

H N C Technology and Management of Paper And Boardmaking

The finishing of paper and board module will increase the individual's knowledge of the finishing process in a Paper or Board mill.

Reeling, slitting, sheeting, guilloting and packaging will all be covered in respect to the optimum scheduling of work loads.

AIMS.

1. To develop the technical knowledge in the reducing of jumbo reels from the making machine, to a size and condition acceptable to the customer.
2. To increase the understanding of scheduling a finishing departments workload.

LEARNING OUTCOMES

On completion of this module the student should be able to: -

1. Understand the operation of a reeler and slitter
2. Understand the operation of a sheeter
3. Understand the need for and the operation of a guilloting
4. Explain the packaging of paper and board
5. Understand the basic factors that go to the scheduling of a finishing department

H N C Technology and Management of Paper and Boardmaking

FINISHING OF PAPER AND BOARD.

INTRODUCTION

The reeling, slitting, sheeting, guillotining and packaging is an integral department of any paper or board mill, and an understanding of these finishing operations is important, so that optimum scheduling can be undertaken and the needs of the customer satisfied.

FINISHING

Finishing is the “converting” of papermachine jumbo reels into the finished form required by the customer.

What does the customer need - apart from perfection -. They need goods of the right quality in the correct quantity delivered without damage on the right date.

It is therefore essential that the finishing department should be able to perform the converting operations in a manner that will effectively satisfy all of these service demands at the same time contribute towards the vital mill profit margin that is so essential for business survival.

Cost Consciousness

The importance of a cost conscious attitude may be highlighted by the fact that, in 1972, finishing accounted for about 25% of the total cost of converting the basic raw material into the final product delivered to the customer. Even more significant is the fact that 75% of that cost was labour costs.

From these figures is it any wonder that the finishing operation has seen tremendous cost reductions. Hopefully without sacrificing quality or service.

COSTS.

The normal breakdown of factory costs are: -

1. Wages
2. Materials
3. Power
4. Repairs
5. Overheads.

The two significant items in finishing are Wages and Wrapping materials.

Wrapping materials vary directly with the volume of production, but wages are virtually a fixed cost that must be borne regardless of output.

To minimise wrapping costs it is preferable to compromise between the extremes of holding generous stocks of different sizes and a low stock level of a small range of sizes.

Choosing low limits results in less working capital and a saving of floor space, but there is a danger of excessive costly wastage of materials if this philosophy is overdone.

Wage rate are usually dictated by National or Local agreements Therefore the only way to keep costs down is to carefully control both the total number of employed and the output rate of each machine or group of operators.

As a general rule the way to control these costs are: -

1. Selection of the right equipment, the best possible layout and the most effective working methods
2. Good industrial relations to determine standard complements, with a highly trained flexible labour force, capable of using the right tools and equipment.
3. First class planning and programming of orders to obtain a maximum through put and best possible machine utilisation consistent with the over-riding need to meet planned delivery dates and to maintain correct stock levels.

FACTORS AFFECTING LAYOUT

STARTING AND FINISHING POINTS OF FLOW LINES.

The “finishing end” begins at the point of entry of reels, normally arriving directly from one or more papermachines.

Reels are placed in a temporary store before the first process.

It may be more convenient to locate this storage space within the area of the machine house, but it is this storage point that the finishing end starts, if the reels are not stored sensibly, it will be finishing efficiency that suffers rather than that of the making department.

The end of the finishing flow line is the point at which paper is ready for dispatch, and enters the warehouse for storage, which may be long term stock items or short term for customer orders.

Length of storage and final loading point will - or should - determine the exact location within the warehouse and the flow line will normally be directed toward that point.

There may be more than one paper warehouse and more than one point of entry into each, but it is sometimes an advantage, for central purposes, to restrict the number of entry points.

NUMBER AND TYPE OF PROCESSES.

Not every finishing end will contain “all” finishing processes, as a product will be mainly reels or mainly sheets rather than a mixture of the two. Even so any flow line must pass through all the essential processes involved in the particular order they have to take place, therefore the layout plan must be to line up these processes on the most direct route between the start and finishing points.

AVAILABLE SPACE.

Almost any layout could be accommodated without too much difficulty in a large rectangular building without interior walls or columns, with adequate headroom and no difference in floor level.

Unfortunately such facilities are rarely available and even when they are someone invariably installs something that is either unsuitable from the start or rapidly becomes so as volume increases and finishing requirements change.

Consequently the planner is usually faced with a collection of unsuitable buildings containing finishing equipment well dug in and supervisory staff prepared to resist any suggestion of change in layout or working methods.

Frequently the result is a compromise between the ideal and the practical so that operating costs are still higher than they need be, but yet not high enough to justify the capital cost of rebuilding.

Eventually a point will be reached when there is no alternative but to tear it down and start again.

PEAK DEMAND.

Assuming that capital is available, it is desirable to have within each finishing process enough capacity to cope with normal peak demand, this means that sufficient machines and working areas must be provided even if some are not manned all the time but only when required.

A flexible workforce with a certain amount of overtime working has the advantage that, it avoids the necessity of providing storage space before overloaded processes. It gives the minimum lead time between making and dispatch and by keeping up close with the making machines, it provides a rapid feed back on quality and other production information.

FAST AND SLOW PRODUCT LINES.

It is unrealistic to expect that all orders will move through the finishing end at the same speed.

Small sizes of reels and sheets will involve more man and machine hours per ton than larger sizes, as will orders that require special treatment

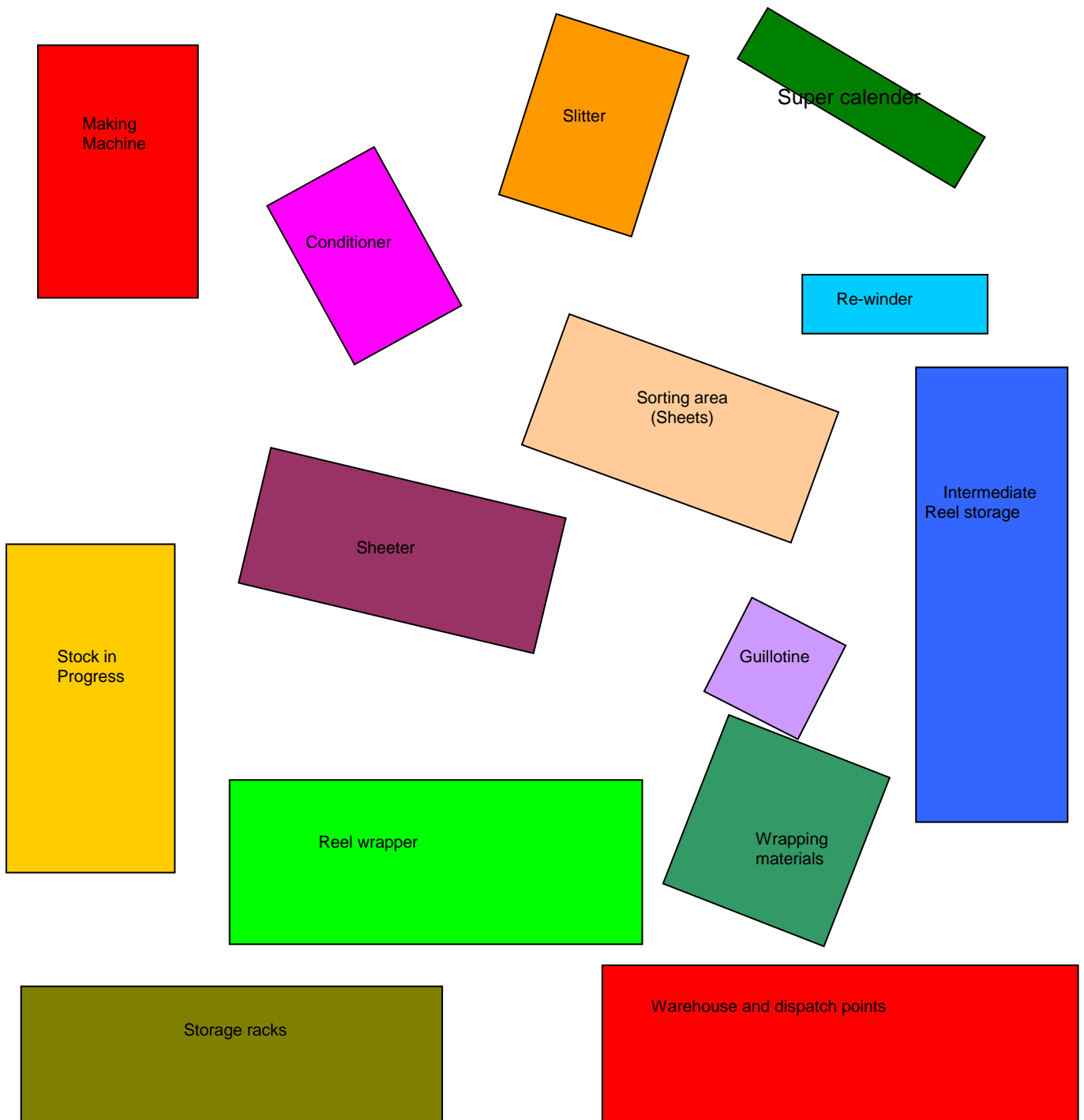
It is vital therefore that fast flow lines and high output machines are reserved for large lots of tonnage for which the processes are standard so that these will move more quickly into the warehouse.

Anything known to be slow moving must be diverted from the main route and dealt with on a slow line.

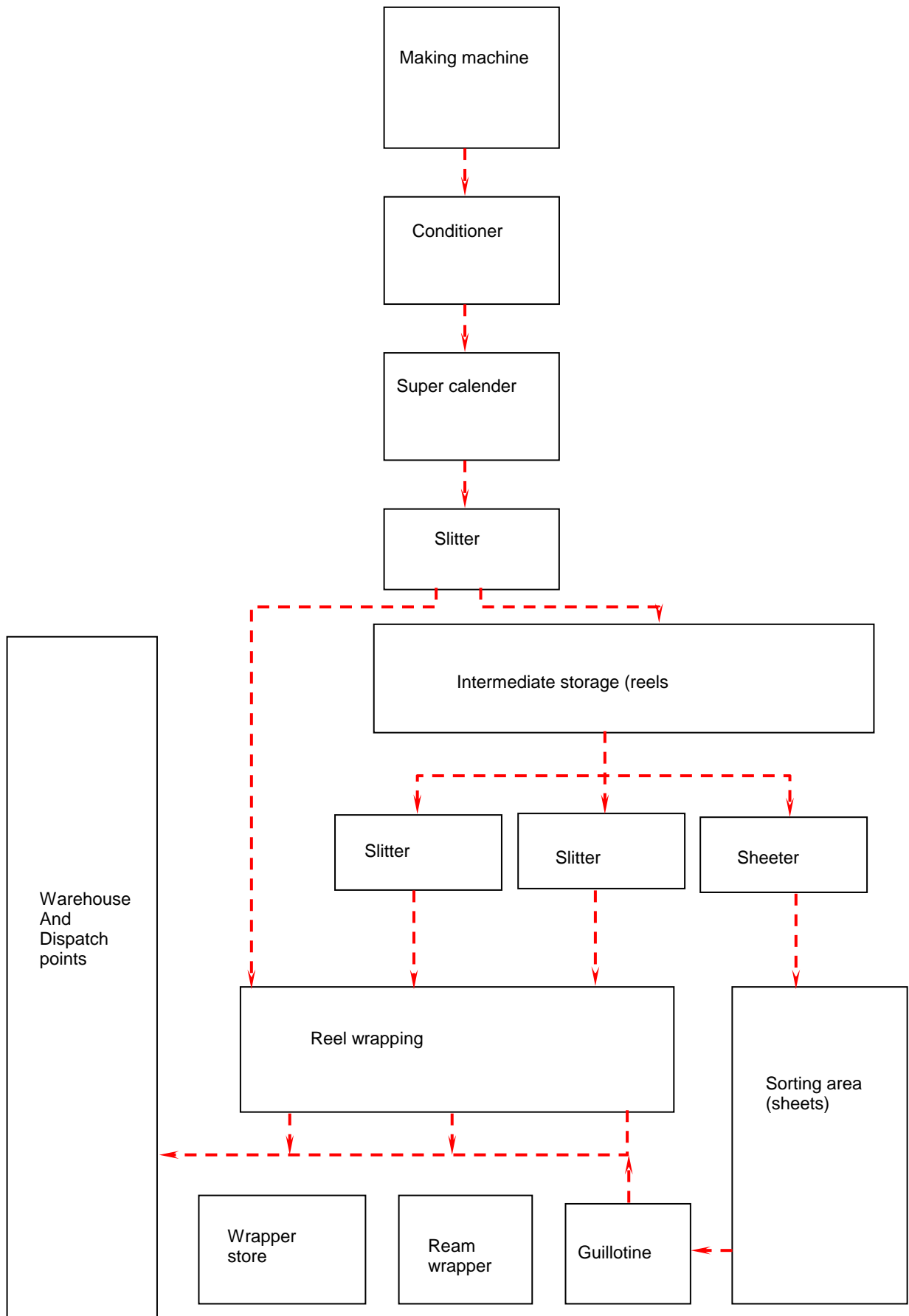
Care must be taken to keep the various parts of an order together and not allow it to be split up. Otherwise the “last little bit” arrives at the warehouse (or even the customers premises) hours or days after the bulk of the order.

Fairly rigid flow lines and correct manning should ensure that nothing goes astray and if anything is deliberately diverted, it should preferably be a complete order. Since few things are more frustrating than a warehouse full of half completed orders and a score of waiting customers not one of whom can be satisfied.

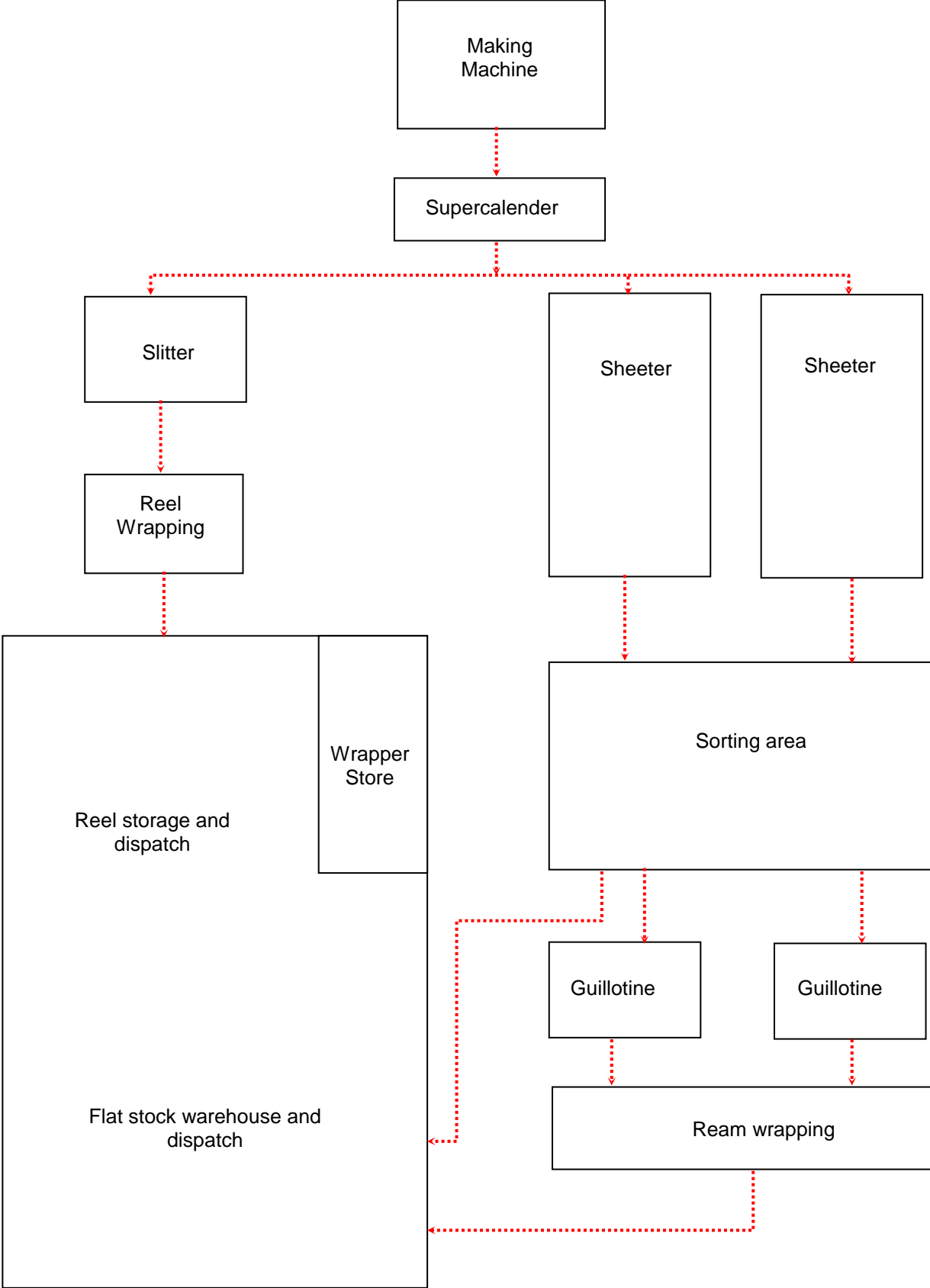
LAYOUT COMPONENTS



REEL PRODUCTION WITH SALVAGE SHEETING



MAINLY SHEET PRODUCTION



PRINCIPALS OF A GOOD LAYOUT.

1. The points of entry into and out of the finishing end must first be established. Good flow lines will follow the shortest route between these points.
2. Reels arriving from the making machine must be stored in such a way that they are easily accessible for the finishing process. The making department must not clear its own lines at the expense of the finishing end.
3. The process should be laid out in the correct sequence with the best possible handling facilities in and out. Within existing buildings advantage should be taken of natural changes in direction or level
4. Sufficient capacity should be provided at each process to cope with peak demand. Care must be taken to ensure that the process itself is efficient and that the designed throughput rate is achievable.
5. A flexible balanced labour force should be created, based on average total workload. Agreement must be reached on complement and overtime working.
6. There must be adequate servicing arrangements for the movement of paper between processes the supply of materials and the removal of broke and other waste. When powered vehicles are used at critical stages in the operation, it is essential that a replacement vehicle should be available in the event of a breakdown.
7. The programme and procedures for passing orders through the finishing end must be clearly laid down and adhered to, the workload being balanced between the various sections; operators should be transferred as necessary. Bad planning can render the best layout unworkable.
8. Clearly defined flow lines should be laid down and rigidly observed. It may be necessary to install fixed conveyers just to ensure that units of work follow the correct route in the right sequence. If flexibility is essential, it is generally better to use servicemen with a truck or a transporter rather than a conveyer.
9. Work should not be allowed to build up at any process or to move backward along an established flow line. If a problem arises over an order and a decision to continue processing cannot be taken immediately, that order should be taken out of the system and not fed in again until definite instructions are available. In the event of one process being genuinely over loaded, it may be necessary to stop the preceding processes until the work is cleared. It is better to accept a little idle time than to allow the congestion to effect other orders or flow lines.
10. It should not be accepted that, once a flow line is established, it is there for all time. Finishing machines are not immovable and should be taken out and moved or replaced in the same way as machines on any other production line. Once a layout has become obsolete and the operating costs have risen, action should be taken.
11. Above all, most emphatically, cost efficiency must not be put before customer service. The demands of the customer are not unreasonable, since all they ask for is to receive the right quality of paper in the correct quantity delivered undamaged on date promised. If the finishing layout does not permit this to be done EVERY TIME then however efficient it may be otherwise, it is failing in its object.

CONDITIONING.

It is believed that, if moisture levels can be evenly adjusted in the machine and cross direction to a desired level whilst the paper is in a free condition, then strain free flatter paper can be produced, static hazards reduced and runnability improved.

The technique used to rid paper of undesirable stress built in during the papermaking process and to stabilise the moisture content is known as conditioning.

Conditioning can be installed in the finishing end as a separate process; it may be built in line with coating plants, for which this operation is required, or it can find a place at the end of the papermachine immediately after the drying section. The correct sight depends on many factors.

Not only is the sighting a matter of careful deliberation, but also quantitative evaluation of the process is complex, hence the topic is sometimes disputed.

WHY CONDITION?

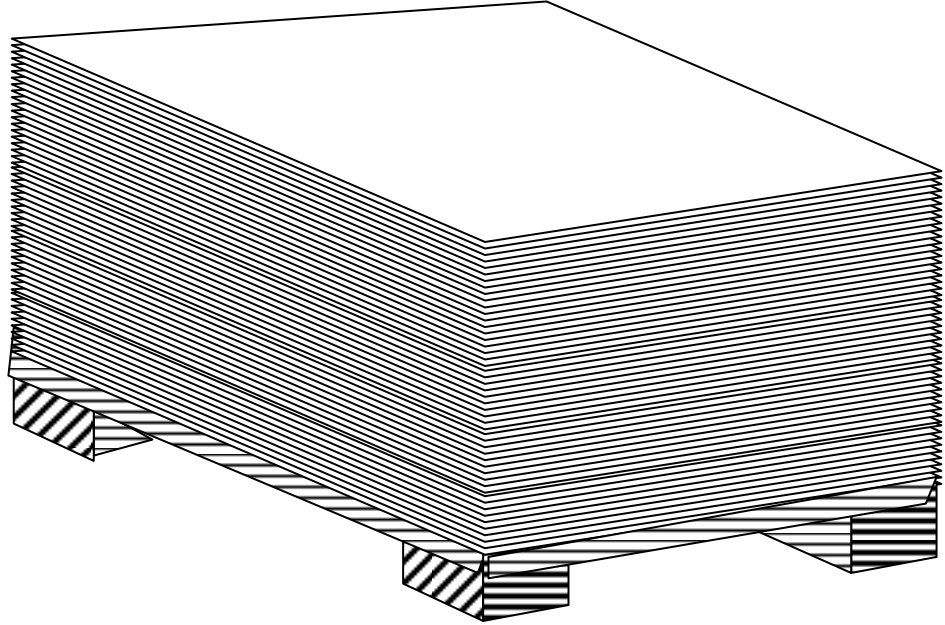
The object of conditioning is to eliminate some of the undesirable side effects that have been incurred during the papermaking process. It cannot be simply defined but essentially it is a maturing process having two principal objects.

1. To rid paper of those stresses incurred during the papermaking process that would otherwise be released during subsequent treatments.
2. To stabilise the moisture content evenly across the width and length of the paper to a desired level.

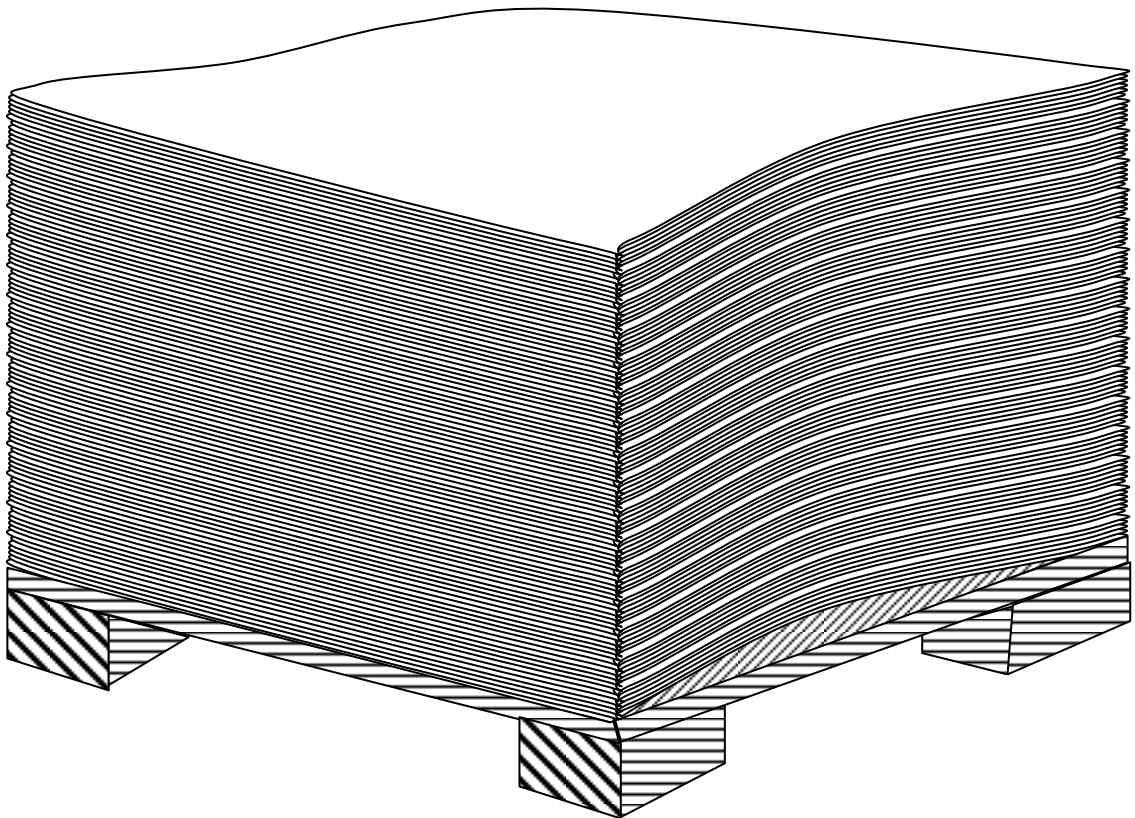
Conditioning also brings certain benefits that may be major or minor ones, depending on the problems that the particular mill be facing, for example: -

1. The ability to sell paper with a higher moisture than the normal obtained on the papermachine.
2. A reduction in static electricity
3. A slightly increased caliper
4. An improved runnability

The picture on the next page shows the difference in appearance of two stacks of paper of identical quality and specification. The one on the left is untreated the one on the right has been conditioned.



The picture below illustrates the effect of conditioning on the finished product; in the lower picture the product has not been conditioned.



CURL AND COCKLE.

Curl in paper and board can be divided into two types: -

1. Curl arising from the structure of the web.
2. Curl arising from the treatment of the web.

Curl arising from the structure of the web may be caused by either the differences in fibre orientation between the top and bottom of the sheet or the difference in the distribution of fines.

Curl arising from treatment of the web can be subdivided into two varieties: -

1. Inherent curl, which is apparent as soon as sheet is released after drying
2. Curling tendency, this comes apparent only after the paper is subjected to changes in the surrounding atmosphere.

The different rates of expansion or shrinkage of the two sides of the sheet causes curl.

Cockle is caused by differences in internal stresses in the sheet. Generally this is the result, during drying of purely localised variations of moisture and substance.

The caused of curl and cockle should be attacked, as far as possible, by regulation of the papermaking machine, but conditioning can assist in reducing these faults in some instances.

DIMENSIONAL INSTABILITY.

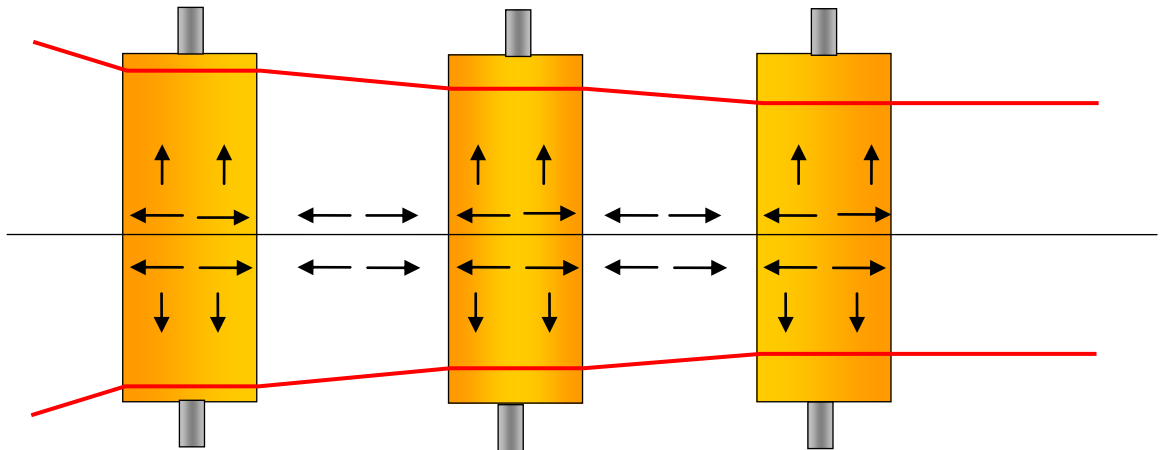
When a piece of paper has been dried in an artificially deformed state, its dimensions immediately after manufacture will be different from those that it would have had it dried while free from tension.

The amount of deformation of sheets during the drying operation on a conventional multi-cylinder dry part is controlled by three main factors.

1. Fibre orientation
2. Longitudinal stress
3. Dryer fabric tension.

The majority of fibres lie in the machine direction and this “out of squareness” affects dimensional stability. The main causes however are the constraints applied during the drying process.

While the sheet is being dried it tries to contract in all directions. The forces that resist this contraction in the machine direction, however, are different from those acting in the cross machine direction. The diagram on the next page represents the passage of a sheet of paper through a conventionally felted dryers of a papermachine.



Web contraction when drying.

The arrows represent the forces that restrict the contraction of the sheet, while the sheet is on the drying cylinders, the pressure of the dryer fabric tends to prevent contraction of the sheet in both the cross and machine directions.

Between the cylinders however, there are no forces resisting contraction in the cross direction, although the paper is still prevented from contracting in the machine direction by the draw. This inequality of constraint in the two principal directions while the paper is between the cylinders is very important, as it is here that a large portion of the drying takes place. The freshly dried sheet therefore possesses much higher internal tensions in the machine direction. Conditioning endeavors to relieve some of these tensions.

POOR MOISTURE CONTROL IN THE MACHINE DIRECTION.

The control of moisture in the machine direction provided by many machines leaves much to be desired, because of the length of time involved in making the correction in drying. Conditioning can correct this variation to a large extent.

UNEVEN CROSS DIRECTIONAL MOISTURE PROFILE.

Although every attempt should be made to remove the causes of poor moisture profile in the paper machine, it is still sometimes difficult to obtain good profiles, particularly on fairly wide machines. Conditioning can help to correct this variation.

BASIC OPERATION.

The operation is based on the ability of paper to absorb moisture from the surrounding air, which occurs for two main reasons: -

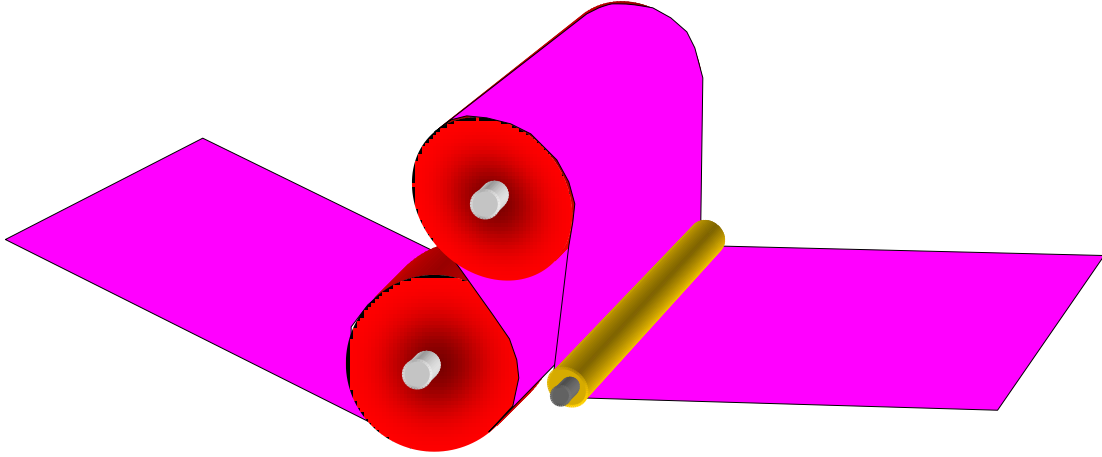
1. It is generally found to be most practical to dry paper to a moisture content of between 4.5 to 5.5% on the paper machine
2. The natural characteristics of cellulose are such that there is a tendency to absorb moisture from the atmosphere until the paper is in equilibrium with it. This figure varies with different papers, but is generally between 6.5 to 8.0% in surrounding humidities of 55 to 60% and temperatures of 18 to 20 °C.

The function of the conditioning process is to allow the sheet to absorb moisture while running under low machine direction tensions and, as a result some of the internal tensions will be relieved.

Conditioning can only eliminate only those strains that would otherwise be relieved in the hands of the eventual user or converter. Obviously it cannot restore the sheet to those dimensions it would have had if dried while totally free from applied tensions

It is interesting to note that the relief of strain is in practice indicated by an increase in width of the sheet by 0.5% after conditioning. This increase has two components, one of which is the fibres swelling more in width than length, and the other is the relief of the inbuilt strain.

OFF MACHINE CONDITIONER



WINDING AND SLITTING.

The need for a winder is to prepare the product from the papermachine for subsequent operations and the operation may be either winding or rewinding.

WINDING

This is in effect a rewinding operation, but the special term is used to describe the operation immediately after the papermaking process.

Papermachines produce jumbo or parent reels which need to be converted into smaller reels more manageable reels to suit the unwind stands of the subsequent processes. This conversion is known as winding.

REWINDING

As its name implies, *rewinding* is the term used to describe subsequent winding processes, which perform various duties. The main function is the final conversion of the reel into finished product size, which may be smaller in diameter than the parent reel and will almost certainly be of narrower widths.

Defective paper is removed during the rewinding operation, making proper joins to ensure a rapid trouble free passage through a later process.

Frequent size changes and the short cycle time when producing small reels, will obviously prevent rewriter production from matching the papermachine output so the finishing department will usually house several machines.

REEL QUALITY.

For both winders and rewinders, the target must be to produce reels of paper or board of optimum quality that satisfy the demands of subsequent processes. Although requirements will vary slightly depending upon the grade of paper and the converting process the following table gives a set of general rules to be observed.

1. Good runability and freedom from breaks and imperfections.
2. Roll structure hard enough to prevent distortion during handling and transportation.
3. Clean, "square sided" reels with minimum dust in the webs
4. Perfect splices to ensure no web breaks during subsequent converting operations.
5. Sufficient hardness of reel at core to prevent reel slipping on the core when running in the converting operation.

REEL HARDNESS.

This is a measure of firmness or solidness. The hardness of a reel should be such that it can be transported without deformation and with low risk of damage by knocks.

Too hard a reel is not desirable, however, as the wound in tension is liable to give rise to bursts (cracks) inside the reel. Besides which some form of elasticity must be left in the web to give control in subsequent operations.

Too soft a reel will also cause trouble, as it is more susceptible to damage in transit. It also makes tension control difficult or even impossible in the converting operations because of the tendency to slip on the core with consequent lack of uniform breaking. In addition, owing to the slipping damage can occur to the surface of the paper particularly in art grades.

“Telescoping” and “Starring” are typical examples of incorrect hardness of roll.

TYPES OF WINDER.

Apart from specialized winders, winders have developed into three types.

1. Overfeed
2. Underfeed
3. Single drum.

The underfeed winder is by far the most common type. It's main characteristics are inherent stability at high operation speeds and the ability to deal with most grades of paper. There are exceptions of course and for some grades a different design of winder will produce better quality reels. For example crepe tissue, lightweight publications, and in some cases board grades.

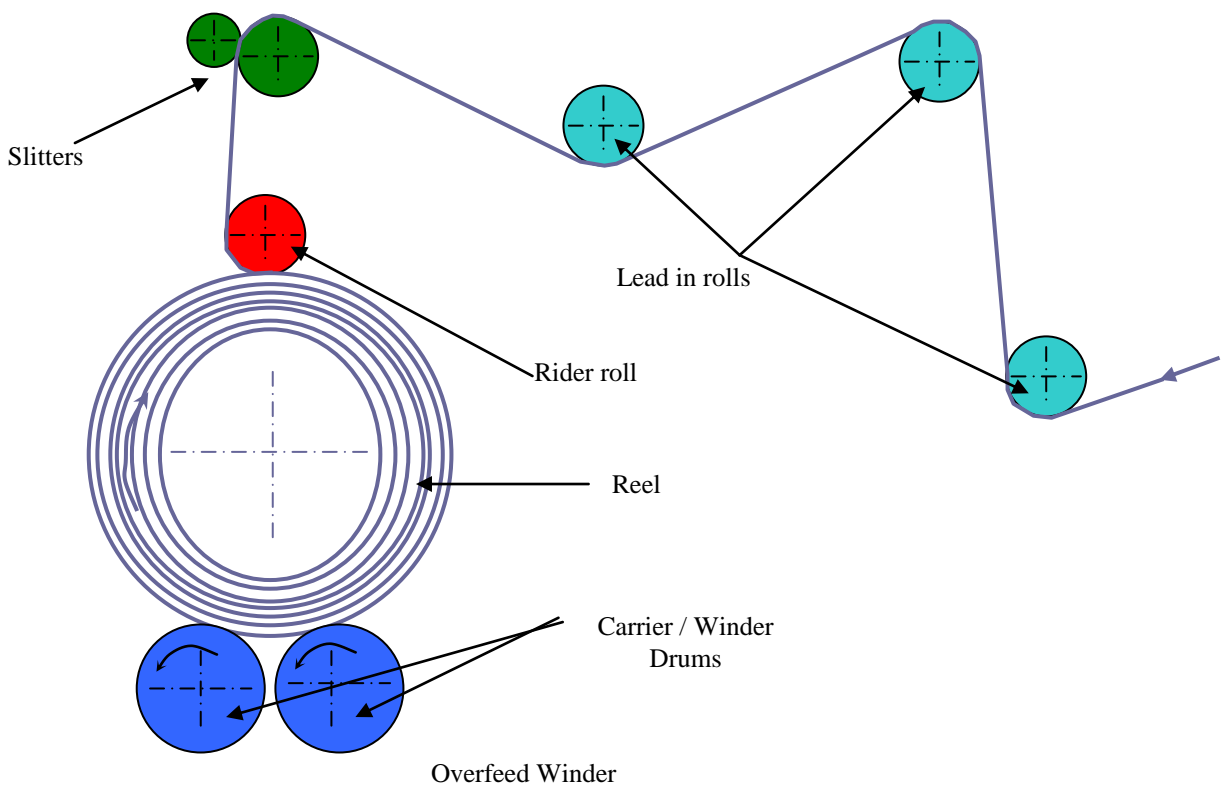
1. OVERFEED WINDERS.

In the overfeed winder, (see diagrams), the web passes over the top of the machine with the slitter head and the rider roll assembly traveling in a vertical plain as the reel increases in diameter. The advantages of this design are that it is easy to “web up” and permits good access to the slitters

Hard reels can easily be produced, owing to the weight of the rider roll and slitter assemblies being carried on the reel with consequent high reel/drum nip loadings. (The higher the nip loading the harder the reel).

As the web passes directly from rider roll to reel, there is little or no control of hardness obtained from adjustment of the draw differential between the two carrier drums. Thus, the ability to control reel hardness is limited, particularly if there is a desire to wind soft reels.

As the papermachines increase in width and speed, the general proportions of the overfeed winder become so massive to enable it to handle large reels at high speeds that the design becomes impracticable.



UNDERFEED WINDERS.

The underfeed winder carries the web under the machine, passing it to one or other of the winder drums (see diagrams).

The majority of paper mills now use this kind of winder for most grades of paper as it has the inherent advantages that cannot be obtained from other designs.

The geometry of force reactions between the reel and carrier drums is such that the web tension tends to pull the reel against the drums, giving stability to the developing reel and retaining reel quality at high operating speeds.

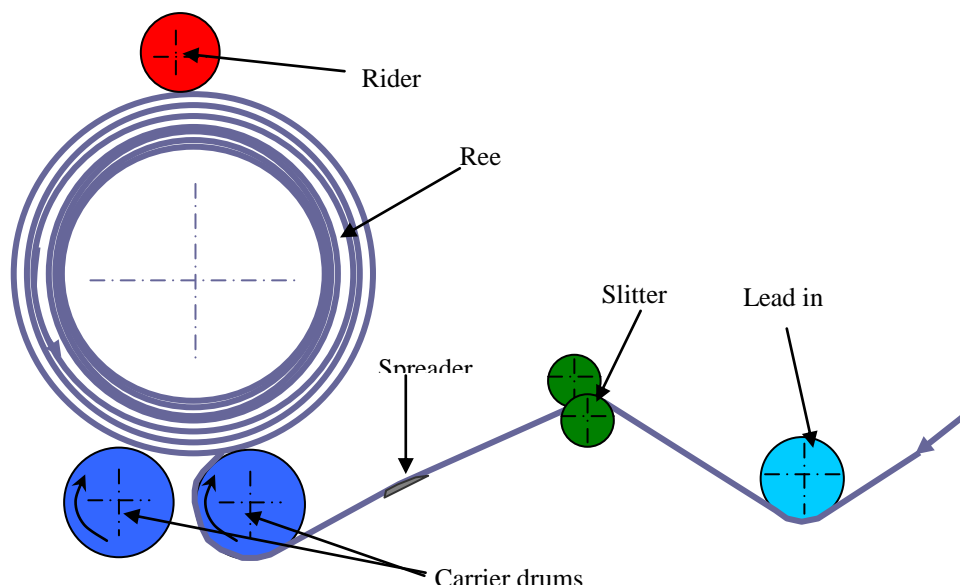
The web run also permits use of a torque differential between the two carrier drums, which has a significant effect on reel hardness. This feature, combined with rider roll/reel nip adjustment, gives good control of reel quality.

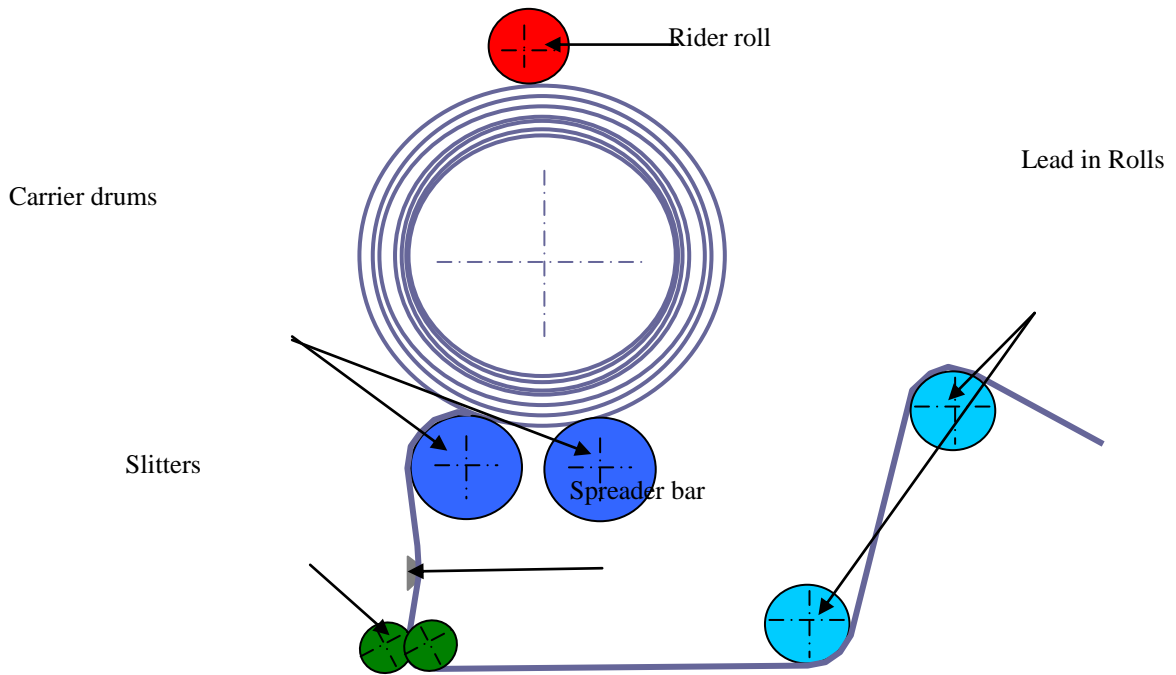
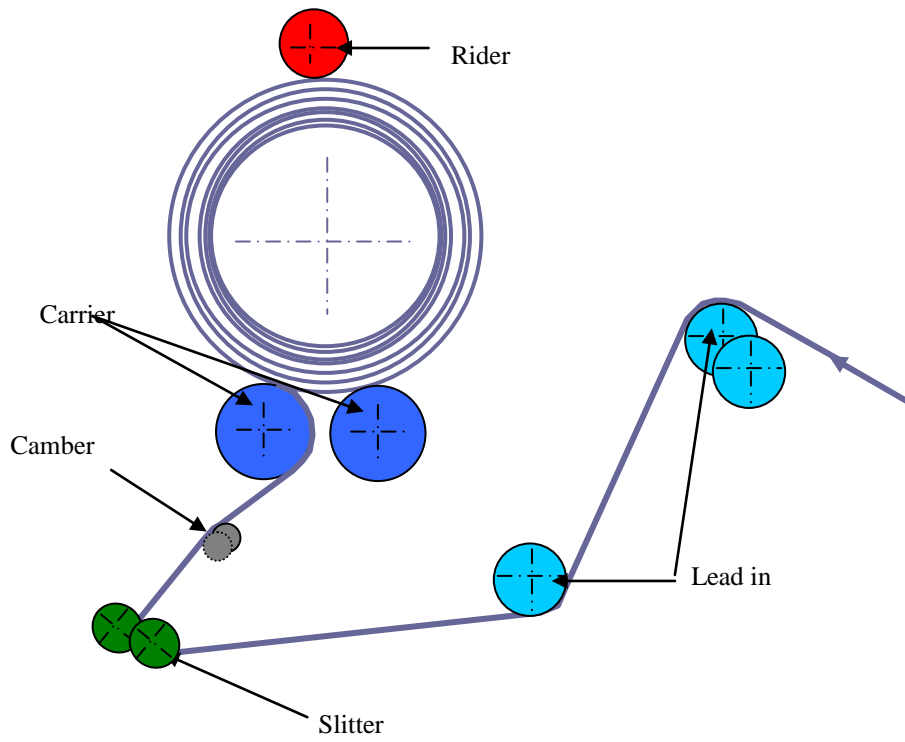
With this winder the great mass of rotating parts is close to floor level, giving a low centre of gravity that results in stable running conditions.

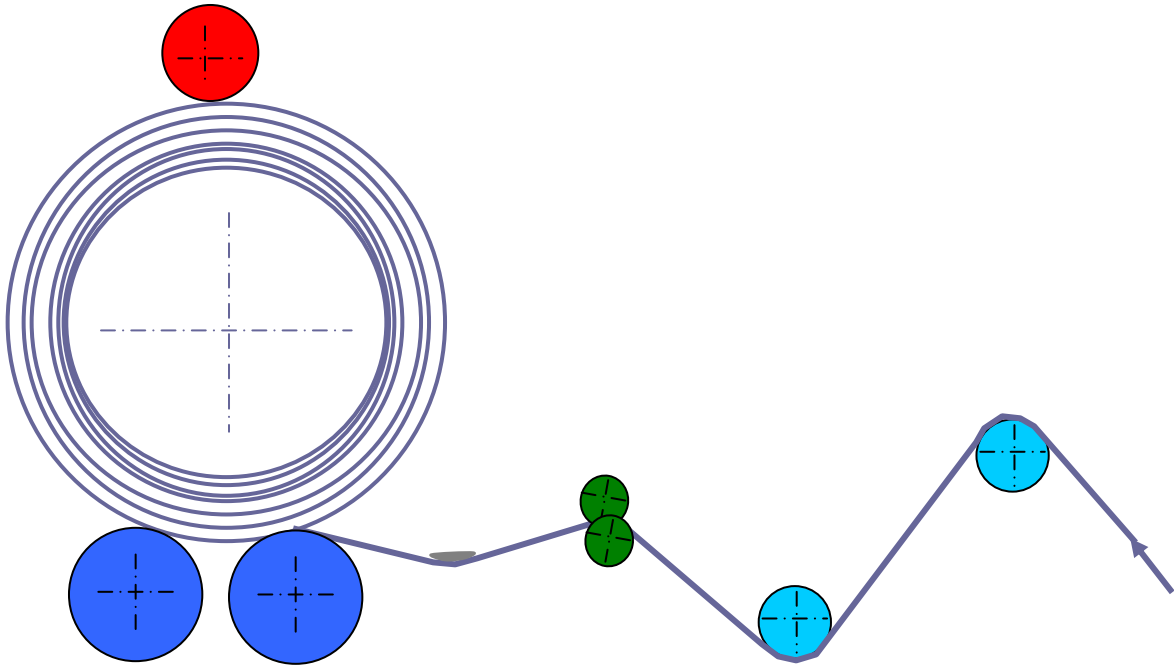
The design is suitable for speeds up to 2500 m/min and widths up to 10m, and can be used on paper grade from lightweights to boards.

The disadvantage of this winder is poor access, both for feeding up and for spreader adjustment. It is customary for a pit to be located under the machine, therefore, to allow the operators to have better access to the machine. Automatic feed devices and remote-controlled spreader adjustments can sometimes minimize this disadvantage.

Under feed winders are available in several forms, and some of these designs are more applicable to reworker operations when the production of a number of narrow width reels are required.







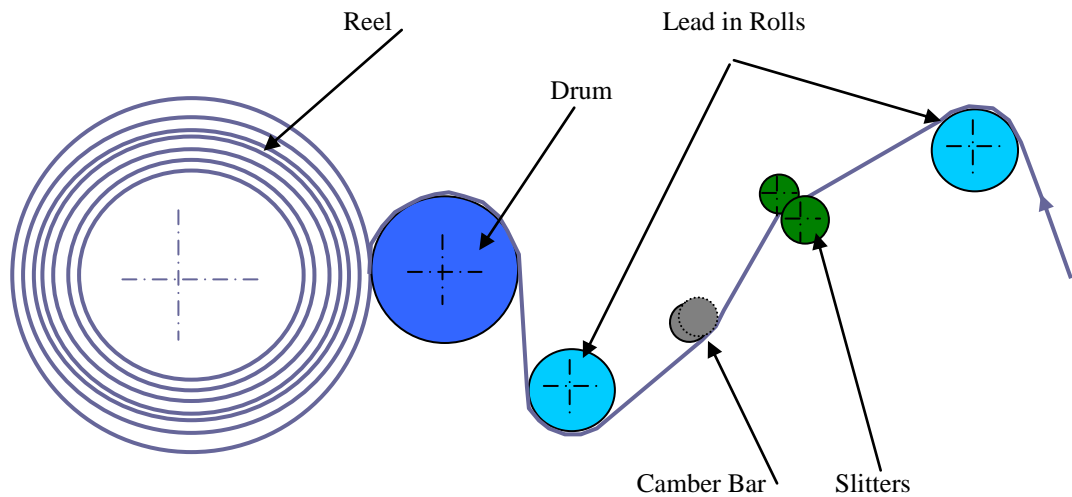
SINGLE-DRUM WINDERS.

This is a winder primarily used with off machine coaters and has a web run show below.

It accepts the un-coated reel from the papermachine trims the deckle edges, splices breaks and rewinds the reel on to shells suitable for the coater unwind.

It consists of a single drum with the reel supported on a horizontal level rail, an unwind station, slitters for edge trim and a spreading device.

The reel hardness is controlled by loading the reel against the drum by means of arms operated by pneumatic or hydraulic cylinders. This design produces the clean-edged break free reels that are essential for the flying splice unwinds of continuously running coaters.



SPECIALISED WINDERS

The winding of specialty grades such as lightweight publications, pressure sensitive papers, polythene-coated, silicone papers and super-calendered papers requires an exacting art.

On some of these grades, the maximum possible reel diameter is limited by the use of a two-drum winder, and other grades are not possible to wind.

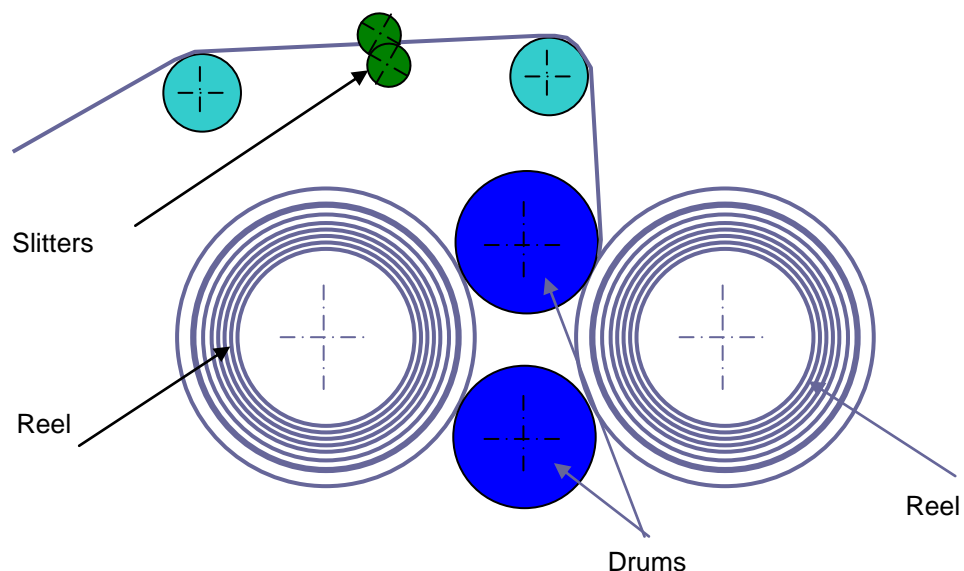
This is because as the reel diameter grows on a two drum winder, the increasing weight of the reel on the carrier drum can give rise to an excessive reel hardness leading to bursts, negative tension, telescoping and starring.

To some extent the problem can be over come by relieving of the core shaft, but this is not always possible because of the width of the machine and/or the choice of core diameter required by the converter.

To cater for these grades a different design of winder is therefore required. Various types have been developed, but probably the best known system is the duplex or Bi-winder.

In each case the same fundamental idea is used, namely, that the winder drums do not carry the reel weight.

One concept is shown below.



The Bi-Winder

The winding drums are arranged in a vertical plain and each slit reel is wound alternately on either side of the drum so that the problem of reel separation is eliminated.

Each rewinding core is carried on sub-shafts mounted in anti-friction bearings and is loaded by means of pneumatic or hydraulic cylinders on to the two drums. The wedge action of the two drums and the torque differential between them gives the desired tight start to the reel.

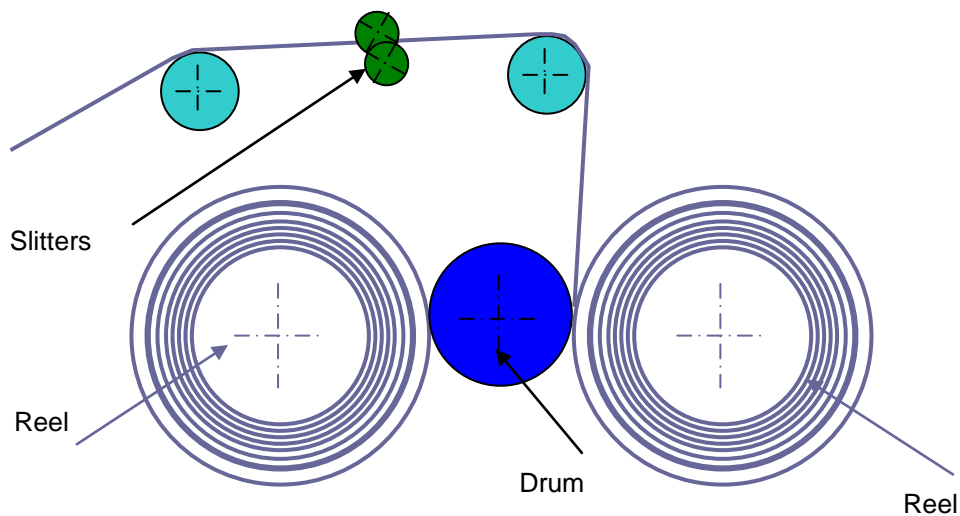
The reels are supported by inclined rails so that, as their diameter increases, the developing reels are transferred from the centre line of the drums into contact with one drum. Thus the two drum winder slowly converts into a single drum winder.

Pneumatic cylinder arms control the hardness of the developing roll. This more sophisticated control allows much larger diameter reels to be produced.

An alternative type of winder (shown below) works on the single drum winder principle, winding alternate reels on opposite sides of the drum. Hardness control is achieved by the nip/reel loading as before, plus a drive to the core shaft itself.

A further advantage of these types of machine is that, since each rewinding reel is individually controlled, any cross direction variations can be more easily accommodated.

Disadvantages of these winders are the complicated multiple controls required, the increased web-up and size change time and the higher capital cost.



**Single Drum Winder with staggered reels
(Duplex Winder)**

MACHINE ELEMENTS

UNWIND STATION

The purpose of the unwind station is to support the reel and to provide a brake for applying tension to the web.

The stand is fitted with a cross machine adjustment to align the reel with the winder, particularly useful for locating the web when narrow trims are being run. This cross machine adjustment can be either manual or power operated, depending upon the weight of the reel. A machine direction adjustment of one side of the unwind stand, is fitted so that the reel may be skewed out of alignment with the winder to allow for uniform tension to be applied across the web.

The selection of the brake for the unwind section from two of the types commonly used is determined by the grade of paper and the operating speed. The two types are - Friction brake and Braking generator or accelerator.

On modern winders accelerations of 0 – 2000 m/min are achieved, coupled with declaration times of 40 s. Therefore, the selection of the brake depends upon the tension that the web will safely carry.

When the web strength permits an acceptable acceleration rate, then the mechanical brake would be used; when the web strength is insufficient, then a braking generator is required to assist the reel to accelerate. For both types, the brake has to be sized for emergency stop conditions – that is, the brake must have sufficient capacity to stop a maximum diameter reel running at top speed in 15 – 20 s.

With a friction brake, this is achieved by suitably sizing of the brake; with a braking generator, by use of an auxiliary friction brake.

SHAFTLESS UNWIND STATION.

This does not employ a machine shell, but deals with reels that have been previously wound on card or strawboard cores on a previous winder.

The reel-carrier arms are pivoted on a main cross shaft and are raised and lowered by means of hydraulic cylinders. Both carrier arms are fitted with interchangeable reel core driving dogs and brakes for controlling web tension. The arms can move simultaneously in and out so that any width of reel can be accommodated.

This type of unwind stand is versatile in dealing with many combinations of core size and reel widths and gives much more unwind stability than the conventional unwind with a thoroughgoing bar particularly on small-diameter cores and narrow width reels.

UNWIND BARRING GEAR.

The trend towards large diameter reel has made it increasingly difficult for operators to rotate a reel by hand for the purpose of webbing up. Barring gear is therefore fitted, which consists of a slow-speed motor and clutch arrangement to rotate the reel. The controls are positioned in the main control desk with the clutch interlocked to prevent the winder starting up until the barring motor is disengaged.

OSCILLATING AND EDGE GUIDING SYSTEMS.

Oscillating the unwind stand slowly in the cross machine direction helps to even out any defects in the reel such as “rope marks”, ridges, and areas of caliper variation. The stroke of this oscillation can be upto 150 mm and, although a greater trim loss is inevitable, what may have been a substandard reel can sometimes be rewound and made acceptable.

Edge guiding equipment is used to monitor the edge of “telescoped or uneven-sided reels so that a reel can be rewound with minimum trim loss. To enable the response to the guide equipment to be fast and accurate, the whole stand is often mounted on a roller or recirculating ball race assembly.

LEADING OR PAPER GUIDE ROLL.

Between the unwind stand and the slitter station, paper guide rolls are fitted to ensure that the web has a constant approach angle to the slitters. On both large and high acceleration rate winders running lightweight webs, a DC motor synchronised with the main drive motor drives this roll. It is also fitted with a mechanical brake for emergency stops.

SLITTING.

The slitting section is a most important part of a rewinder and is very accurately constructed to give clean cuts at high operating speeds with minimum maintenance.

The shear cut slitter is by far the commonest slitter used, because it give a high quality cut on grades of paper from lightweights to boards. It consists of two overlapping circular knives, one of which is driven, that cut by scissor action. There are two main types – individual motor driven and multi knife.

Individual motor-driven. This principle comprises a knife mounted on an adapter carried from a motor. The complete assembly is mounted on a carrier bracket adjustable in the cross section for setting the width of cut. The motors can either be ac or dc, depending on the minimum width of slit required, but both types must be controlled from the winder drive to give the correct cutting speed ratio at any operating speed.

Multi-knife roll. This kind of shear-slitting assembly comprises a number of cutting bands mounted on a common carrier roll. The roll can be fitted with a centre bearing when the width and speed require additional stability. The individual cutting bands are adjustable along the carrier roll to cater for width adjustment and the complete is driven in conjunction with the main drive.

Top knife assembly. The top knife assembly is the same for individual-motor and multi-knife rolls. With shear slitting the top and bottom knives work as a pair; the top knife is set to a predetermined angle to give the correct shear angle and maximum knife life. The knives are engaged against the bottom band by means of a spring or air pressure to give the required side loading to drive the top assembly. For web feeding the top knife assembly is disengaged from the bottom assembly.

Both top and bottom knives must always be ground to the correct angle to ensure high quality cutting and minimum paper dust.

SPREADING

Spreading of the web is frequently used to maintain web separation after slitting, so ensuring that each slit reel does not interweave with its neighboring reel on the machine.

On some grades of paper, the spreaders are sometimes used before the slitters. The object is to remove wrinkles and slack areas, which is essential to ensure the correct conditions for good slitting.

The following types of spreaders are used: -

1. D-section spreader bar
2. Camber bar
3. Camber roll

D-section spreader bar. This consists of a flexible steel bar fitted with adjusting screws at approximately 200-m.m. pitch. The screw brackets are mounted on a carrying beam situated between the slitter section and the carrier drums. It is used for most grades of paper except coated papers and tissues.

The bar is set parallel to the web, then penetrated into the web and adjusted into a smooth curve. Both the amount of penetration and bow are used dependent on the paper grade. The D-section spreader bar can give good steering qualities to the web to prevent wander after the slitters. In addition adjustments can be made to its shape to cater for local faults in the sheet

Camber bars. This type of spreader consists of a stationary bar formed to a set bow and is fitted with controls to vary the depth of penetration into the sheet and the angle of the bow relative to the web line. The device is limited to the number of slit widths it can handle and is not as flexible in operation as the D-bar spreader, as local control is not available.

Camber rolls. A camber roll consists of a stationary bowed axle mounted on what are a series of close-pitched bearings. Over these, a flexible composition sleeve is fitted to form a curved rotating roll. This roll can be either driven or undriven, depending upon its application.

The rotation of the roll produces a much better spreading than the stationary camber bar and, on more sophisticated designs the curvature of the bow can be varied. This type of spreader is ideally suited to delicate webs and coated grades of paper.

WIND-UP SECTION.

The heart of the winder is the wind-up section, which comprises the carrier drums, rider roll and slides, also the core shaft heads and slides.

Carrier drums. These support the reel of paper during the winding cycle. They must be designed to support the reel with minimum of deflection and run at high speeds free from vibration. The drum diameter chosen is a function of the winder speed and face width based upon criteria of critical speed and deflection. In some cases, however, the drum diameter is selected because of the particular grade of paper being wound, as large-diameter drums help to give a softer wind at the start of the reel, which is desirable in grades such as lightweight printings.

The surface of the winding drum is usually scrolled or grooved to give good traction to the reel, the kind of grooving again depending upon the paper grade.

The grooving on the drum can also be a source of noise but by modifying the patterns the noise can be reduced considerably and in some cases eliminated.

Rider roll. The function of the rider roll is to maintain the nip loading between the reel and the carrier drums thus providing sufficient traction at the core to allow the winder to start its winding cycle without slippage.

For some grades the rider roll is driven to impart an additional tightening effect on the web.

On automated systems, the rider roll torque control and the rider roll nip loading are automatically programmed to give a reel with a constant wound-in tension throughout.

This feature compensates for the additional nip loading imparted by the increasing reel weight and gives a constant nip loading between the carrier drums.

Core shaft heads. These locate the core shaft by means of swing over clamp brackets or by spindles that move in to engage the core shaft ends.

The head assemblies move vertically in slides as the reel increases in diameter. The sideways are designed to have a minimum clearance to prevent stepping in the reel arising from speed changes.

A more recent development is shaftless winding. With this method, the cores are placed between the carrier drums and located by adapters that move inward to locate them.

The advantages of this method are that neither core shaft handling equipment nor core shaft maintenance is required. Also on grades that are subject to caliper or grammage variations, each individual reel can rest on the carrier drum, (this would have been impeded with a core shaft).

The disadvantage of this type of winding is the slightly increased down time when feeding and reel instability on certain grades.

Reel handling. Most winders are fitted with reel ejection devices to remove the reel from between the carrier drums on completion of the winding cycle and lower it to the floor.

There are various types available. The selection depends upon factors such as the number of operators, size and weight of core shaft (if any) and the permissible downtime.

Most winders are operated so that, as the finished reel is ejected, a new fully dressed shaft is injected into the winder and the winding operation then continues.

While the new reel is winding, the previous reel on the cradle is lowered, the shaft removed, recorded and inserted in the next storage pockets ready for the next reel change. This method of operation, which reduces down time to a minimum, is essential both on high-speed newsprint winders and on winders producing small diameter reels.

SPECIALISED FEATURES.

The following additional features are used when the paper requires a sophisticated reel structure or when downtime must be reduced to the absolute minimum.

Automatic tension control. Numerous devices are available, such as load cell and pneumatic systems, which will automatically maintain a uniform tension in the unwinding web during the winding cycle.

On some grades, it may be necessary for taper tension devices to be used that automatically reduce the tension as the reel increases in diameter and by this means prevent over-tightening of the outer wraps of the reel.

Programmed rider roll relieving. This feature allows the nip pressure of the rider roll to be automatically reduced, thus compensating for the weight of the reel as its diameter increases during the winding cycle. This feature contributes towards uniform reel density and avoids negative tension in the inner wraps.

Core shaft relieving. This feature will permit the loading of the core shaft against the drums, also the relieving of the core shaft away from the drums. The device can be automatically programmed to regulate the amount of loading or relieving as the reel diameter increases.

Full benefit can be achieved only when using stiff or large diameter core shafts. The method is especially applicable to crepe tissue winding, for which large-diameter shafts are needed to give correct bulk control.

Drum torque differential. On twin-motor drives, when a separate motor drives each carrier drum, it is usual to control the torque to the front drum to give a tight start to the reel. This torque can be varied automatically so that, as the reel diameter increases, the additional torque imparted to the front drum is slowly reduced until both drum torque's are matched. This feature will produce even and correct reel density.

Self-setting slitters. Automatic setting of both top and bottom slitters can be arranged so that during the winding cycle the next set of width changes can be selected. On completion of the reel, the operation of a switch will set both knives to their new positions.

This feature is particularly useful when the winder is dealing with small orders needing constant changes in slit width.

CONTROLS AND INSTRUMENTATION

The degree of sophistication of control panels obviously depends up on the required duty of the winder and must be selected for each particular application.

The control console should be sited to give the operator a clear view of the whole machine and it should not be in danger of burial in a pile of trim as the reel unwinds!

The control panel it self should be as simple as possible and ideally two operator controls are needed, machine speed and reel hardness.

Very many variables affecting reel hardness that require adjustment are only confusing and generally lead to inconsistent results.

Controls and instrumentation are usually electrical or electronic because of the ease with which they can be interlocked and made programmable.

ROTARY SHEETING

The consumption of paper is increasing year by year and paper dispatched in reel form shows the greatest percentage growth. This is largely due to the increase in the number of web fed printing machines particularly web offset machines.

However the demand for sheets also continues to increase and when considering the printing business the reason is clear.

In all countries of the world except USA the vast majority of printing runs is less than 100,000 impressions which are economical on web-fed machines hence it can be assumed with reasonable certainty that sheets will be used for many years.

CHOOSING THE RIGHT SHEETER.

Paper groups. Printings, writings and carton board together form the largest group of papers dispatched from mills. Each group will be looked at in terms of quality the printer requires.

PRINTINGS

By far the most important class is made up of the coated grades. The growth of consumption of coated paper and both wood free and mechanical, has exceeded the general market increase, owing to its improved printing quality, which is possible while using a lower quality paper base

Sheet sizes are in the large category and in as many different dimensions as the printer demands to suit his particular printing jobs.

In terms of quality the printer requires

1. Dimension accuracy for width and length
2. Accuracy of squareness
3. Stacks or reams to be free from dust and debris
4. Minimum shade variation with in a ream or stack
5. Good runability on the press.
6. Accurately counted reams or stacks.

WRITINGS

These papers are generally supplied in small standard sizes, e.g. A4 210 x 297 mm in wrapped or boxed reams. The guillotining process has traditionally produced such small sizes, sometimes known as "cut sizes", but developments in rotary sheeters have seen the introduction of machines that produce a continuous discharge of packets of sheets cut to finished size.

The outlet of these papers to the consumer is largely through merchants.

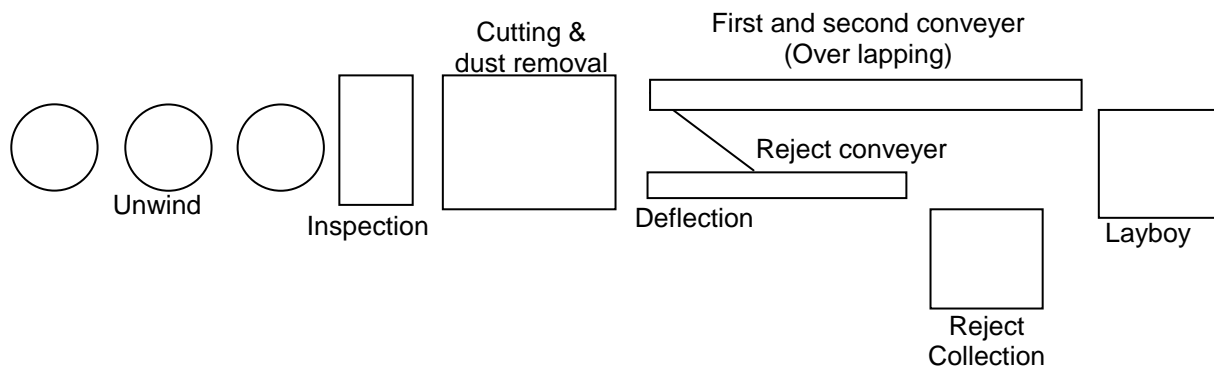
Market demands are: -

1. Attractive appearance
2. Accurate size
3. Accurate count
4. Good runability.

A typical machine of this type is shown on next page. The installation is arranged to discharge reams direct to the packing line. Such an integrated plant gives large labour saving costs compared with the old guillotine line method.

Typical sheeting equipment

It employs shaftless unwind stands for reels, complete with tension control and edge guiding in each reel, splice detection and sampling, heavy duty cutter section having a sophisticated mechanical, dust removal equipment, counting and marking equipment. This outline specification illustrates how selection of the sheeter meets market demands.



CARTON BOARD

This class includes many qualities and types of board, but basically it is used for packaging and display purposes. The growth of supermarkets has seen vastly improved standards of packaging and the numbers of quick changes of packaging, because of one week gimmick sales promotion techniques, has shortened the order run at printers, which has led to a sharp increase in sheet demand at the expense of reels.

This has given the board maker a new set of problems to face. His market demands are: -

1. Dimensional accuracy
2. Freedom from dust and debris
3. Guillotine quality cut edge
4. Consistent printability.

SPECIALTY PAPERS.

Advances in technology have led to the introduction of new grades of paper having special properties. This has, in some cases led to the development of specialists sheeters to handle such materials.

REELS AND UNWIND STANDS

REELS.

There are two possible sources for reels coming to a sheeter - those directly from the making machine and those that have been rewound and slit to a narrower width. The first decision to be made - rewind or not.

The trend to wider faster papermachines means that in many cases the decision is clear, for there are few sheeters over 3.6 meters wide.

So the choice is almost certain to be rewind for the following reasons

1. It enables gross faults such as tear outs and large holes to be removed
2. Brakes can be made good and associated creasing on either side of the brake can be removed
3. The resulting reels are concentrically wound and evenly tensioned, and these conditions are essential for high speed sheeting operations.

On occasions, the paper passes through other off machine processes before sheeting, even then, it still generally desirable to rewind before sheeting.

UNWIND STANDS

Reels are wound on

Strawboard centers, Machine shells or Metal tubes

The type of reel stand best suited to the particular application has to be selected from a multitude of available types and combinations and the tables below gives some indication of the problems facing the finishing manager.

Basic Principle	Types of Centre	Number of cut reels at once	Usual paper grades	Advantages	Disadvantages
Shaftless	Strawboard or metal pipes	One and two reels	Board, High quality coated and uncoated printings (associated with inspection and sampling)	No bars to handle, accurate tension control, concentric off-wind, reduced labour costs.	High capital cost reduced through put
		Four to ten reels	Medium coated grades, general uncoated printings and writings	As above but tension control by master reel system there less accurate	High capital costs.
Shafted	Strawboard or metal pipes	One and two reels	High quality papers on machine shells Board - full machine width applications	Lower capital cost	Heavy bars, bars deflect when carrying narrow reels, high labour cost, less accurate tension control
		Four to ten reels	Very general	Lower capital cost	Heavy bars, bars deflect when carrying narrow reels, high labour cost, less accurate tension control

One fact is clear sight of the final users requirements must never be lost. For example, if high quality blade coated paper is being produced for the offset litho printer who will not except any variation in shade, then it is no use whatsoever even considering an unwind stand that will take 8 to 10. Out put is important only after all other market demands have first been met.

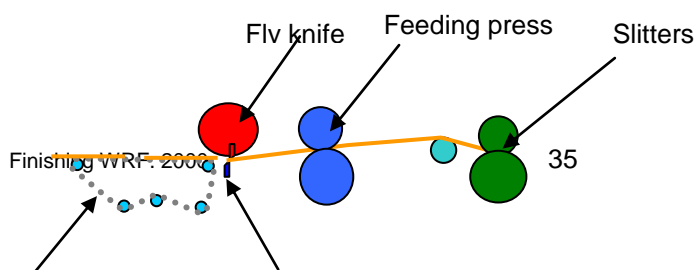
CUTTING UNIT.

There are two basic types of rotary cutter:-

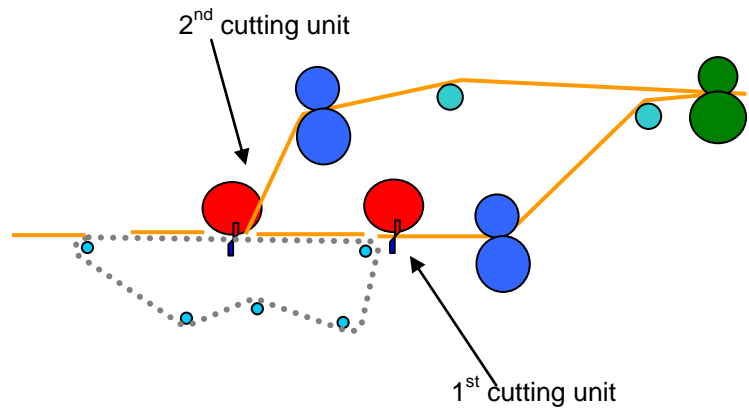
The single rotary cutter, which has a single rotating knife cutting against a dead knife. The double rotary cutter, which has two rotating knives synchronized mechanically to cut at web speed regardless of the sheet length being cut.

These terms must not be confused with simplex and duplex.

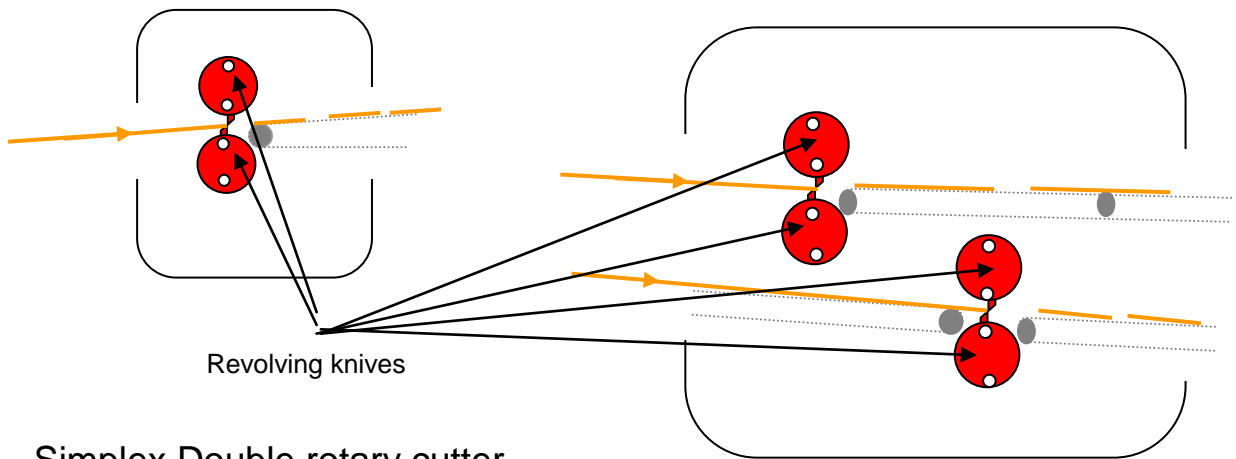
A simplex cutter is one having only one knife station, and a duplex cutter has two knife stations and can therefore produce two different lengths of sheet at the same time. Both are illustrated below.



Conveyer



Duplex single rotary cutter

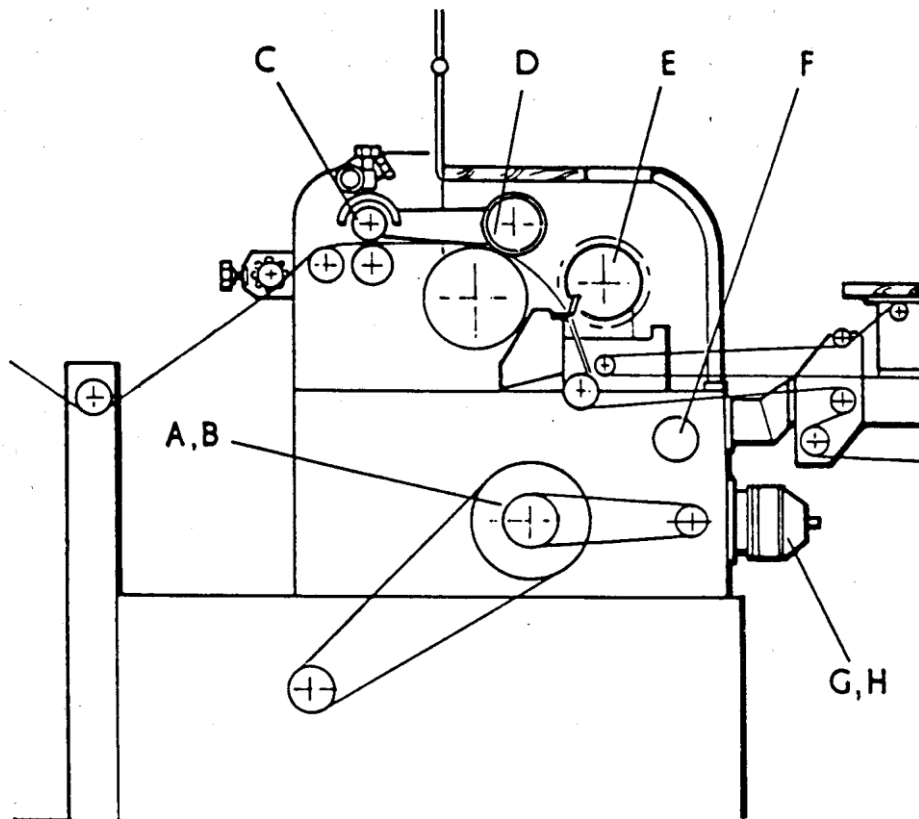


Simplex Double rotary cutter

Duplex Double rotary cutter

SINGLE-ROTARY CUTTING UNIT.

The illustration below shows a section through a typical simplex unit



- | | | | |
|---|------------------------------|---|-----------------------------------|
| A | Main drive | E | Fly and dead knife assembly |
| B | 3 UP P.I.V gearbox H-portion | F | Pick-up roll assembly |
| C | Top and bottom slitter units | G | main conveyer (with variator) |
| D | Top and bottom press rolls | H | main conveyer drive (fixed ratio) |

POINTS ON DESIGN

The *draw rolls or feeding press* pull the paper webs off the reels, located in the unwind-stand, against the tension of the brakes.

This takes the webs through the slitters, which generally take an edge off either side of the web and can slit longitudinally into two or more finished sheet widths.

. Check that: -

1. Are there enough lead in rolls and support plates to control the web while being slit. If not a wavy sheet will result.
2. Are the slitters easily adjusted. This will effect down time
3. Are the top and bottom knives easily removed. This also will effect down time

The draw rolls usually comprise a steel bottom and a rubber covered top roll, the latter has a chevron pattern cast into it during the making process, this is to impart a degree of spreading to the sheet.

Check that: -

1. The rolls are of substantial size otherwise deflection will occur
2. There is an efficient means of loading the rolls/press, because any slip will effect sheet length.
3. The rolls are positively driven, any variation relative to the knife section will also produce a variation in sheet length
4. Loading of the press can be varied at each side.
5. The nip is properly guarded

After the slitting operation, the paper webs are now fed (pushed) into the kife assembly. The fixed knife (the dead knife) is mounted on a beam that is supported on the main side frames of the cutter section and the ends of this beam also provide the support for the rotating knife (the fly knife).

The cross cutting unit can therefore be considered one unit. The knives are mounted in a manner so that the actual point of cut travels across the width of the web, as with a pair of scissors

Check that: -

1. The dead knife beam is of heavy construction, this governs the maximum substance of paper that can be effectively and efficiently cut and the time between knife changes.
2. Is the angle at which the paper moves through the cutting assembly correct for the particular grade of paper to be cut. Examples of angles are as follows: -

- One and two web operations on papers up to 200gsm 10-15°

- Multi-web operation for medium weight papers and one and two reel operation for heavyweights 35°
- Lightweights 45°

3. Are the knife seatings ridged

4. Is the fly knife streamlined, if not it will disturb the air at high speed causing disturbance of the paper flow.

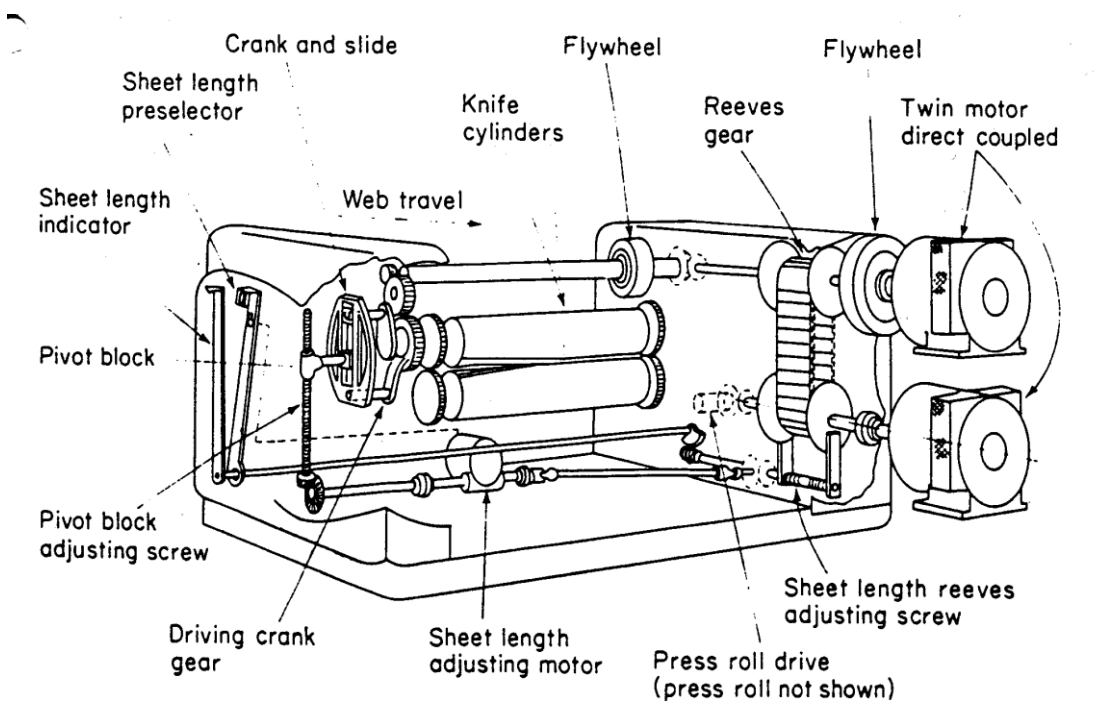
DOUBLE ROTARY CUTTING UNIT.

The principle of the feeding press and the slitters is the same for the single rotary cutter.

The cutter contains two rotary knives that are geared together. The two knives are on a helical mounting and as the knives engage at the moment of cut, a true scissor action travels across the width of the cut.

The knives have to be synchronised to travel at the moment of cut regardless of the sheet length being cut. As with a single rotary cutter there is an ideal cutting condition, this on a double rotary cutter is when the two knives rotate at constant velocity, termed 1 to 1. If the sheet length is adjusted either side of 1 to 1 the knives have to be accelerated or decelerated during each revolution in such a manner that they travel at web speed at the moment of cut.

With this synchronising feature, the drive becomes more complicated, the illustration shows the basic principles



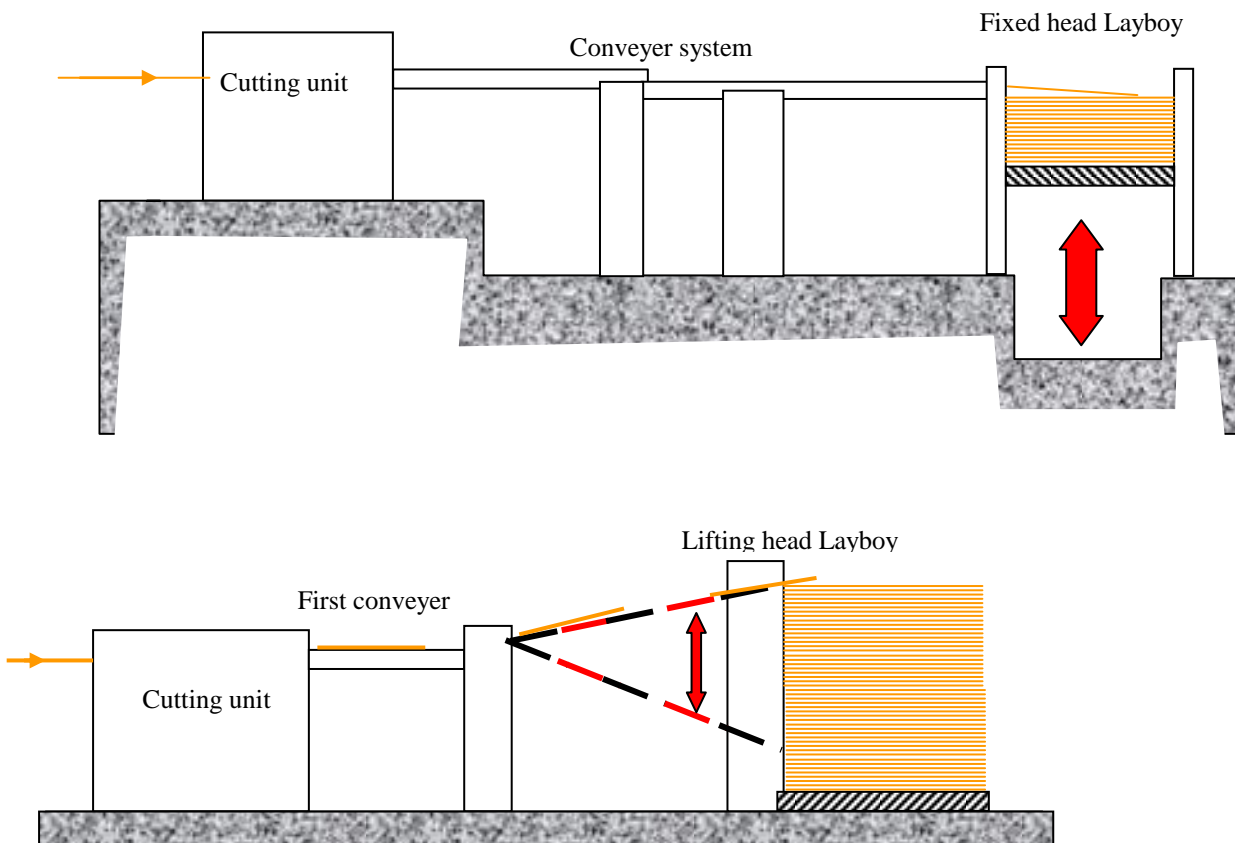
LAYING SYSTEMS

Up to the knife unit a continuous web is being handled, after the knife sheets have to be accommodated.

90% of the problems on a sheeter occur when the sheet is being cut.

Modern handling systems take a wide variety of forms but their primary function is basically the same, namely to take away sheets from the cutting section and stack them.

There are two basic types, the lifting head and the fixed head. The difference being that in the lifting head the conveyer swings up and down and the stack remains stationary. Where as on the fixed type the conveyer remains stationary and the stack moves up and down.



Most sheeters now employ fixed head type because the major disadvantage with the lifting type is that the angle of the sheet is constantly changing which imposes a speed limitation at the start and finish of the stack

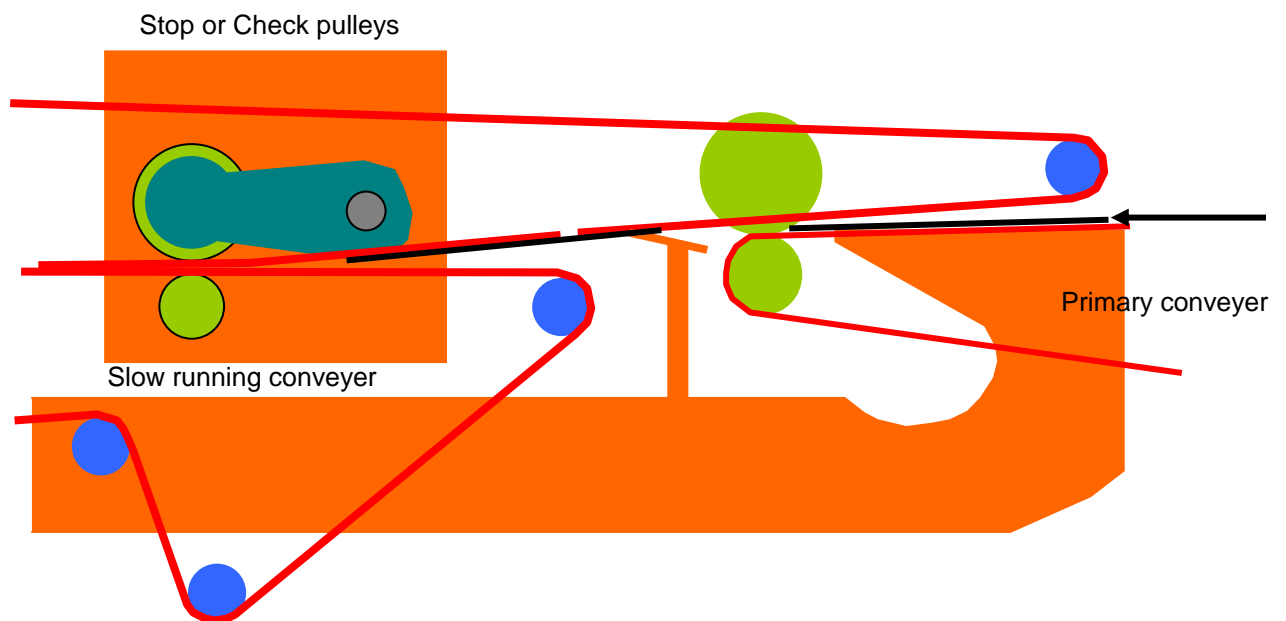
PRIMARY CONVEYER.

This is the section that takes the sheets away from the cutting assembly. It is always arranged to run faster (by about 10 - 20%) than the speed of the uncut web. This over speed condition is to create gaps between the packs of sheets so that the over lapping can reliably be achieved at the transfer point from the fast running primary conveyer to the slow running secondary conveyer.

It is most important to be able to adjust the speed of the primary conveyer relative to the uncut web and the secondary conveyer so that the optimum over lap conditions can be obtained regardless of the length of sheet being cut.

OVERLAP

The requirement at the end of the sheeter is, that the sheets are brought to rest either in the form of a neatly dressed stack or as individual reams, this is usually done in two stages, the first of them being the over lapping of the sheets and slowing them down. The illustration below shows the overlapping section of a sheeter.



The slow running conveyer or the secondary is lower than the primary conveyer by about 15mm.

As the sheet leaves the fast running section, the sheet is 'corrugated in the cross direction by channeling pieces or a specially designed roll. This is to impart additional rigidity to the sheet. The sheet continues to travel at the primary conveyer speed until the leading edge reaches the stop pulleys or the stop roll, which brakes the sheet down to the secondary speed.

The trailing edge drops onto the overlap plate allowing the next sheet to pass over the top, the process is then repeated.

This design of overlap slows the sheet from the front and has limitations in certain grades, in that the sheets tend to buckle as they hit the stop pulleys restricting the operating speed.

This led to the development of systems of overlapping that slow the sheet by gripping the trailing edge.

This is accomplished by either a pulse vacuum system or mechanical devices. The vacuum system is usually fitted to installations operating from only one reel at a time and the mechanical two or more web operations. The timing of the retardation is critical in these type of systems and the timing must be adjusted for different sheet lengths.

SECONDARY CONVEYER.

This is the slow running section that delivers the overlapping sheets onto the pallets in the form of a stack that is acceptable to the final user.

The last conveyer roll on this section is usually termed the final delivery roll and its job is to project the sheets onto the stack were they are finally brought to rest by striking a stationary back board.

Jogging devices usually operate on three sides of the stack to finally dress the sheets endeavoring to give a "block of ice" effect desired by the trade.

In the case of specialty sheeters, two ream formation systems work alternately, each ejecting precise finished - to -size reams into an inline packing machine.

A unique sheet arresting principle forms tidy reams without the necessity for the conventional overlapping and is a great advantage when running lightweight pressure sensitive grades.

OPTIONAL REFINEMENTS.

Other features that may be added to the sheeter are: -

1. Ream counting
2. Sheet counting
3. Dust and debris removal
4. "pile up" detectors
5. Static eliminators.

FACTORS AFFECTING SHEETER PERFORMANCE.

EXTERNAL FACTORS.

1. Will the papermaking process produce paper to the required quality
2. Do the winders constantly give the quality of reel for the market, if not will these reels find their way to the sheeter?
3. Are the reel graded before they come to the sheeter
4. Are the flow lines to and from the sheeter correct? Poor throughput can cause machines to stand idle

HUMAN ELEMENT.

If the machine is a well-proven installation, then it is possible that on the job training will sufficient to secure good runnability. But if it is the first generation of a new generation of machines then training with the manufacturer will be needed as well as some "conditioning" if the machine is to run considerably faster than existing machines.

MECHANICAL LIMITATIONS.

These can be roughly classified into categories, engineering design and the nature of material being handled.

The first is affected by speed A double rotary cutter may be subject to speed limitations at extreme lengths of sheet range, owing to the complex cycle drive arrangement. The performance charts fitted to the machine should be strictly adhered to.

On a single rotary cutter, there may be also a restriction on the shorter sheets governed by the number of revolutions of the knife drum per minute (cuts).

The material being handled (The paper)

These may be varied and it is difficult to lay down clear guidelines, but the main factors will be: -

1. Paper quality. The lower the quality the lower the running speed owing to the limp nature of the sheet.
2. Paper substance. The higher the paper substance the lower the speed
3. Number of sheet being cut. The fewer reels the lower the speed, but there is also an upper limit associated with quality of cut and slit.

4. Moisture content. Generally if the moisture content is kept above 5% there will be few difficulties, below this figure the paper becomes prone to static. Humidifiers in the finishing room could be the answer.
5. Caliper profile. This can cause creasing and or stacking problems.
6. Reel quality. Reels should be of the same quality as those sent out for reel orders, free from slack starts, poor quality centers, out of round and over tight reels causing stretching of the paper.
7. Curl. Reel should be free from curl, however effective curl correction can be achieved if each individual sheet is passed through a curl correction device.

Having established the limitations, the aim is to obtain the maximum output while still meeting the market demands on quality.

Factors affecting throughput are: -

1. Width utilisation of the cutter. Whenever possible make effective use of the full cutter width.
2. Number of reels cut at one time. Cut the maximum number of reels while keeping quality standards.
3. Downtime. Keep the sheeter running.
4. Operating speed. Aim for consistent speeds rather than short bursts of high speed followed by clean up time.
5. Order size. A large proportion of small orders has a significantly bad effect on throughput.

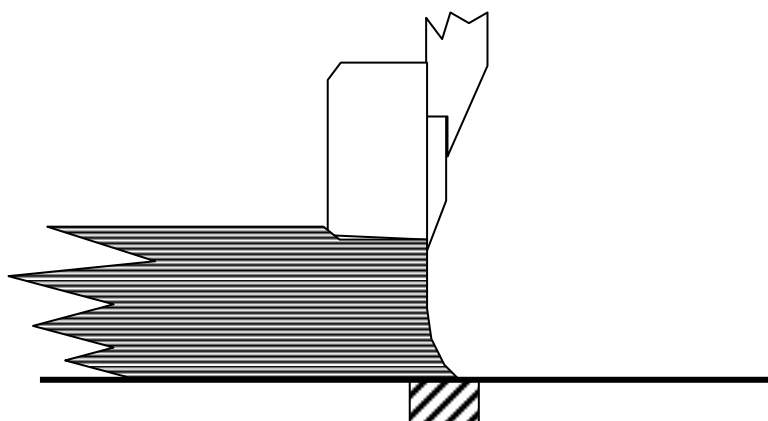
GUILLOTINING.

The trend now is to high speed, large through put rotary sheeters which give very precise sheet sizes. However a guillotine may still be used in some mills and here are listed some points to look for or note if a guillotine is in operation.

Problems

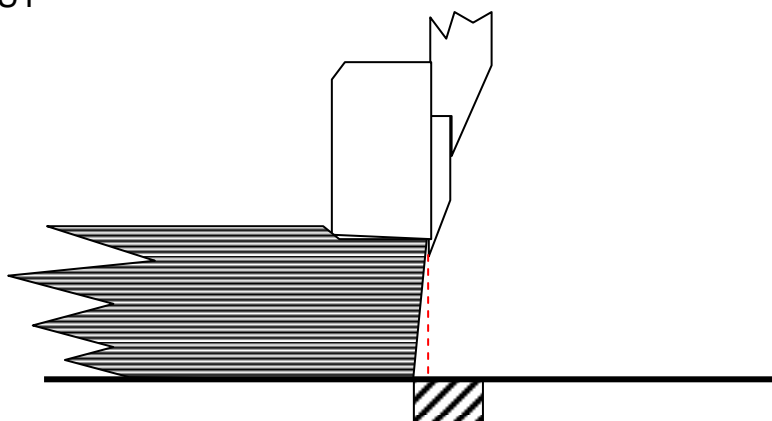
The following problems are either the fault of the knife or the clamping mechanism.

OVERCUT.



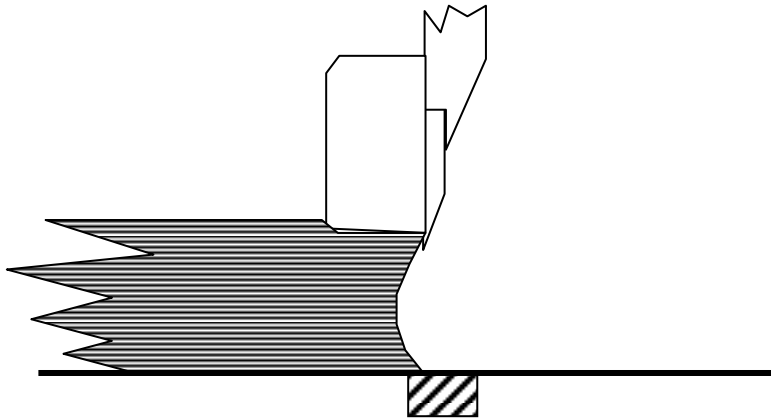
CAUSES, The knife may be blunt or bevel too large, knife is not seated in holder properly or the back of the knife is not perfectly flat.

UNDERCUT



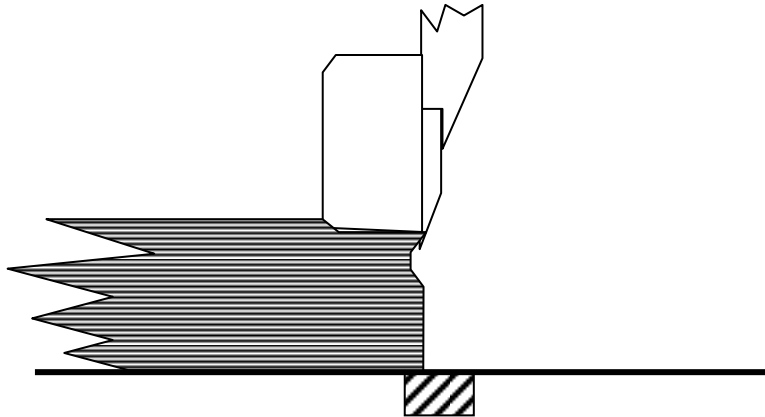
CAUSES. The knife may be blunt or the bevel too small, knife not seated in holder properly, knife too small or clamping pressure too low.

CONCAVE CUT



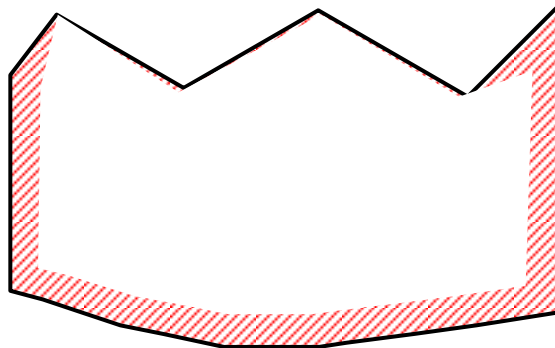
CAUSES. Knife bevel too small, pre-clamping not sufficient.

SCOOP CUT.



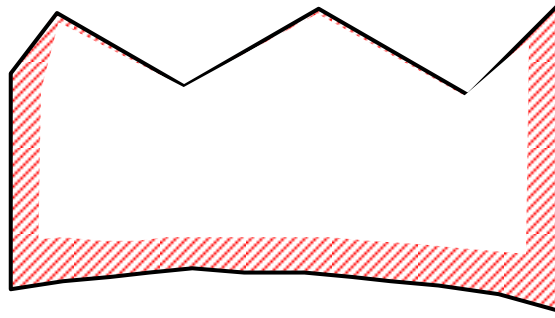
CAUSES. Clamping not complete before the cutting takes place.

BOWED CUT



This usually indicates that the clamping pressure is greater in the middle possibly due to the pile being higher there.

HOLLOW CUT



This can happen when the clamping pressure is too high on a wavy sheet. The clamp pushes the waves backward into the pile and return to their original place after the cut has taken place.

REAM & PALLET WRAPPING

The main objects of ream and pallet wrapping are to provide an "enclosure" that must protect the contents during transit and also have a sales appeal

In addition the package should be easy to handle, open and store. These functional requirements need to be attained in the most economical manner suited to the local circumstances.

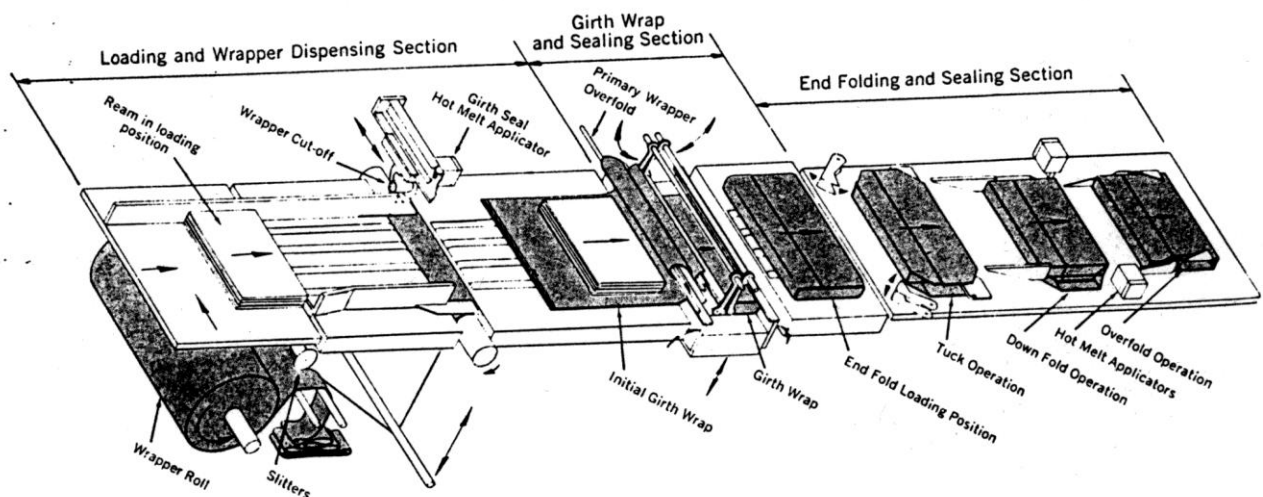
Pallet loads versus ream packs.

The advantages of pallet loads are: -

- Reduced handling costs
- Saving in wrapping materials
- Reduced labour costs.

The disadvantages are: -

- Bulk handling and transporting problems
- Storage, loads can become unstable.
- Inadequate protection against damage
- The pallet it self



Stages in an automatic ream wrapper.

REEL WRAPPING

Again the fundamental reason for wrapping is to prevent damage but the second reason in the case of reels is to prevent moisture penetration.

Factors affecting the choice of pack.

1. Method of transportation considerations to be made are: -

- Are the reels to be containerised?
- Are the reels to be transported in a rail car (abroad)?
- What distance are they to be transported over?
- What are the climatic conditions at their destination?

2. Method of storage

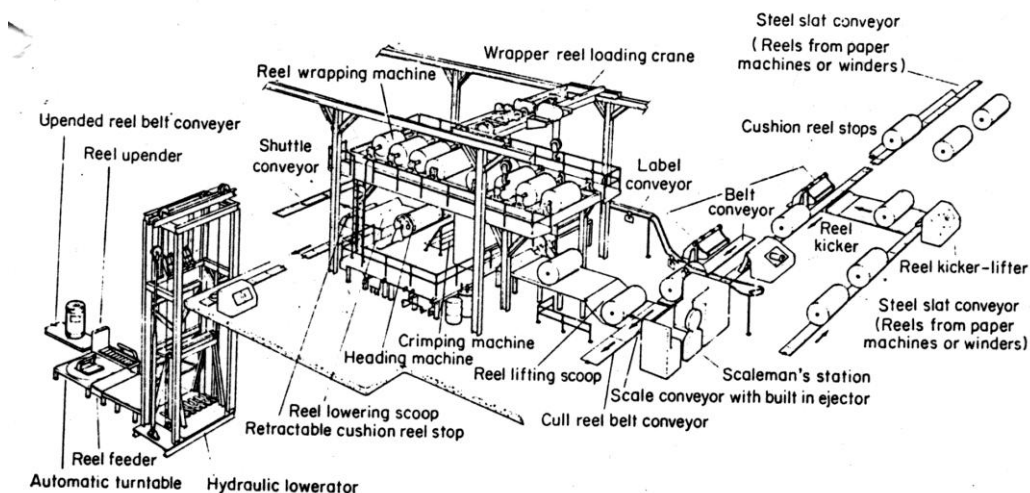
- How are the reels going to be stacked, chimney, pyramid or belly stacked?

If they are going to be stacked on end then particular attention should be paid to the method of pleating and the sealing of the ends, because in some cases this could make a stack unstable.

If they are to be stacked pyramid or belly stacked then the most important part of the wrapper is round the body of the reel. It must be tightly applied to avoid splitting under the pressure of the upper reels.

3. Period of storage. The importance of moisture proofing and physical protection are the prime consideration when the reels may be stored for a considerable time.

A point worth noting is that the customer invariably purchases the wrapper weight at the equivalent paper rate; consequently it is not in the interest of the paper mill to wrap the reels in an expensive wrapper.



An example of a reel wrapping machine.

SHRINK FILM WRAPPING

Shrink film wrapping offers the least capital cost and the the simplest form of automatic packaging.

But there can be difficulties.

- Film disposal
- Condensation, in certain climatic conditions condensation can form inside the film.
- Difficulty in opening the pack
- Appearance, shrink wrapped reels and reams do not have the same appeal
- Protection. Because there are different grades of film there are doubts that some of the inferior grades do not offer as good as protection as kraft.