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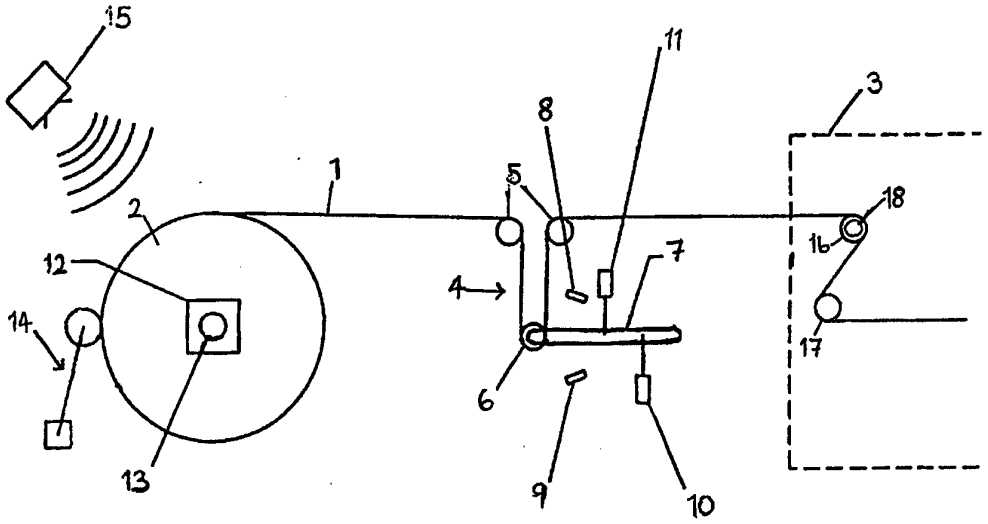
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(54) Title: WEB REEL BRAKE CONTROL SYSTEM



(57) Abstract

A method and apparatus for controlling a tension brake for a web reel (2) such as is used in machinery for printing newspapers, where very large and heavy rolls of paper need to be controlled at high line speeds. The method and apparatus are particularly applicable to tension brake control during a fast stop of such an unwinding reel. According to the method prevalent machine conditions are measured and the braking torque required to match the initial machine deceleration is calculated and used in control of the tension brake during fast stop operation. Thus, the tension brake is controlled as a function of the linear speed (v) of the web (1) and of the inertia of the reel (2). This makes the apparatus more responsive to sudden machine speed changes thus providing a more reliable control system. Reel speed may be measured by sensing web reel (2) rotation velocity or calculated from the machine speed (v) and the measured diameter of the reel (2). Ultrasound or a roll follower can be used. The method and apparatus are particularly applicable to systems with a tension controller (4) with a dancer arm (7) and can be applied to the tension control of a web of material other than paper, e.g. light plastic film or heavy gauge aluminium foil.

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WEB REEL BRAKE CONTROL SYSTEM

DESCRIPTION

The present invention relates to a control system and particularly to a control system for a brake for a paper reel, for example in a paper printing machine.

In machinery for printing newspapers or news-sheets, very large rolls of paper are used which can weigh 2 or 3 tons and when printing is in progress, spin quite fast. A typical line speed would be 400-500m/min and a reel in a modern printing machine will usually be exhausted in about 20 minutes. Careful control of such machinery is necessary, especially control of the tension of the unwinding paper, or web, which is typically achieved through a braking force applied to the unwinding reel. If the web tension is too high, the web may break and considerable down time will result, thousands of copies may be lost and deadlines missed. If the paper or web tension is too low then the web will be slack causing the quality of the printed product to suffer.

In normal operation a closed loop control is effected by constantly monitoring the tension in the unwinding web and adjusting the braking force applied to the unwinding reel; this force is typically applied by a tensioning brake. Such a system can take into account machine speed changes provided that the changes are relatively gentle.

However, a problem arises if the machine is stopped suddenly because known systems of brake control are not responsive enough to cope with sudden machine speed changes and the web tends to break too easily.

Some improvement is seen if the diameter of the unwinding reel of paper is constantly monitored and the tension brake controlled during the fast stop in accordance with this information. Unfortunately, the improvement is not sufficiently satisfactory especially if the machine is stopped quickly from a speed other than its normal running speed.

The present invention aims to provide a more reliable

control system, which is more responsive to sudden machine speed changes, and avoids the problems of the known systems.

According to a first aspect of the present invention, there is provided a method of controlling a tension brake for a web reel comprising measuring prevalent machine conditions such as for example the speed of the machine into which the web is being fed and the rotational speed of the web reel, and calculating the braking force required to match the initial machine deceleration and controlling the tension brake during the fast stop in accordance with the calculation.

Hence, the braking force of the tension brake may be controlled as a function of both the speed of the web and the speed of the machine.

The reel speed may be measured by sensing the velocity of rotation of the unwinding web reel, or it may be derived from the machine speed and the measured diameter of the reel. This measured diameter may be by ultrasound means or by a roll follower. The machine speed is conveniently measured by sensing the velocity of rotation of one of the web rollers.

Known control systems measure web tension between the web reel and the printing machine either with a force transducer, a load cell or with an arrangement known as a dancer arm. In the dancer arm arrangement the web passes over a dancer roll which has an arm extending from it, either vertically or horizontally. The desired web tension is created by a tension cylinder, which is typically pneumatic, acting upon the dancer arm. The position of the dancer arm is monitored by a position sensor, which can be of the linear or rotary type, and tension in the web maintained by adjustment to the tension brake (which is typically but not exclusively pneumatically actuated) acting on the unwinding reel. High and low tension stops are incorporated as limits on movement of the dancer arm. If the web reel is braked suddenly or too hard, then the dancer arm hits the high tension stop and the web is likely to break with the attendant unsatisfactory consequences.

The dancer arm is a preferred tension controller because

it is more able to cope with mis-shaped web reels, i.e. those which are not entirely circular. However, the dancer arm system is less able to cope with sudden braking of the web reel so that the present invention is particularly useful for machines with such a dancer arm tension control system.

Nevertheless, the invention also improves control in a machine with a load cell tension system or any other tension control system.

Of course the invention is also applicable to the control of a web of material other than paper, for example anything from light plastic film to heavy gauge aluminium foil.

For a better understanding of the present invention and to show hoe the same may be carried into effect, reference is made by way of example only, to the single figure which is a schematic representation of a machine embodying a control system according to the invention.

In the figure, a web of paper 1 is drawn from reel 2 mounted on an unwind stand (not shown) holding 1, 2 or possibly 3 reels, and is fed into printing machine 3 via a web tension controller arrangement indicated generally at 4.

The web tension controller 4 comprises two rollers 5 for guiding web 1 to a dancer roll 6 round which the web 1 passes and to which is attached a dancer arm 7. The arm 7 moves pivotally about point X either upwards to lower the tension if the web tension measured is high, or downwards to increase pressure if the web tension measured is low. Movement of the dancer arm is limited by high tension stop 8 and low tension stop 9. The position of the arm 7 is monitored by position sensor 10 of a known type such as a linear sensor and a pneumatically controlled tension cylinder 11 controls the position of the dancer arm to set the required tension.

Paper reel 2 is fitted with a tension brake 12 which controls the tension in the web 1. For example if the dancer arm 7 moves upwards because of high tension in the web 1 the arm 7 movement is detected by sensor 10 and the brake 12 is released a little. This reduces the tension in the web 1

allowing the tension cylinder 11 to move the dancer arm 7 back to its datum position. If on the other hand the dancer arm 7 moves downwards because of low tension in the web 1 the arm 7 movement is detected by sensor 10 and the brake 12 is increased a little. This increases the tension in the web 1 overcoming the force from the tension cylinder 11 forcing the dancer arm 7 to move back to its datum position.

As the web enters the machine 3 (which is typically a printing machine) it is guided by further rollers 16 and 17. Roller 16 incorporates a speed sensor 18 and this gives an indication of the running speed of the machine 3 and can indicate whether the machine is accelerating or decelerating. The speed sensor 18 can be situated on any roller such as 5 or 6. Paper reel 2 is also fitted with a rotation sensor 13. In conjunction with the speed sensor 18 the diameter of the reel 2 can be calculated. The size of reel 2 can be alternatively measured using a roll follower 14 or an ultrasonic sensor 15.

Signals from the various sensors in the system, particularly from speed sensor 18 and rotation sensor 13 are used to calculate the initial braking force required from the tension brake 12 at the start of the fast stop procedure. Preferably the signals are supplied to a microprocessor and this is preferably the same microprocessor as is used to control the web tension in the dancer arm assembly 4. Signals from the dancer arm 7 movement sensor 10 in the dancer arm assembly 4 can be incorporated into the calculations. Preferably the stopping profile of the printing machine, which is usually reasonably predictable and consistent is also programmed into the calculations. Tension brake 12 performance can also be established and fed into the calculations.

The calculations also need to take into account the reel 2 width and this can usually be set to either half-width or full width. For a half-width reel, less brake torque is needed for the same stopping power and the control system can be arranged say to reduce the brake torque performance by either reducing the air pressure to the tension brake 12 or by

using a reduced number of actuators. It is preferable for the controller to select the correct number of actuators by signalling a number of solenoids valves that decrease (or increase) the number of active actuators.

The speed sensor 18 on the machine roller 16 indicates the web 1 line speed. Consecutive speed readings are logged. The reel 2 speed is measured by sensor 13 and in conjunction with machine speed the reel 2 diameter is calculated. This diameter together with the machine 3 speed is used to achieve the correct rate of reel 2 deceleration to avoid the tension in the web 1 falling outside the preferred limits.

Preferably the calculations are effected in accordance with the formula:

$$T = \tfrac{1}{2}\ \pi\ WpR^3\ d/_{dt}(V)$$

where:

T = the increase in braking torque required at any point in time after the initiation of the stop until the machine comes to rest.

π = Pi = 3.141592654 (to nine decimal places).

W = Reel width.

p = Density of reel.

R = Reel radius = ½ of reel diameter

$d/_{dt}(V)$ = a function of the machine's deceleration profile where , V is the machine's speed at any point in time after the initiation of the stop until the machine comes to rest.

Once the printing machine is fully stopped and come to rest, the control system can be arranged to adjust the tension brake 12 pressure to allow the dancer arm 7 to return to an ideal standby condition for a machine restart without causing the web 1 to go slack. This position is generally with the dancer arm 7 at the low tension end stop 9 and allows the machine to be run at crawl speed again without undue delay.

CLAIMS

1. A method of controlling a tension brake for a web reel, the method comprising measuring prevalent machine conditions and calculating the braking force required to match the initial machine deceleration and controlling the tension brake during a fast stop in accordance with the calculation.

2. A method according to claim 1 comprising controlling the braking force of the tension brake as a function of both the linear speed of the web and of the inertia of the reel.

3. A method according to claim 1 or claim 2 comprising measuring the linear web speed by sensing the velocity of rotation of the unwinding web reel.

4. A method according to claim 1 or claim 2 comprising measuring the reel speed by measuring the machine speed and measuring the diameter of the reel.

5. A method according to claim 4 comprising measuring the diameter of the reel by ultrasound means.

6. A method according to claim 4 comprising measuring the diameter of the reel by a roll follower.

7. A method according to any one of claims 4 to 6 comprising measuring the machine speed by sensing the velocity of rotation of one of the web rollers.

8. A method according to any preceding claim when used with a web tension controller comprising a dancer arm.

9. A method according to any one of claims 1 to 7 when used with a web tension controller comprising a load cell

tension system.

10. A method according to any preceding claim when used with a web of paper.

11. A method according to any of claims 1 to 9 when used with a web of plastic film.

12. A method according to any of claims 1 to 9 when used with a web of aluminium foil.

13. A method according to any one of the preceding claims comprising calculating the required instantaneous increase in braking torque during a fast stop of the machine, as a function of the machine's instantaneous deceleration.

14. A method according to claim 13, wherein the braking torque increase is calculated also as a unction of reel width, density and radius.

15. A method according to claim 14, wherein the braking torque increase is calculated in accordance with the formula:

$$T = \tfrac{1}{2} \pi W p R^3 \, d/_{dt}(V)$$

where:

T = the increase in braking torque required at any point in time after the initiation of the stop until the machine comes to rest.

π = Pi = 3.141592654 (to nine decimal places).

W = Reel width.

p = Density of reel.

R = Reel radius = ½ of reel diameter

$d/_{dt}(V)$ = a function of the machine's deceleration profile where V is the machine's speed at any point in time after the initiation of the stop until the machine

comes to rest.

16. Apparatus for controlling a tension brake for a web reel, the apparatus comprising means for measuring prevalent machine conditions, means for calculating the braking force required to match the initial machine deceleration and means for controlling the tension brake during the fast stop in accordance with this calculation.

17. Apparatus according to claim 16 comprising means for measuring the speed of the web and means for measuring the speed of the machine and wherein the calculating means calculates the braking force of the tension brake as a function of both speed measurements.

18. Apparatus according to claim 16 or 17 comprising means for monitoring the rotation velocity of the unwinding web reel and for calculating the reel speed.

19. Apparatus according to claim 18, wherein the reel diameter measuring means comprises an ultrasound emitter and detector.

20. Apparatus according to claim 18, wherein the reel diameter measuring means comprises a roll follower.

21. Apparatus according to any of claims 18 to 20. wherein the machine speed measuring means comprises means for monitoring the speed of rotation of one of the web rollers.

22. Apparatus according to any of claims 16 to 21 further comprising a web tension controller having a dancer arm and means for monitoring and controlling the position of the dancer arm.

23. Apparatus according to any of claims 16 to 22, wherein the calculating means comprises a microprocessor.

24. Apparatus according to any one of claims 16 to 23, wherein the calculating means is arranged in accordance with the formula:

$$T = \tfrac{1}{2} \pi W p R^3 \, d/_{dt}(V)$$

where:

T = the increase in braking torque required at any point in time after the initiation of the stop until the machine comes to rest.

π = Pi = 3.141592654 (to nine decimal places).

W = Reel width.

p = Density of reel.

R = Reel radius = ½ of reel diameter

$d/_{dt}(V)$ = a function of the machine's deceleration profile where V is the machine's speed at any point in time after the initiation of the stop until the machine comes to rest.

25. Apparatus substantially as hereinbefore described with reference to the accompanying drawing.

26. A method for controlling a tension brake for a web reel substantially as hereinbefore described with reference to the accompanying drawing.

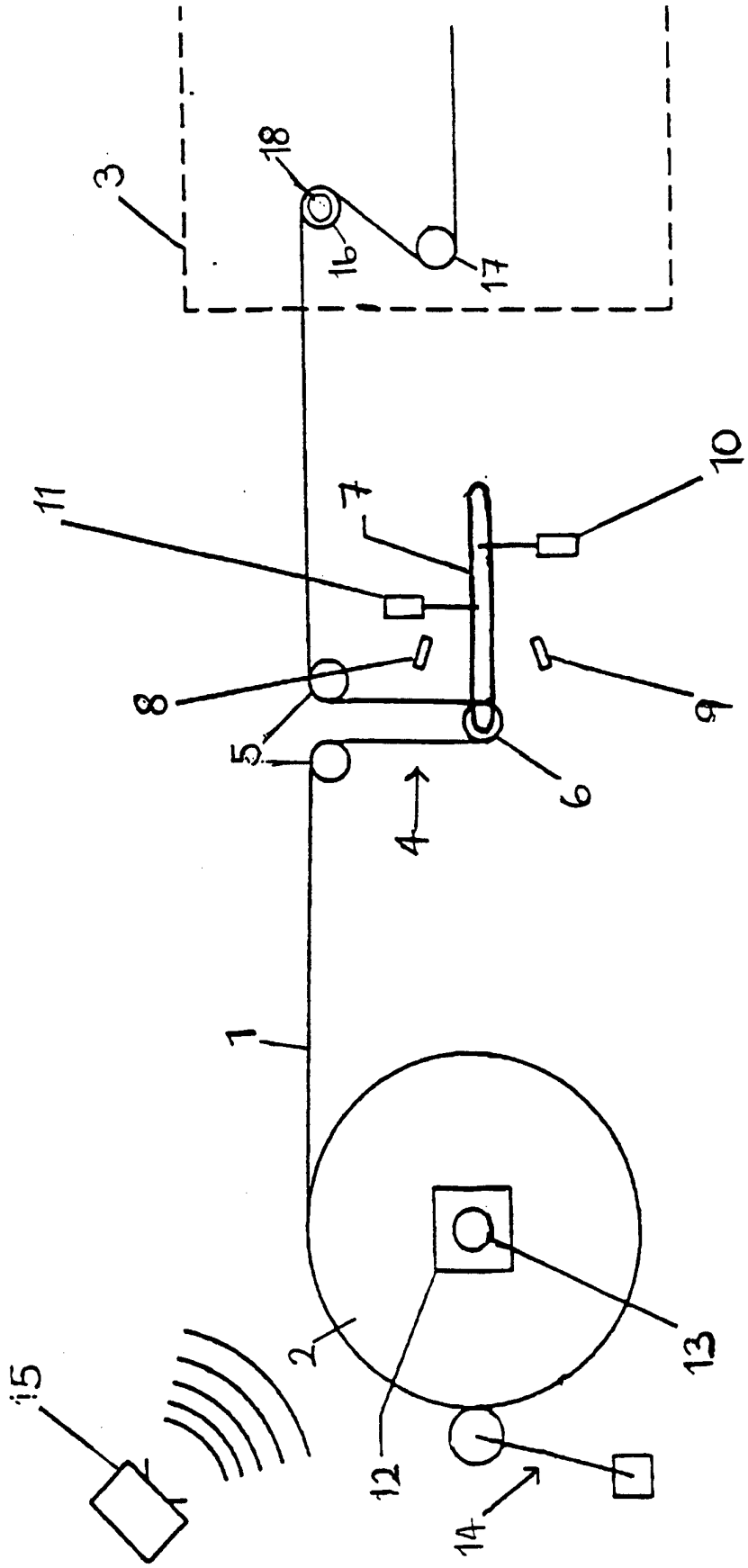


FIGURE 1

INTERNATIONAL SEARCH REPORT

Intern nal Application No
PCT/GB 95/00027

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B65H23/06 B65H23/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B65H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US,A,4 286 757 (H. WIRTH) 1 September 1981 see abstract; claims 1-4; figure 1 see column 4, line 26 - column 5, line 15 see column 6, line 22 - column 7, line 29	1-4,7,8, 10-18, 21-26
Y	---	5,6,19, 20
Y	US,A,3 862 723 (Z. BONIKOWSKI) 28 January 1975 see figures 1,2 see column 1, line 5 - line 12 see column 2, line 1 - line 15	6,20
A	---	3,4,18
	-/--	

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CH,A,681 657 (BENNINGER AG) 30 April 1993 see claim 1	5,19
A		4

X	FR,A,2 277 020 (HARRIS CORPORATION) 30 January 1976 see claims 1-3,5; figures 1,3,4 see page 1, line 6 - page 2, line 10 see page 2, line 26 - page 3, line 24 see page 5, line 37 - page 6, line 20 see page 6, line 34 - page 7, line 14 see page 7, line 30 - page 8, line 4 see page 8, line 29 - page 9, line 25	1,2, 7-18, 21-26
A		4

X	US,A,4 199 118 (R.S. TETRO ET AL.) 22 April 1980 see abstract; claims 1-3,7-10; figure 1 see column 4, line 9 - line 65 see column 6, line 16 - column 7, line 14	1-4,7,8, 10-18, 21-26

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INTERNATIONAL SEARCH REPORT

Information on patent family members

Intern .ıal Application No
PCT/GB 95/00027

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US-A-3862723	28-01-75	NONE		
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