United States Patent [19]

Johnson et al.

[11] **3,862,724**

[45] **Jan. 28, 1975**

[54] **APPARATUS FOR CONTROLLING WEB TENSION**

[75] Inventors: **John R. Johnson; Richard I. Ashcroft,** both of Toledo, Ohio

[73] Assignee: **Owens Illinois, Inc.,** Toledo, Ohio

[22] Filed: **Apr. 18, 1973**

[21] Appl. No.: **352,315**

[52] **U.S. Cl.** **242/75.43**

[51] **Int. Cl.** **B65h 25/22**

[58] **Field of Search** 242/75.43, 75.44, 156.2, 242/189, 75.45, 75.46, 75.47

[56] **References Cited**

UNITED STATES PATENTS

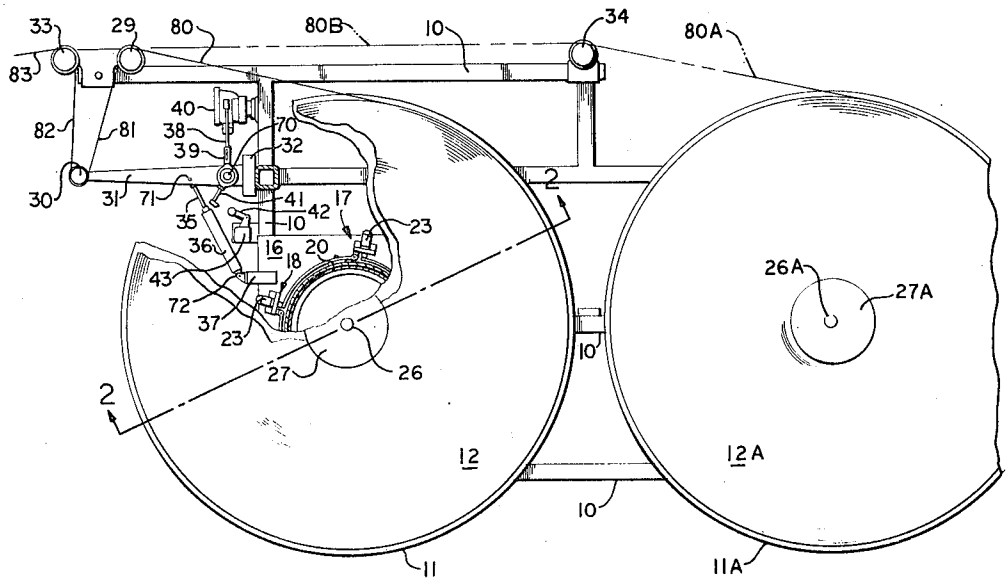
2,261,891	11/1941	Stewart	242/75.43
2,972,452	2/1961	Aumann	242/75.43
3,083,602	4/1963	Obenshain	242/75.43 X
3,202,376	8/1965	Dutro et al.	242/75.43 X
3,630,463	12/1971	Mistele	242/75.43
3,764,438	10/1973	Voss et al.	242/75.43 X

Primary Examiner—John W. Huckert
Assistant Examiner—John M. Jillions
Attorney, Agent, or Firm—Steve M. McLary; E. J. Holler

[57] **ABSTRACT**

Apparatus and method for controlling the unreeling of a roll of web-like material into equipment for processing the web where the equipment exerts a pulling force on the web, including maintining a constant tension in said web by varying a drag braking force applied to the spool holding the roll to offset part of the pulling force exerted by the processing equipment, the required drag braking force changing as the diameter of the roll decreases during unreeling or when the pulling force changes, and including brakes to stop the roll and spool should the web break in order to prevent a runaway condition, both control features relying on sensing the position of a biased dancer roll in a tortuous path arrangement for the web.

1 Claim, 7 Drawing Figures



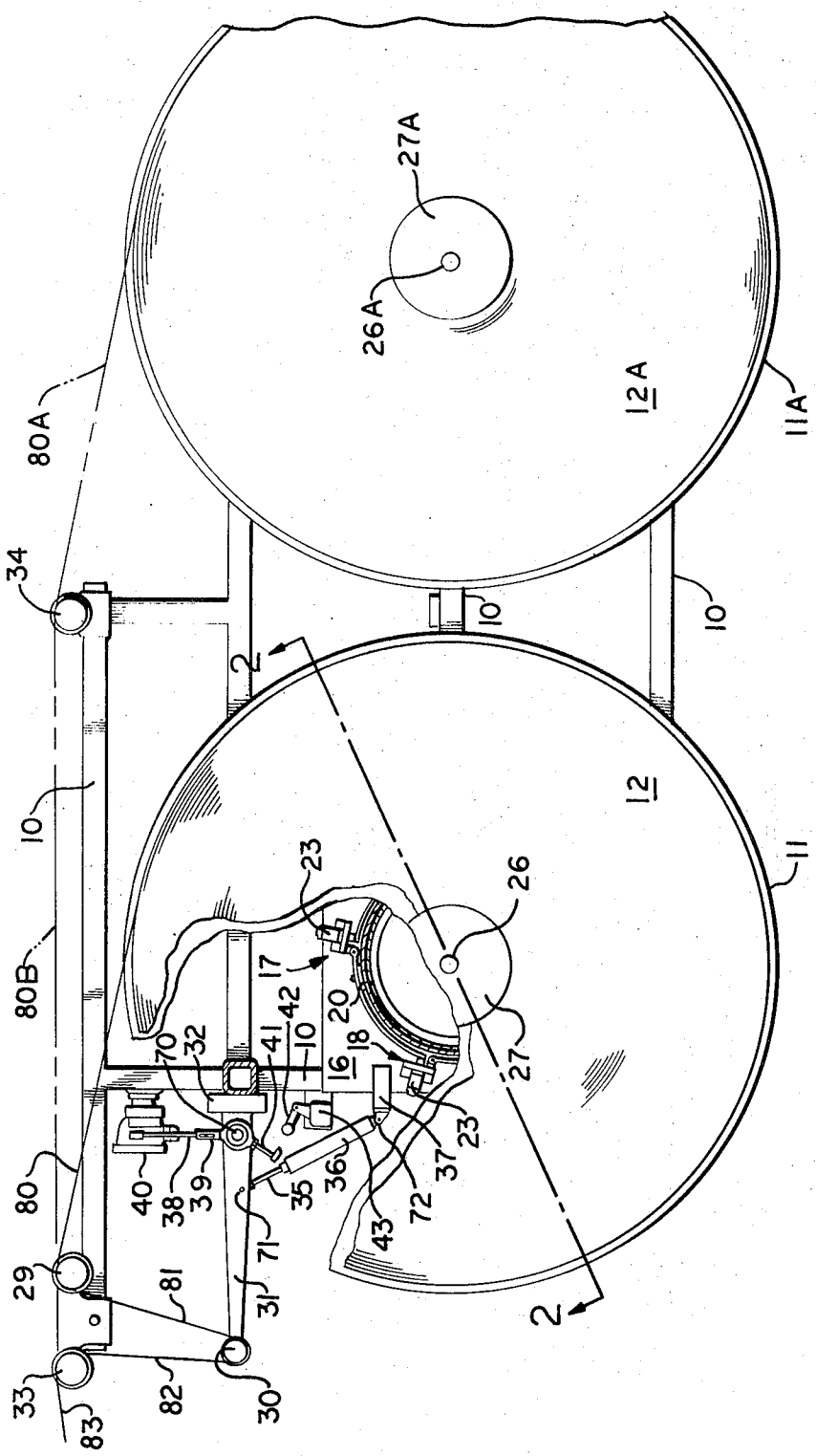

27A
26A
12A
11A
80A
34
10
2
12
11
23
26
80B
17
42
20
70
32
41
18
16
27
40
38
39
35
36
37
72
43
71
31
80
29
81
33
82
30
83

FIG. 1

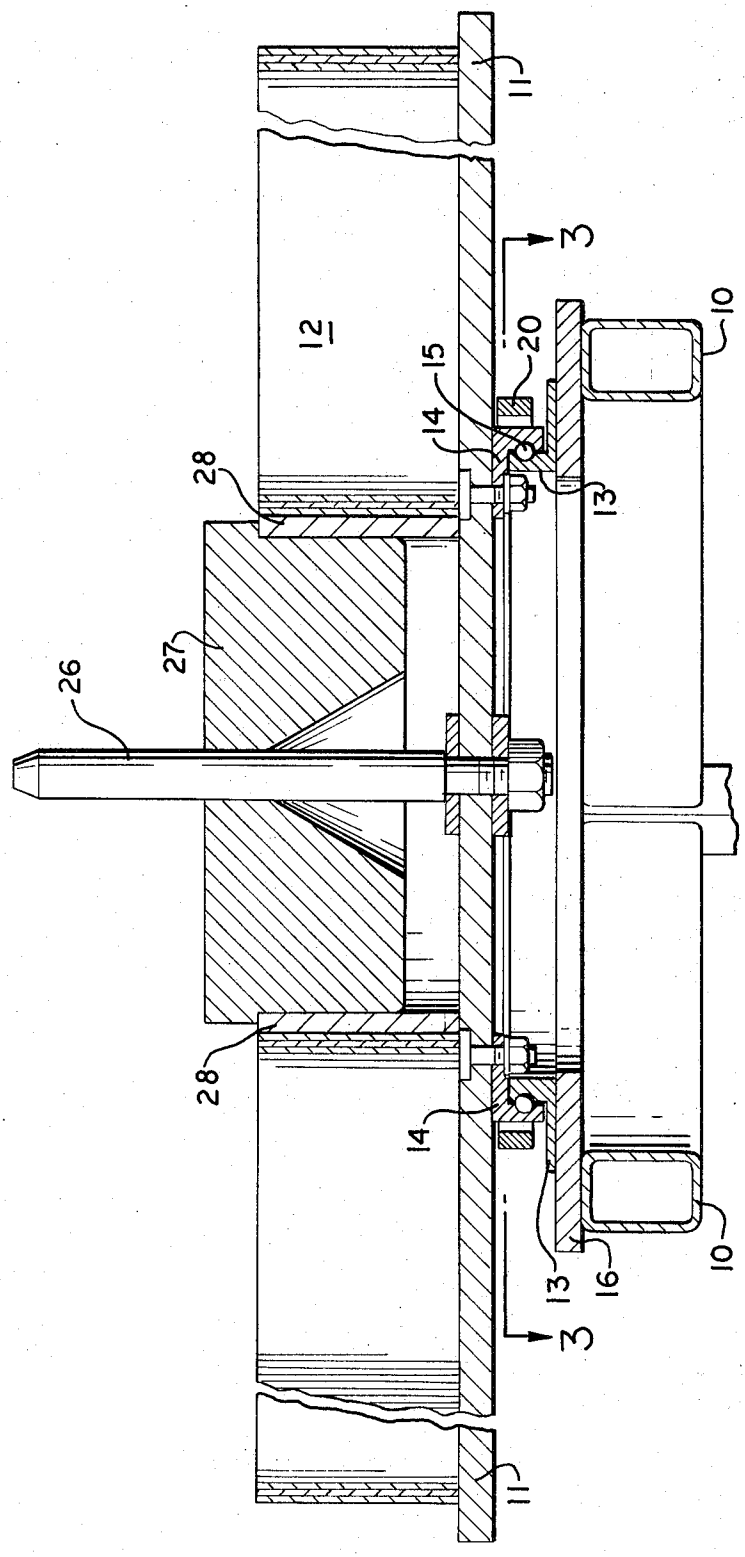


FIG. 2

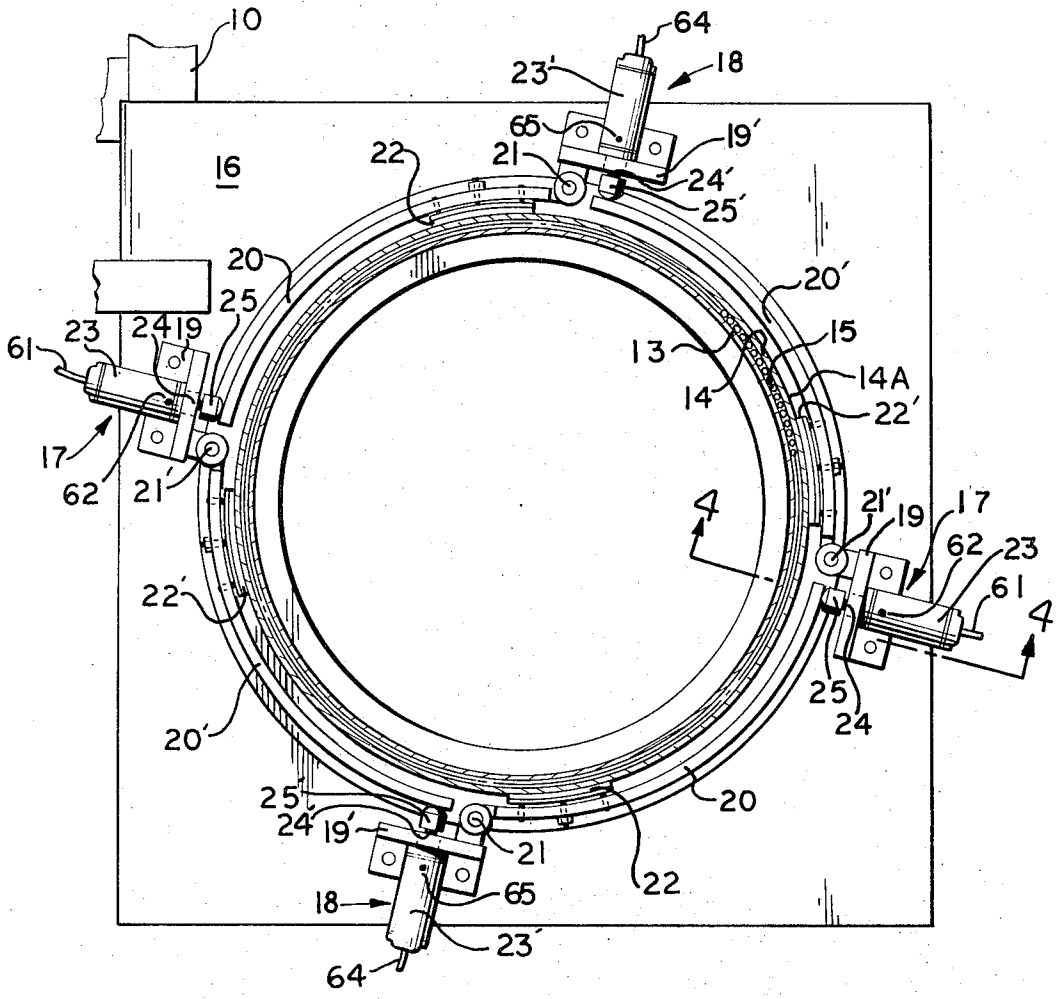

10
64
23'
18
65
19'
22
21
16
24'
25'
20
20'
25
23
24
19
61
13
15
14A
14
22'
17
62
21'
4
21'
19
17
62
23
61
4
22'
25
24
20'
20
25'
24
19'
21
22
18
65
23'
64

FIG. 3

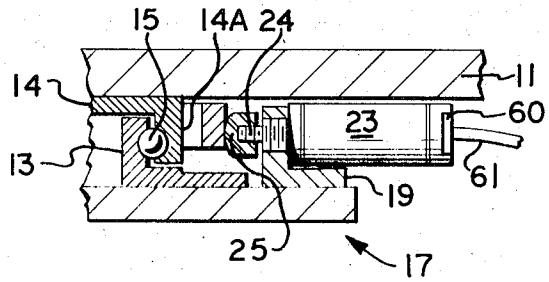

15
14A
24
11
14
23
60
13
61
19
25
17

FIG. 4

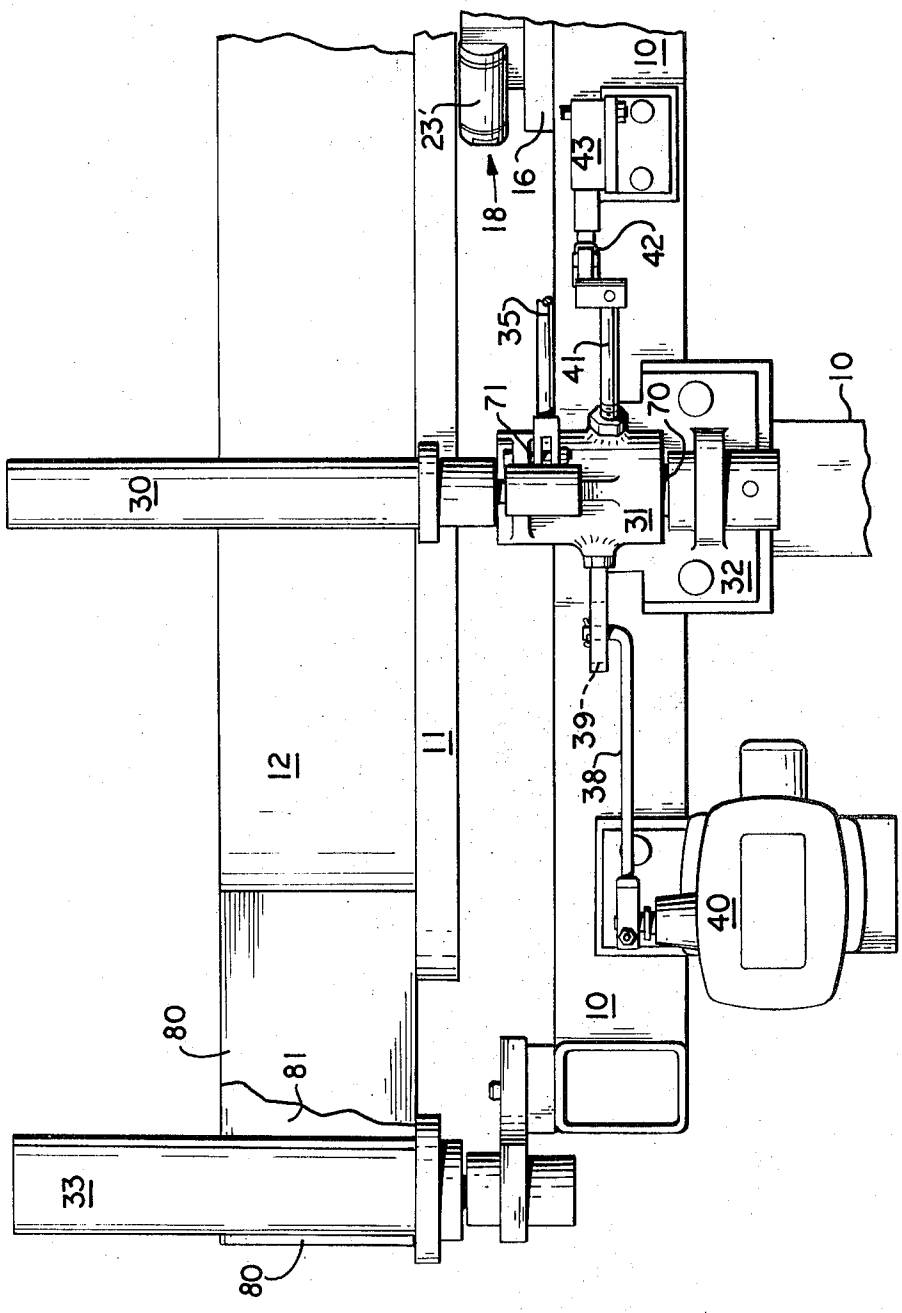


FIG. 5

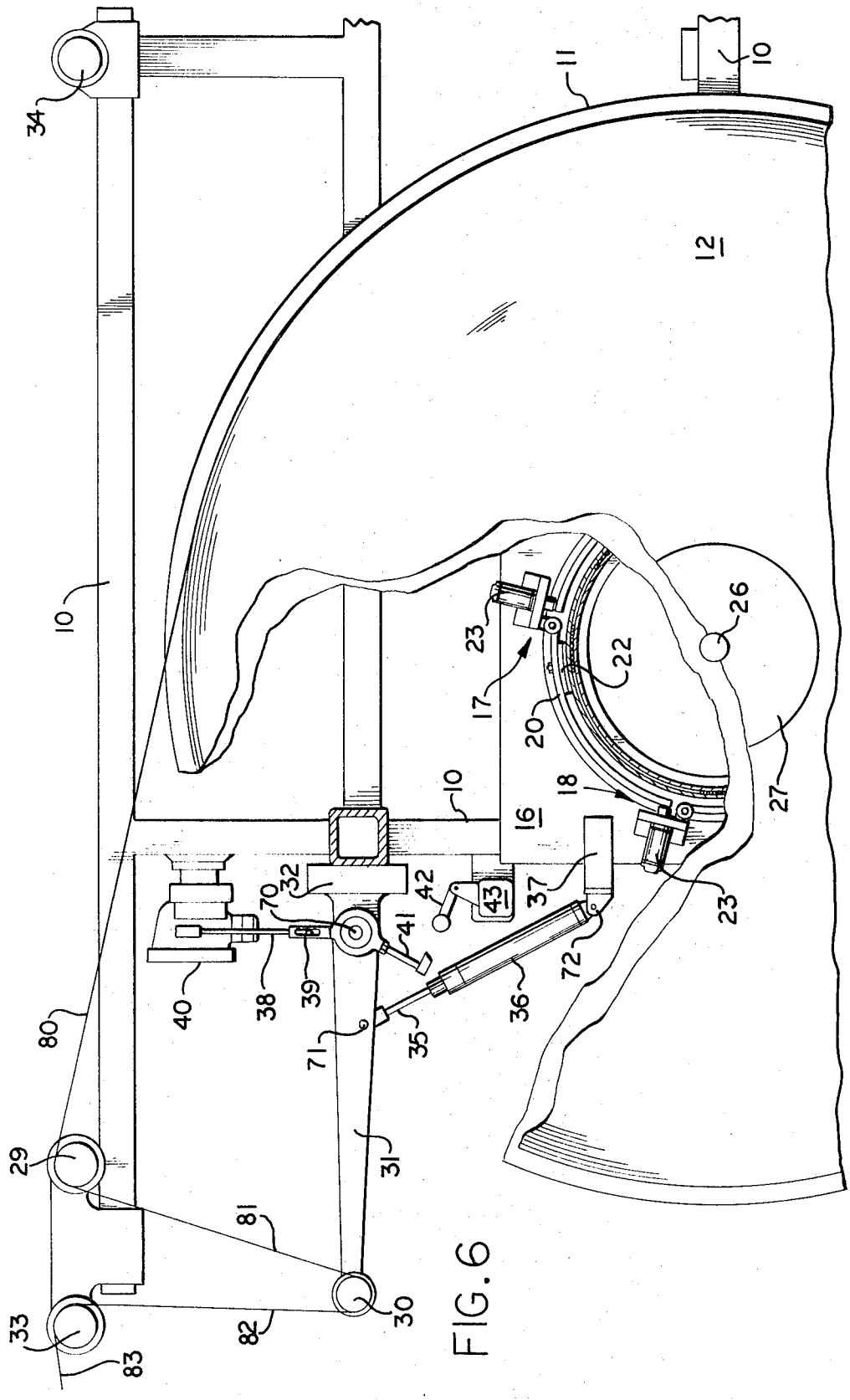

34
11
10
12
10
23
26
22
17
20
18
27
16
10
32
70
42
43
37
41
23
72
40
38
39
36
35
71
80
29
31
81
33
30
82
83

FIG. 6

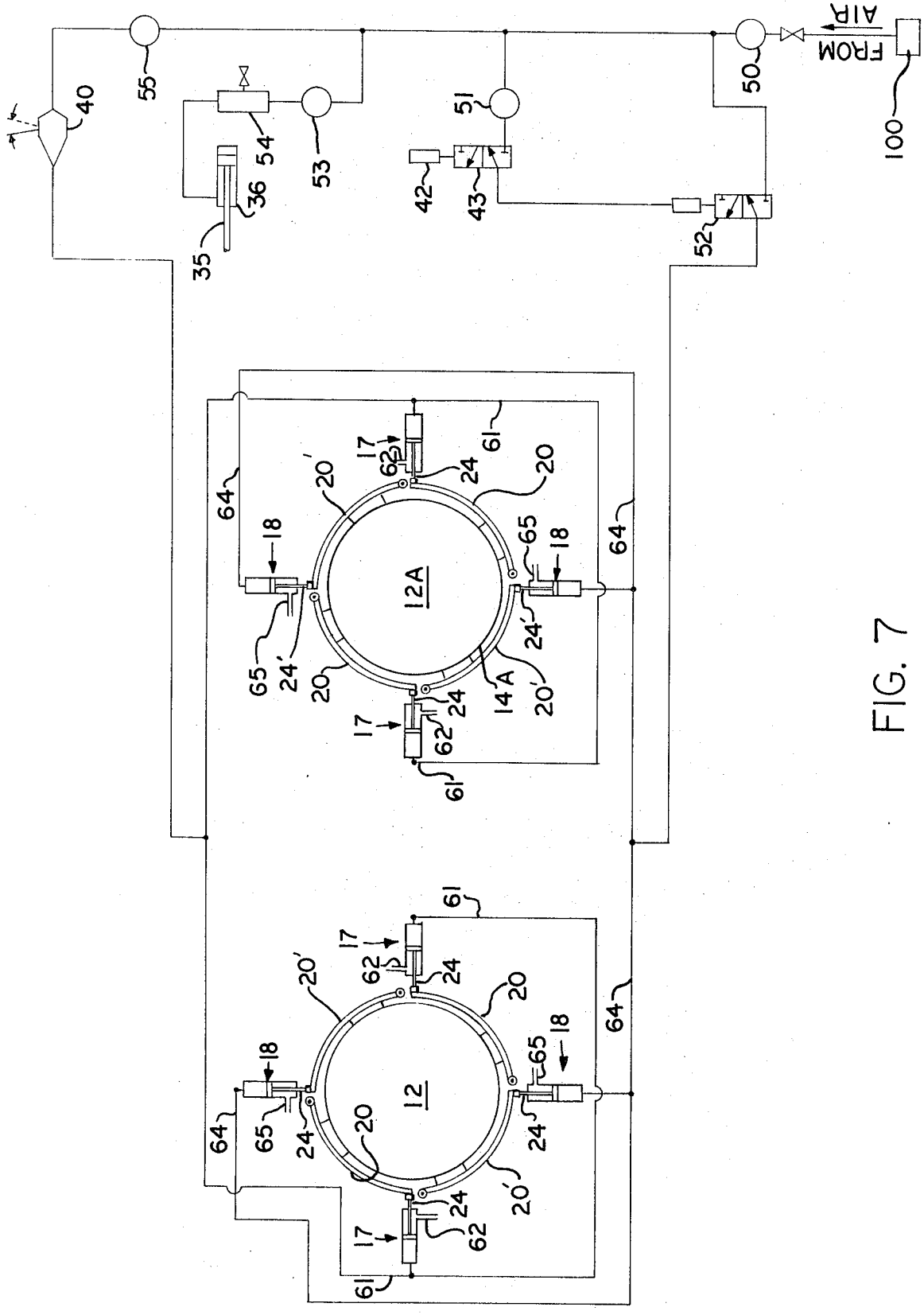

AIR
FROM
100
50
51
52
53
54
55
40
42
43
35
36
12A
12
14A
17
18
20
20'
24
24'
61
62
64
65

FIG. 7

APPARATUS FOR CONTROLLING WEB TENSION

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to apparatus for unreeling a web of thin, ribbon-like material from a roll where the web is pulled by the equipment into which it is being directed for processing. The apparatus includes a drag brake arrangement acting against the spool holding the roll of web-like material to set up a tension in the web. The web is directed through a tortuous course including a movable dancer roll between at least two idler rolls and biased to provide tension in the web and position the dancer roll when the web tension and biasing force are in equilibrium. A proportioning system varies the drag braking force to maintain a constant tension in the web as the diameter of the roll of web-like material decreases or other production parameters change, and another system activates stopping brakes should the web break and the dancer roll be moved radically out of position by the biasing force applied thereto. In the preferred embodiment shown, the biasing forces on the dancer roll, the drag braking forces, and the stopping brake forces are obtained using pneumatic cylinders and compressed air.

2. Description of the Prior Art

In the field of material handling where a large roll of web-like material is to be unreeled into apparatus for performing some operation upon that material, as in the paper industry or in the bottle industry, where a bottle is to be wrapped with a length of material to be cut from the web coming off the roll, it is of extreme importance to be able to control that unreeling process. When the after-operations are high speed and the velocity of the web into that equipment must be closely uniform, it is necessary to ensure constant tension in the web being unreeled from the roll.

Where a roll of large diameter is employed, there is a substantial difference in the angular velocity for a given linear web velocity at the beginning as compared to the end of the unreeling process. To provide for uniform motion into the after-operation processing equipment, a resisting force can be applied to the web to induce a tension in the web and reduce fluttering after leaving the roll. One way to accomplish this is to apply a drag braking force to the spool used to hold the roll of material, where the resulting force is less than that exerted on the web by the processing equipment. An example of such a device is found in U.S, Pat. No. 3,239,161 to Dutro, et al.

The problem with such a system, however, is that a constant drag braking force will not be satisfactory. As the diameter of the roll decreases, this would indicate less drag braking force is needed as the roll gets smaller. However, the total mass of the roll is also being reduced so that a greater braking force may be required to keep the web tension constant. The ability to increase or decrease the drag braking force is a desirable feature to maintain constant web tension.

Also, a problem is the stopping of the system when the web breaks to prevent the roll from spilling out large lengths of web due to the inertia of the rotating roll. To solve this, an additional stopping brake force must be applied to halt the rotation of the roll in a relatively short period of time after the break occurs.

SUMMARY OF THE INVENTION

The present invention solves both these problems by providing separate drag brakes and stopping brakes. The stopping brakes are only activated if the web breaks or if some malfunction causes a sudden and severe reduction in the tension in the web. The drag brakes are set when the roll is new and are increased or released as production parameters change, by a signal from a device sensing the tension in the web.

A tortuous path using two idler rolls and a dancer roll are included whereby the dancer roll is mounted on a movable arm which is biased to counteract the tension in the web and which floats in an equilibrium position so long as the forces of the biasing means and web tension are equal.

A sensing device is provided to sense when the dancer roll arm is moved radically out of position when the web breaks, and this device activates the stopping brakes.

A proportioning means is mounted near the dancer roll arm and senses the position of the arm. If the production parameters change and the force exerted by the drag brakes becomes greater than that required for the desired tension in the web, the tension increases moving the arm against the biasing means. This movement changes the adjustment of the proportioning means and reduces the force exerted by the drag brakes, which, in turn, lowers the tension in the web until the web tension and biasing force are equal, stopping movement of the arm. The reverse effect occurs should the web tension decrease to less than that of the biasing force on the dancer arm. The web tension remains constant and the dancer arm position may change during operation of the apparatus.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1. is a plan view of the described apparatus, partially in section.

FIG. 2 is a side elevation view of a portion of the described apparatus taken along the section line 2—2 in FIG. 1.

FIG. 3 is a partial plan view of one of the rotary turntable support and braking systems, taken at the elevation shown by section line 3—3 in FIG. 2.

FIG. 4 is an enlarged elevation view taken at section 4—4 in FIG. 3.

FIG. 5 is a side elevation view of a part of the apparatus in FIG. 1.

FIG. 6 is an enlarged plan view of a portion of the described apparatus shown in FIG. 1, partially in section.

FIG. 7 is a schematic diagram of the pneumatic circuits employed in the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown generally in the drawings, a base framework 10 is used as a foundation for the apparatus. Turntables 11 and 11A are mounted on the framework 10 for holding rolls of web-like material 12 and 12A. Two turntables 11 and 11A are used so that a minimum of time is lost in switching production to a second roll of material when the previous roll has been completely used. A pair of plates 16 and 16A are attached to the top of base 10 with one plate 16 or 16A under each turntable assembly 11 or 11A, respectively.

As best seen in FIG. 2 and FIG. 4, each turntable 11 is mounted to the base 10 by means of a bearing assembly made of a circular inner bearing track 13 affixed to the base 10 and plate 16, and an outer bearing track 14 affixed to the turntable 11. The two bearing tracks 13 and 14 each have formed therein a semi-circular cross-section cavity which forms a bearing race for rotary ball bearings 15. This bearing arrangement is employed around the entire circumference of the turntable 11.

Base plate 16 is used, not only as support for the turntable 11, but for the braking systems as well. Each turntable has two brake systems, including a pair of drag brakes 17 and a pair of stopping brakes 18. Each of the brake assemblies is alike, whether used as a drag brake 17 or a stopping brake 18.

As shown in FIGS. 3 and 4, a mounting bracket 19 is affixed to the base plate 16 for each drag brake assembly, and a bracket 19' is affixed to base plate 16 for each stopping brake assembly. These mounting brackets are spaced at 90° intervals around the periphery of the outer bearing track 14. A drag brake shoe mounting arm 20 is hingedly attached to each stopping brake mounting bracket 19' by a hinge pin 21, allowing the drag brake shoe mounting arm 20 to pivot in the plane of the outer bearing track 14. A drag brake shoe pad assembly 22 is mounted to each drag brake shoe mounting arm 20 for easy removal when worn. A pneumatically operated drag brake cylinder 23 is mounted on both drag brake assembly mounting brackets 19. Each cylinder 23 has a piston mounted therein (not shown) and a piston rod 24 extending out one end. Each piston rod 24 has a piston cap 25 mounted thereon and facing radially inward to push against the end of each drag brake shoe mounting arm 20 remote from the stopping brake mounting brackets 19'.

For simplified operation, a typical single-acting spring-return type air cylinder may be used; for example, a Bimba model from their catalog series No. 090 with 1-1/16 inch bore. An air intake port 60 allows air into the cylinder from compressed air line 61, part of a pneumatic circuit to be described later. A relief port 62 permits air to escape out of the cylinder when it is activated.

When the drag braking cylinders 23 are activated, pressure is applied to the free end of each drag brake shoe mounting arm 20, and, in turn, the drag brake shoe pads 22 are each forced against the outer surface of the outer bearing track 14, designated as 14A.

Similarly, with the stopping brake systems, a stopping brake shoe mounting arm 20' is hingedly attached to each drag brake mounting bracket 19 by a hinge pin 20', allowing the stopping brake shoe mounting arm 20' to pivot in the plane of the outer bearing track 14. A stopping brake shoe pad assembly 22' is mounted to each stopping brake shoe mounting arm 20' for easy removal when worn. A pneumatically operated stopping brake cylinder 23' is mounted on both stopping brake assembly mounting brackets 19'. Each cylinder 23' has a piston mounted therein (not shown) and a piston rod 24' extending out one end. Each piston rod 24' has a piston cap 25' mounted thereon and facing radially inward to push against the end of each stopping brake shoe mounting arm 20' remote from the drag brake mounting brackets 19.

Cylinders like those described for the drag brakes 23 may be used and are shown with intake ports connecting air lines 64, and relief ports 65 for pneumatic operation.

Stopping brake cylinders 23' operate similar to drag brake cylinders 23, forcing stopping brake shoe pads 22' against the outer braking surface 14A of the outer bearing track 14.

The amount of leverage obtainable by this arrangement, of course, can be varied by the placement of the brake shoe pads 22 or 22' in relation to the pivot point hinge pins 21 or 21'. When the pad 22 or 22' is placed close to the hinge pin 21 or 21', as shown in FIG. 3, the mounting arm 20 0r 20' must be rigid so that the end of the arm 20 or 20' adjacent to the piston cap 25 or 25' does not bend and contact the contact surface of the outer bearing track 14A.

A roll of material (shown as either 12 or 12A in FIG. 1) rests on the turntable 11 or 11A and is centered about a spindle 26 or 26A by a centering fixture 27 or 27A which engages the reel 28, making up the core of the roll 12 (shown in FIG. 2).

A roll of material may be on either position of the apparatus, and the unreeling process will first be described from that position shown on the left side in FIG. 1, with a roll designated as 12. The roll of material 12 is placed on the turntable 11 so that to unwind, the rotation of the roll 12 is counterclockwise. As shown in FIG. 1 and FIG. 6, the web is brought off the roll 12 and around a first idler roll 29. This portion of the web is shown as 80. Idler roll 29 is mounted on the base 10 and is free to rotate.

The next web portion 81 extends from the first idler roll 29 to and around a dancer roll 30 mounted for rotation on a dancer roll mounting arm 31. The dancer arm 31 is affixed to a support bracket 32 by a pivot pin 70 which allows the dancer arm 31 to pivot in a plane to keep the dancer roll 30 at the same height as the first idler roll 29.

The next web portion 82 extends from the dancer roll 30 to and around a second idler roll 33, with the web portion moving on to the after-operations shown as 83.

When the turntable 11A on the right in FIG. 1 is used, the web comes off the roll 12A as shown by 80A and moves around an auxiliary roller 34, with a further portion 80B extending between the auxiliary roller 34 and the first idler roll 29. Auxiliary roll 34 is attached to base 10 at the same height as idler rolls 29 and 33.

The after-operations are performed by equipment (not shown) which exerts a uniform pulling force on the web 83, which is transmitted through portions 81 and 82 and which tends to put the web 80 in tension and initiate the unreeling process. This tension is in part created by a force exerted by the drag brake assemblies (to be described later) to control the rotation of the turntable 11 or 11A and set up a tension in the web 80.

The dancer roll mounting arm 31 has rotatably attached thereto by a hinge pin 71 a piston rod 35 of a pneumatic biasing cylinder 36 (cylinder 36 is not shown in FIG. 5). Cylinder 36 is rotatably mounted to base 10 by a bracket 37 and hinge pin 72. This cylinder 36 is pressurized with a constant air pressure to provide a uniform biasing force on the dancer roll arm 31 which offsets the tension in the web 80 and allows the dancer roll mounting arm 31 and dancer roll 30 to remain stationary as the web portions 81 and 82 pass through the tortuous course made up of dancer roll 30 and idler rolls 29 and 33. Any reduction in web tension will re-

sult in the dancer arm **31** being moved away from the idler rolls **29** and **33** by the force exerted by the air cylinder **36.**

Also attached to the dancer roll arm **31** is a link **38** slidable in a slotted bracket **39** attached to the dancer roll arm **31.** As the tension in the web portions **80** through **83** becomes greater or less due to some change in the production parameters, such as the force exerted by the equipment in the after-operations, the balance between the force from the dancer arm cylinder **36** and the web tension is lost.

When these two forces are not in balance, the dancer arm **31** and dancer roll **30** move, either toward the idler rolls **29** and **33** in the case of increased web tension, or away from the idler rolls **29** and **33** in the case of reduced web tension.

This motion displaces the link **38** horizontally as the slotted bracket **39** is moved by the dancer arm **31.** The opposite end of the link **38** is attached to a proportioning valve **40.** When the dancer roll arm **31** moves because of an increase in web tension, the proportioning valve **40** decreases the air pressure to the drag brakes **17** until the forces of web tension and dancer arm pressure are equalized, at which point the movement of the dancer arm stops. The reverse situation occurs when the web tension increases and moves the dancer arm **31** toward the idler rolls **29** and **33.**

The proportioning valve **40** may be any standard pneumatic linear output position transmitter such as a Foxboro model BO-152-LT. Most such devices have angular ranges and output pressure ranges which must be tailored to suit the particular apparatus.

A striker arm **41** is attached to dancer roll arm **31** and positioned to contact a trip cam **42** of a cam-operated pneumatic valve **43** attached to the base **10.** The positioning of the trip cam **42** is such that it can only be contacted by the dancer roll arm **31** if that arm **31** moves radically out its normal position as when, for example, a portion of the web **80** through **83** breaks and the biasing cylinder **36** moves the dancer roll arm **31** to its furthest extension away from the idler rolls **29** and **33.** When the trip cam **42** and valve **43** are activated, pilot air is released to activate another valve **52** (shown in FIG. 7) which sends air to the stopping brakes **18** under such pressure as to halt the rotation of the turntable **11** in a very short span of time to prevent runoff from the roll **12** in the event of a break in the web **80.**

Referring now to FIG. 7, the stopping brakes **18** and drag brakes **17** are shown for both turntables along with the pneumatic conduit used in the circuit. Air under pressure is fed into the system from a source of compressed air **100** and controlled at an initial maximum level by regulator **50.** This air pressure setting is that used in the stopping brakes **18** when they are applied. Also utilizing this regulated air is the cam-operated pneumatic pilot valve **43,** which is normally in the closed position as shown. If a portion of the web **80–83** were to break and the dancer roll arm **31** should be moved into contact with trip cam **42,** the valve **43** would be shifted to the pass-through mode allowing pilot air, having been decreased in pressure by regulator **51** to shift the valve **52** into the pass-through mode and allow system pressure air to the stopping brakes **18** to halt the turntable.

The valves **43** and **52** used are generally of the shifting spool type which have inlet and outlet ports, and which are either closed to passage of air through the ports or, when the spool is shifted, allow air to move on into the conduit at the outlet port through a communicating passageway in the spool.

A second system utilizing system air is the dancer arm pneumatic biasing cylinder **36.** Air is regulated to the desired pressure by a regulator **53** and to ensure no variation in cylinder pressure, an accumulator **54** is provided ahead of the cylinder **36.**

Thirdly, the drag brakes **17** are operated with system air as the primary source by first passing it through a regulator **55** to reduce the pressure to that level required for proper tension in the web **80–83** at the start of the unreeling process using a fresh roll of material **12** or **12A.** The air to the drag brake cylinders **23** passes through the proportioning valve **40** which changes the pressure set by the regulator **55** as the tension in the web **80–83** increases or decreases due to variations in production parameters which casue the dancer arm **31** to be displaced. The stability of the dancer arm **31** during the unreeling process depends on the sensitivity of the proportioning valve **40.** The position of the dancer arm **31** will vary as the web tension changes and adjustments are made to the drag braking force by the system.

Pneumatic lines **64** are used to convey air to the stopping brakes **18** from the valve **52,** and lines **61** are used to convey air to the drag brakes **17.**

I claim:

1. Apparatus for unreeling a roll of web-like material from a spool containing said material to supply equipment performing a processing operation upon said web-like material, said equipment exerting a pulling force on said material, which comprises, in combination:

a. a base;

b. a turntable, rotatably mounted on said base, for carrying said spool containing said web-like material, said turntable including a circular rim extending downward from the underside of said turntable;

c. a pair of diametrically opposed drag brake means, each of said drag brake means including:

i. a curved drag brake shoe support mounted to said base at one end of said drag brake shoe support for rotation within the plane of said rim, said drag brake shoe support being spaced radially outwardly from said rim and extending in a concentric curve around no more than one quarter of the circumference of said rim;

ii. a drag brake shoe pad mounted on said curved drag brake shoe support; and

iii. drag brake actuator means for moving said curved brake shoe support to bring said drag brake shoe pad into contact with said rim;

d. a pair of diametrically opposed stopping brake means, said stopping brake means and said drag brake means being positioned adjacent to one another in the same horizontal plane about the circumference of said rim, each of said stopping brake means including:

i. a curved stopping brake shoe support mounted to said base at one end of said stopping brake shoe support for rotation within the plane of said rim, said stopping brake shoe support being spaced radially outwardly from said rim and extending in a concentric curve around no more than one quarter of the circumference of said rim;

ii. a stopping brake shoe pad mounted on said cuved stopping brake shoe support adjacent said rim; and

iii. stopping brake actuator means for moving said curved stopping brake shoe support to bring said stopping brake shoe pad into contact with said rim to thereby stop the rotation of said turntable;

e. a plurality of idler rolls mounted on said base for guiding said material from said spool to said equipment;

f. a dancer roll mounting arm pivotally mounted at one end on said base for rotation about an axis parallel to the axis of rotation of said turntable;

g. a dancer roll attached to said mounting arm, said dancer roll being positioned intermediate two of said idler rolls to thereby form a tortuous path of travel for said web;

h. biasing means connected to said mounting arm for normally rotating said mounting arm away from said idler rolls to thereby provide a known tension in said material;

i. proportioning means, connected to said mounting arm and responsive to the angular position thereof, for controlling the application of said drag brake actuator means to thereby control the speed of rotation of said turntable to maintain a constant tension in said material as it is unreeled; and

j. means for activating said stopping brake actuator means to thereby stop the rotation of said turntable in response to the movement of said mounting arm to its most remote location away from said idler rolls by said biasing means.

* * * * *