# United States Patent

**Fleming, Jr. et al.**

[15] **3,668,922**

[45] **June 13, 1972**


## [54] WEB SAMPLING METHOD AND APPARATUS


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[73] Assignee: **Industrial Nucleonics Corporation**



[22] Filed: **Aug. 13, 1970**

[21] Appl. No.: **63,597**

**Related U.S. Application Data**

[63] Continuation of Ser. No. 601,750, Dec. 14, 1966, abandoned.

[52] **U.S. Cl.** ..... **73/1,** 83/27, 83/106, 83/167, 83/428, 83/522, 83/555, 83/919

[51] **Int. Cl.** ..... **B26d 1/02,** G01c 25/00

[58] **Field of Search** ..... 83/13, 27, 80, 105, 106, 167, 83/428, 433, 371, 353, 522, 919, 425, 332, 678, 555; 324/157; 162/49, 263, 198; 73/1



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*Primary Examiner*—James M. Meister

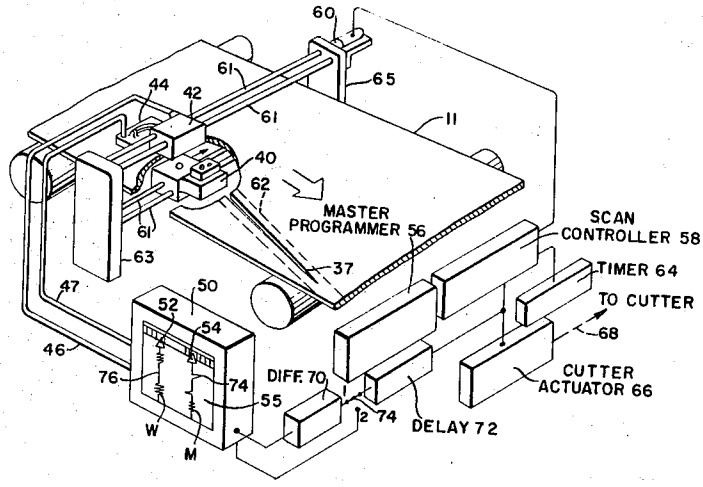
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[57] **ABSTRACT**

A cutter for removing samples from a moving web comprises a knife having a pair of cutting edges that are selectively urged into contact with the web being cut. In one embodiment, the blades are crossed relative to each other while in a second embodiment the tips of the two blades have a common apex. The blades may be positioned so that they slope with or against the web being cut. The sample has an area coincident with an area monitored by a gauge to enable the gauge calibration to be determined.


**37 Claims, 12 Drawing Figures**



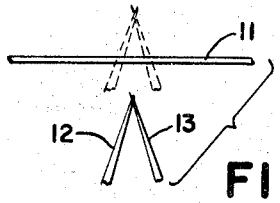



FIG. 1.

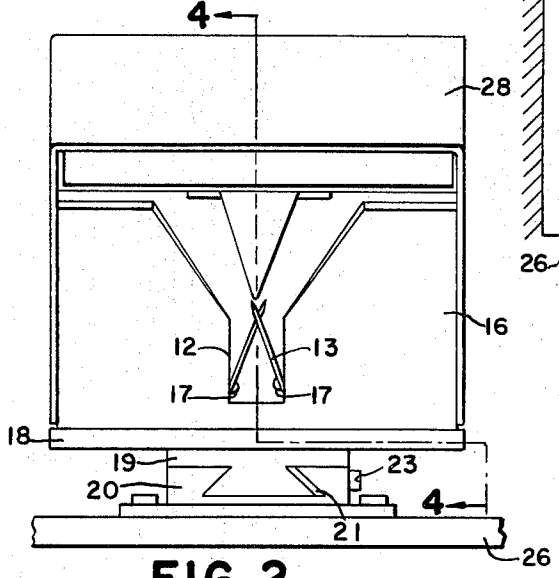



FIG. 2.

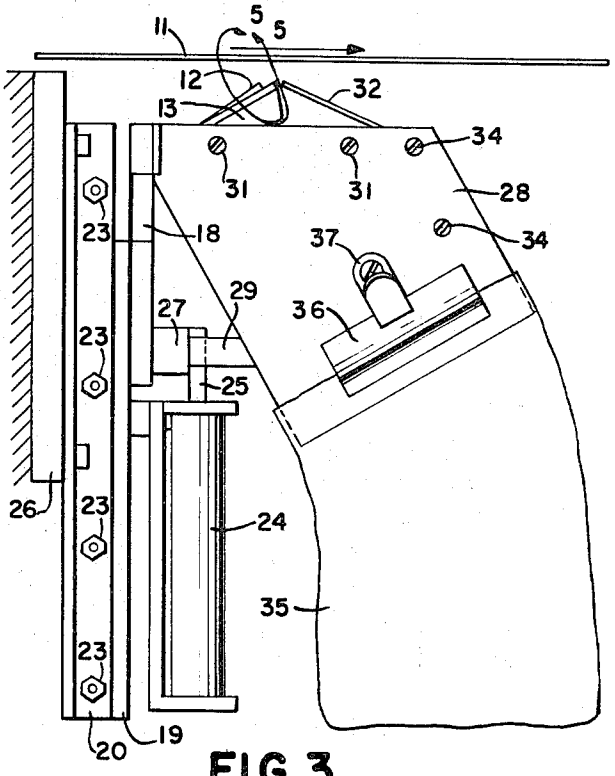



FIG. 3.

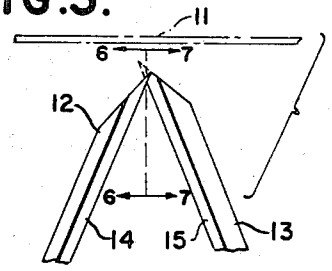



FIG. 5.

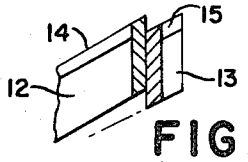



FIG. 6.

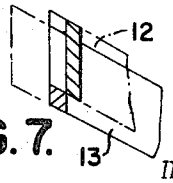



FIG. 7.

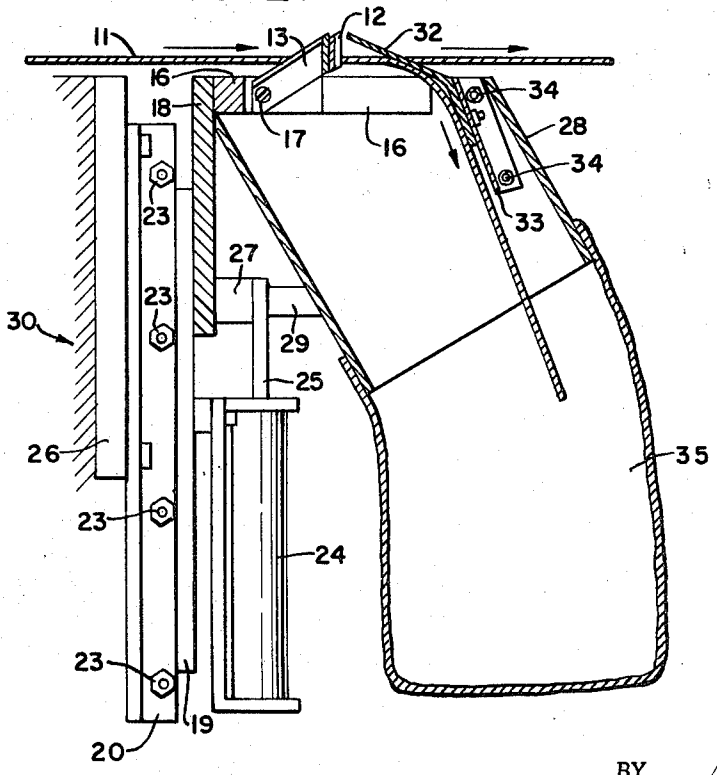



FIG. 4.

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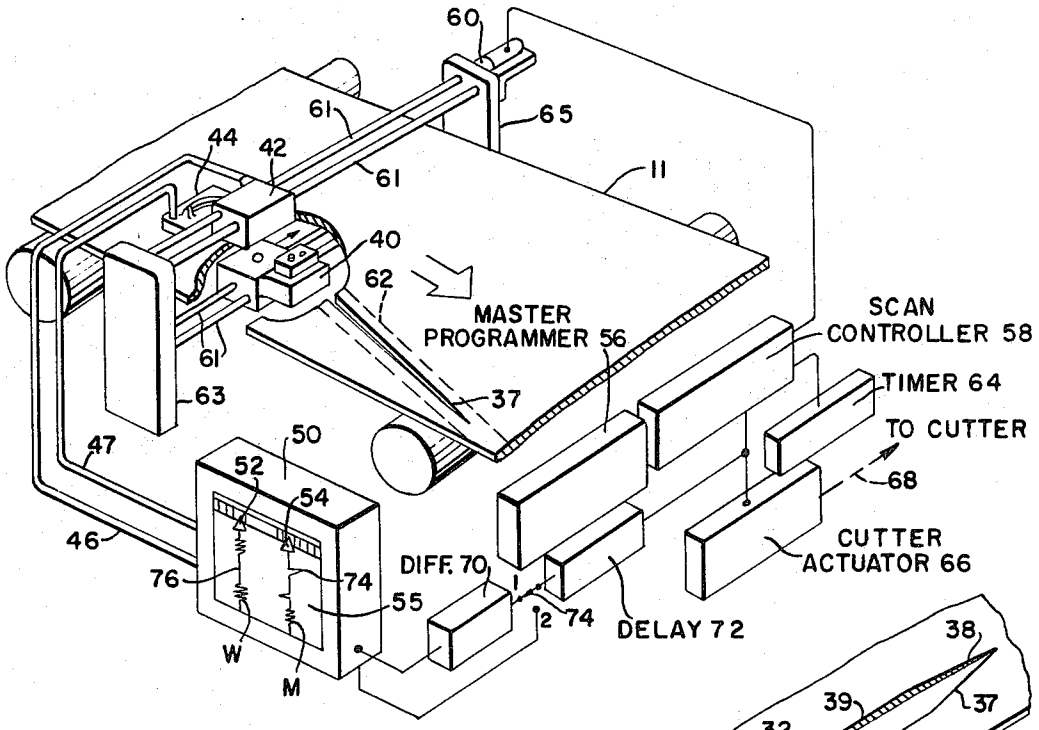



FIG. 8.

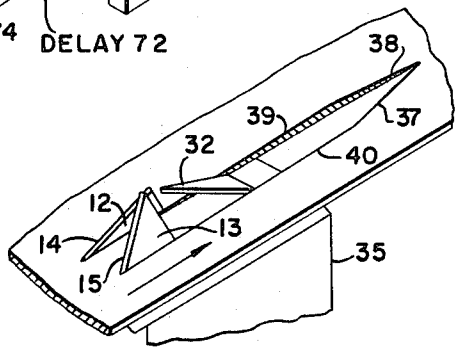



FIG. 9.

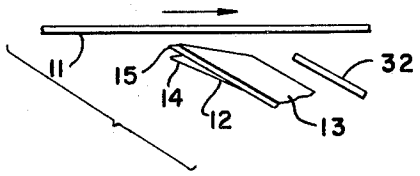



FIG. 11.

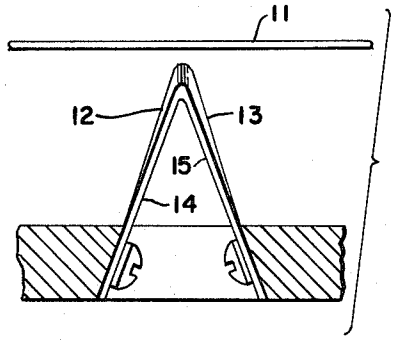



FIG. 12.

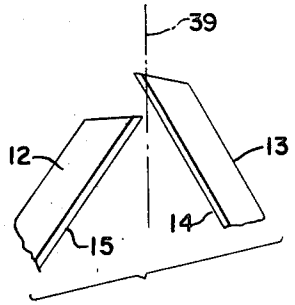



FIG. 10.

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# WEB SAMPLING METHOD AND APPARATUS

This application is a continuation of Ser. No. 601,750, filed Dec. 4, 1966, now abandoned.

The present invention relates generally to systems for removing samples from a web, and more particularly to a station for cutting samples from a web moving longitudinally relative to the station comprised of a pair of blade edges tapering from a common point where the edges selectively intersect the web.

In many applications dealing with the processing of web material, such as paper, metal foil or cellophane, it is necessary to cut a sample from the interior of the web as it moves in the manufacturing process. For example, in paper manufacture, on-line moisture measuring equipment must be frequently checked to determine if it is properly calibrated. To ascertain if the on-line moisture measuring equipment is properly calibrated, a sample is cut from the web downstream of the moisture measuring equipment and the sample is fed into a container where the properties of the sample do not change.

In the manufacture of paper, it is necessary to monitor the moisture and basis weight (the combined weight per square foot of the paper fiber and the moisture included therein) during the manufacturing process. These parameters are measured by gauges that monitor a relatively small area across the web at any time. To provide an indication of the entire web characteristics, the gauges are translated transversely of the longitudinally moving web. If the gauges were maintained at the same transverse position relative to the web, the great variations that exist in the characteristics of the paper across its width would not be measured.

These industrial measuring devices, however, require relatively frequent calibration to determine if they are providing accurate measurements. Previously, gauge calibration was accomplished by manually removing a section of the web with manually operated knives. In addition to being extremely slow and crude, manual paper removal changes the sample characteristics compared to what they are at the time when a measurement is being made. Variations in the sample occur because of: handling; moisture leaving the sample and escaping into the atmosphere; and difficulty sometimes encountered in packing the sample into a container for storage. Of course, the manual removal of samples from a paper web necessitates a complete shutdown of the manufacturing process and reduces mill efficiency. Another disadvantage attendant with manual cutting of samples is the possibility of the sheet or web being torn from one edge to another, whereby the sheet must be reapplied to a roller.

According to the present invention, these problems are obviated by utilizing an automatically activated cutter that has its transverse position relative to the web aligned with the gauges being calibrated. The cutter and gauges are arranged so that they may both be moved transversely relative to the longitudinally moving paper web whereby the sample cut has the same moisture and basis weight characteristics as the portion of the web analyzed by the gauges. By translating the gauges and cutting mechanism in synchronism across the web, calibration of the gauges for a plurality of different values is achieved because the paper characteristics vary considerably in moisture and basis weight as a function of the distance across the paper.

In cutting a sample from a moving web in a paper manufacturing process, it is, of course, desirable for the sample to be removed without reducing the velocity of the sheet material as it moves by the cutter. To our knowledge, there has been no cutting device developed that is capable of cutting paper at the web velocities attained with modern paper making machinery, wherein the web is translated on the order of 1,700 feet per minute and weighs between 15 and 20 pounds per thousand square feet.

According to the present invention, cutting samples from a paper web moving at velocities on the order of 1,600 or 1,700 feet per minute and with a weight of approximately 8 to 150 pounds per thousand square feet, can be accomplished with a



cutter having a pair of cutting edges that are selectively brought into engagement with the web so that they cut two slits having a common point on the web. After the cutting operation has been terminated, the cutter is returned to approximately the same position where it was located prior to the cut, whereby there is formed a sample with the shape of an elongated hexagon having a pair of parallel sides and additional sides tapering at either end. According to one embodiment of the invention, the blade edges are formed from a pair of separate knives that cross each other slightly so that one blade is positioned downstream of the web relative to the second blade. In another embodiment, the blades have a common apex and are formed as a single V-shaped member that pierces the web.

The cross blade configuration is preferred over the V-shape because the material cut does not have an opportunity to collect between the blades. An essential aspect of the invention, however, is that the blade edges intersect a common point on the web during the cutting operation. If the blade edges do not intersect a common point on the web, no sample will be taken from the web because there will be no mutual meeting point of the two separate slits or cuts.

In order to provide a mutual meeting point for the blades in the separate two blade configuration, the blades must be crossed. We have found that separate blades have a tendency to spread outwardly at the end of each cut in response to the force exerted on them by the moving web because they are thin and not infinitely rigid. If the separate blades have a common apex, and are not crossed, the slight outward spreading prevents the two separate cuts from ever intersecting each other. Of course, if the two cuts do not join, no sample is taken from the web and two elongated slits are merely placed therein.

It has also been found that the cutting blades are most advantageously positioned so that they slant in a direction against the web movement. Optimum results occur with the blades so positioned because the web has a tendency to be flexed as the blades initially cut. By positioning the blades so that they enter the sheet or web in a direction against the movement of the web, the web is driven downwardly against the blades and is not flexed upwardly to a position where the blades may not shear the sheet.

Another aspect of the present invention, particularly concerned with maintaining the properties of the sample as they were at the time when the cut was made, comprises deflecting the cut sample from the remainder of the web by means of a tongue. The tongue is positioned downstream of the cutting blade so that the cut sample is directed through a chute into a plastic bag which preserves the moisture and basis weight properties of the sample, as described in U.S. Pat. No. 3,276,303.

Another feature of the present invention is that the gauges are coupled to recorders that have marks inserted thereon in synchronism with cutting of the sample. Thereby, the cut sample can be analyzed and quickly compared with recorder charts responsive to the output of the recorders.

It is, accordingly, an object of the present invention to provide a new and improved system for cutting samples from a moving web.

It is another object of the present invention to provide a cutter for removing samples from webs traveling on the order of 1,600 or 1,700 feet per minute, whereby the time for manufacturing webs of paper and the like is not reduced to obtain a sample.

It is an additional object of the present invention to provide a system for cutting samples from a moving web and feeding the sample to a container where it is maintained in the same condition as existed at the time when the sample was cut.

An additional object of the present invention is to provide a web sample cutter wherein material is not collected between the blades utilized for slitting the sample from the web.

Still another object of the present invention is to provide a system for cutting samples from a moving web by utilizing a pair of separate blades arranged so that the adverse effects as-

sociated with the tendency of the blades to spread at the end of a cut are obviated and the possibility of material collecting between the blades is avoided.

Still another object of the present invention is to provide a system for cutting samples from a moving web wherein the cutting apparatus may be utilized for taking a plurality of samples from the same web and without stopping the web since the cutter position relative to the web is approximately the same prior to and after a sample has been taken.

Still an additional object of the present invention is to provide a relatively inexpensive, efficient and maintenance free system for removing samples from a moving web.

Still another object of the present invention is to provide a new and improved system for determining the calibration of gauges utilized in analyzing the characteristics of a moving web.

Yet a further object of the present invention is to provide a system for automatically cutting samples from the same transverse portion of a moving web as it is analyzed by a gauge for measuring parameters of the web, whereby the gauge calibration can be determined with measurements made from the cut sample.

An additional object of the invention is to provide a system for ascertaining the calibration, over a relatively wide range, of gauges utilized for monitoring the characteristics of a moving web, wherein a sample is taken from the web at a plurality of positions across a web that is susceptible to appreciable variations along its transverse dimension.

The above and still further objects, features and advantages of the present invention will become apparent upon consideration of the following detailed description of several specific embodiments thereof, especially when taken in conjunction with the accompanying drawings, wherein:

FIG. 1 schematically illustrates one embodiment of the invention;

FIG. 2 is a top view of one cross blade cutting station embodiment of the invention;

FIG. 3 is a side view of the cutting station illustrated in FIG. 2;

FIG. 4 is a sectional view of the cutting station, taken along the lines 4—4, FIG. 2;

FIG. 5 is an enlarged view of the blades and paper, taken in the area indicated by the lines 5—5, FIG. 3;

FIG. 6 is a side sectional view of the blades taken through the center lines 6—6, FIG. 5;

FIG. 7 is a side sectional view of the blades taken through the center lines 7—7, FIG. 5;

FIG. 8 is a perspective view of the gauges and recording instruments in combination with the cutting station illustrated in FIGS. 2–7, wherein the blades are illustrated as cutting a sample from a moving web from within a transverse measurement zone;

FIG. 9 is an enlarged partial perspective view of the cutter blades in the process of cutting a sample strip;

FIG. 10 is an enlarged front view of a modification of the crossed cutting blades wherein only one of them extends beyond the center line between them;

FIG. 11 is a side view illustrating another modification of the cutting blades wherein they slant against the sheet or web being cut; and

FIG. 12 is still another embodiment of the invention wherein the cutting blades are comprised of a single unitary structure having an inverted V-shape.

Reference is now made to FIG. 1, wherein the web 11 to be cut for removing samples therefrom is assumed to be translated in a plane at right angles to the sheet in which the drawing lies. Positioned in the quiescent condition above or below web 11, which is considered hereafter as being a moving sheet of paper being manufactured, are cutting blades or knives 12 and 13. The sharpened edges of blades 12 and 13 lie at right angles to the direction in which web 11 is translated, whereby the paper engages and is sheared by the sharpened knife edges when the blades are translated upwardly to the dotted line position. When it is desired to terminate the cut, blades 12 and 13 are returned to the solid line position indicated, whereby there is formed a sample shaped as an elongated hexagon having in its center a pair of parallel sides and at either of its ends a pair of tapering sides that meet at a point.

In the embodiment illustrated specifically in FIG. 1, blades 12 and 13 cross each other slightly at their tips and taper in opposite directions away from the crossing point which lies on the center line between them. Alternatively, the knife may comprise a U-shaped member having a pair of cutting edges. Blade 13 is positioned behind blade 12 and extends slightly above the tip of the latter blade, although the forward blade could extend slightly above the rearward blade without changing the operation of the cutter. Because blades 12 and 13 do not touch one another, material is not embedded therein nor is it collected between the two cutting edges of the blades. Another advantage in utilizing two separate blades is that the blades need not be sharpened at their upper most tips, whereby the expense involved in blade fabrication is reduced. Blades 12 and 13 preferably slope with or against the direction of movement for sheet 11. While it is preferred that the blades 12 and 13 contact the sheet at a direction other than at right angles to the direction in which web 11 is translated, it may be desirable to employ an angle of attack of 90° in some applications. If blades 12 and 13 are inserted through the paper in a direction other than at right angles to the paper movement, sliding action occurs between the blades and paper, thereby facilitating shearing of the web. If the blades do not slide relative to the sheet being cut, the sheet may be broken, rather than sheared, and uneven, irregular cutting may occur.

In a particular embodiment of the invention illustrated by FIGS. 2–9, blades 12 and 13 are positioned so that they slope in the same direction as web 11 is translated. In order to obtain optimum results with this configuration, it has been found that the angle of attack between blades 12 and 13 and sheet 11 is on the order of 35°, i.e., the angle of the cutting surfaces 14 and 15 of blades 12 and 13 relative to the horizontal plane in which web 11 is translated in FIG. 3 is 35°. It has been found that an angle of attack less than 30° frequently causes sufficient upward deflection of web 11 when the blades come in contact with it to prevent the blades from penetrating through the web. On the other hand, if the angle of attack for cutting edges 14 and 15 is in excess of 40°, web 11 is often broken rather than sheared, whereby a clean cut is not obtained.

Reference is now made more particularly to FIGS. 2–9 wherein blades 12 and 13, as well as the specific structure utilized for translating them into engagement with web 11, are illustrated. As shown in FIGS. 2 and 4, the ends of blades 12 and 13 remote from their crossing point are bolted to horizontally extending plate 16 having a Y-shaped aperture therein. Blades 12 and 13 are fastened to plate 16 by bolts 17 that extend into threaded bores on opposite sides of the stem of the Y-shaped aperture. Blades 12 and 13 taper inwardly and upwardly from their connection by bolts 17 to plate 16 so that blade 13 crosses above blade 12 and extends farther from the stem of the Y-shaped aperture.

Horizontally disposed plate 16 is rigidly connected to vertically extending plate 18, located upstream of cutting blades 12 and 13. Plate 18 is fixedly mounted on male slide 19, which together with female guide 20 and strip 21 comprises a V guide with a removable strip. Removable strip 21 is fixedly mounted on female guide 20 by means of bolts 23, whereby the strip can be replaced when it wears.

To selectively translate guide 19 as well as blades 12 and 13 vertically relative to fixedly mounted guide 20, air cylinder 24, for driving vertically extending piston 25, is fixedly connected to post 26, that also carries guide 20, and is fixedly secured to gauge housing 30. The end of piston 25 extending from cylinder 24 is connected to plate 18 by block 27 and is also connected to chute 28 by means of arm 29.

Chute 28 comprises four plates arranged as a square hollow shaft. The plates are connected at their upper edges by bolts 31 to horizontally extending plate 16. Centrally mounted in

the upper end of chute 28 and extending above the top of the chute is triangularly shaped tongue 32 for deflecting or guiding the sample cut from web 11 through the chute. The apex of tongue 32 is positioned in close proximity to and slightly below the upper tips of blades 12 and 13. Thereby, as blades 12 and 13 are translated upwardly through web 11, tongue 32 follows through the aperture cut in the web. Of course, the uppermost surface of tongue 32 is slightly below the upper tips of blades 12 and 13 to preclude engagement of the tongue with the web prior to the knives cutting a sample. Because the sample cut from web 11 may veer slightly to one side or the other as it passes through chute 28, tongue 32 is formed as a triangle having sides sloping away from blades 12 and 13, rather than as a rectilinear bar or the like. For the same reason, the apertures in plate 16 downstream of where blades 12 and 13 engage web 11 are tapered outwardly.

Tongue 32 is curved or bent from the upper surface of chute 28 so that it extends toward blades 12 and 13. With in chute 28, tongue 32 is positioned so that it extends at approximately a 60° angle below the horizontal plane, whereby the cut sample is definitely turned into chute 28. Tongue 32 is maintained in situ on chute 28 by being bolted to plate 33, which is in turn rigidly connected to the side walls of chute 28 by bolts 34.

To receive the sample cut from web 11 that emerges from chute 28, plastic or cellophane bag 35 is positioned at the end of the chute remote from blades 12 and 13. Bag 35 is fastened to the end of chute 28 by spring biased clips 36, mounted on opposite walls of the chute by means of bolts 37. Samples entering bag 35 are preserved in the same condition as they were at the time that the cut was made in web 11 because the bag is very closely positioned to the blades and the contents of the bag are not directly exposed to ambient environmental conditions. After a sample or a plurality of samples have been cut, bag 35 is removed from chute 28 by opening spring biased clips 36 and the bag is then sealed to preserve the characteristics of the cut sample.

As illustrated most particularly in FIGS. 5–7, only cutting edges 14 and 15 of blades 12 and 13 that engage and shear web 11 are sharpened. At the upper tips of edges 14 and 15, blades 12 and 13 slope downwardly so that the uppermost portions of the blades do not contact web 11 even when the blades are initially moved through the web. Hence, there is no need for the upper tips of blades 12 and 13 to be sharpened, whereby the cost of blade fabrication is reduced. Of course, blades 12 and 13 should be as thin as economically and structurally possible to provide the best cut; blade thicknesses on the order of one sixty-fourth inch have been found satisfactory for combined performance and expense criteria.

The tips of blades 12 and 13 are mutually separated from center line 6—6 and spaced apart by one-eighth inch to one-sixteenth inch. As blades 12 and 13 are brought into contact with web 11, each of cutting edges 14 and 15 forms a separate slit in the web. The two slits meet approximately at the center line between blades 12 and 13 to initiate the tapering sides of the sample. As blades 12 and 13 are withdrawn from web 11, the moving web exerts a force on the blades to spread them slightly from the center line 6—6. Hence, the tapering sides at the end of the cut sample meet at a smaller angle than the corresponding sides at the beginning of the cut sample. The force separating blades 12 and 13 as they are withdrawn from web 11 is not, however, great enough to cause the blades to uncross. Because blades 12 and 13 remain crossed, the two slits formed by the blades meet to terminate the sample as the blades are lowered.

To provide a more complete understanding of the manner in which the present invention functions, a complete operation cycle will be described. Prior to activation of the sample cutter, air cylinder 24 is deactivated, whereby piston 25 is in the lower position illustrated in FIG. 3. With piston 25 in the lowered position, cutting blades 12 and 13 lie beneath the lower surface of web 11 and no sample is fed into bag 35. In response to activation of air cylinder 24, piston 25 translates blades 12 and 13 upwardly towards web 11. The uppermost tip of cutting surface 15 of blade 13 first engages web 11 at a point slightly downstream of where the upper tip of blade 12 is located. Thereby, blade 13 begins to cut a slit in web 11. As blades 12 and 13 continue to rise, the slit extends outwardly, as indicated by reference numeral 37, FIG. 9. Within milliseconds after blade 13 has begun to slit web 11, blade 12 comes into engagement with the web and initiates a second slit 38. Blades 12 and 13 cut a common point on the web, approximately through the center line 6—6 (FIG. 5), whereby slits 37 and 38 have a mutual contact point, forming the apex at one end of the cut sample. It is noted, however, that a small slit is cut in web 11 by each of blades 12 and 13 at a position slightly upstream of the apex at the leading edge of the cut sample.

As blades 12 and 13 continue to rise, the distance between slits 37 and 38 enlarges until the vertical position of the blades is stabilized, as indicated by FIG. 4, generally at a location whereby the separation of the slits is approximately a half inch. The width of the cut sample is changed from one cut to another so that cutting surfaces 14 and 15 of blades 12 and 13 do not wear excessively in one location. The sample cut from web 11 continues moving with the web in a generally horizontal plane until it engages the wall of tongue 32 facing the cutting blades. The cut sample is deflected downwardly at an angle of approximately 20° by tongue 32 and is fed into bag 35 at an angle approximately 60° from the horizontal.

After the desired length of cut has been taken, air cylinder 24 is deactivated, whereby piston 25 returns to the unactivated position illustrated in FIG. 3. As piston 25 returns to its quiescent position, blades 12 and 13 are withdrawn from web 11, whereby the end of the sample is terminated with sides that taper towards each other. As blades 12 and 13 are withdrawn from web 11, they have a tendency to spread apart because they are relatively thin, on the order of one sixty-fourth inch in thickness, and are not infinitely rigid. Spreading of the blades is to an extent of less than one-sixteenth inch whereby both of them intersect a common point on sheet 11 as they are lowered, even though they are spread outwardly. Thereby, the tapering trailing edges of the cut sample meet to provide a definite end to the sample. If blades 12 and 13 do not intersect a common point on web 11 as they are withdrawn from the web and the two slits did not converge on each other, the sample would not be cut from the web and the cut material could possibly be pulled out of bag 35 and chute 28 to flap beneath web 11.

While the crossed blade configuration of FIGS. 2–9 is advantageous because it obviates the spreading problem, it has a slightly deleterious effect on web 11 in that a pair of V notches are formed in the web slightly upstream and possibly downstream of where the sample is cut. The V notches can be easily caught in and foul web processing equipment downstream of the cutter. These notches are formed because blades 12 and 13 enter and might leave web 11 on opposite sides from their common point where, e.g., slits 37 and 38 are initiated. To obviate this problem, blades 12 and 13 can be crossed in a modified manner as illustrated in FIG. 10 wherein only blade 13 extends beyond center line 39 and blade 12 terminates at the center line. In the blade configuration of FIG. 10, the tips of edges 14 and 15 are laterally spaced by one-eighth inch to one-sixteenth inch. As the cutter is translated into web 11, a slit is initially formed only by upper blade 13. Lower blade 12 enters web 11 at a point coincident with the slit formed by blade 13 so that only one slit is formed in the web upstream of the cut sample, rather than a V notch. As blades 12 and 13 are withdrawn from web 11, they again have a tendency to spread. As in the previously described configuration, the blade spread is not great enough to overcome the cross blade configuration, whereby the slits at the rear end of the cut sample meet. The slits forming the sides of the cut sample do not meet at the center of the cut sample, however, because lower blade 12 is deflected so that its tip is removed to the left of center line 39. A single slit is usually cut in web 11 downstream of the cut sample as blade 13 is finally lowered, although occasionally the extreme upper tips of

blades 12 and 13 finish cutting slits at a common point on the web, whereby no slit downstream of the sample occurs.

Reference is now made to FIG. 11 of the drawings, wherein there is illustrated a further modification of the present invention wherein blades 12 and 13 are positioned so that their angle of attack is against the direction of motion of web 11. It is to be understood that the cross blade configurations of both FIGS. 5 and 10 can be positioned with an angle of attack against the web movement.

By positioning blades 12 and 13 so that they slope in a direction against the movement of web 11, any tendency of the web to flex and rise upwardly out of engagement with cutting edges 14 and 15 is obviated. Instead, with the blades sloping against the direction of movement for web 11, there is a tendency for the web to be driven downwardly into cutting edges 14 and 15 so that piercing of the web is assured as blades 12 and 13 rise upwardly.

As in the case of the embodiment of FIGS. 2–9, the angle of attack for blades 12 and 13 in the embodiment of FIG. 11 is preferably 35°, with limits of between 30° and 40°. If the blade angle of attack is less than 30°, there is an excessive tendency for web 11 to be deflected downwardly, whereby it is not pierced by the blades 12 and 13. If the upper limit of 40° is exceeded, sheet 11 is broken rather than sheared by blades 12 and 13 as there is insufficient sliding contact between the blades and the web to enable proper shearing forces to be developed. Breaking the sheet rather than shearing it prevents an evenly cut sample from being taken from web 11, whereby the quality of the resultant sample is impaired and an increased probability of fouling downstream web processing equipment arises.

Reference is now made to FIG. 12 of the drawings, wherein there is illustrated still another embodiment of the present invention. In the embodiment of FIG. 12, blades 12 and 13 are not crossed or separated but are bonded to each other by, for example, spot welding, to form a single V-shaped cutting element. The blade configuration can have an angle of attack either in the same direction as or against the movement of web 11, as indicated by FIG. 3 and FIG. 11, respectively.

While the V-shaped configuration of FIG. 12 is easier to handle and install at the cutter station than the separated blades of the embodiments illustrated in FIGS. 1–11, there is the disadvantage that the upper tips of blades 12 and 13 must be sharpened. If the upper tips of blades 12 and 13 are not sharpened web 11 will not be sheared as the blades are forced through the web. It is desirable to avoid sharpening the tips of the blades because of the expense involved in forming such blades and in maintaining them. Another disadvantage associated with the configuration of FIG. 12 is that material from the web has a tendency to be embedded in the intersection of blades 12 and 13, thereby destroying its effectiveness to a great degree after repeated usage.

Referring again to FIG. 8, the sample cutter of the present invention may be used to cut a strip extending transversely across the width of sheet 11 carried between a pair of supporting roll members 39 and 41. To this end, the cutter housing may be carried across the sheet 11 and actuated to remove a strip from within the edges of the sheet. This is a great advantage because on many sheeting lines the profile of the variable being measured may vary across the sheet making a sample taken in single point, i.e., at a fixed cross-sheet location, non-representative of the entire sheet.

Since the primary purpose of the sample cutter is to provide a calibration check on one or more measuring instruments positioned adjacent to the sheet, it may be desirable to mount the cutter housing 40 on the instrument carriage. In the illustrated case, a beta radiation gauge 42 and a moisture gauge 44 are preferably constructed as disclosed in U.S. Pats. Nos. 2,790,945 and 2,920,272, assigned to the same assignee as the present application. Briefly, the radiation gauge measures the basis weight of the sheet 11 and transmits a signal over line 46 to a recorder 48. The moisture gauge 44 comprises a probe coupled by line 47 to recorder 50. For convenience, the moisture gauge is mounted on the basis weight gauge bracket. Recorder 50 includes two marking pens 52 an 54 to provide a basis weight trace W and a moisture trace M on a chart 55. Alternatively, two recorders could be used to provide separate records of the variables of interest.

A master programmer unit 56 directs the movement of the gauges 42 and 44. Operating personnel may require that the gauges be continuously maintained either in single point at either edge of the sheet or at any position in between, or in a scanning mode. A scan controller 58 causes a gauge positioning motor 60 to drive the gauges back and forth across the width of the sheet 11. Alternatively, the measuring instruments may be automatically switched from one mode to the other.

Regardless of the mode of operation, the gauges 42 and 44 monitor a defined measuring area, and a zone 62, extending down the length of sheet 11, defines the portion of the sheet which passed adjacent to the gauges and was measured thereby. It is desired to remove a strip from within this zone to check the calibration of the moisture gauge 44, for example. To accomplish this, our system uses any of cutter blade configurations described above to automatically remove the desired strip and to automatically identify on the chart 55 what portion of the recorded indications corresponds to the removed strip.

If the master programmer 56 calls for a scanning type measurement, the scan controller 58 moves the gauge assembly from left to right (as viewed in FIG. 8) across the sheet 11 on traversing rods 61 carried between a pair of upstanding end members 63 and 65. Both weight and moisture signals are concomitantly displayed on the chart 55. After the gauges are sufficiently on sheet, timer 64 generates a voltage pulse to energize a cutter actuator 66 coupled to the cutter as indicated by the heavy dotted lines 68. The cutter blades 12 and 13 (see FIG. 9) rise through the sheet 11 and the cut strip is deflected by tongue 32 down into the sample storage bag 35.

Timer 64 times out before the gauges reach the other side of the sheet 11 and the voltage pulse is removed. Whereupon the cutter blades drop back down through the sheet 11 ending the sample.

An R-C differentiator 70 may be employed to pulse the moisture pen 54 as the cutter is energized and deenergized. Opposite-going pips 74 on the chart 55 define that portion of the trace M representing the moisture content of the removed strip. Since there is some time lag due to the inertia of the cutter blade housing, a delay unit 72 may be provided to delay the recorder chart identification for about one second.

Alternatively, other identifying techniques may be employed such as, for example, clamping the recorder pen motors. A switch 74 may be switched to an alternate position to clamp the basis weight servo pen motor during the sampling period. In this case, the weight trace W is drawn with a straight-line segment 76. Calibration personnel can tell what portion of the moisture trace corresponds to the removed sample by visually horizontally superimposing the straight-line segment 76 of the basis weight trace W onto the moisture trace M. Any time lags due to different time responses of the two measuring and recording systems must, of course, be taken into account.

While both types of chart identification are illustrated, they cannot both be provided simultaneously by the apparatus shown in FIG. 8. While both pens may be clamped, it is advantageous not to clamp the one associated with the gauge to be calibrated, since it is usually desirable to know what the measured values were prior to and subsequent to the removal of the sample.

Translating gauges 42 and 44 across the width of sheet 11 has an advantage of enabling the gauges to be calibrated for conditions that may vary widely. The widely varying conditions arise because the moisture and basis weight of a paper sheet during the manufacturing process are frequently variable by a factor of 2:1 from the center of the sheet to either of its edges or from one edge to the other. Hence, an indication

of the dynamic calibration of gauges 42 and 44 can be attained merely by translating them across the width of web 11 and cutting a transverse sample that intersects each of the analyzed points. While gauges 42 and 44 are longitudinally removed from blades 12 and 13, the readings from chart 55 can be correlated with data taken from the cut samples because the time required for web 11 to propagate from the gauges to the cutter is on the order of half a millisecond, a time interval less than the response time of the recorder pens 52 and 54.

After the sample has been cut and blades 12 and 13 lowered, the sample is sealed in bag 35 and transported to a laboratory where a very precise measurement of the moisture content of the cut web is made. The precise laboratory measurement is compared with the readings taken by the moisture gauge 44 and indicated on the recorder chart 55 between the pips 74. Any disagreement between the measured and the actual values of moisture necessitates adjustment of the moisture measuring and readout circuitry.

The operation of the system in single point will be obvious from the above description. In this case, a longitudinal zone is measured and timer 64 may be adjusted to provide a strip of any desired length in accordance with the speed of travel of the sheet 11. The cross-sheet location of the zone may be selected by operating personnel.

In alternative embodiments, the cutter may be mounted upstream from the measuring gauge because it removes only a narrow strip from within the measuring zone. Instead of being linearly displaced, the cutter blade housing may be pivotally mounted and driven by a linkage to swing on an arc toward the sheet 11. The width of the removed strip can be controlled by varying the extent to which the blades 12 and 13 are pushed into the sheet 11. It may be desirable to oscillate the cutter to spread the wear of the blades 12 and 13 along the length thereof.

The sample cutting and gauge correlation techniques described hereinabove have been successfully employed on industrial lines in tests of the most severe nature. For example, the system of FIG. 8 has been used to cut and correlate thin paper sheet having a weight per unit area of 8 pounds per 1,000 square feet and traveling at a speed of 2,000 feet per minute. Strips of the desired length are provided and sheet breakdown has been virtually eliminated.

While we have described and illustrated several specific embodiments of our invention, it will be clear that variations of the details of construction which are specifically illustrated and described may be made without departing from the true spirit and scope of the invention as defined in the appended claims.

We claim:

1. In a system for calibrating a gauge that monitors the characteristics of a web moving longitudinally relative to the gauge, a station for carrying the gauge in proximity to the web, whereby the gauge is responsive to a characteristic of the web and derives a signal indicative of the characteristic, means for selectively cutting a sample from the interior of the web as it is longitudinally moved, said cutting means being positioned downstream of the gauge and cutting an area from said web substantially the same as the area monitored by the gauge, and means positioned downstream of said cutting means and in proximity thereto for deflecting the cut sample from the remainder of the web.

2. The combination of claim 1 further including means for moving said cutting means and gauge together transversely to the web while maintaining the area cut from the web substantially the same as the area monitored by the gauge.

3. The combination of claim 1 wherein said cutting means comprises a pair of blade edges, both of said edges being positioned for selectively cutting a common point on said web and tapering in opposite directions away from said point, said blade edges being separated from each other to prevent the cut sample from accumulating between the edges.

4. The combination of claim 3 wherein said edges have tips for piercing said web, and said blade edges are crossed relative to each other slightly to the rear of said tips.

5. The combination of claim 1 wherein said deflecting means comprises a guide having a surface for receiving the cut sample and for directing it into a passageway.

6. The combination of claim 5 wherein said passageway includes means for carrying a removable container for receiving the cut sample.

7. Apparatus for monitoring and obtaining a sample from a longitudinally moving sheet comprising: gauge means for monitoring a portion of the sheet less than the sheet width, a cutter means, means for supporting said cutter means and said gauge means adjacent said sheet, means for actuating said cutter means to remove a strip extending generally longitudinally of the sheet from between the sheet width edges of said moving sheet, said means for actuating bringing the cutter means into and out of operative relation with the sheet and holding said cutting means in operative relation with the sheet as the sheet is being longitudinally translated.

8. The apparatus of claim 7 further including means positioned downstream of the cutter means and gauge means for deflecting the strip removed from the sheet away from the remainder of the sheet, said means for deflecting projecting through the plane of the longitudinally moving sheet.

9. The apparatus of claim 7 wherein said cutter means is mounted on said gauge means.

10. The method of obtaining a calibration sample from a sheet moving between supports, comprising the steps of: measuring a variable property of said sheet along a zone extending diagonally across the width thereof, cutting said sheet to remove a strip from a portion of said sheet, the removed sheet portion being in a diagonal area between and not up to the sheet width edges and corresponding with said zone, correlating said variable property of said removed strip with the measured value therefor.

11. The method as in claim 10 further including the steps of: inserting at least a pair of blades into said moving sheet to cut a strip starting at a point, and withdrawing said blades from said moving sheet after a predetermined period of time to complete said strip to a point.

12. The method as in claim 11 wherein said removing step further comprises: deflection of said strip away from said sheet to store said strip.

13. In a system for calibrating a gauge that monitors a variable property of a sheet moving longitudinally relative to said gauge, a station for carrying said gauge across the width of said sheet to monitor an area extending diagonally across said sheet, and means for selectively cutting a sample strip from the interior of said sheet from within said monitored area.

14. In a system for calibrating a gauge that measures a variable property of a sheet moving longitudinally relative to said gauge, traversing means causing said gauge to move from one side of said sheet to the other to measure variations in said property along a zone extending diagonally across said sheet, knife means positioned adjacent said sheet and mounted downstream from said gauge, and means for actuating said knife means in response to said gauge movement to remove a sample strip from said sheet from within said measurement zone.

15. Apparatus for removing a representative sample from a moving sheet comprising: a cutter, a housing for supporting said cutter adjacent said sheet, traversing means for moving said housing from one side of said sheet to the other, and means for actuating said cutter to remove a strip of said sheet from within a zone extending diagonally across said sheet.

16. The method of obtaining a calibration sample from a sheet moving lengthwise between supports, comprising the steps of: measuring a variable property of said sheet along a zone extending diagonally across the width thereof, cutting said sheet to remove a diagonal strip from a portion of said sheet between and not up to the sheet width edges, and correlating said variable property of said removed strip with the measured value therefor.

17. A method of removing a sample from a longitudinally translating sheet comprising the step of cutting a longitudinal sample strip from the sheet diagonally of and not including the sheet edges while the sheet is translating longitudinally.

18. Apparatus for measuring and obtaining a sample from a longitudinally moving sheet comprising: gauge means for measuring a property of said sheet, means for traversing said gauge means and said removing means together across the width of said sheet, said gauge means scanning said sheet and said removing means being operable to remove a strip from said sheet.

19. Apparatus, as defined in claim 18, wherein said removing means comprises a cutting means normally positioned away from said sheet; and means for moving said cutting means into and out of said sheet to remove said strip.

20. Apparatus for measuring and obtaining a sample from a longitudinally moving sheet comprising: gauge means for measuring a property of said sheet, means for removing a strip from said sheet, means for traversing said gauge means and said removing means together across the width of said sheet, to cause said gauge to scan said sheet, and means for activating said removing means to remove a strip from said sheet.

21. Apparatus, as defined in claim 20, wherein said removing means comprises a cutter normally positioned away from said sheet, and said actuating means automatically moves said cutter into and out of said sheet to remove said strip between and not up to the sheet width edges.

22. The method of obtaining a calibration sample from a sheet moving between supports, comprising the steps of: measuring a variable property of said sheet along a zone extending diagonally across the width thereof, cutting said sheet to remove a strip from a portion of said sheet by activating a cutter into and out of operative relation with the sheet and holding the cutter in operative relation with the sheet as the sheet is longitudinally translating, the removed sheet portion being in a diagonal area corresponding with said zone, correlating said variable property of said removed strip with the measured value therefor.

23. The method of obtaining a calibration sample from a sheet moving lengthwise between supports, comprising the steps of: measuring a variable property of said sheet along a zone extending diagonally across the width thereof, cutting said sheet by activating a cutter into and out of operative relation with the sheet and holding the cutter in operative relation with the sheet as the sheet is longitudinally translating to remove a diagonal strip from a portion of said sheet between the sheet width edges, and correlating said variable property of said removed strip with the measured value therefor.

24. Apparatus for calibrating a gauge that monitors a variable property of a sheet moving longitudinally relative to said gauge and between supports, said apparatus comprising: means for monitoring said sheet property along a zone extending down the length of said sheet, and means positioned between said support means for removing a strip from a longitudinally translating portion of said sheet between and not up to the sheet width edges and corresponding with said zone, said strip removing means including: means for cutting a strip having a width transverse of the sheet less than the width of the sheet, and means for activating said cutting means to bring said cutting means into and out of operative engagement with the sheet and for holding the cutting means in operative engagement with the sheet.

25. The apparatus of claim 24 further including means for mounting said monitoring means and said removing means together adjacent said strip.

26. In a method of calibrating a gauge monitoring a characteristic of a sheet moving longitudinally relative to the gauge, the gauge monitoring a sheet zone of relatively small area compared with the sheet area, cutting a strip having a width substantially less than the sheet width from the sheet as it is longitudinally moved, the cut sheet strip corresponding with the sheet zone adapted to be monitored by the gauge, said strip and zone extending generally in the direction of the sheet longitudinal direction of movement, said strip being cut by actuating a cutter into and out of operative relation with said sheet and by holding the cutter in operative relation with the sheet while the sheet is translating longitudinally.

27. The method of claim 26 further including the step of maintaining a housing for the cutter a fixed distance from the sheet prior to and while the cutter is in operative relation with the sheet.

28. A method of calibrating a gauge monitoring a property of a longitudinally translated sheet comprising the steps of deriving a response from the gauge as a portion of the sheet is translated past the gauge, removing a generally longitudinally extending strip from said sheet between said sheet width edges by actuating a cutter into and out of operative relation with the sheet and holding the cutter in operative relation with the sheet while the sheet is longitudinally translating and having property variations substantially the same as the property variations in said portion, and correlating the gauge response with the property variations of the strip.

29. The method of claim 28 wherein the correlating step comprises precisely measuring the property of the removed sheet strip, maintaining the property of the removed sheet strip constant between the time the strip is removed from the sheet and the precise measuring step, and determining the relationship between the precise measurement relative to the derived gauge response for the sheet portion.

30. The method of claim 28 further including the step of maintaining a housing for the cutter a fixed distance from the sheet prior to and while the cutter is in operative relation with the sheet.

31. A method of obtaining a sample to enable a gauge monitoring a property of a longitudinally translating sheet to be calibrated, said gauge monitoring a relatively small area compared with the sheet area, comprising removing a strip extending generally in the direction of the sheet translation and having a width less than the sheet width from the sheet while the sheet is longitudinally translating by bringing a cutter into and out of operative relation with the sheet and holding the cutter in operative relation with the sheet while the sheet is being longitudinally translated, the strip of the sheet removed having property variations substantially the same as property variations monitored by the gauge, said strip extending generally in the direction of the sheet longitudinal direction of movement.

32. The method of claim 31 wherein the sheet portion is removed downstream of the gauge.

33. The method of claim 31 wherein the removed sheet portion coincides substantially with a region of the sheet monitored by the gauge.

34. The method of claim 31 wherein the removed sheet portion coincides substantially with a region of the sheet monitored by the gauge and the sheet portion is removed downstream of the gauge.

35. The method of claim 31 further including the step of maintaining a housing for the cutter a fixed distance from the sheet prior to and while the cutter is in operative relation with the sheet.

36. Apparatus for calibrating a gauge that monitors a variable property of a sheet moving longitudinally relative to said gauge and between supports, said apparatus comprising: means for monitoring said sheet property along a zone extending down the length of said sheet, and means positioned between said support means for removing a strip from a longitudinally translating portion of said sheet corresponding with said zone, said strip removing means including: means for cutting a strip having a width transverse of the sheet less than the width of the sheet, and means for activating said cutter means to bring said cutting means into and out of operative engagement with the sheet and for holding the cutting means in operative engagement with the sheet as the sheet is translating longitudinally.

37. The apparatus of claim 36 further including means for mounting said monitoring means and said removing means together adjacent said strip.

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