.	19	2.6	5824 lbs.	62.4
38%	1.5	3360	1867 sq. ft.	14.3	1.95	4368 lbs.	46.8

It will be clear from the table that a saving of 15.6 tons of steam or roughly Rs. 175/- (Rs. one hundred seventy five) per day can be effected on the machine as discussed above by simply improving the dryness figure of the sheet leaving the press part from 32 percent to 38 percent solids. The investment for improving the press part would be in the region of about Rs. 3.5 lakhs. Conversely an increase in production of 6.5 tons/day can be expected from the dryer part with almost the same steam consumption. However, to obtain the same increase in production without improving the press part would entail an initial investment of approximately Rs. 6/- lakhs with extensive extension to the dryer part and recurring running cost. To illustrate the point further we take the case of a 150 inch trin Yankee machine with the cylinder surface area of 520 sq. ft. and a constant evaporation rate of 10 lbs/sq. ft/hour and consider the gain in production and saving in steam consumption as the dry content of the sheet entering M. G. Nip is increased from 30 percent to 40 percent solids.

Table II

Yankee Machine with M. G. Cylinder drying surface of 520 sq. ft. and equipped with high velocity hood. Calculations made at a constant evaporation rate of 10 lbs/sq. ft/hour.

Table II

Sheet leaving press percent solids.	Paper at Reel percent solids.	Production lbs/hour.	Production Tons per day.	Water Evaporated lb/lb paper	Steam required lb/lb paper
30%	95%	2280	24.4	2.2807	2.8
32%	95%	2504	26.8	2.0724	2.6
34%	95%	2753	29.5	1.8886	2.4
36%	95%	3014	32.3	1.7251	2.25
38%	95%	3293	35.2	1.5790	1.95
40%	95%	3592	38.5	1.4474	1.8

N.B. Steam required per pound of paper on M.G. machines will be less than indicated in this table which had been actually compiled for standard dryers.

It will be quite obvious from the above that while considering the renovation of an existing machine due consideration should be given to the water removal aspect at the wet end and particularly the press part of the machine. Since with an efficient press part extensive changes to the dryer part may be more or less curtailed.

Much efforts have lately gone in towards reducing the moisture content of the sheet leaving the press part with the extensive research programme at Central Laboratory of the Swedish Paper Mills Stockholm, Mead corporation; Ohio, and Beloit Corporation, Wisconsin etc., who have come out with several extremely interesting and successful conceptions. To name a few recent innovations, the Divided Press, Fabric press, and Vented Press assemblies are worth mentioning. On old machines much improvement can be effected by installing a first suction press but on machines already equiped with the 1st press as a suction press, it is the second or third press which generally receives the attention and appreciable advantage can be gained by application of some of the recent innovations here. In fact, so far it has not been possible to apply the new designs to the first press position as it has not been possible as yet to remove large volume of water needed at the position.

Divided Press : The conception of a Divided press is based on the theory that a conventional standard press has to perform two distinct functions; that of pressing the water from the wet web of the paper into the felt and that of squeezing the water out of the woilen fabric. In the Divided Press, endeavour is made to separate these two functions and work is done by two individual and separate presses which may be termed as a sheet press and a felt press. The web is pressed in a plain sheet press in a normal way, but the water forced into the felt does not express at the nip in the conventional manner as the in going felt has already been dried and conditioned at the felt press to absorb all the water. The felt press, in order to condition and dry the felt has to operate at comparatively higher nip pressures which may be in the range of 350 to 450 lbs/1 inch. On medium speeds a plain press felt with synthetic wire cloth is used as a medium of transporting the water from the felt to the fabric at the felt press nip but at higher speeds suction rolls are generally found to be necessary. However, with the advent of fabric press and venta press, Divided press is not much heard of.

Fabric Press : The principle behind the new approach to pressing is to provide increased void space in the nip of plain roll by inserting an incompressible synthetic (plastic) wire to carry the water away pressed out of the paper web and the felt. Part of this water expressed in the nip adheres to the bare press roll and is removed by a wiper arrangement. Part of the water retained by the fabric is removed either by the centrifugal action or by a narrow lipped suction box.

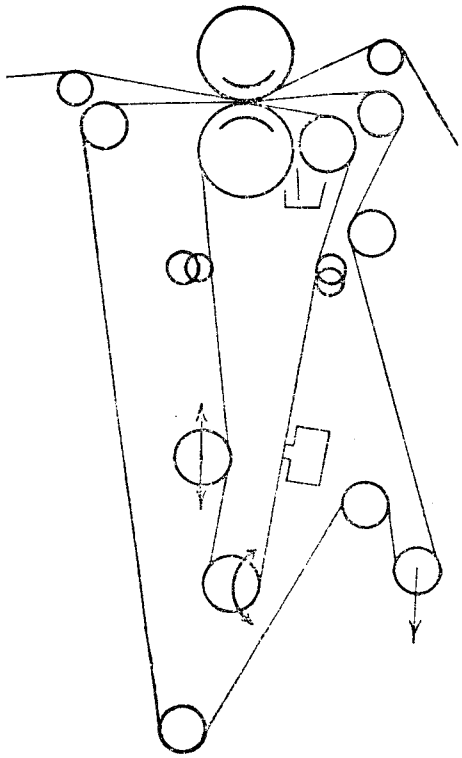


FIGURE - 5

The synthetic wire cloth used is practically incompressible and does not make any difference to the total nip pressure applied. On the other hand since there is lower resistance to the flow of water on account of the presence of void space in the nip more pressure is available for the compression of the felt and consequently dewatering. The amount of water pressed out is dependent on the linear pressure and on commercial installations nip pressures of 300 to 350 lbs/1 inch are quite common.

From the point of view of water removal the press felt should be very permeable and also compressible. The wire should have large void area to carry the water expressed at the nip. To meet this requirement a double layer fabric with large open area has been designed by the felt suppliers.

Vented Press : This is yet another concept of practical value and has the added advantage that extra piece of clothing and felt rolls etc. are not needed. Nor does it require the extra attention for running the felt and the fabric together as is the case with the fabric press assembly.

When considering a conventional plain press, it will be observed that the distance for the water flow from the sheet and to escape from the nip is much larger than the perpendicular distance through the felt. Suction press, though much better vented through a very large number of holes in shell still has flow lengths many times the compressed thickness of the felt and as such is prone to development of pressure gradient in the plane of the felt On the other hand with spiral grooves cut into the vented roll, the distance water has to travel to reach an atmospheric vent is kept to a minimum so that pressure gradient build up in the plane of the felt is the least. The grooves on the vented roll are normally so dimensioned that the maximum distance expressed water has to travel to reach a vent is not more than 0.500". The groove dimensions of course depend on paper grade and machine speed. A sketch showing the principle of the vented press gives a general idea of the corresponding dimensions.

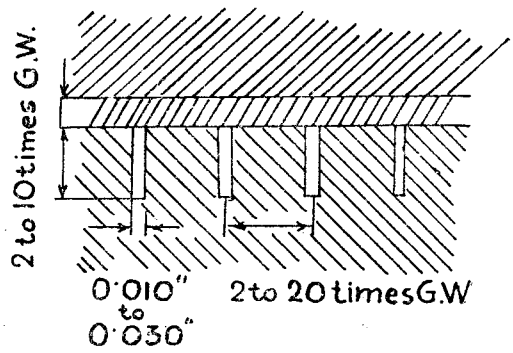
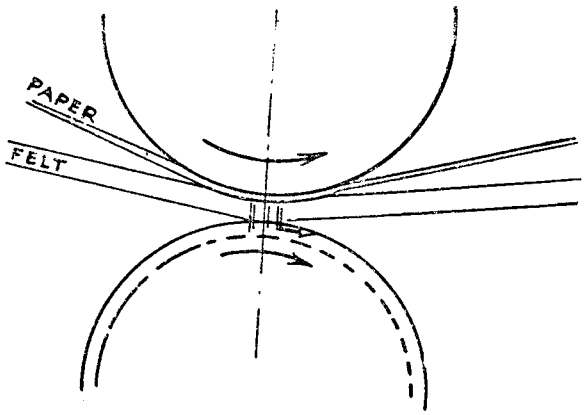


FIGURE - 6

To avoid rewetting of the felt the plain top press roll is lapped to some degree by the press felt, but at the same time it is also considered advisable to seperate the sheet from the felt as soon as it emerges from the nip. In addition to this, it is also considered essential to doctor off the vented roll to arrest the splash from the out going nip as well as to prevent the throw back into the nip.

A somewhat harder roll cover has to be used in the vented roll position due to the

configuratfon of grooves and higher nip pressure. The felt wear is more. A heavier felt in the 3 to 3.5 oz/sq. ft. range has to be used as compared to 2.4 oz/sq. ft. on 2nd plain press but the cost is more than offset by the dryer sheet delivered to the dryers.



VENTA NIP PRESS

FIGURE 7

Filling of the grooves on the recent installations, according to reports, is no problem at all and it is claimed that the roll can run practically a whole year between grindings.

Some of the advantages claimed for the various new concepts in pressing are :—

1. Lower cost of installation and lower power consumption (elimination of vacuum pumps).
2. Comparable or better performance than of a suction press when sheet dryness figures are compared.
3. Absence of shadow marking.
4. More even moisture profile.
5. Saving in steam at the dryers to the extent of 10 to 15% or increase in production from 20 to 30% provided other machine conditions permit.

To sum up, on machines where press part and drying capacity is the limiting factor, serious considerations should be given in the new concepts in pressing for improving the performance.

Press Roll Coverings

Some of the older units which have already been speeded up often experience serious troubles for press picking etc., partly due to the inappropriate composition of the Top Press Roll. The wide range of new compositions besides the standard stonite and Granite coverings are available to suit the individual requirement. For long fibred Kraft stock-self skinner and self peelar compositions are giving good results but because of the soft covering frequent grinding of the rolls is considered essential to keep the rolls in shape. On short fibred stock where picking and press breaks are frequent special coverings with rubbers and Granite composition in the range of 0 to 5 P & J have been developed which are reported to be giving excellent results. These roll covers require no more frequent gridings than the conventional granite and stonite rolls.

Sheet Width

Due to pressing demand on the paper makers for increased production on the existing machines, wire widths in most cases have been utilised practically to the full and the machines forced to produce as wide a sheet as the calenders can take. This step has been taken to accomodate certain sizes which were previously been produced at lower deckles with subsequent loss in production. This has consequently resulted in large edge breaks at the presses and more frequent snapoff's at the calenders due to thinner edges or poorly formed sheet edge at the wire.

It is common knowledge that during drying process the shrinkage of paper in cross direction is anything from 4 to 6 % and sometime is as high as 8% in case of wet beaten sheet. Instead of trying to use the maximum width of the wire to meet the increased deckle requirements with subsequent trouble later on, it is customary these days to instal adjustable bow curged rolls in the wet press as well as the dryer part to attain the same end. Maximum benefit is obtained when the curved rolls are mounted in the press section and beginning of the dryer part. For each roll installed, 0.5 to

0.7% increase in sheet width is claimed. It is considered that the cost of installation of curged roll will pay for itself in a very short time by minimising the trouble along accentuated by strimming an unnecessarily wide web at the wire.

Dryer Part

Extension of the existing dryer part for increased production by installing additional drying cylinders involves maximum amount of work and large capital cost. It generally means shifting of the existing calanders and reel further down the finishing house, relocation of the driving units and extension of the drive line shaft etc. Additional dryer section with its driving unit will in most cases necessitate installation of a larger prime mover if there is no margin left on the generator set for absorbing additional load. However, all this may not be necessary if the existing operating conditions are correctly analysed and future demands assessed in details. More than often it will be found that dryer part of a particular machine may be operating much below the present day standards may be due to faulty dryer drainage system, unsuitable dryer felts or the inadequate machine room ventilation etc., Apart from rectifying these faults much can be done to enhance the rate of evaporation by incorporating a few of the recent innovations in the existing dryer part. The cost of such modification may be found to be a fraction of that required for the extensive changes when installing additional drying cylinder.

Dryer Screens

Though the subject may not be considered within the scope of the trends in machine design and their application towards modernization of the existing units yet the influence that the development has on the increase in production on the paper machines has automatically transferred it to the sphere of this article.

It is generally believed that the drying of paper during its passage through the dryer part is effected by intimate contact of the paper with the heated cylinders, which quickly raises the sheet temperature and promote evaporation. The dryer screen which is suggested here to replace the conventional dryer felts, is a synthetic felt of screen construction capable of running at far greater tension and having a very high air permeability. Since it has been established that about 70 to 80% of the evaporation takes place in the section covered by the felt, it is quite logical to imagine that the vapours from the paper will pass the highly permeable screen into the atmosphere more freely. This factor coupled with higher felt tension applicable, should promote rate of evaporation on the existing dryer part. Free discharge of vapour into the machine house necessitate adequate ventilation and circulation of hot dry air to take care of the moisture laden air. When all the sections of the machine are clothed with the dryer screen, 10 to 15% increase in production and or 15% saving in steam consumption are cited. Besides, claims for less grainy edges and more uniform moisture profile are also made.

Excepting for the last dryer group, where the sheet is still cold for the evaporation to take place, the rest of the top drying cylinders may be clothed with the synthetic dryer screens and advantage taken of the vertical ventilation of the vapours. The bottom dryers may still preferably be jrovided with the conventional felts but equipped with Blow Rolls for improved efficiency.

To stop sideways travel of the dryer screen, it is necessary to provide reliable automatic guides otherwise the screen may develop edge cracks and be destroyed very soon.

Blow Rolls : The conventional felt drying cylinder does not appear to be a satisfactory piece of equipment to condition a dryer felt when it is realised that the felt may be fairly dry as it may enter the 1st dryer ; but as it proceeds from the first to the second and from second to third dryer and so on in the group, it may keep on absoring moisture from the sheet till the felt may get completely saturated and lose its ability to absorb any more moisture. When it is considered that 70 to 80% of the evaporated water is absorbed by by the dryer felts, it becomes clear that the dryer felts may soon be getting saturated and loosing efficiency while proceeding from one dryer to the next. Not only this entails loss in felt efficiency but the drying capacity of

the whole dryer part is reduced by saturation of the dryer felts. It is quite logical to assume that far more improved drying results could be assured if means for drying and conditioning the felts between travel from one cylinder to next could be provided. The simplest method of achieving this is by substituting the felt carrying rolls in-between the drying cylinders with Hot Air Blow Rolls.

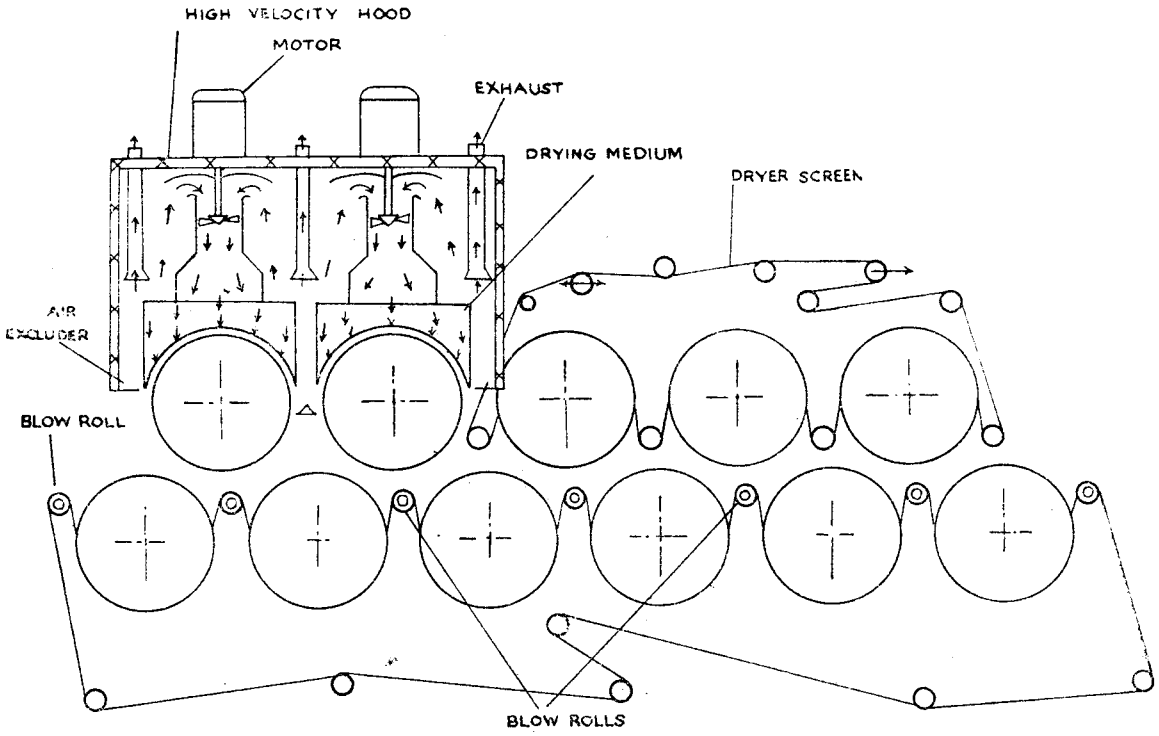


FIGURE · 8

The steel blow roll is constructed around a tubular pipe with radial jet pipes for distributing the hot air over the whole width of the roll covered by the felt. Distributor heads on both ends of the roll ensure that hot air is confined to the zone covered by the felt only. Hot air is blown at about 170°F through the roll which not only dries the felt but also assists in removing moisture-laden air from the dryer pockets. Increase in production upto 20% for the Madeliene, Leckner, and Voith rolls have been achieved, depending of course on the number of rolls installed on the machine.

Further advantages claimed for these rolls are (a) more uniform sheet moisture profile, (b) Flatter sheet (c) Longer felt life (d) Better ventilation of dryer pockets. and the machine house and (e) Saving in steam per pound of paper.

High Velocity Hoods

In recent past, High Velocity Hoods for the dryer section of the fourdrinier have evoked very great interest because of the exceptionally high evaporation rate claimed for them. These hoods are the natural developments of the Yankee Hoods which have contributed immensly towards increased production on the M. G. Machines.

In the design of the High Velocity Hoods, advantage is taken of the principle that, by increasing the velocity and raising the temperature of the drying medium, rate of heat transference is greatly increased. Theoretically, the higher the velocity and higher the temperature, the greater is the drying capacity.

The most common drying medium used is air ; but any gas can be used for transference

of heat. In case of high velocity hoods on fourdrinier the role of the air is played by the super heated steam produced by heating the vapours liberated from the sheet. This vapour is naturally in the from of steam but when heated to high temperature, is super-heated and transformed into dry gas. This gas at the elevated temperature or the super-heated steam is utilised as the drying medium by circulating and impinging it on the paper at very high velocities within the hood to accelerate the rate of evaporation.

On the conventional dryer part, the evaporation rate is generally around 1.6 to 2.4 lbs/sq. ft/hour ; but with the high velocity hood the evaporation rate of 3.5 to 4.5 lbs/sq. ft./hour are claimed. A chart prepared by one of the leading high velocity hood manufacturer makes an interesting study.

Table III (Green Bank)

Evaporation Rate	32%	33%	34%	35%	36%	37%	38%	39%	40%	B.D. content of sheet after presses.
1.4 lbs/sq.ft/hr	24.1	23.0	21.9	21.0	20.0	19.2	18.3	17.6	16.8	T.W. Hoods Top Cylinders only
1.6 lbs/sq.ft/hr	21.1	20.1	19.2	18.3	17.5	16.8	16.0	15.4	14.7	
1.8 lbs/sq.ft/hr	18.7	17.9	17.1	16.3	16.5	14.9	14.3	13.7	13.1	
2.0 lbs/sq.ft/hr	16.9	16.1	15.4	14.7	14.0	13.4	12.8	12.3	11.8	
2.2 lbs/sq.ft/hr	15.3	14.6	14.0	13.3	12.8	12.2	11.7	11.2	10.7	
2.4 lbs/sq.ft/hr	14.0	13.4	12.8	12.2	11.7	11.2	10.7	10.2	9.8	
2.6 lbs/sq.ft/hr	13.0	12.4	11.8	11.3	10.8	10.3	9.9	9.5	9.1	
2.8 lbs/sq.ft/hr	12.0	11.5	11.0	10.5	10.0	9.6	9.2	8.8	8.4	
3.0 lbs/sq.ft/hr	11.2	10.7	10.2	9.8	9.4	8.9	8.6	8.2	7.8	
3.2 lbs/sq.ft/hr	10.5	10.1	9.6	9.2	8.8	8.4	8.0	7.7	7.4	
3.4 lbs/sq.ft/hr	9.9	9.5	9.0	8.6	8.3	7.9	7.6	7.2	6.9	
3.6 lbs/sq.ft/hr	9.4	8.9	8.5	8.2	7.8	7.5	7.1	6.8	6.5	

Unfelted cylinders ← Bottom cylinders

T.W. Hood Top and Felted Cylinders →

Number of 5 ft. dia. cylinders required per ton per hour per 100 inch machine width.

It would be apparent from the chart that considerable saving in space and number of drying cylinders installed could be effected by installation of the high velocity hoods on the existing cylinders for a given rate of production. However, for an existing unit, hooding the first two or three top cylinders, equipping the rest of the top cylinder groups with Drying Screens and providing atleast two to three Hot Air Blow Rolls in aach group on the bottom felts will offer an interesting combination and increase in drying efficiency. Of course, the arrangement may be varied to suit the individual requirment.

Size Press

Size presses are becoming more and more popular with the paper makers because of the excellent surface characteristics they impart to the paper. Not only it is possible to apply sizing material to the paper but light coating can also be applied to the paper with judicious selection of the coating material. With the increasing demand for superior quality writing and printing papers and larger discriminating customers, it is an excellent tool for up-grading the paper qualities. Some of the very old machines may not offer bright prospects for renovation in view of the small return that may be worked out due to large capital investment but small gain in production. On such machines, up-grading the quality of paper and range of product by installing a size-press provides excellent additional return. A horizontal size-press seems to be more versatile and is generally preferred these days in view of its flexibility in operation and ease of handling.

Drum Reel : On slow speeds, the two spools upright friction reel is still considered to be quite satisfactory. Variable speed constant load electrical drives for upright reels have of course superceded the friction drum arrangement but the increase in machine speeds have necessitated installation of the drum type reels. The horizontal drum reel has a definite edge over the conventional pope reel in that it is capable of building large reels with uniform paper roll density and winding tension throughout which in turn assist in turning out better reels at the rewinders.

Machine Drive : On most of the old and existing machines, the Marshall Type line shaft drive is to be found with a Ward Leonard Set as the prime movers. The limiting factors for speeding up are generally :

(a) the inability of the generator set to take additional load which is proportional to the speed of the driver motor ;
(b) critical speed limit of the line shaft and the cone pulleys ;
(c) trouble with slippage and breaking of driving belts ; and
(d) trouble with the clutches.

Prime Mover : The only possibility of utilising the existing Ward Leonard set is to instal a "Helper Drive" on the drive line shaft to relieve it of the extra load which may be placed on it either due to installation of additional equipment or speeding up the machine. The feasibility of the proposition can be best judged by the original drive supplier. The speed of the line shaft can of course be accelerated by changing the pulley ratios of the drive motor as well as the line shaft.

Line Shaft and Cone Pulleys : The drive supplier can give positive information about the critical speeds and suitability of the equipment at higher speeds in mind. If the equipment is declared unsuitable there is not much choice left but to replace the same.

Drive Belts : Nylon core belting is giving excellent results and is practically trouble free at higher speed.

Friction Clutches : The conventional friction clutches when replaced with the air flex clutches provide a great improvement in operation and require much less maintenance. Belt shifters when remote controlled from the tending side of the machine provide further improvement in the operation.

Conclusion : The rebuilding of old machine and incorporating the new INNOVATION opens a very fruitful and interesting field of investigations for Technicians and Mill Management. The possibilities of rebuilding of Paper Machines are many and the objectives in view can be achieved in a number of ways. However, in order to get the best benefit from a plant under the given conditions requires a scientific and rational approach to the problem starting from the market survey, quality and the quantity of paper to be made on a particular machine. The local conditions and the nature of the equipment very much determines the mode of building machine. However, with so many possibilities at the command of the Technician, the solution, however, to the particular set of conditions in detail is to be found. It has been observed that most economical way of re-building a machine is to do it in stages. The Technician tries to study the working of the machine and to remove the bottleneck which is preventing further speeding up of the machine and having done this, he again tries to find out whether the bottleneck has shifted, the bottleneck has progressively moved and ultimately the objectives in both quality and production are achieved. However, in the present conditions of the foreign exchange difficulties such procedure may not suit the Indian conditions, and more often it is found practicable to attempt the whole rebuilding of the machine at a time. The capital investment has to be assessed in relation to the results achieved and the recurring expenses which may follow later on. The above discussions on the various aspects of re-building of the machine, it is hoped, would help to the Technician and the Management to tackle the problem to the benefit of the production of the Indian Paper Mills.

References

1. Trends in Paper Machine design and their application in modernisation of existing fourdriniers and M. G. Machines.
W. J. Binns and B. Priestley
Proceedings B. P. and B. M. A. June, 1959.

2. Recent trends in Paper Making Machinery design
C. R. Dawson
Proceedings B. P. and B. M. A. December, 1958.

3. A relationship of Fourdrinier wire length and Machine output
K. R. Suttle
Paper Technology, August, 1961.

4. Plastic Fabrics for Paper Industry
S. V. Sergeant
Paper Technology, October, 1964.

5. Economical Design Consideration for paper machines and their alteration, D. R. Barbour and J. Tweedie Paper Technology, August, 1964.

6. "Baggallay" Suction/Air Transfer Box Bertrams Ltd., Screnes, Edinburgh.

7. Summaries of lectures at Nordiska Felts Technical Conference 28-29/8 1964, Nordiska Felt Publication C2.

8. Fourdrinier Paper Making—GUNNAR-GAVELIN Lockwood Trade Journal, June, 1963.

9. First Report on Scandinavian Experience with Fabric Presses
ERIC TENFAT AND BORJE WAHISTROM
Paper Trade Journal, February 24, 1964.

10. The Mead Fabric Press—M. R. Castagne Pulp & Paper—January 7, 1963.

11. The Wire Felt Press—Otto Brauns
Paper presented at European Conference of Pulp and Paper Industrial Technology.

12. Summaries of Lectures at Nordiska Felts Technical Conference 28-29/8, 1964—Nordiskafilt Publication D4.

13. Darwen Paper Mills install Europe's first Venta Nip Press Paper Maker—September, 1964.

14. Thilmarry's Experience with the Beloit Vents Nip Press—A. H. Martin—Paper Industry—September, 1964

15. The Principles of Curved Rolls—W. M. Gallahue, Indian Pulp and Paper September, 1964 also
Machinery Equipment and Suppliers September, 1964.

16. Development in stiffening and stabilisation of paper—W. M. Gallahue—Paper Maker, February, 1963.

17. Application of Madeleine—SRRI hot air felt drier roll in Paper Industry.

18. Summaries of Lectures at Nordiskafilts Technical Conference 28-29/8, 1964
Nordiskafilts Publication E3.

19. Drying Paper on cylinders with accelerator hoods—Principles and practice—M. D. Jepson, Paper Technology, June 1963.

20. Roll of high velocity dryers in paper making—J. D. Whittaker, Paper Technology, June 1963.

21. Use of high velocity air in paper manufacture—D. R. Barbour, Paper Technology February, 1962.

22. Forced convection drying as applied to Fourdrinier Dry Parts—J. D. Whittaker Paper Technology—February, 1961.

23. High Velocity Air Drying—D. N. Hill Paper Technology—August, 1961.

24. Mechanical Machine Drives—K. R. Suttie Paper Technology—April, 1960.

25. Pulp and Paper Manufacture Vol. III—Mc Graw, Hill 1958.

26. Paper Making Practice—H. Hardman & E. J. Cole—Manchester University Press 1960.

27. Features of Modern Paper Machine
Philip H. Goldsmith
Dominion Engineering.