The function of the winder is to wind paper into manageable rolls, paper wound with even tension throughout the roll to facilitate further conversion into an ultimate end product.

There is one common denominator for all rolls leaving the paper mill, they are not an end product. They serve no other purpose than to be converted into something else. After being carefully rewound, the rolls are sent once more to the unwind stands for further proccesing. It goes without saying that converters pose widely varying demands on the quality of rolls, considering the numerous applications for the final product. However, there is no avoiding one basic demand, regardless of the type and size of the converting machine: the roll quality must be uniform throughout, ensuring trouble free unwinding at even the highest operating speeds. Of all converters, the demands of the printer are critical. The rolls must be of uniform density, from the first layers on the core to the outer periphery. Only perfectly uniform rolls will ensure optimum printability.

The next requirement calls for the largest possible paper roll diameters. Winder uptime increases as the rewind diameters increase, which in turn saves operator time between preparation of each splice. As operating speeds increase, the larger roll diameters increase the intervals between splices. Large diameter rolls also save material, reducing the inherent waste that accompanies each roll change.

With the requirements of the winder clearly defined, the design engineers at JAGENBERG went to work with a new concept in winder design: to develop a new winder permitting more uniform winding hardness, while at the same time, increasing conventional roll diameters. The parameters that govern winding hardness, or roll density, were established, and tested in both theory and actual practice. These parameters are as follows:

a. Size and arrangement of winder drums.

b. Differance of winder drum peripheral speed - advancing and retarding effects - also known as overspeed and lagspeed.

c. Web tension.

d. Rider roll nip pressure.

Please refer to illustration, (ILLST. 1) , when revueing the text in this section.

ILLST. 1 clearly shows the geometry and position of conventional two drum winders, as well as the speed relationship between the winder drums.

ILLST. 1A demonstrates that if two drums of identical diameters are selected, and if the drum that is not wrapped by the web is not driven, then the roll hardness greatly increases with the increasing roll diameter. At small diameter, there is a strong lag speed. This lag speed diminishes with an increasing diameter with the eventual near synchronisation of the peripheral speed of the two drums.

ILLST. 1B demonstrates that if the drums are mounted in a slanted plane, an increase in diameter of the roll will correspond to a gradual shifting of the roll weight, from the non driven drum to the driven drum wrapped by the web. The natural result is an increase in roll hardness, or density, due to higher nip pressure on the wrapped winder drum. It is also noticeable that in the medium diameter range, the roll hardness curve levels off. This effect, producing a more uniform density in the medium diameter range, stems from the geometry - slanted plane - in connection with the drum diameters, and results in a certain overspeed of the non wrapped winder drums, from a given roll diameter onward.

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Please refer to illustration, (ILLST. 1) , when revueing the text in this section.

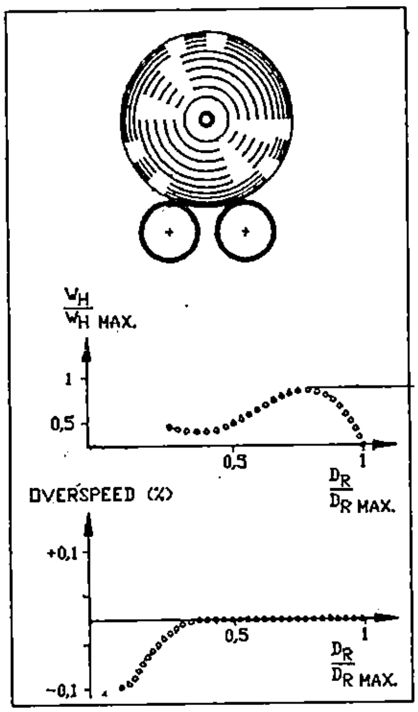
It is an accepted fact that larger drum diameters result in lower roll density.

ILLST. 1C demonstrates the increased diameter of driven winder drum wrapped by the web. The total hardness level can be reduced and a larger degree of uniformity can be obtained. The overspeed inherent in the system already becomes effective at small roll diameters, if larger drum diameters are selected. This effect, in connection with the slanted position of the drums, is the result of a deeper impression of the larger drum, in combination with a softer winding structure.

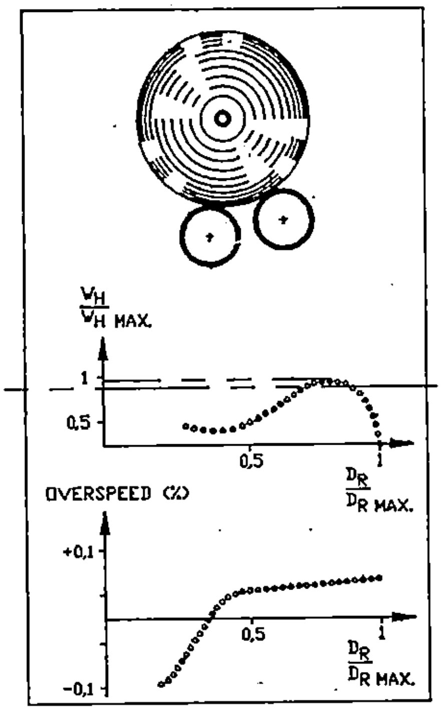
ILLST. 1D demonstrates that if a winder is furthermore driven by an adequately sized flat belt, adapted to the overspeed required as shown, a sufficiently high overspeed is obtained in the area of the roll center. In the further winding process, the overspeed adjusts to the overspeed generated by the system. This results in a higher level of uniformity.

ILLST. 1E demonstrates the effect of the new concept. The roll hardness curve of a conventional winder is shown. In this comparison, both the web tension and overspeed were identical. However, in the case of a conventional system, the overspeed must be forced upon the roll, through an expanding pulley, or a two motor drive, over the full roll diameter range. This will permit the conclusion that the overspeed factor, inherent in the VARI-STEP system, treats the paper roll much gentler.

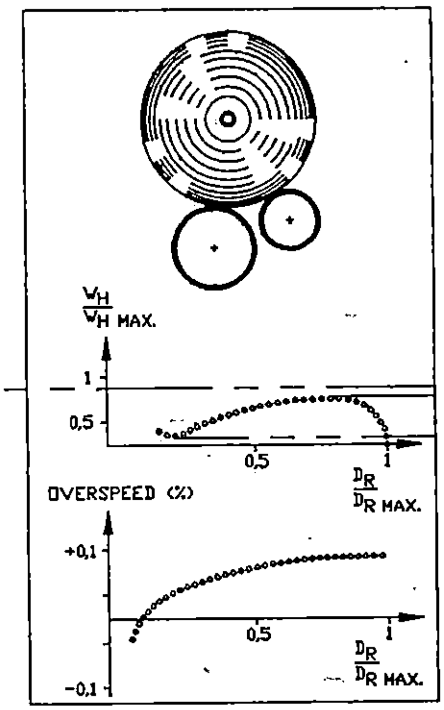
ILLST. 1 - Winder Drum Geometry



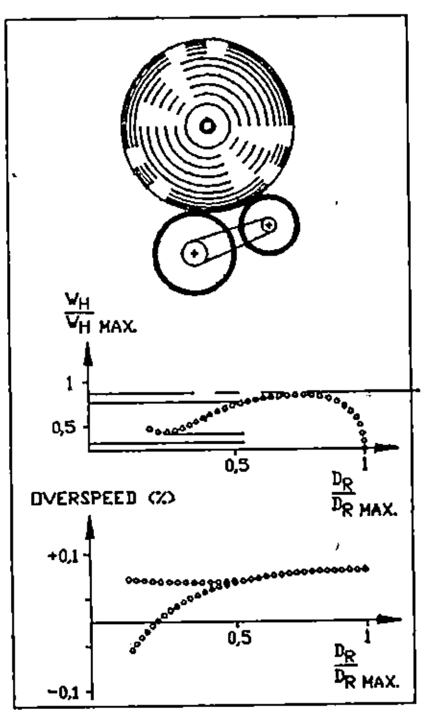
ILLST. 1A



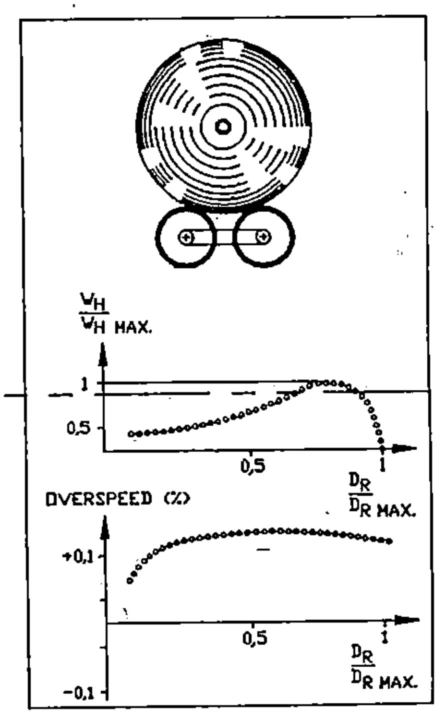
ILLST. 1B



ILLST. 1C



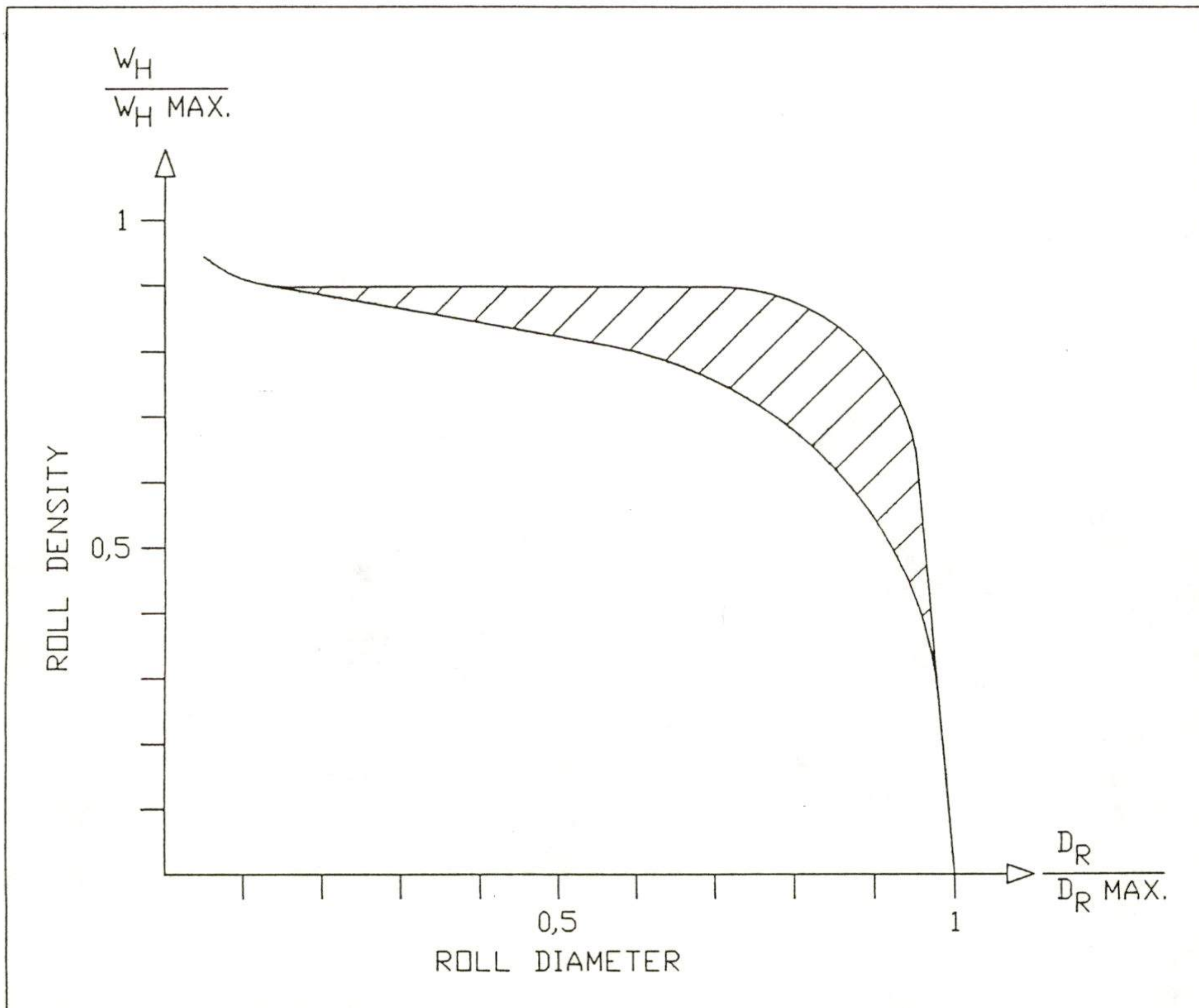
ILLST. 1D



ILLST. 1E

ILLST. 2 - Desirable Roll Density Curve

Additionaly, the influence of the rider roll nip loading must be considered. A rider roll is required to ensure good roll starts and to achieve the desired optimum roll hardness level, relative to the roll diameter.



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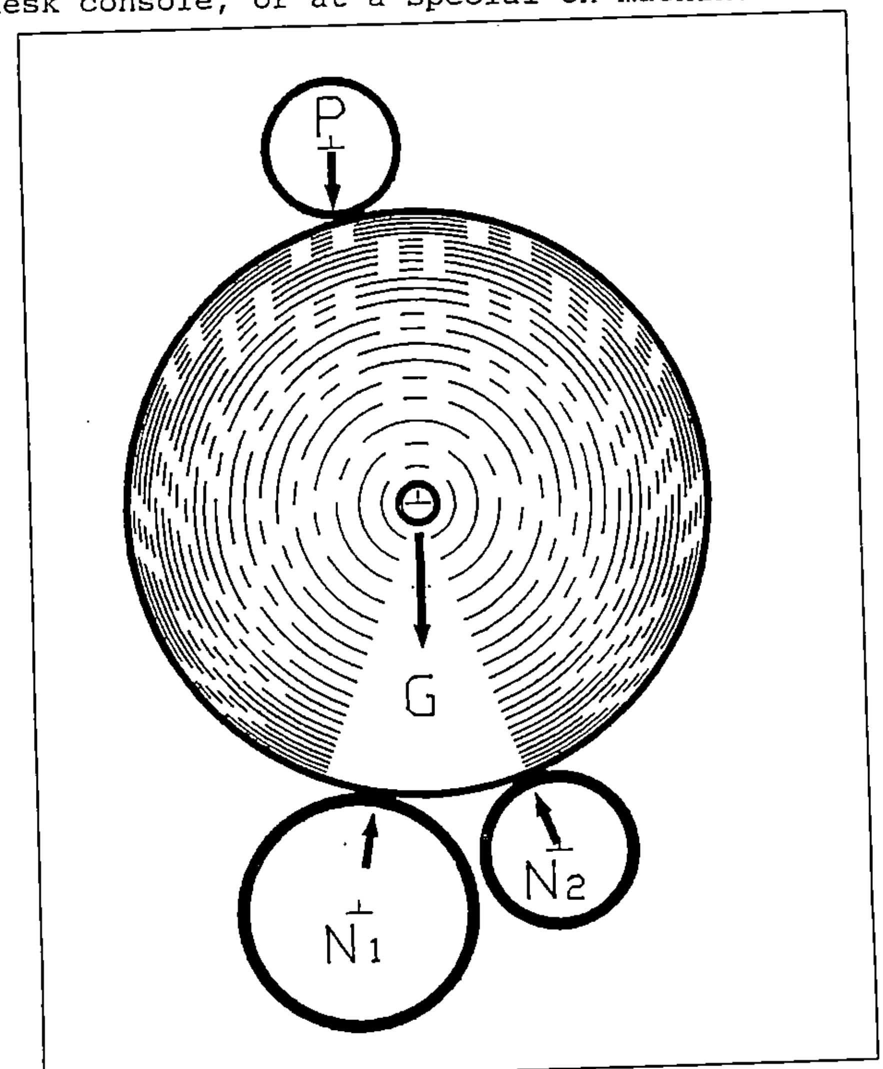
ILLST. 3 - Influence Of The Rider Roll Nip Pressure

In order to reach the optimum roll hardness level,the load factor (P) is controlled in such a manner that the forces N1 and N2 acting on the nips, the nip pressure, is raised and maintained over a wide diameter range, starting from the roll center.

A comparison of the roll hardness curves of a conventional winder with a VARI-STEP - ILLST. 1D and 1E, show that in order to obtain the desired roll hardness level, a conventional winder needs a much higher rider roll nip pressure. But a higher load also means a greater danger of shifting, or slipping between layers, with the possible end result of wrinkling - crepe formation. This means that the VARI-STEP winding system creates less danger of wrinkling, through lower rider roll nip pressure. The rider roll nip pressure is controlled electronically, by a parabolic curve representing the preset values. Setting is done at the control desk console, or at a special on-machine control panel



ILLST. 4 - Programmable Counterloading Curve

- See section on MPCS system later in this manual.

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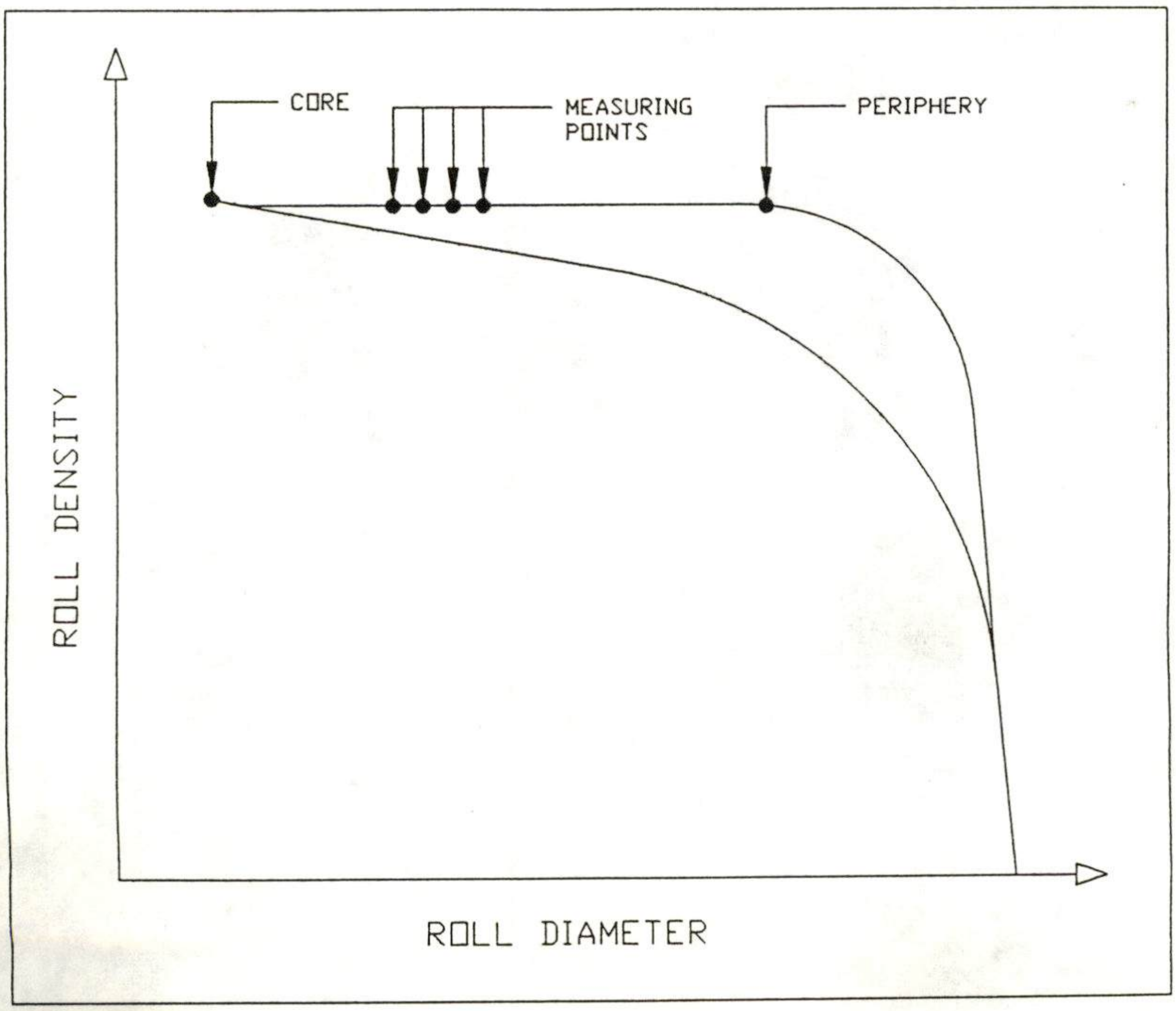
ILLST. 5 - Roll Hardness Diagram

The system described allows further fine tuning of the programmed rider roll nip pressure, so that the desired roll hardness level is reached automatically, without further operator intervention. We are thereby approaching the ideal curve, representing uniform or slightly declining roll hardness level, during total winding process. The differances gauged between the measuring points are very slight, and the maximum winding hardness in the center, and near the roll periphery, does not cause any damage.



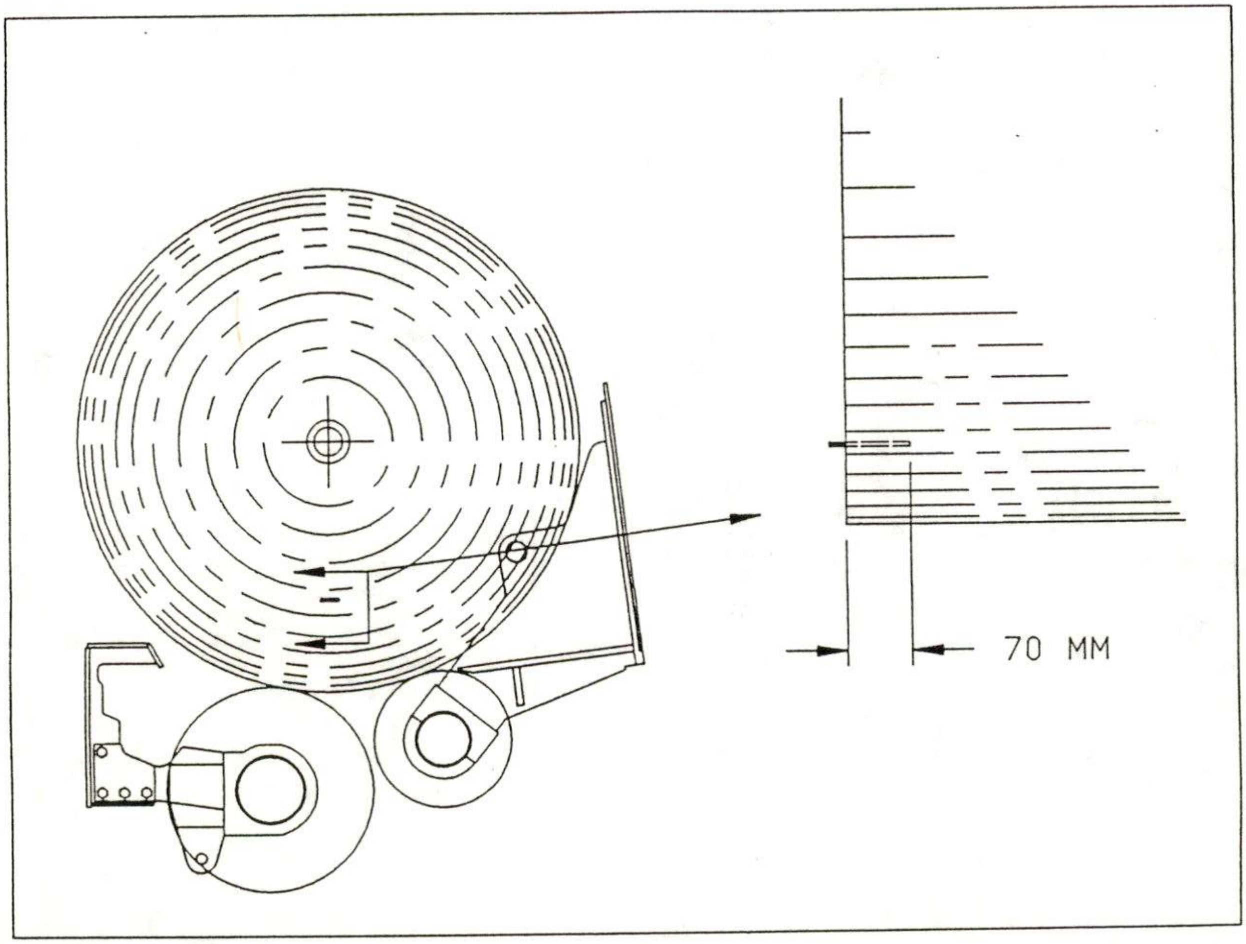
ILLST. 6 - Adjustable Belt Pulley

If widely varying paper grades are to be handled, the VARI-STEP can be equipped with a handwheel for adjusting the variable speed pulley during a stop. The handwheel permits raising or lowering the total hardness level, by increasing or decreasing, the speed differential between the drums. A display dial permits the repeat of settings found to be practical. Altering the overspeed during the operation is not necessary, since the geometry of the winder drums automatically initiates the desired adaptation. In most circumstances, the most efficient overspeed factor is already determined during the commisioning period. This means that the adjustable pulley will only be required, and supplied, if certain limits for caliper range are exceeded, or if there are larger deviations in the paper structure.

However, there is the possibility of altering the web tension to obtain a rise, or fall, of the total hardness level. This web tension has a far greater influence on the winding hardness than the variation of the overspeed factor.

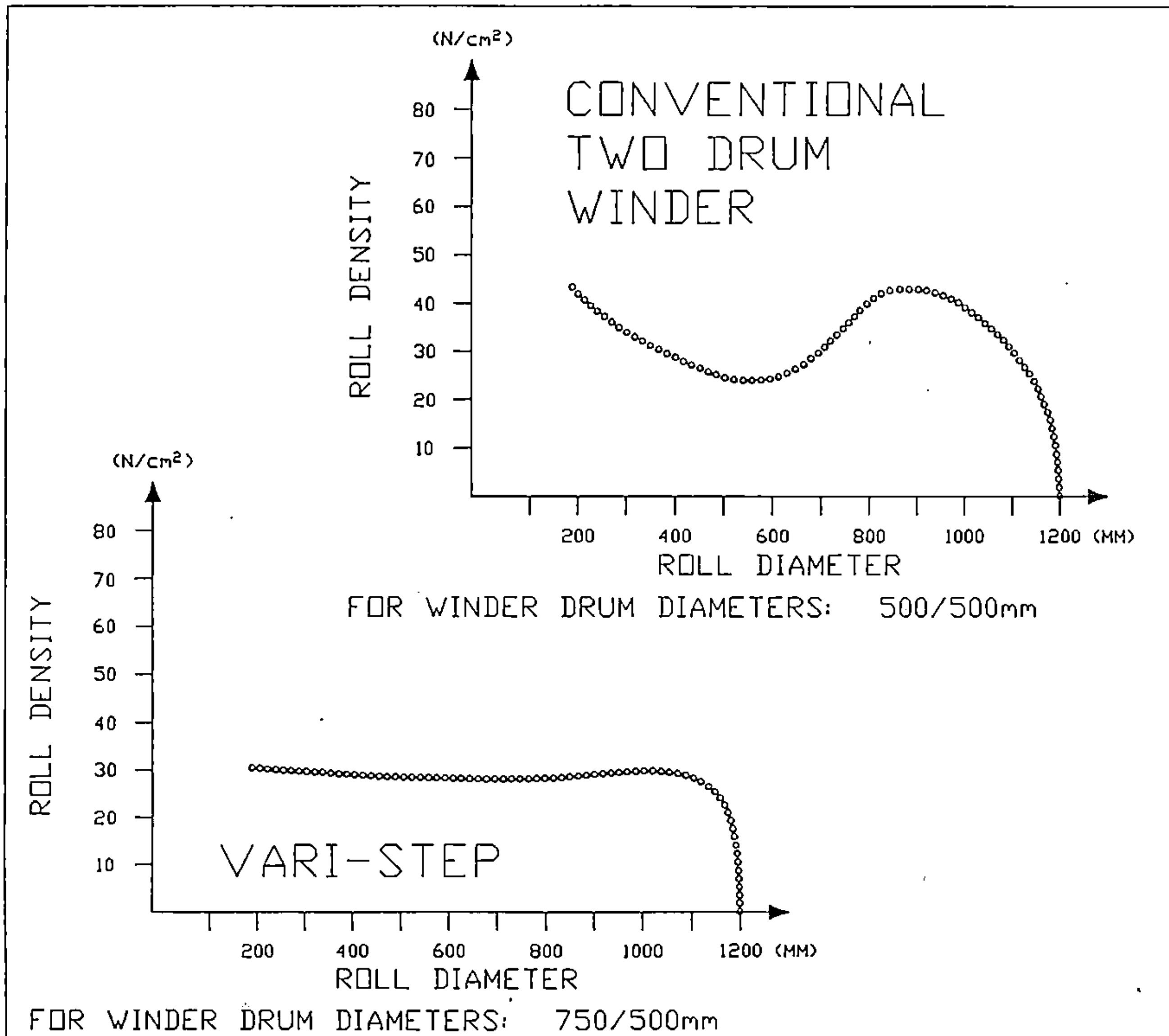
ILLST. 7 - Hardness Testing

Since the conventional hardness test methods, such as rapping the finished roll, the gap test, the Smith needle test or the Schmidt Hammer test are not to reliable, JAGENBERG developed a simple but safe method for controlling the winding hardness. With this method, steel strips of approx. 90mm (3 1/2") length, 6mm (1/4") idth and .05mm (.002") thick, are inserted during the winding operation into the side of the roll between the paper layers. Prior to this, the steel strips have been placed in paper sheaths so that the coefficient of friction remains constant between the metal and sheath - whereas it would vary with differant grades of paper.



ILLST. 8 - Winding Hardness Diagram

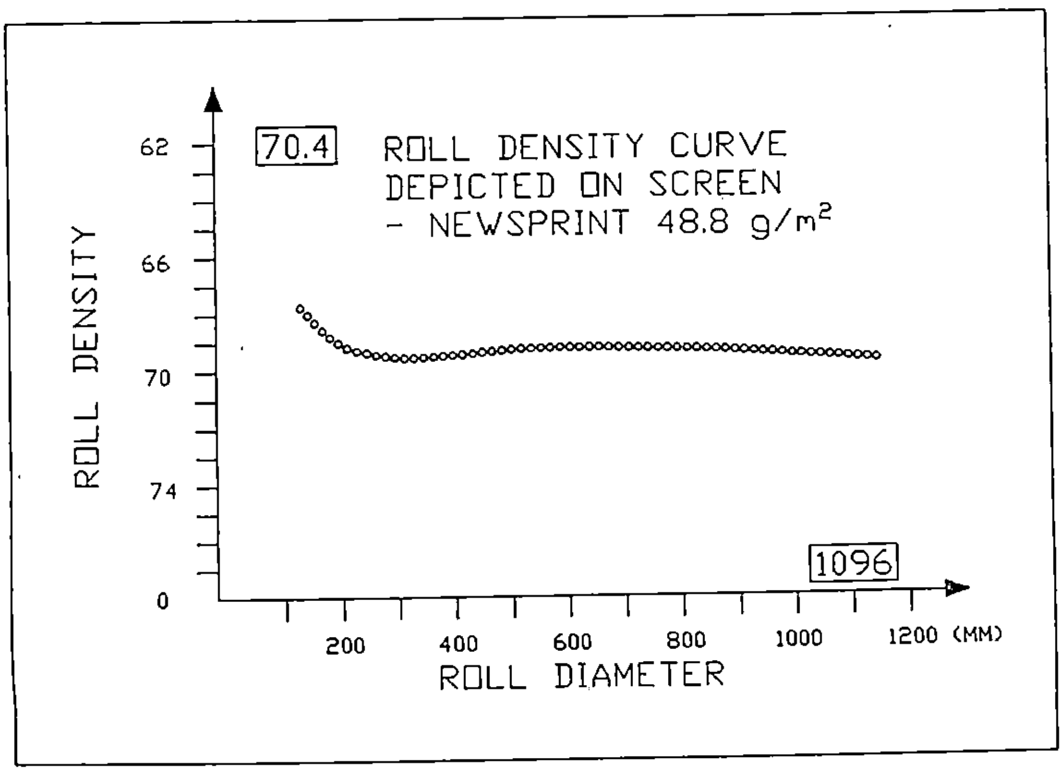
The force required to pull the metal strip from the roll, in which it was inserted about 70mm (2 3/4"), serves as the test value. Since the friction coefficient between sheath and steel strip is a known value, the result of the test measurement will reflect the pressure between the roll layers. These results are computed into hardness diagrams. Such a diagram is shown below. The left hand curve represents a two drum winder with two drums of 500mm (20") diameter each. The right hand curve shows the diagram of the VARI-STEP winder with 750mm (30") and 500mm (20") diameter drums. The diagrams represent comparable conditions and machine settings during winding.



ILLST. 9 - On-Line Winding Hardness Test

A recommended alternative to the previous measuring system is the On-Line winding hardness test. The system is based on a JAGENBERG micro-processor and a color CRT, a printer is optional. Linear footage of paper, as well as the roll diameter, are determined on a continuous basis. For this purpose, pulse generators are fitted to a winder drum, and to the rewind. Footage, and diameter, serve to calculate the caliper. By computing footage and diameter, as well as paper basis weight, we get the roll density, or hardness, at any desired roll diameter.

Since the order of magnitude is very small, - paper caliper being measured in thousandths of a mm, and change in tenths of microns, it becomes necessary to measure each time, many plies of paper. Realistic numbers are between 100 and 300 plies. Therefore, there will be a reference value at every 5 - 40 mm (1/8" - 1 1/2"), depending on paper caliper. Thus, we obtain a picture of paper caliper, and the specific density, or hardness, over the total diameter of the roll during operation. At the end of each winding cycle, there is the possibility to print out a diagram of paper caliper, or specific density over the diameter of the roll. A log sheet is printed out for each set of rolls, which informs the operator of the state of the rolls.



Practical results have proven it possible to offer larger roll diameters, which at the same time are more uniformly wound. This assures improved runability, and less waste, for the customer.

VARI-STEP users have been able to double the quota of paper which can be converted into new and usable rolls, if the VARI-STEP was used as a roll doctor. Often it is sufficient to rewind the rolls on a VARI-STEP as they are, that is, without trimming - in order to eliminate profile faults, and to make the winding hardness more uniform. This, of course, means recycling of a roll without any material loss. If more serious faults have to be compensated for, then additional backstand oscillation will require edge trimming, and possibly further slitting into narrower rolls. This could result in such quality improvement as to qualify the rolls as first grade material.

Summarizing the advantages of the VARI-STEP concept, it certainly confirms that this machine can do more than a conventional two drum winder:

- Production of larger and more uniform rolls, particularly in the case of difficult paper grades.

- Improved runability during further conversion of the rolls.

- Less waste at the mill and at the converter.

- Increase of the recycling quota, more saleable rolls of good quality, when used as a roll doctor.

All these advantages are obtainable at no increase in operating cost, probably less, additionally, the machine is simpler to operate and maintain. Auxiliary devices, assisting the operator to run the machine more efficiently, are already included in the basic machine price, or are available as optional equipment.

The VARI-STEP can be supplied in trim widths:

- 1800mm (72") to 6500mm (260")

Operating speed - 2200 m/min. (7200fpm)

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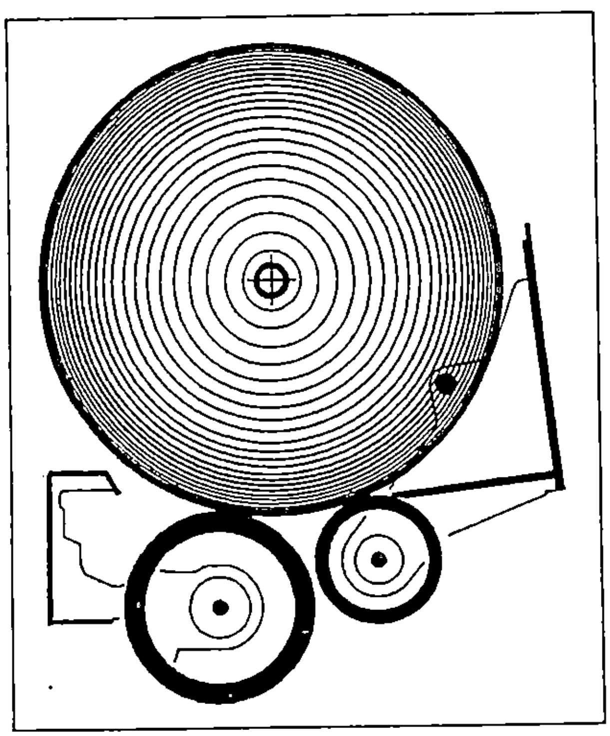
The VARI-STEP 43 is a two drum winder, designed and built using state of the art technology. It will produce large diameter rolls with constant hardness, from the core to full roll diameter.

The principle features of this design are as follows:

- Winder drums of differant diameters. The size, and placement from one another, cause the weight of the rewind roll to gradually shift to the larger rear drum.

- Use of a larger diameter drum, at the infeed position, will considerably reduce web tension generated in the nip.

- Only the first winder drum, in web travel direction, needs to be driven. If the winder needs to handle a wide variety of grades, an expandable pulley drive, or two motor drive with speed or torque regulation can be supplied to vary overspeed.



An unwind, or backstand, as it is commonly refered to, is used to feed the paper, or media, roll to the winder.

The unwind can be one of several designs, for the purpose of illustration, an inclined ramp configuration is shown.

The function of the unwind is as follows:

1. To raise the paper roll from the floor, by means of motorized shaftless core chuck carriages.

2. To maintain a constant tension on the paper web, by means of either air cooled disc, or water cooled drum brakes, mounted on the core chuck carriages.
- Tension control is discussed in more specific detail in the tension control section of this manual.

3. If an edge guiding system is supplied, the unwind is designed to move laterally to accomplish the guiding operation.
- Information and specifications on edge guiding would be located in the unwind operating manual.

See next page for illustration of machine setup.