

[54] **CORRUGATED SHEET CUTOFF LENGTH
ADJUSTMENT APPARATUS**

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[58] Field of Search **83/37, 38, 324, 593,
83/347, 299, 298**

[56]

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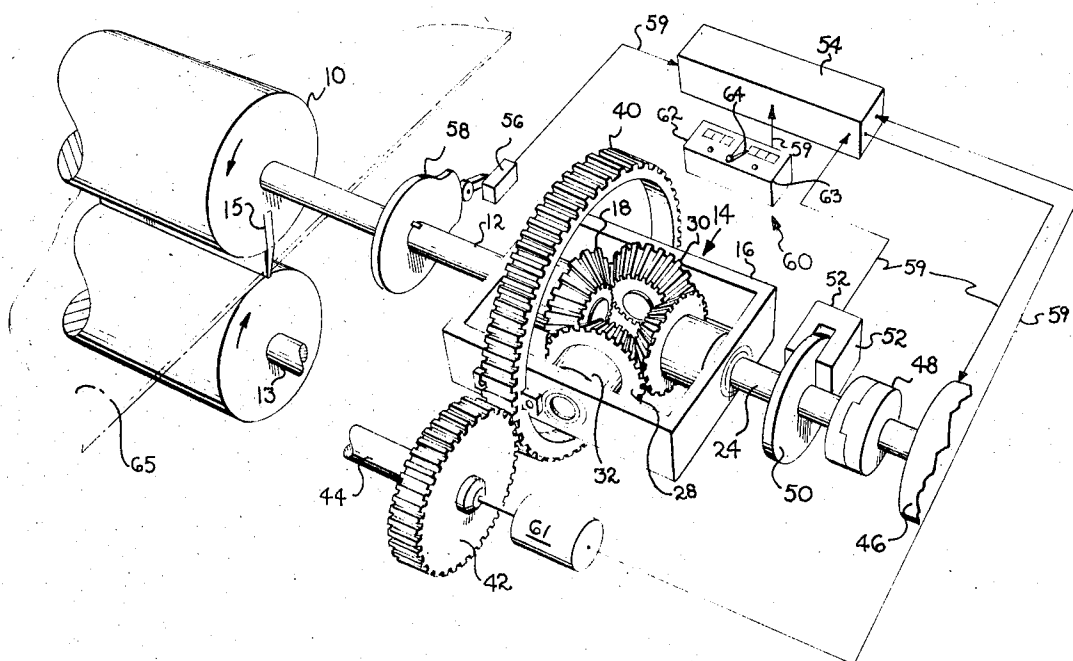
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[57]

ABSTRACT

Apparatus for making immediate running changes in the length of sheet cut from a continuous web of newly manufactured corrugated paperboard. A corrugated cutoff knife is driven by the output shaft of a bevel gear differential. A differential cage is driven through a line shaft operating at the same speed as the running speed of the corrugated board. The cutting knife is driven at the speed of the board during the cutting stroke. However, the speed of rotation during noncutting periods is retarded to allow a specific length of board to pass under the knife. The input shaft to the differential is driven during such periods to retard the speed of the cutting knife. A pulse counter is preset to allow the input gear to be driven only long enough to allow the desired amount of corrugated board to pass before making the next cutting stroke. A control panel is set with a next pre-selected length of sheet to be cut, and by merely switching from the present length to a new length, the counter is reprogrammed and a new length of sheet will be delivered at once.

8 Claims, 3 Drawing Figures



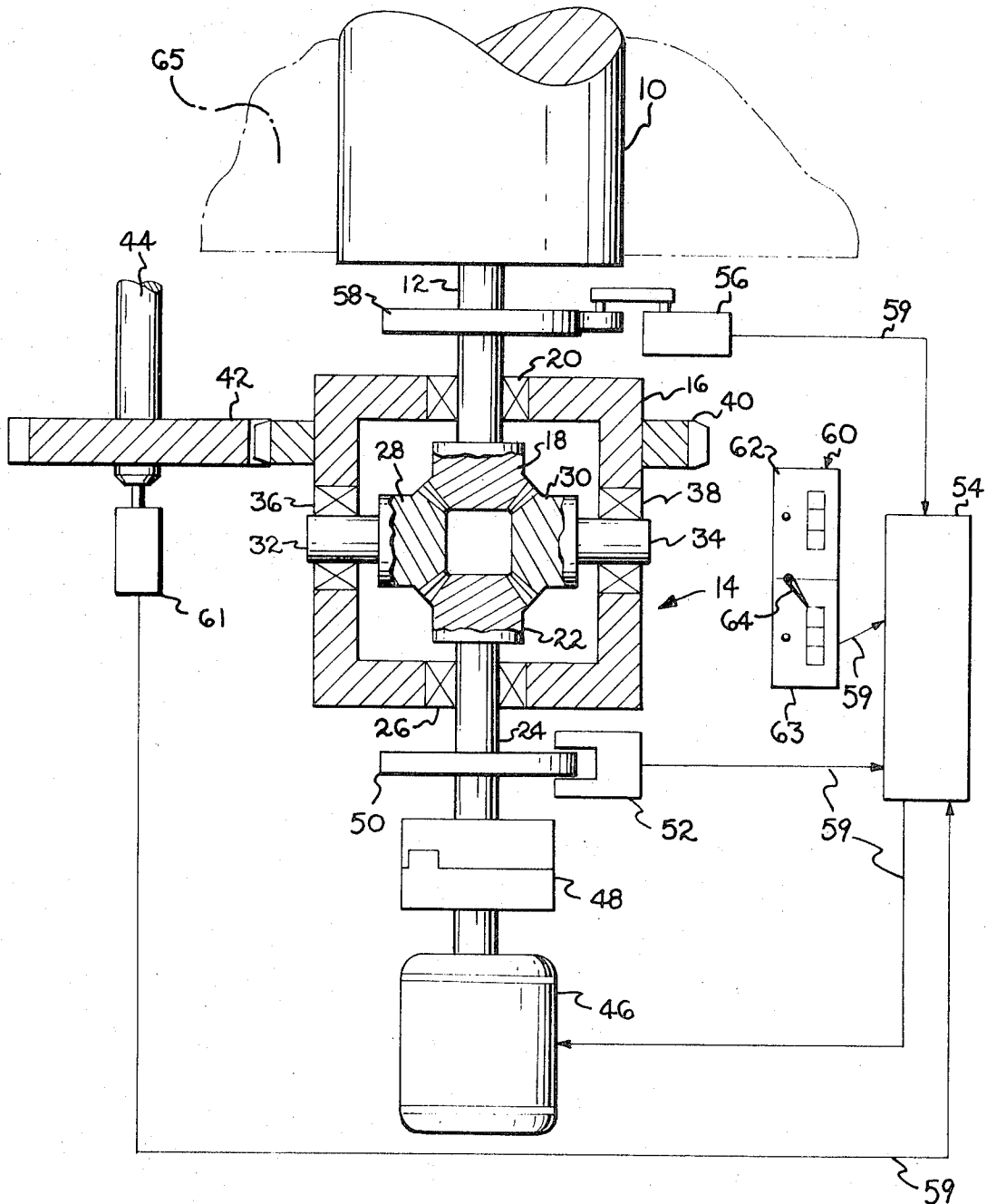


FIG. 1

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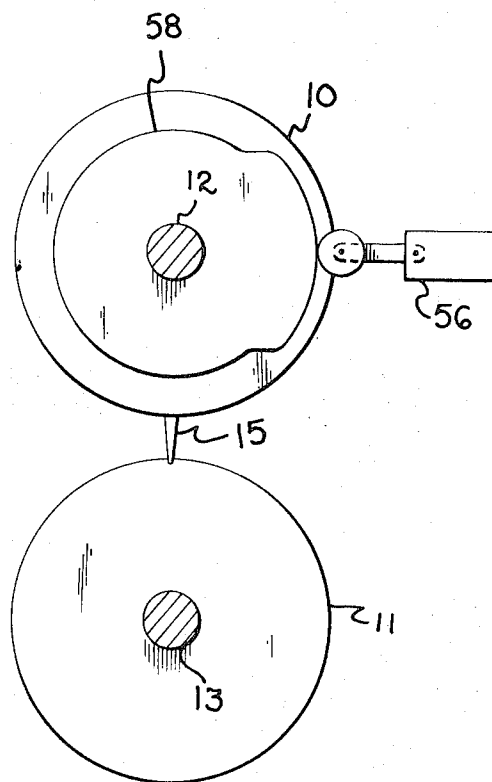


FIG. 2

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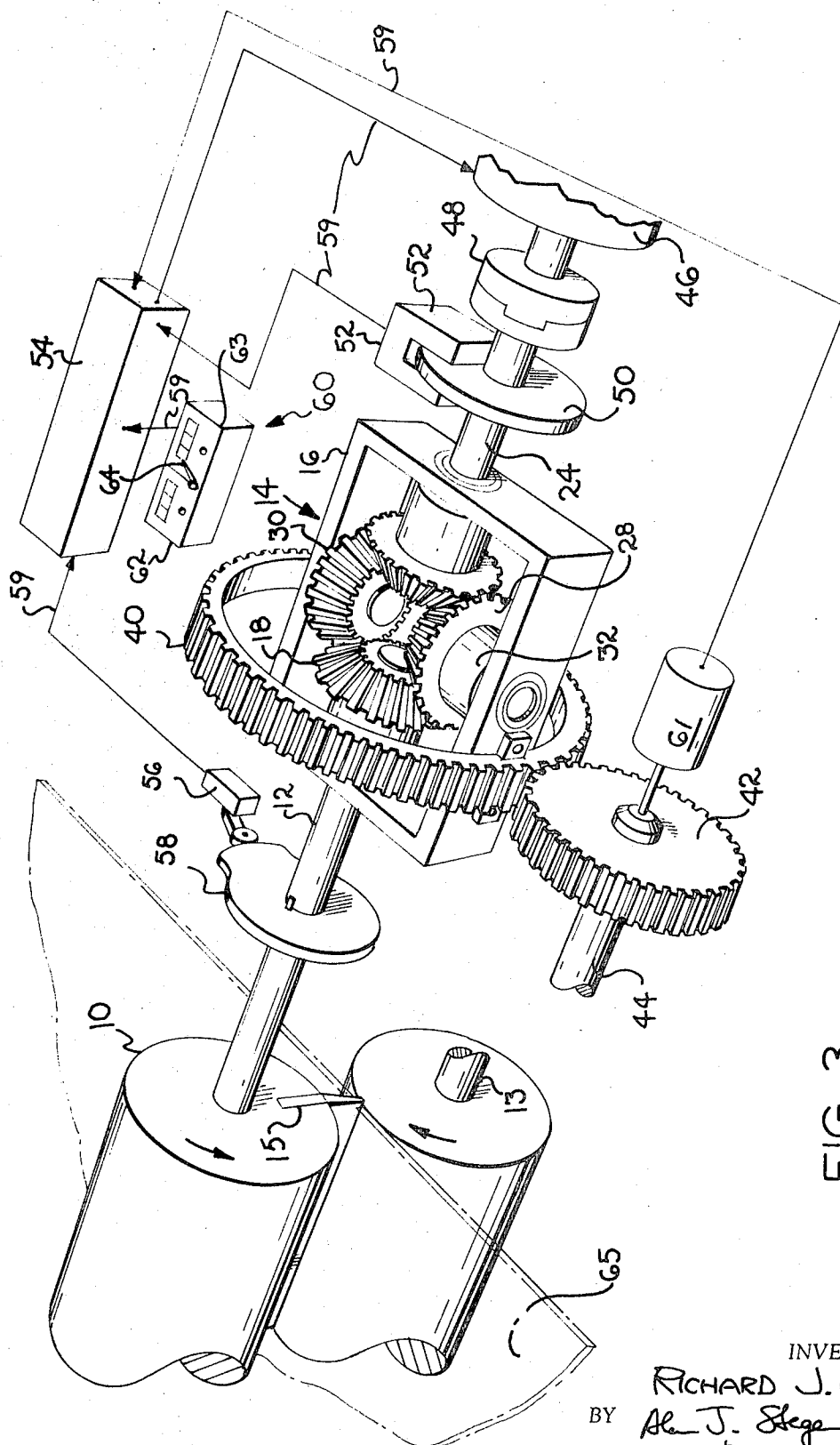


FIG. 3

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CORRUGATED SHEET CUTOFF LENGTH ADJUSTMENT APPARATUS

BACKGROUND OF THE INVENTION

This invention relates generally to cutoff knives for corrugated board manufacturing machines. More specifically, this invention relates to an apparatus for adjusting the rotational speed of a cutoff knife cylinder on a corrugated board manufacturing machine. Most specifically, this invention relates to an apparatus for changing the rotational speed of a corrugated board manufacturing machine cutoff knife cylinder to allow immediate changes in the length of sheets being cut from the continuous web of corrugated material.

In the manufacture of sheets of corrugated paper-board material, it is necessary to sever sheets of a desired length from a continuous web of corrugated material manufactured by a corrugating machine. The sheets are most commonly cut by counter-rotating knives mounted on cylinders which shear the sheets at the desired length. In order to achieve a clean cut, it is necessary that the peripheral speed of the knives be equivalent to the lineal speed of the corrugated material at the time the cut is made. Thus, if the lineal speed of the corrugated web is kept constant, which is normally the situation, the rotational speed of the knife cylinders must be adjusted if a sheet of a different length is desired. The present state of the art is illustrated by rotary cutoff mechanisms such as the Model (JR) manufactured by the Langston Corp., 6th and Jefferson Sts., Camden, N.J. 08104. This is an involved mechanical linkage system which will allow the cylinders to rotate at a slower rate during noncutting periods than during the cutting period, and will allow adjustment of the overall speed of rotation of the knife cylinders to compensate for different lengths of corrugated sheet to be cut. However, this system has a serious deficiency in that it is impossible to immediately change the length of sheet being cut. That is, should one change from a shorter to a longer sheet, there is a period of time in which sheets will be cut at intermediate lengths between the shorter and longer sheets while the mechanism is being adjusted. These sheets of intermediate length must be trimmed by hand to the length of the original shorter sheet. In addition, the increasing automation in the corrugated manufacturing process requires that uniform length sheets be delivered to automatic stacking apparatus at the end of the corrugating machine. The intermediate length sheets produced during the sheet length change cycle frequently jam such automatic equipment and lead to production delays. The present invention overcomes this problem by allowing the change in sheet length to be made from one cutting cycle to the next cutting cycle, thereby changing immediately from one sheet size to the next. This then allows the automatic stacking equipment to be set up to receive one size and then diverted to receive another size with the sheet sizes known to be uniform. In addition, the intermediate length sheets do not appear and the hand-trimming operation is eliminated.

SUMMARY OF THE INVENTION

My invention is an apparatus for immediately changing the length of sheet cut from a moving web of corrugated material. A rotating knife carrying cylinder is driven by a bevel gear differential system. A second cylinder covered with a resilient material is mounted in

opposition to the first cutting cylinder and is driven at a speed corresponding to the lineal speed of the corrugated web. The bevel gear differential is supported in a cage which in turn carries a ring gear that may be rotated to drive the bevel gear cage. The ring gear in turn is driven through a line shaft at a speed corresponding to the linear speed of progress of the corrugated board itself. Thus, if only the ring gear were driven, the knife cylinder would rotate at a speed equal to the lineal speed of the corrugated material. This is the proper speed for the cutting stroke of the knife cylinder. However, to cut different lengths of corrugated sheets, the speed of rotation of the knife cylinder must be retarded during the noncutting periods. To achieve this, the bevel gear differential is registered backward to allow a pre-selected length of corrugated board to pass.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic plan view of the apparatus of the present invention;

FIG. 2 is a schematic elevational view of the knife cylinder and control cam of the present invention;

FIG. 3 is a perspective view partially in schematic of the apparatus of the present invention as it would operate in severing a corrugated sheet from a web of corrugated material.

DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in the drawings, a knife cylinder 10 carrying a cutting knife 15 is attached by an output shaft 12 to a bevel gear differential 14. The bevel gear differential 14 is supported by a cage 16. Carried by the cage 16 is an output gear 18 connected to the output shaft 12, the output shaft 12 being supported by suitable bearings 20 carried by the cage 16. An input gear 22 is connected to an input shaft 24 which is supported by suitable bearings 26 carried by the cage 16. Idler gears 28 and 30 are provided and serve to interconnect the input gear 22 and the output gear 18. The idler gears 28 and 30 are supported on stub shafts 32 and 34 which are carried in suitable bearings 36 and 38 in the cage 16. Attached to the cage 16 is a ring gear 40. Rotation of the ring gear 40 will result in a corresponding rotation of the cage 16. The entire assembly thus constitutes a mechanical adder with a scale factor of one-half. That is, the angular displacement of the cage 16 equals one-half the sum of the angular displacement of the output shaft 12 and the input shaft 24.

The ring gear 40 is driven by a line speed control gear 42. The line speed control gear 42 in turn is driven by a line shaft 44 which is driven at a speed corresponding to the linear speed of an advancing web 65 of corrugated material. A rotating drive means 46 is connected through a one-way clutch 48 to the input shaft 24. The one-way clutch 48 prevents driving of the drive means 46 by the input shaft 24. The rotating drive means 46 may be an electric motor, or a hydraulic motor. In this preferred embodiment, the rotating drive means 46 is shown as an electric motor and will be referred to hereinafter as such. Attached to the input shaft 24 is a pulse generator 50. The pulse generator 50 is of the type which provides 360 pulses per rotation or one pulse per degree of rotation. Since the pulse generator 50 is attached to the input shaft 24, it is clear that the pulse generator 50 will measure the rotation of the input shaft 24. A pulse transmitter 52 transmits the pulses

generated by the pulse generator 50 to a logic and control unit 54. The logic and control unit 54 is of the type well-known in the art which will remain on until a preset number of pulses have been received from the pulse transmitter 52, at which time it will turn off. The logic and control unit 54 controls the on and off cycling of the electric motor 46. In turn, the logic and control unit 54 is turned on and off by a roller-type switch 56, whose functioning is controlled by a cam 58 attached to the output shaft 12. The preset number of counts on which the logic and control unit 54 controls, is introduced through an operator's control panel 60. The operator's control panel 60 is such that the operator may set two pre-selected number of counts on the control panel 60. With a switch 64 thrown in one direction, one set of counts will be used to control the logic and control unit 54. If the operator throws the switch 64 to the other possible count number, the logic and control unit 54 will then be responsive to that preset number of counts.

To understand the significance of the counts generated by the pulse generator 50, first assume that the minimum length of sheet to be cut is 36 inches. In reality a shorter minimum could be set, but 36 inches is a convenient number to use for the purposes of this explanation. In order to cut the 36 inch length, the cutoff knife cylinder 10 must turn one revolution per 36 inches of corrugated material fed forward. In a specific example using a 36 inch circumference knife cylinder 10 at a 600 foot per minute corrugated material travel, the knife would rotate at a constant 200 revolutions per minute. To cause this, the input shaft 24 would be held stationary, and the ring gear 40 would be caused to rotate at 100 rpm. If at any time the line speed changed, the rotational speed of the ring gear 40 would correspondingly change, since it is driven through the line shaft 44. The net result of this drive train is to allow the knife cylinder 10 to rotate at exactly the line speed of the corrugated web 65 being fed forward. However, should a different length of sheet be required, the knife cylinder 10 must travel at a rate slower than the line speed during a part of its rotation to allow a greater length of corrugated board to pass under it before it cuts. Nevertheless, at the time of cutting, the knife cylinder 10 must be traveling at the same speed as the corrugated web 65 which it is cutting. As an example, if the web 65 speed remains 600 feet per minute and a 72 inch long sheet is desired, the average knife speed must be 300 feet per minute, but must be 600 feet per minute at the time of cutting. The reduction in speed necessary to cut longer sheets is accomplished by providing a secondary input to the bevel gear differential 14 in order to register the output of the bevel gear differential 14 backward. The formula describing the motion of this particular mechanism is $\theta_{40} = (\theta_{18} + \theta_{22})/2$ where the subscripts 40, 18 and 22 refer to the gears 40, 18 and 22, and theta is the degrees of rotation of each of the gears. In order to cut a 72 inch length, θ_{18} must equal one revolution per 72 inch of web travel. For 72 inch of web travel $\theta_{40} = 360^\circ$; for one cut, $\theta_{22} = 360^\circ$. Therefore, $\theta_{22} = 2\theta_{40} - \theta_{18} = 360^\circ$. It is quite obvious from these calculations that any given length of sheet can be cut by turning the gear 22 backward 10° per inch of length in excess of 36 inches. Thus a 72 inch sheet requires a 360° rotation of the gear 22, and a $64 \frac{1}{2}$ inch sheet requires a 285° rotation of gear 22.

Turning now to FIG. 2, the function of the cam 58 may be clearly seen. In addition, it may also be seen now that a second cylinder 11 is mounted below the knife cylinder 10. The second cylinder 11 is covered with a resilient material into which the web 65 is slightly imbedded as it is cut by the knife 15. The cylinder 11 is driven by a line shaft 13 at a speed corresponding to the lineal speed of advance of the web 65. This invention would also function using the more conventional apparatus of both cylinders 10 and 11 carrying knives 15 to sever the web 65. However, less power is required of the motor 46 if the combination of the knife cylinder 10 and the resiliently covered cylinder 11 are used as a means to sever the web 65. The cam 58 is manufactured such that the knife cylinder 10 is driven solely by the ring gear 40 through the differential 14 for a period of approximately 45° on either side of the point of cutting the corrugated web by virtue of the switch 56 being on the lobe of the cam 58 in which position, the logic and control unit 54 is off. This insures that the knife cylinder 10 is traveling at the proper speed at the time the cut is made. After this period of cutting, the roller switch 56 is turned off by virtue of dropping off of the lobe of the cam 58, thereby energizing the logic and control unit 54, which in turn energizes the electric motor 46 and begins counting pulses from the pulse transmitter 52. It is important to realize that the cessation of pulse counting and consequently the cessation of the rotation of the electric motor 46 will not necessarily correspond to any particular position on the profile of the cam 58. When the switch 56 once again rides up the lobe of the cam 58, it will turn off and reset the logic and control unit 54. The point of cessation of counting will occur when the input from the motor 46 has retarded the angular displacement of the knife cylinder 10 by the amount of web 65 length desired in excess of 36 inches. At the time of the cessation of counting, the differential 14, through the ring gear 40 and cage 16, will drive the knife cylinder 10 at line speed again until the point at which the cut is made. The speed of the electric motor 46 is critical only in the sense that it must be below the speed at which the knife blade 15 on the knife cylinder 10 would be brought to a complete halt. In the example given, this would be a speed of 200 revolutions per minute corresponding to a speed of 100 revolutions per minute of the ring gear 40. The closer the actual operating speed of the electric motor 46 approaches this maximum operating speed, the longer the theoretical length of sheet which may be cut from the web. The system may be operated successfully by knowing the maximum speed at which the line shaft 44 would ever be operated and setting the maximum speed of the electric motor 46 correspondingly below this maximum speed. In a modified and somewhat more sophisticated method shown in the embodiment of FIG. 1, a tachometer 61 is attached to the line shaft 44 and transmits the line shaft speed to the logic and control unit 54. An additional circuit within the logic and control unit 54 is set to control the speed of the electric motor 46 at a preset percentage of the actual rotational speed of the line shaft 44 as sensed by the tachometer 61.

Turning now to FIG. 3, the apparatus of the present invention is shown in perspective view partially in schematic form. A continuous web of corrugated material 65 is being severed by the knives 15 of the knife cylinder 10. In addition, it may clearly be seen that the oper-

ator's control panel 60 contains two separate segments 62 and 63 which may be individually preset to allow an immediate change in the length of board to be cut. By merely dialing in the number of pulses corresponding to the new width of board to be cut into one of the segments 62 or 63 and throwing the operating switch 64 to the new length set in the segment 62 or 63, the next sheet which will be cut by the knife cylinder 10 will be of the proper length with no intermediate sheets of varying lengths during the transition from one length sheet to another. The two segments 62 and 63 have been found to be sufficient for the needs of most commercial operations, since length changes are not made frequently, and one segment may be reset while the other is being used as a set point. However, the operator's control panel 60 could contain a plurality of individually set segments, each for a different set point value of degrees of rotation of the input shaft 24. A multiple pole switch corresponding to the switch 64 could then be used to select one of the plurality of values for a set point. It is understood that since the logic and control unit 54, the electric motor 46, the pulse transmitter 52, the roller switch 56, the operator's control panel 60, and, when used, the tachometer 61 form a control circuit, all of these components are interconnected by suitable electrical wiring means 59.

It will be understood that the logic and control unit 54, the pulse generator 50, the pulse transmitter 52, the one-way clutch 48, and the electric motor 46, all serve in combination as a means to register the output of the differential 14 backward. It is possible in theory to use a stepping-type motor in place of this entire system. This type of motor is driven by a series of electrical pulses and rotates a discrete amount per pulse. However, the horsepower requirements for this invention are at present beyond the capability of stepping-type motors, but future developments in this area would allow the utilization of a stepping motor to replace these components.

What I claim is:

1. Apparatus for cutting sheets of a preset length from a moving continuous web of corrugated material produced by a paper corrugating machine, said apparatus having the ability to immediately change from cutting one length of sheet to cutting another length of sheet and comprising, in combination:

a differential means including a rotatable cage, input and output shafts supported by said cage, and a bevel gear differential connected to said input and output shafts and carried by said cage;

a ring gear drivingly connected to said paper corrugating machine and attached to said cage for imparting rotational movement to said cage;

means for severing said web of corrugated material, including at least one rotatably mounted cutting cylinder carrying a cutting knife and driven by said output shaft of said differential means, to form individual sheets of said corrugated material; and means for registering said differential backward while a pre-selected length of corrugated material passes between said means for severing said web and

for changing, upon demand, the amount of backward registration of said differential between cutting of successive sheets of corrugated material to thereby allow an immediate change from cutting one length of sheet of corrugated material to cutting a second

length of sheet of corrugated material without cutting any sheets of corrugated material of an intermediate length.

2. The apparatus of claim 1, wherein said means for registering said differential backward and for changing, upon demand, the amount of backward registration of said differential between cutting of successive sheets of corrugated material comprises, in combination:

rotating drive means connected to said input shaft;

a pulse generator attached to said input shaft for rotation therewith for generating a representation of the degrees of rotation of said input shaft;

a pulse transmitter for sensing and transmitting the pulses generated by said pulse generator;

means connected to said pulse transmitter and said drive means for limiting the rotation of said drive means to a pre-selected number of pulse counts; and

means connected to said rotation limiting means for activating said rotation limiting means after a sheet of corrugated material has been cut.

3. The apparatus of claim 2, wherein said means for limiting the rotation of said drive means comprises, in combination:

an operator-control panel having at least two independently set values of degrees of rotation of said input shaft, the magnitude of said value corresponding directly to the length of sheet to be cut by said cutting cylinder;

a switch for selecting one of said values; and

an electronic control and logic unit connected to said operator-control panel and preset to allow said drive means to rotate only the number of degrees of said selected value, whereby operating said switch to select another one of said set values will cause an immediate change in the length of corrugated sheet cut by said cutting cylinder.

4. The apparatus of claim 2, wherein said means for activating said rotation limiting means comprises, in combination:

a plate cam attached to said output shaft for rotation therewith; and

a switch controlled by said cam and connected to said means for limiting the rotation of said drive means for turning said limiting means on after the cutting of a sheet by said cutting cylinder.

5. The apparatus of claim 2, further including means connected between said drive means and said input shaft for limiting the rotation of said drive means to a single direction.

6. The apparatus of claim 2, further including means for holding the rotational speed of said rotating drive means to a preset percentage of the speed of said moving web of corrugated material.

7. In a corrugated paperboard manufacturing process, wherein a continuous moving web of corrugated material is severed to form individual sheets by a rotating knife-carrying cylinder, a method for driving said knife cylinder to allow immediate changes in the length of sheet cut, comprising the steps of:

driving said knife cylinder with the output shaft of a bevel gear differential;

driving a second cylinder covered with a resilient material mounted in opposition to said first knife cylinder at a speed proportional to the linear speed of said corrugated web;

driving said differential through a line shaft rotating at a speed proportional to the linear speed of said corrugated web when said web is to be severed; registering said differential backward to retard the rotation of said knife cylinder to allow a pre-selected length of web to pass between said knife cylinder and said second cylinder before said web is severed; controlling the backward registration of said differential as a function of the number of degrees of rotation of an input shaft of said differential with an electronic logic unit; feeding one of a plurality of rotational values of said input shaft to said logic unit as a registration set point; and inter-connecting said plurality of rotational values of said input shaft and said logic unit with a multiple-pole switch, whereby any one of said values may be selected as said registration set point and changes in said set point may be made from one severed sheet to the next.

8. Apparatus for cutting sheets of a preset length from a moving continuous web of corrugated material produced by a paper corrugating machine, said apparatus having the ability to immediately change from cutting one length of sheet to cutting another length of sheet, comprising, in combination:

a differential means including a rotatable cage, input

and output shafts supported by said cage, and a bevel gear differential connected to said input and output shafts and carried by said cage; a ring gear drivingly connected to said paper corrugating machine and attached to said cage for imparting rotational movement to said cage; means for severing said web of corrugated material, including at least one rotatably mounted cutting cylinder carrying a cutting knife and driven by said output shaft of said differential means, to form individual sheets of corrugated material; rotating drive means connected to said input shaft for registering said differential backward; control means connected to said drive means for limiting the backward registration of said drive means to allow a pre-selected length of corrugated material to pass between said means for severing said web; and switching means, connected to said control means, for changing, upon demand, the amount of backward registration of said drive means between cutting of successive sheets of corrugated material to thereby allow an immediate change from cutting one length of sheet of corrugated material to cutting a second length of sheet of corrugated material without cutting any sheets of corrugated material of an intermediate length.

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