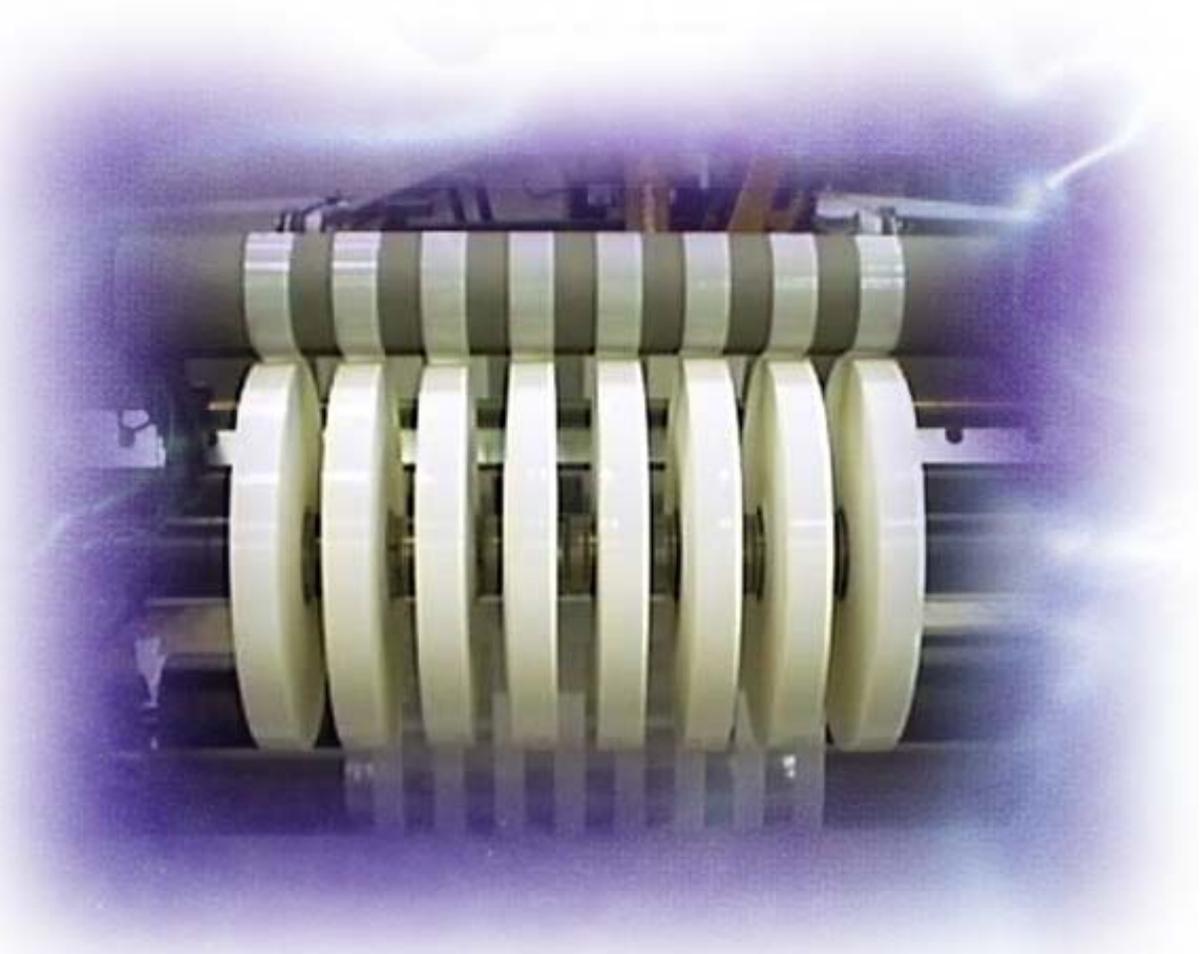




Guide to Winding & Slitting



Information and techniques described in the following pages has been compiled from the experience of a variety of individuals from across the Converting Industry. It is offered in the spirit of endeavour and Ashe Controls Ltd makes no warranty as to its application to any specific product or circumstance.



Winding & Slitting

Introduction

Web processors are challenged daily by the continuing introduction of new and unique materials in plastics, film, paper, foil, laminates, tapes, nonwovens . . . Material conditions, surface air and mechanical conditions are the major problem areas associated with winding, which are discussed in this guide.

This is followed by an analysis of basic slitting and winding techniques which should be helpful in solving these problems.

Where appropriate, specific equipment is discussed in terms of its usefulness in achieving optimum, efficient, quality production.



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Material Conditions

All films, coated materials and laminations are subject to some or all of the following variations:

Gauge Variation

A gradual uneven thickness across the web width from edge to edge.

Gauge Band

An abrupt change in thickness in a small area. Gauge bands run parallel to the main axis of the web and can exist for the length of the web, or only for short lengths.

Slack Zones

Slack Zones are caused by the uneven production of the original material. In this condition, the gauge can be even, but if the web were laid out on a flat surface and cut into strips parallel to the machine direction, the slack zone strips would be longer than the normal or tight zone strips (Figure 1-1).

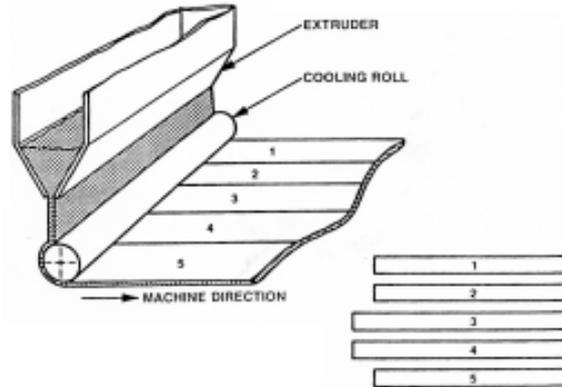


Fig. 1-1. Slack Zones

Surface Air

All materials carry a surface layer of air with them as they move through a machine. When films are slit and rewound, the layer of air is carried into the rewind roll. At low speeds, this layer of air can escape at the ends of the slit rolls without causing problems in winding. At high speeds, air is wound into the roll. This can result in the air acting as a lubricant or becoming trapped between the layers of material. When air acts as a lubricant between the layers of material it allows shifting of the second, third, and lower layers (from the outside in) within the axis of the roll (Figures 1-2 and 1-3).

Fig 1-2

Fig 1-3

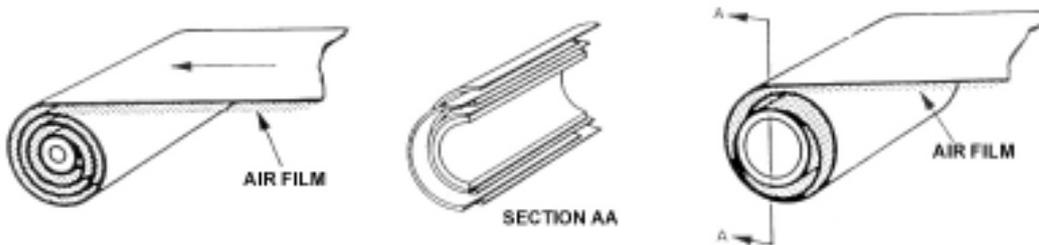


Fig 1-2 and 1-3 Air wound between layers showing the relative shifting of the material

When air is trapped between the layers of material and is wound into the roll, it forms tires, balloons or bubbles, causing deformation and occupying volume as a secondary layer (Figure 1-4). This causes poor roll formation and deformation of the web.

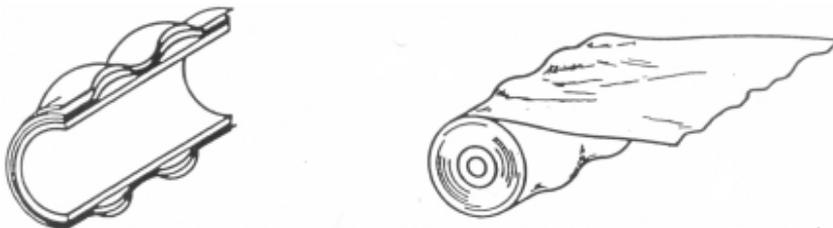


Fig. 1-4. Air Trapped in Rewound Roll



BASIC SLITTING TECHNIQUES

Razor Blade Slitting

Shear Slitting

Score Cut Slitting

Basic Slitting Techniques

The type and thickness of material determines whether shear cut, razor blade or score cut slitting should be employed. For example, soft films such as polyethylene, vinyl and polypropylene are cut quite easily by razor blades, as are the light gauges of polyester. Heavier gauges of polyester, starting at .002" thick should be shear cut, as should paper foil, and most laminates of the above. Score cut slitting is usually employed where speed of set-up is more important than the quality of the slit edge or the material is too abrasive for shear or razor blade slitting.

Razor Blade Slitting

If original equipment cost, cost of knives and speed of set-up alone were used as a criterion, only razor blade slitting would ever be used. However, razor blades cannot be set to hold close slitting tolerances, nor are they capable of cutting through heavy rigid, or abrasive materials.

Figure 11-1 shows razor blade slitting in air and Figure 11-2 razor blade slitting in a grooved roll. Of these two, the use of the grooved back up roll with the web wrapped around the roll provides for a cleaner, smoother and more accurate cut because, the roll gives very close support to the web as it is being cut. It cannot stretch or shift under the blade as it can when slitting in air between two rolls. If the web runs tangential to the grooved roll rather than wrapping around it, the benefits of the grooves are lost.

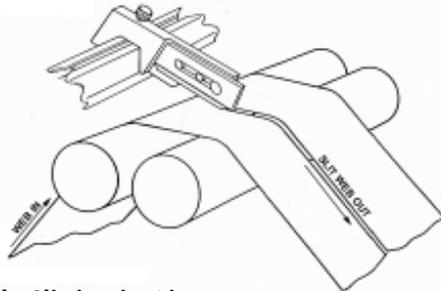


Fig 11-1 Razor Blade Slitting in Air

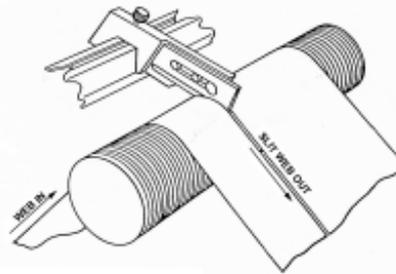


Fig 11-2 Razor Blade Slitting in Grooved Roll

Set-up of razor blade slitting in air is faster, but also results in a loss of accuracy in slitting. The grooved roll requires more set-up time because the blade must be centered in the groove not touching either side or the bottom. Contact between the razor blade and the grooved roll quickly destroys the blade and tends to damage the groove.

Figures 11-1 and 11-2 also show the most commonly used method of having the blade penetrate the web. However, recent tests have shown that much cleaner cuts are obtained by using the method shown in Figure 11-3.

Tangential Razor Slitting

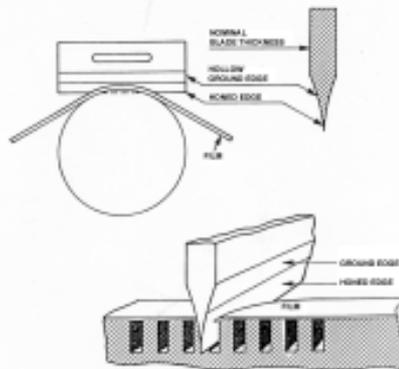


Fig. 11-3. Grooved Roll. Magnified Section

In this arrangement the film touches only the finely honed area of the blades keeping abrasion of the film to a minimum. When hollow ground blades are used there is less interference between the blade and the film being cut.

At nominal running speeds, say through 1500 FPM the blades also tend to burnish the film as it is being slit giving a polished edge. Over these speeds heat is generated. If enough heat is generated to start melting the film, a bead can be generated at the slit edge. This bead can be very detrimental to achieving good winding of the slit strips.

The razor blade is the most economical of the knives used for slitting. Set-up is easily accomplished just by clamping a blade in place along a bar so that the blade penetrates through the web. Hence razor blade slitting can be recommended for quality and for fast set-up on any light, non abrasive materials.

Shear Slitting

Shear cut slitting uses two rotary knives to produce the same cutting effect as obtained by using a pair of scissors. Scissors present a condition with two sharp blade edges crossing at an angle as is shown in Figure 11-4. To cut the material it is necessary to apply force on the handle of the scissors. The cutting takes place at the junction of the two sharp edges, and as the scissors close, the angle of the junction gets smaller. As the angle changes, the cutting effect changes. There is an ideal angle at which a material will cut. We have all tried taking scissors, holding them open, and pushing them through a sheet of paper. At a certain angle they cut cleanly and very easily. Change the angle slightly, and the paper tears. This is exactly what happens with a pair of rotary knives.

If the web is running slower than the knives, effectively the knife is closing in on the web or cutting it the way scissors cut. If the web is running faster than the knives, the effect is the same as pushing the material through the scissors. This is why material can be effectively slit at a knife speed which is either slower than synchronous, synchronous with the web, or faster than synchronous. The angle of junction between the knife cutting edges is the c

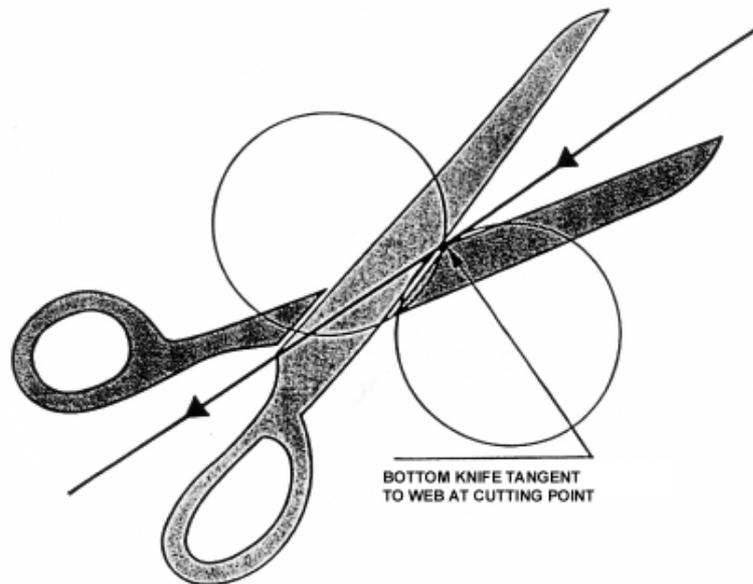


Fig. 11-4. Shear Slitting Principle

Changing the analysis from scissors to two rotary knives, there are two circles that overlap and form a junction angle.(Figure 11-5) similar to that formed by the scissors. Squeezing the blades together creates a reaction force which pushes the blades apart. This is the, same force that is used to squeeze the handle of the scissors. When a large number of cuts are being made, these reaction forces can bend a knife shaft. This is a factor that must be considered in all slitting applications. No table of the shearing forces required for various materials is yet available.

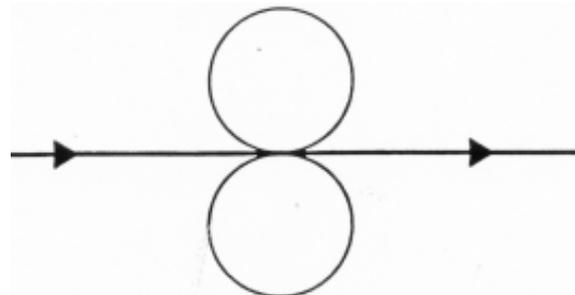


Fig. 11-5. Shear Slitting As Applied to Rotary Knives

At the present, we are using a figure of approximately a pound. to a pound and a half per cut per mil of material thickness. Also uncertain, at this time, is the effect that the relative speed between the material and the knives has on the shearing force. This is also being studied. We now feel that when the knives are running faster, the unit shearing force is less, because less material is being cut per knife revolution than would be at synchronous speed. Hence higher knife speed results in lower shearing forces. Also under study is the relationship between knife speed and slit edge quality. There is some indication that faster speeds are better for foil. To date most plastic films and paper are slit at synchronous speed with excellent results. On most materials, problems exist at speeds below synchronous. These are generalities that can be made about cutting effects and the relationship between scissors and shear knives.

Next, consider the configuration of the web and the knives in the machine. There are two primary arrangements: "Wrap Slitting" and "Kiss Slitting". The preferred arrangement is "Wrap Slitting". Here the web actually wraps around the female knife and is positively supported while being cut.

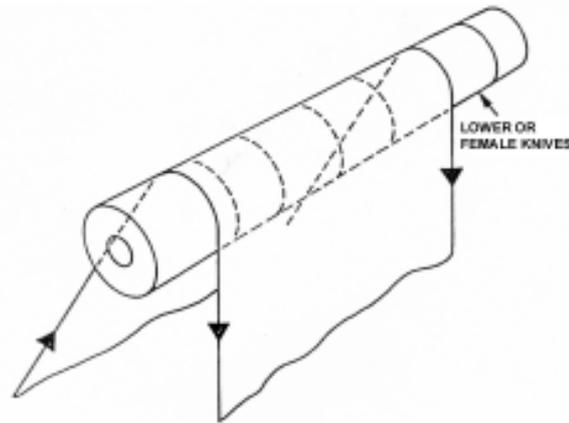


Fig. 11-6. Web Wrap Around Female Knife

as shown in Figure 11-6. The arc of contact between the web and the female knife must be greater than the arc of contact between the male knife and the female knife. See Figure 11-7 the arc of web contact is smaller than the arc of knife contact, the male knife hits the unsupported section of the web, The web is, therefore, torn rather than cut. This condition is illustrated in Figure 11-8. Knives and spacers must be assembled on the shaft to form or to simulate a solid supporting shaft. Unless the web is supported by a shaft solidly stacked with knives and spacers, the web will pull or sag into the voids and irregular slit widths will result.

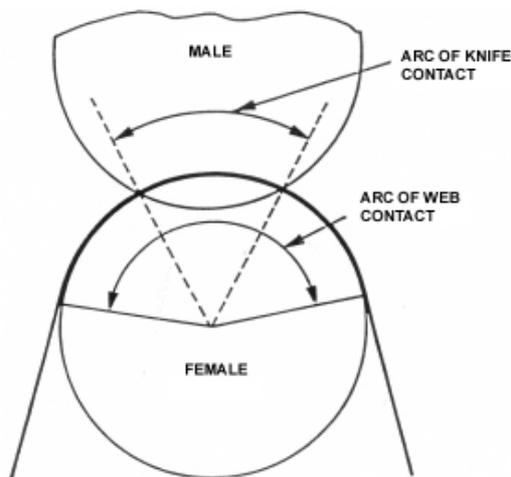


Fig. 11-7. Arc of Contact between Male Knife & Female Knife

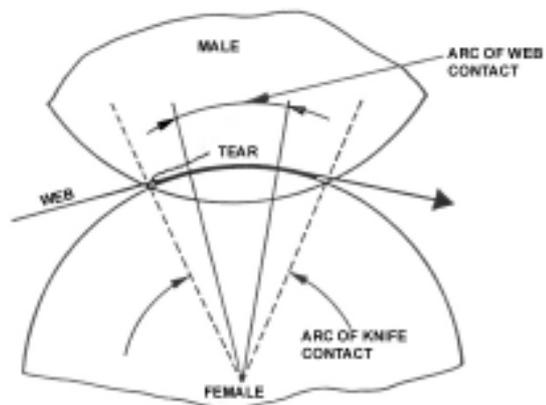


Fig. 11-8. Detail of Contact Arc

The second arrangement is tangential or kiss slitting. In this arrangement the web only kisses or touches the outside diameter of the female knife, it doesn't wrap around it. See Figure 11-9. If the web hits the male knife before it hits the female, a cutting angle is not achieved. This is the same as taking scissors and trying to cut with only one blade. The web is ruptured, not cut. Conversely, if the web hits the female knife first, nothing happens, but, when it leaves the female and hits the male, again the web is ruptured. A clean cut is not achieved. It is essential in kiss slitting that the female knife, the web and the male knife, contact each other at the critical point. This critical point will change as the male knife overlap is increased; therefore, you cannot increase the overlap beyond an ideal condition without creating problems. This ideal condition is minimum overlap and point contact. Increasing overlap increases the arc of contact between the two knives and the male knife hits the web before the female. Using a male knife of a smaller diameter will give a greater overlap before reaching the critical point. See Figure 11-10. The large diameter male knife has a larger arc of contact for the same overlap. Therefore, the smaller the diameter of

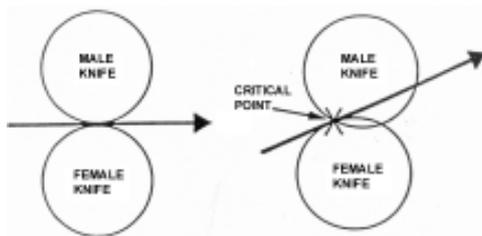


Fig. 11-9. Kiss Slitting

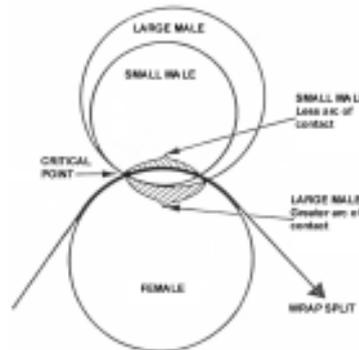


Fig. 11-10. Detail of Contact Arc Wrap Slitting

the male knife, the greater the permissible amount of overlap. The greater the diameter of the male knife, the smaller the permissible overlap. The large radius will give a bigger arc as you increase the overlap. To this degree, the individual knives, permitting fine adjustment of each individual knife, give better control than multiple knives mounted on a single shaft where additive tolerances must be overcome by increasing the overlap.

The advantage of kiss slitting is fast setup of individual female knives. These knives can be repositioned on the shaft without removing the entire-knife shaft. Wrap slitting requires the removal of the shaft from the machine, taking off the knives and spacers and then putting them back in rearranged order. In kiss slitting, the knife is loosened, shifted to the next cutting position, and tightened again. It can be accomplished in a minimum of time in the machine without removing any parts from the machine. The disadvantage lies in the quality of cut achieved. The cut is not as good as that obtained by wrap slitting. In wrap slitting, the web wraps around the female knife. The male knife penetrates to the ideal depth and gives a good clean cut. In kiss slitting, the web comes in tangential to the female knife. When the web and the male knife come in contact at this same point the cut is clean. To achieve this geometrical arrangement the male knife must be offset toward the exiting side of the web. Looking at Figure 11-11, you will notice that a good portion of the male knife now is underneath the web that has been cut. As the male knife rotates out of the web, the web rubs both on the cutting side and the backside of the male knife, creating a frictional drag and filing the material that passes through. This is a decided disadvantage because it causes fuzz and, dust.

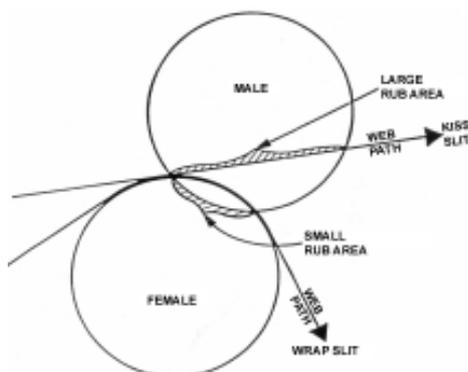


Fig. 11-11. Comparison of Rub Areas in Kiss Slitting Depending on Web Path

Looking at Figure 11-12, it is seen that when shear slitting a web, on the cutting side the male knife comes in and cuts clean and square. On the other side, the knife has pushed the web aside and down in the cutting operation. Consequently, the web, depending upon the condition or type of material being slit, can be permanently or temporarily deformed. The edge of foil, for example, takes a permanent deformation on the edge, and as it winds up layer after layer, builds a bevel on the edge of the rewound roll which eventually causes the sheet to tear. In foil, this deformation occurs with both kiss and wrap slitting.

There is a second problem that arises in kiss slitting. When the web comes straight out, there is a greater interference angle between the web and the male knife. As the male knife rotates out of the web, it has a rough grind on the back edge. It will tend to file the edge of the slit strip. The result on a hard material is a filing action which causes little particles to fall onto edge of the slit strip. These particles will create a buildup similar to that mentioned above with identical results. Kiss slitting is good for fast setups. The quality of the cut is not as good as in wrap slitting because of the greater interference between the male knife and the exiting web.

In wrap shear slitting, accurate slit widths and close tolerances are possible through the use of spacers for measuring and positioning the knives. This combination of knives and spacers, stacked on the shaft, provide a complete support for the web, thereby reducing, to a minimum, the possibility of wrinkling, bagging or sagging. This results in excellent slit width accuracy.

In kiss slitting slit width accuracy is more difficult to achieve, because there are voids between the knives, permitting the web to sag and wrinkle,

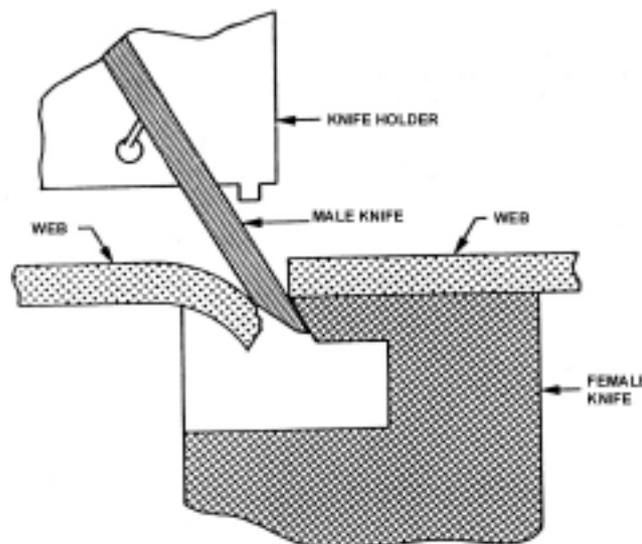


Fig. 11-1 2. Shear Slit Cross Section

In conclusion, we can say that shear cut slitting offers many advantages and can be used in several different ways. Careful consideration must be given to results that are desired or required in selecting the best arrangement for each application.

It is standard practice to incorporate driven rolls in all types of machines to maintain control of the web as it passes through the knives and to isolate the slitting tension from the unwind and rewind tensions. All driven rolls also serve to keep a constant tension in the slitting area, thereby maintaining the slit width.

A slight overdrive in web speed is maintained from driven roll to driven roll to hold tension constant. For speeds in excess of 500 fpm and film thickness below .001 in., it is necessary to positively drive all rolls since changes in web speed, due to undriven roll inertias, tend to distort the web and affect the quality of the rewound rolls. This is especially true when narrow webs of light plastic films are run on wide machines (i.e. webs less than 70 per cent of the maximum web width capacity of the machine).

Score Cut Slitting

Score Cut, also known as Crush Cut, slitting is the oldest form of cutting known to man. and the first employed in slitting machinery. As the name implies, it is crushing of the material..to sever one part from another. Since this method of slitting relies on the crushing of the material, it follows that the "knife" cannot be dead, or razor sharp, because a very narrow knife edge will dull and chip almost immediately upon contact with the surface it is crushed against. Hence, the knife used in score cut slitting is one that is dulled (rounded) to the ideal condition before we start trying to slit-with it.

Figure 11-13a shows a fully sharp knife, Figure 11-13b shows the proper edge configuration of a good score cut knife. Figure 11-13c is an enlarged view of the cutting edge of the good score cut knife.

Figure 11-14 shows these respective knives penetrating through a material and against the "bed" or backup cutting surface. This illustrates our original premise that pressure on the "Dead Sharp" knife will dull this knife almost immediately, whereas the rounded edge of the other knife will not break down as easily

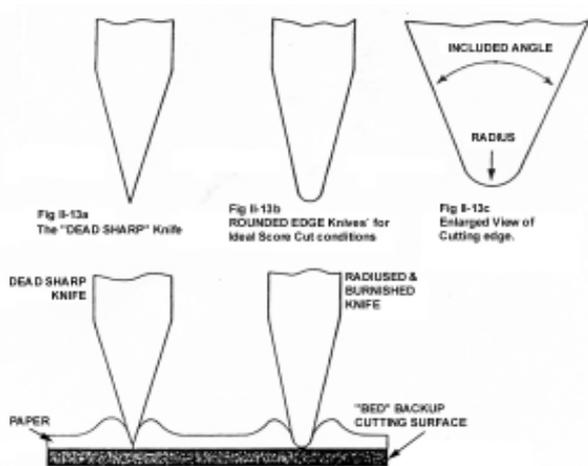


Figure 11-14. Comparison of Knives

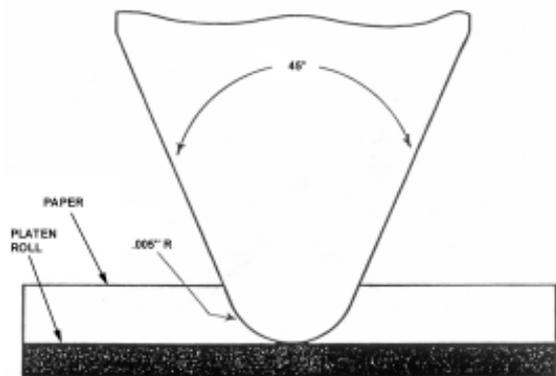


Figure 11-15. Paper Displacement Producing Dust

When slitting a continuous web, it is obvious that a round backup or platen roll and round slitting knife must be used. With the knife pressed against the web with sufficient pressure to cut through it, we achieve slitting". For best results, the web, the platen roll and the knife must all be moving at the same speed.

Since this method requires enough pressure to cause the web of material being slit to separate completely, it is again obvious that after a short running time, the platen roll will groove a edge abrade. At this point, there is intermittent cutting only To avoid this, we make both platen roll and the knife of steel that can be hardened. Further, the platen roll is ground to a very smooth finish. The score knife itself after hardening is not only ground but the cutting is radiused and then burnished to a very high polish. The smoother the platen roll and the knife edge, the cleaner the cut and the longer the life of the blade and roll.

The oldest method, score cut slitting is very quick to set up, thus offering a very distinct advantage. it is, however, losing favor in many areas. As explanation, let's examine this cutting method first on paper. When we crush the fibers of the, paper web, a very fine powder of crushed paper fibers is created. If the knife is "sharp", that is smooth and highly polished, the slit edge of the paper will appear smooth, but there will also be a deposit of paper dust. The amount of paper that the knife displaces, as shown in Figure 11-15, turns to dust. Years ago, this dust was quite acceptable, but in today's high speed printing presses and automatic packaging machines, dust accumulates faster and causes equipment malfunctions. For this reason, score cut slitting is becoming less acceptable.

In addition to "dust", score cut slitting paper may be undesirable in another way. As soon as the edge of the knife becomes slightly rough, the slit edge is no longer smooth. Instead, it has slight feathers or threads where the paper has not been completely pulverized. These feathers or threads tend to accumulate on the edge of a slit roll making it feel and look very rough. The normal tendency when this occurs is to increase the slitting pressure on the knives. This is usually successful, but only for a short time. The increased pressure causes further deterioration of the knife resulting in a still poorer slit edge.

Applying score cut slitting to plastic films and sheet, we have similar situations. On extensible, soft plastic films like polyethylene, a good smooth knife and platen roll yield excellent results. However, as soon as any defect appears in either surface, this defect creates a void and the film is squeezed into the void and is not separated. At first, these strings or ties tear to give separation but they soon reach a point where adjacent sections of film stretch and deform causing rejects. (Figure 11-16 shows a good score cut slitting operation.)

On hard plastic films such as cellophane, acetate and oriented polystyrene, the result is somewhat different. As the knife crushes its way through the material, it not only severs the web as desired but causes minute cracks perpendicular to the slit web. As shown in Figure 11-17, these cracks when put under slight strain tend to propagate further into the web. With wide webs, this is not too critical. On narrow webs, the only too frequent result is a tear completely across the web.

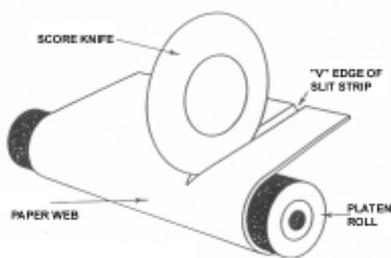


Figure 11-16. A Good Score Cut Slitting Operator

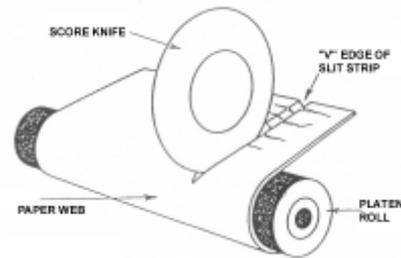


Figure 11-17. Cracking of Plastic Films

This brings us to the area where score cut slitting really shines: the slitting of paper pressure sensitive tapes. The nature of the material is ideally suited to this slitting method. Figure 11-18 shows a paper coated with pressure sensitive adhesive being slit into a narrow tape. You will notice in this illustration the desirable separation of the paper web. In addition to this, you can see the adhesive is forced away from the edge of the paper. Also, the adhesive forms a small ridge on each edge.

These conditions give us a perfect result. When we wind up the strip, we have a roll that has a "dry" non-sticky edge. This is seen in Figure 11-19 where the adhesive is away from the edge of the roll.

Score cut slitting is ideal where quick and easy set-up is required. It can be used to some degree of satisfaction on most materials being slit today. However, before making a final decision on score, shear or razor blade slitting, a careful analysis of the desired results should be made.

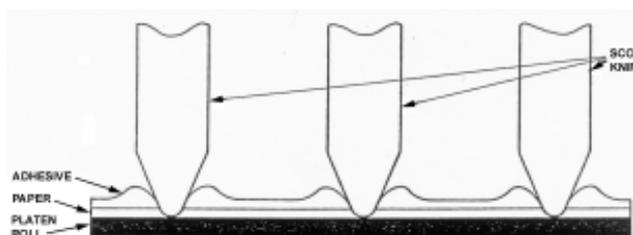


Figure 11-18. Paper-Backed Pressure Sensitive Adhesive Slitting

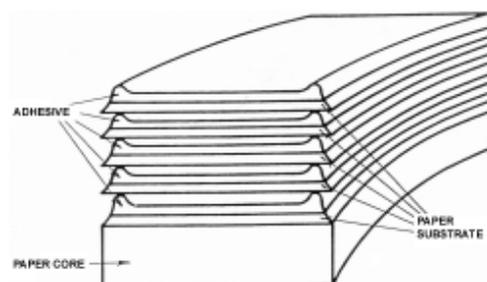


Figure 11-19. Paper and Adhesive Configuration After Slitting

BASIC WINDING TECHNIQUES

Center Winding

Differential Rewinding

Cores and Adaptors

Individual Top Riding Rolls

Preventing Gauge Band Build-Up

Surface-Center Winding

Surface Winding

The initial approach to solving the problems of winding either full width webs or slit webs is through the selection of types of machines that will produce the desired results. winding machines are based on three basic types of winding techniques: center winding, center surface winding and surface winding.

Centre Winding

On some materials contact pressure cannot be applied because the materials could become blocked or damaged. Here center winding becomes necessary. Today center winding is the most prevalent type of winding, and the basic principles remain the same whether the operation takes place in a vacuum or in ordinary atmosphere or in a pressurized chamber.

In center winding (Figure 111-1) the winding force is derived solely from the rewind shafts and is transmitted to the winding web through the core and layers of material that have already been rewound. The winding force is generated by a D.C. motor, a fluid motor, or a slip clutch.

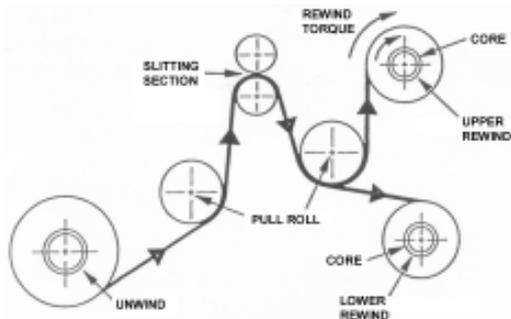


Fig. 111-1. Center Winding - (Duplex Winder)

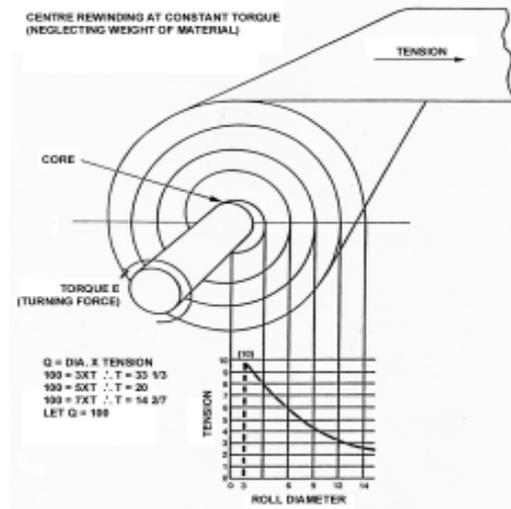


Fig III-2. Reduction in Tension as web diameter increases during winding.

The graph in Figure 111-2 shows the effect of constant torque input. This results when a slip clutch is used and no adjustments are made as the roll grows in diameter. As the roll builds up in diameter, the tension drops off. This puts a limit on the maximum diameter to somewhere between 12" to 14" if initial winding was started on a 3" I.D. core.

Keeping a 3" core, the only way to get larger rewind diameters is by increasing the input power or torque as the roll diameter builds up. The bottom line in Figure 111-3 shows the basic constant torque curve. As the roll diameter builds up, the web tension decreases. Normally after slitting there are two rewind positions, when center winding, generally located one above the other, to ensure positive separation of the rolls. Adjacent cuts are wound alternately on the upper and lower rewind mandrels.

Therefore, in center winding it is easiest to wind at constant torque. When it is necessary to wind to larger diameters on a given core size, programmed torque is used. It is seldom advisable to attempt constant tension winding in a center wind operation.

The bottom line in Figure 111-3 shows the basic constant torque decreasing tension curve. The upper line is the constant tension curve. This is one form of programmed torque. The ideal arrangement for building a good roll is somewhere in between as is shown in the programmed torque curve. The exact ideal curve varies with the material and winding conditions and is usually best found by experimenting with varying programs until ideal performance is arrived at. The above conditions hold true in all center winding operations.

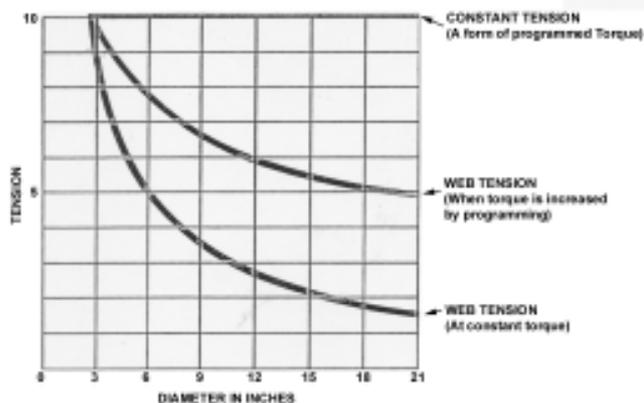


Fig III-3 Effects of Different Tensions in Centre Winding.

Differential Rewinding - Core/Spacer/Core

In slitter-rewinders, the most common type of center winding is the duplex type winder. The duplex center winder is an application of center winding utilizing differential rewinding. Typical of this type of machine are the Ashe Sapphire series of machines and their many derivatives. Differential rewinding is utilized in these machines. Engineered for versatility, differential rewinding is an arrangement whereby each individual rewinding roll is completely isolated from all others. This is essential to satisfactorily rewind materials of non-uniform gauge.

Without differential action, the heavy gauge areas of the material would wind tightly while lighter gauge areas would wind loosely. The former condition may result in stretching of the material and/or collapsing of the core. The latter condition may cause the roll to telescope and/or fall apart in handling. High quality rewinding, therefore, depends directly on differential winding (Figure 111-4).

Differential rewinding is accomplished on duplex center winding machines through a system of alternating cores, and spacers on each mandrel. Figure 111-4 shows this. The spacers are keyed so that they are free to slide axially on the mandrel, while being restrained from rotating. An adjustable air pressure system is used to exert a force axially along the mandrel. Each core is squeezed between the spacers adjacent to it. The rewind mandrel is driven faster than the slit strips are fed onto the core. Thus, the cores are held back by the slit strips and are forced to slip with respect to the mandrel and the keyed spacers. The adjoining faces of the cores and spacers act as slip faces of slip clutches, providing a driving torque on each core proportional to the axial pressure exerted. Each core therefore has the equivalent of its own individual slip clutch drive.

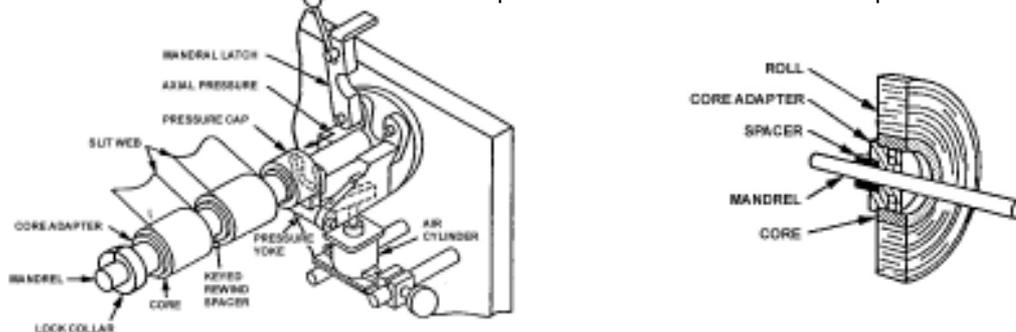


Fig III-4 Components of Differential Rewind Mandrel **Fig III-5 Core Adapters**

The tension of all slit strips is the same since all cores are acted on by the same axial force acting on identical slipping surfaces. Each core is its own slip clutch and, therefore, each slit strip is free to wind at its own speed and tension regardless of the size or condition of the rolls being rewound on either side of it.

For maximum versatility, four sets of rewind tension controls, one at each end of each mandrel, are installed as standard equipment on this type of machine. Thus, by utilizing each of the four different tension control zones it is possible to slit and rewind up to four different slit widths concurrently from a single web and maintain the correct tension for each individual slit width.

Cores & Adapters

Cores are an integral part of differential rewinding and they are a critical factor in obtaining a good rewound roll. For best results, the ends of the cores must be smooth and square to the inside diameter. Any burrs or turned over edges on the inside diameter of the core will cause binding between the core and the mandrel. Burrs catch in the mandrel keyway or act as a point contact with the rewind spacer. These conditions cause an erratic slipping action resulting in erratic tensions on the rewound web strip.

Since the cores are stacked together with the rewind spacers, any cumulative size variation in the individual elements will cause successive increases in misalignment between the cores and the slit webs. Techniques here, therefore, necessitate holding close tolerance on the length or width of the core used.

Where commercially cut narrow-width cores are used and erratic operation exists due to poor core edges and/or excessive friction between the core I.D. and the mandrel body, core adapters have been developed. Core adapters are used to eliminate contact between the core body, the rewind mandrel, and the rewind spacer (Figure 111-5).

All core adapters serve to control the friction between the mandrel, rewind spacer and the core. By placing the core on the core adapter and utilizing a low friction insert in the core adapter as the slipping surface on the mandrel and against the rewind spacer, very fine tensions can be maintained on all operations, especially when thin, stretchy films are being rewound.

Careful attention must be given when winding at high tension directly on mandrels of the same diameter as the core I.D.- Even a slight compression of the core due to tight winding could cause a locking of the core to the mandrel. eliminating the slipping and differential winding action.

High torque adapters (Figure 111-10) are used to obtain the higher rewind tensions while eliminating the problem of the core collapsing and seizing. Here the core is supported by the pilot of the adapters and not by the mandrel.

Fig. 111-10. High Torque Adapter

In both Figures 111-9 and 111-10, the brake lining (clutch face and the adapter body) act as a thermal insulator. This insulating quality protects the core and the rewound material from being subjected to heat that could be detrimental to the quality of the finished roll. All types of core adapters can be used for reminding on large size cores where mounting and handling make it impractical or expensive to use a mandrel of matching diameter. The type of core adapter selected depends on the intended use.

Differential Rewinding - Slip Chucks

The core/spacer/core method requires increased set up time because of the need to alternate spacers and cores, generates heat and core end profile can have an effect on the winding tension. Individual slipping chucks have been developed which standardise the forces exerted on the core and therefore increase winding quality. Each chuck consists of an inner drive tube which is keyed onto and driven by the rewind shaft, and an outer segmented tube which is designed to expand and grip the inside of the core. Between the inner drive tube and the segmented core tube there are some clutch pads which are actuated by a rubber bag inflated by compressed air.

When only a small air pressure is applied to the chuck, the bag only inflates slightly and therefore the drive from the rewind shaft via the inner drive tube to the segments (and therefore the core) is of very low power. If the core is stopped from rotating (ie by the web) then the outer tube is slipping relative to the inner drive. If the air pressure is increased to the bag then more force is exerted by the clutch pads and more power is fed to the core, therefore more tension will be created by the core into the web.

Chucks are positioned on the rewind shaft such that two chucks are used per core, these should be mounted near to each end of the core. If the core is less than 150 mm long then one chuck can be used but it must be mounted central to the core length. Plastic spacers are used to position the chucks and these spacers have a sealing face to prevent air leaking out from the groove which is machined down the full length of the rewind shaft. This groove is used like a pipe to feed the air pressure to the chucks and then inflate the bags which cause the tension rise. The air pressure value supplied to the chucks is dependant on the tension setting control and the diameter of the rewind reel, at core diameter the pressure will be low, but as the rewind diameter increases the pressure will be increased gradually by the machine control system to enable a constant tension to be maintained at the increasing radius point of the web.



A variety of Differential Core Chucks.

Individual Top Riding Rolls

Being constantly aware of the obligation to provide equipment capable of satisfactorily winding at high speeds, the individual top riding roll for multiple roll slitting was developed as still another refinement to an already production proven and versatile piece of equipment. The development of the independent top riding roll permitted satisfactory high speed winding of films and other off caliber materials because these rolls would positively maintain constant contact with the rewinding roll; thus preventing air from entering between the layers of film. (See Figure 111-1 I.) The incoming web is guided precisely to and brought into contact with the rewinding roll so that side shift and weaving are eliminated, and individual rolls are not affected by off-gauge conditions of materials in adjacent rolls.

Individual top riding rolls are used to obtain straight, smooth sided rewind rolls, at high and low speed, when winding off-gauge, high slip - light tension "problem" materials. Of all the progress which has been made with regard to the slitting and rewinding of these materials, the development of the individual top riding roll for each individual rewind roll is probably the most outstanding engineering advance. Efficient subsequent Operations. to a large extent, depend on the smooth edged, even density rolls of packaging materials which can be produced on the slitting-rewinding equipment. Four major factors must be compensated for in order to produce the desired slit and rewind roll. These factors are: gauge variation, gauge bands, slack zones and entrained surface air, which acts as a lubricant when an excessive amount is trapped and wound within the rewind roll. (Refer to Material Conditions.)

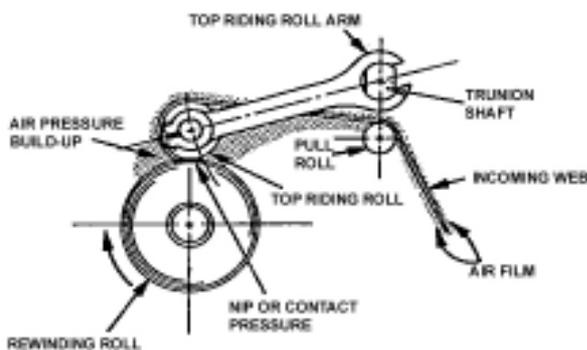


Fig. 111-11. Top Riding Roll

All materials carry a surface air layer with them as they move through a machine. When films are slit and rewind, this air layer is carried toward and partially into the rewind roll. At low machine speeds, most of this air layer can escape as the web enters the rewind roll without causing a problem in winding. However, at high speeds, an excessive amount of air enters the rolls and this results in two conditions:

- 1 - Air becomes a lubricant, and acts as a frictionless separator between the layers of material allowing shifting of second, third and lower layers within the convolutions of the roll.
- 2 - Air is trapped between the layers of material and is wound into the roll. Once inside the rewind roll, it forms tires or balloons or bubbles, which can have various detrimental effects depending upon the characteristics required of the finished roll.

The top riding rolls may be 3 in. I.D. paper cores mounted on two flanged ball bearings, in turn mounted on aluminum tubular center shafts. These are held in position by easily removed arms and are quickly changed from one width to another by simply changing the paper core or the whole assembly.

For maximum utilization of these individual top riding rolls, it is necessary to have the incoming web enter into contact with the rewinding roll at the point of contact with the individual top riding roll or better yet..to wrap around the top riding roll, If the incoming web contacts the rewind roll some distance ahead of the individual top riding roll, the tracking and guiding effect of the top riding roll is lost. Once this has occurred, it is extremely difficult, if not impossible, to force the air out.

Ashe, therefore, have developed their machines so that the incoming web wraps around the individual top riding roll as shown in Figure 111-11. This action positively eliminates any possibility of web contact with the rewinding roll other than at the immediate point of contact between the individual top riding roll and the rewinding roll. Hence, the best possible condition for the positive elimination of air exists. Further, the web tension assists in maintaining contact between the individual top riding roll and the rewinding roll.

Top riding rolls are available in four varieties. Paper Core, Aluminum Tube. Rubber Covered Aluminum.. Shell and Filament Wound Tubing.

The paper core top riding roll has advantages in the following areas:

- a. Fast. easy set-up.
- b. Economical.
- c. Works particularly well on materials which have a rough surface or materials with a high coefficient of friction.
- d. Works well with printed plastic materials.

Disadvantages of paper core top riding roll are primarily.

- a. Limits the running speed of materials with hi-slip characteristics to below 500 ft. per minute.
- b. Paper, cores have a length limitation of 24" maximum, (lengths greater than 24"are seldom streight.

The rubber covered aluminum shell top riding roll offers advantages in the following areas:

- a. Will permit machine speed to the maximum for the material being processed.
- b. Equally efficient at any length.
- c. Available as either a soft or hard rubber (durometer) consequently several different types can be kept on hand to provide for winding a complete range of materials.
- d. Particularly effective for materials in the "hi-slip" light tension classifications.
- e. Rubber top riding rolls tend to tract difficult material more easily.

Disadvantages of rubber. covered top riding rolls are primarily:

- a. Not as readily available as paper.
- b. Relatively more expensive.

Aluminum rolls offer advantages and disadvantages which fall somewhere in between the paper and rubber top riding rolls.

Filarpent wound fiberglass tubing has all the advantages of the aluminum tubing and although it is more expensive, it is less susceptible to damage.

Numerous tests. both in Production and Laboratory Research have resulted in the following table of recommendations for winding various types of materials at various speeds.

	Paper Core	Fiberglass or Aluminum Tube	Aluminum Tube Soft Rubber Covered
Under 24" Width			
A	Yes	N.R.	N.R.
B	Yes	N.R.	N.R.
C	X	X	Yes*
D	X	Yes	X
Over 24" Width			
A	X	Yes	N.R.
B	X	Yes,	N.R.
C	X	X	Yes*
D	X	Yes	X

- Key: A - Low web speed (Under 300 fpm)
 B - High web speed (to 1500 fpm) - Rough faced material (Hi coefficient friction)
 C - High web speed (to 1500 fpm) - Hi Slip (Low coefficient friction)
 D - Aluminum Foil
 NR - 'Not required but can be used
 X - Will not work - definitely not recommended
 * - Denotes that hold-down springs may be required

Preventing Gauge Band Build-Up

In addition to eliminating air from between the layers of the rewound rolls, individual top riding rolls can be utilized to overcome the problems caused by the build-up of gauge bands.

For example, a roll with a gauge band build-up being wound without top riding rolls will develop tension concentration in the gauge band area resulting in uneven distribution of web tension across the full slit width. Hence, for a 10 in. wide roll winding at one pound per inch of web width (10 lb. total) all 10 lb. will be concentrated at the gauge band. Thus, if the gauge band is 2 in. wide we will have a concentration of 5 lb. per inch instead of the desired 1 lb. This excess tension will cause distortion of most plastic films, causing further build-up of the gauge band. This in turn causes wrinkles to form in the web coming into the roll. Refer to Figure 111-12.

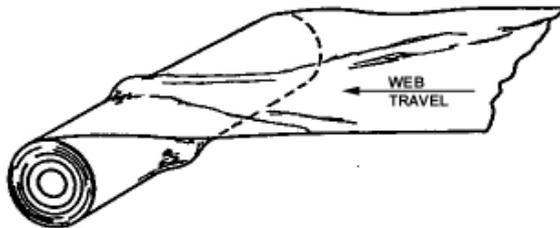


Fig III-12 Web Wrinkles Form on GaugeBand.

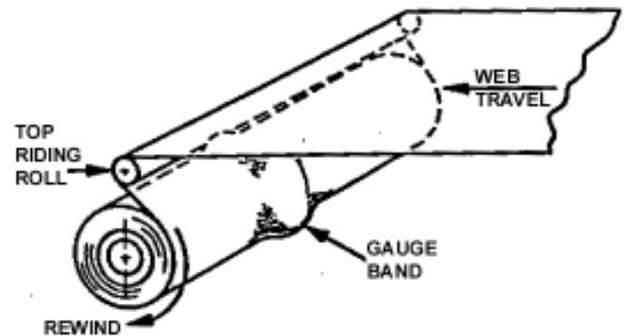


Fig. III-,13. Top Riding Roll Riding on Gauge Band

When individual top riding rolls are used, this tension concentration is immediately redistributed to the full web width as the web wraps around the top riding roll. Further, if the individual top riding roll is held parallel to the rewind mandrel, contact will be maintained only on the gauge band, thus permitting air to be wound into the rewinding roll at all of the other points. Refer to Figure 111-13. The resulting roll will be tightly wound (without stretch) over the gauge band and soft throughout the remainder of the roll. This roll can then be handled easily without telescoping or damage and will feed into the next machine operation without any problems.

Conclusion

Because top riding rolls are maintained in constant positive contact with the rewind rolls, the air which would be trapped between the layers of film is ironed out. Top riding rolls are sometimes referred to as "lay-on rolls" or "ironing rolls". They also serve to distribute rewind tension evenly across the slit width. Because parallelism between the top riding roll and the rewind mandrel is maintained, uneven web tension due to build-up on the rewind roll is eliminated. This action produces a wrinkle free rewind roll; and the rolls are not affected by off-gauge material conditions in the adjacent rewinding roll.



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SETTING THE STANDARD

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