Jan. 14, 1964 P. TROMBETTA 3,117,742

VARIABLE TORQUE BRAKE FOR A WINDING REEL

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FIG. 1

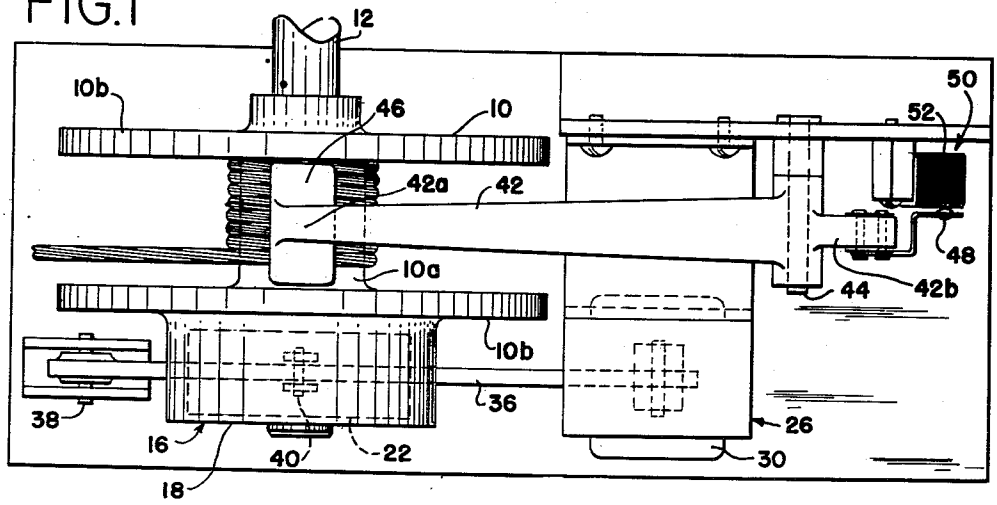


FIG. 2

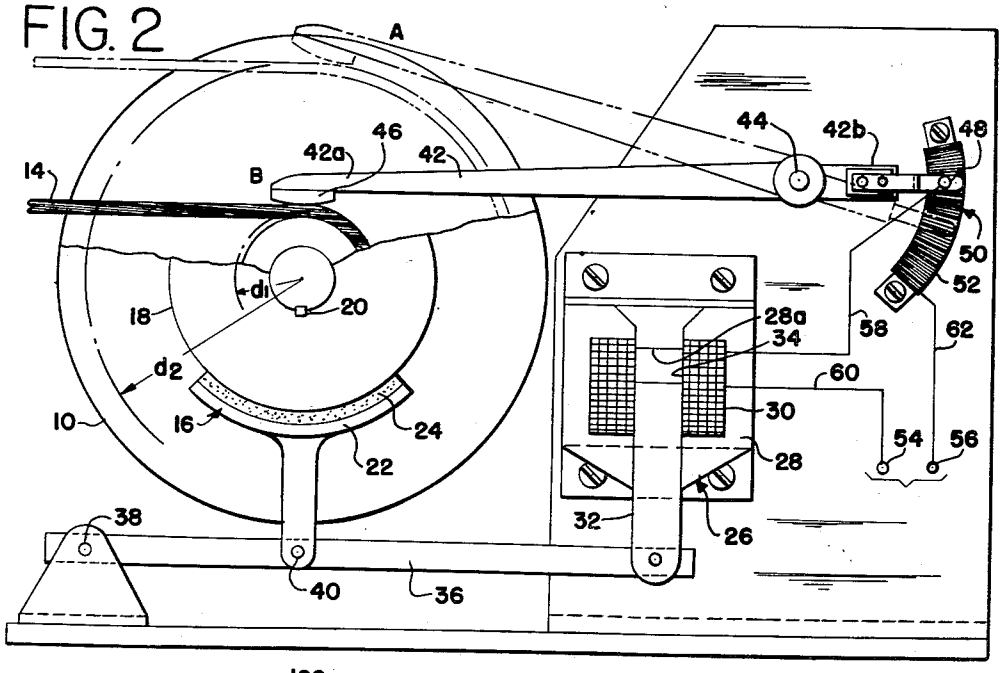
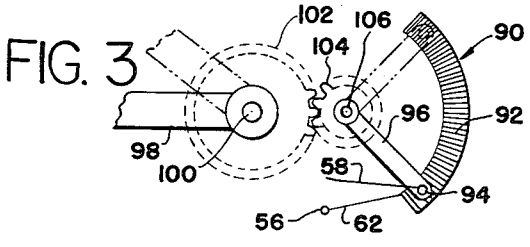


FIG. 3



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FIG. 4

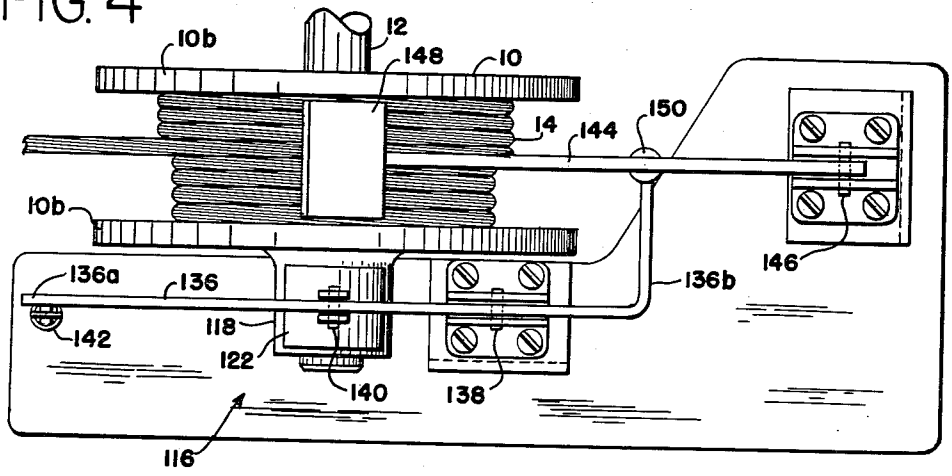
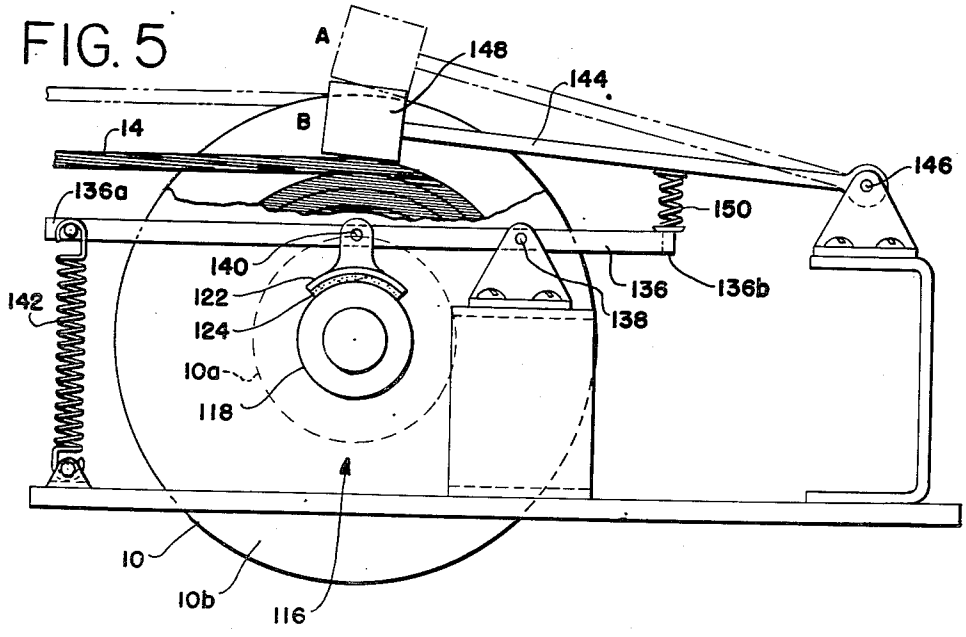


FIG. 5



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3,117,742
VARIABLE TORQUE BRAKE FOR A WINDING REEL

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This invention relates to a brake, and more particularly, to a variable torque brake useful, for example, in connection with the winding or unwinding of materials on reels.

When winding materials, such as rope, wire, steel strips and the like, onto a reel, the winding radius of the reel is constantly changing in relation to the amount of material wound on the reel. In order to control the speed of such a reel, which is either being wound or unwound, it is required that a brake applied for stopping such a reel should have a torque which varies according to some appropriate function of the amount of material wound on the reel at the time that it has to be stopped. It will be appreciated that if the force or pull on the material to be wound remains constant, then the torque which must be overcome to stop the reel will be proportional to the winding radius, which varies with the amount of material wound on the reel. Moreover, reels containing variable amounts of material have a variable moment of inertia which must be overcome and a greater amount of stored kinetic energy to be consumed in order to stop the reel; the inertia of the wheel and material being greater when the reel contains a large amount of wound material.

In cases where material is being unwound from one reel and wound onto another reel, two brakes are required, one for the unwinding reel and one for the winding reel. In order to prevent the material from piling up between reels, the two brakes must be capable of being instantaneously and continuously adjusted to maintain proper relations of torque between the two brakes in order to maintain some tension on the material at all times. According to a different requirement of brakes in winding and unwinding machines, in the process of rewinding material, which is already wound on a reel, in order to maintain a constant tension on the material a brake is required upon the reel that is being unwound. In this case the torque must be applied at all times and must vary as a function of the diameter of the wound reel.

It is therefore an object of the present invention to provide an improved variable torque brake.

A further object of the present invention is to provide a brake for controlling a winding reel and which has a torque proportional to the amount of material wound on the reel at the time that it has to be stopped.

Another object of the present invention is to provide a brake capable of producing a variable automatically adjustable torque to maintain either a constant or variable ratio between its own torque and the torque of at least one additional brake to maintain, in turn, a constant or relatively constant tension on the material between a winding reel and an unwinding reel.

Further objects and advantages of the invention will become apparent as the following description proceeds and the features of novelty which characterize the invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

Briefly stated, the present invention relates to a brake or control adapted to control a rotatable shaft which carries a reel for having material wound thereon and unwound therefrom. The winding diameter of the reel will, of course, vary generally in response to the amount of material wound thereon. Brake means, such as a friction brake, are operatively connected to control the shaft. According to the present invention, means are associated with the reel for sensing the winding diameter of the reel and additional means operatively interconnect the sensing means and the brake for varying the torque of the brake in response to the winding diameter of the reel.

In one preferred embodiment of the invention, the friction brake is electromagnetically applied by a solenoid and a sensing device is provided which rides on the surface of the material on the reel, thereby sensing the winding diameter of the reel. The sensing device controls a rheostat which is in an electric circuit with the solenoid and which is effective to alter the current flow through the solenoid in response to the winding diameter of the reel, thereby to vary the torque of the brake.

In another embodiment, the brake is spring-set and a weight is provided as the sensing device which rides on the material on the reel. A portion of the setting force is counter-balanced by the weight in response to the winding diameter of the reel.

The nature of the invention will best be understood when described in connection with the accompanying drawings, in which:

FIG. 1 is a plan view of a variable torque brake according to the present invention;

FIG. 2 is an elevational view of the brake of FIG. 1 with certain portions broken away;

FIG. 3 is an elevational view illustrating a modified rheostat arrangement which may be used with the brake of FIGS. 1 and 2;

FIG. 4 is a plan view of a variable torque brake according to another embodiment of the present invention; and

FIG. 5 is an elevational view of the brake of FIG. 4 with certain parts thereof broken away.

Referring now to the drawings, and particularly to FIGS. 1 and 2 thereof, there is illustrated an improved variable torque brake according to the present invention and connected to control a winding reel or drum **10**. The winding reel **10** is keyed or otherwise secured to a shaft **12** which may be driven by an electric motor (not shown) or otherwise to turn the winding reel **10** to wind a windable material, here shown as a wire rope **14**, upon the winding reel **10**. The winding reel **10** includes a hub **10***a* interconnected by a pair of spaced sides **10***b* so that the wire rope **14** as it is wound upon the hub **10***a* of the winding reel **10** may, in the illustrated embodiment, form a plurality of side-by-side strands; but additionally will form a plurality of layers of side-by-side strands so as to fill the hub **10***a* between varying diameters d_1 and d_2 (FIG. 2) as the wire rope **14** is wound upon the reel **10**, as illustrated in phantom in FIG. 2.

In order to control the shaft **12** and to stop a winding or unwinding operation of the reel **10**, a friction brake assembly **16** is operatively associated with the shaft **12**. Specifically, the friction brake assembly **16** includes a brake drum **18** secured to the shaft **12** by a key **20** or otherwise, and a complementary brake shoe **22** frictionally engageable with the brake drum **18** and containing a friction material **24** on its inner surface.

In order to apply the friction brake assembly **16** to control the shaft **12**, there is provided an electromagnetic solenoid generally illustrated at **26**. Although the electromagnetic solenoid **26** may be of a known design, briefly, it includes a stationary frame portion **28** carrying an electromagnetic coil or winding **30** and additionally includes a plunger **32** axially slidable through a central opening **34** in the solenoid **26** in response to the energization of the winding **30**. The plunger **32** is pivotally connected to one end of a brake arm **36** and the other end of the brake arm **36** is pivotally mounted to a pivot pin **38**. Moreover, the brake shoe **22** is pivotally mounted

to the brake arm **36** by a pivot pin **40** intermediate the ends of the brake arm **36**. It will be appreciated that energization of the winding **30** is effective to draw the plunger **32** upwardly, as viewed in FIG. 2, thereby applying the brake assembly **16** to stop the shaft **12**. The brake is therein illustrated in the applied position and it is noted that the gap formed between the upper end of the plunger **32** and a pole **28***a* is not closed, but that all the force of the solenoid **26** is transmitted directly to the brake arm **36** and the reaction is applied directly to the brake drum **18** by the brake shoe **22**. As is well known, the force produced by the solenoid **26** is a function of the current flowing through the winding **30**.

According to the present invention, means are provided for controlling the current flow through the solenoid **26** in relation to the winding diameter of the reel **10**. Specifically, such means includes a sensing device for gauging the winding diameter of the reel **10** and including a sensing arm **42** pivotally mounted intermediate its end about a pivot pin **44**. One end **42***a* of the sensing arm carries a pad **46** which during a braking operation rides on the surface of the material on the reel **10**. The other end **42***b* of the arm **42** carries an electrical contact **48** electrically isolated from the arm **42** and forming a sliding contact of a variable rheostat **50**. The rheostat **50** is provided with a winding **52** and the contact **48** is adapted to make sliding contact with the turns of the winding **52** as the arm **42** is moved in response to the changes in the winding diameter of the reel **10**.

In order to vary the current flow in the solenoid **26**, the winding **52** of the rheostat **50** is serially connected with the winding **30** of the solenoid **26** and the circuit is provided with a pair of terminal means **54** and **56** adapted to be connected to an external power source (not shown). Specifically, the contact **48** is electrically connected to one end of the winding **30** by a lead **58**; the other end of the winding **30** is connected to the terminal means **54** by the lead **60**; moreover, one end of the winding **52** is connected to the terminal means **56** by the lead **62**.

From the above detailed description, the operation of the improved variable torque brake is believed clear; however, briefly, it will be appreciated that during the process of winding and unwinding, the winding diameter of the reel **10** varies between the minimum radius, identified as d_1 in FIG. 2 to the maximum radius identified as d_2, as the reel **10** approaches a full reel of material. Moreover, it will be appreciated that if a continuous pull is applied to the wire rope **14**, the torque necessary to stop the shaft **12** will be a function of the amount of material wound on the reel **10**. Furthermore, during the process of unwinding the sensing arm **42** is movable from the position illustrated as A, FIG. 2, in phantom, to the position illustrated in solid therein and identified as B. The position of the sensing arm **42** is effective incrementally to vary the value of impedance or resistance inserted in the circuit by the rheostat **50**. Of course, it is understood that the pad **46** may not actually ride on the material being wound except during a braking operation and so long as the reel **10** is rotating without braking, the sensing arm **42** may be held from engagement with the rope **14** through a solenoid or air cylinder or otherwise. When the brake is applied to the reel **10**, the sensing arm **42** is released to engage the material on the reel **10**, as illustrated in FIGS. 1 and 2, prior or simultaneously with the excitation of the solenoid **26**. In this manner the pad or weight rides on the material being wound only between the time that the brake is set and the time that the reel **10** comes to a stop. Of course, it is also understood that when the brake must be continuously applied to the reel **10** to control the tension of the material, the pad **46** would bear upon the rope **14** on the reel **10** at all times. As the current flow through the solenoid winding **30** depends upon the voltage applied, impedance of the winding **30**, and the impedance of the variable rheostat **50** which is inserted in the circuit, the current flow through the winding **30** will be nearly proportional to the winding radius d_1 to d_2 of the reel **10** and the stopping torque applied by the friction brake assembly **16** will therefore be a function of the winding diameter of the reel.

The improved variable torque brake illustrated in FIGS. 1 and 2 is applicable to either direct current or alternating current applications. However, in an alternating current apparatus, the power lost in the series resistance of the winding **52** in the rheostat **50** may be eliminated by the substitution of a variable voltage transformer in place of the rheostat **50**; the output of the transformer could then be used either in connection with an alternating current apparatus such as an alternating current solenoid or other motive unit as a Recipromotor or Semotor, or the output may be rectified and used as direct current. The power lost in the rheostat **50** would thereby be eliminated.

The embodiment of FIG. 3 illustrates a modified rheostat arrangement which provides for a greater variation in the resistance of the rheostat with a given movement of the sensing arm. The rheostat arrangement therein illustrated is suitable for use with the variable torque brake illustrated in the embodiments of FIGS. 1 and 2 and, therefore, similar parts of FIGS. 1, 2, and 3 are identified by the same numeral. Referring now to the embodiment of FIG. 3, there is illustrated a variable rheostat **90** provided with a winding **92** and a contact **94** on a pivoted contact arm **96** and positioned to make sliding contact with the turns of the winding **92**. A sensing arm **98** is keyed or otherwise secured at one end to a pivotally supported shaft **100** and the other end thereof (not shown) is adapted to ride on the surface of the material on the winding reel. Movement of the sensing arm **98** rotates a gear **102** keyed or otherwise secured to the shaft **100**. Additionally, a pinion gear **104**, smaller than the gear **102**, is keyed or otherwise secured to a shaft **106** which positions the contact arm **96** and is in operative mesh with the gear **102** to be rotated thereby.

It will be appreciated that pivoting of the sensing arm **98** rotates the gear **102** which, in turn, drives the pinion gear **104** to move the contact **94** over the winding **92**. Moreover, since the gear **102** is of a larger diameter than the pinion gear **104**, the pinion gear **104** is driven through a wider angle than that through which the sensing arm **98** moves and, therefore, a wider range of control is more readily obtained on the rheostat **90**.

The rheostat arrangement illustrated in FIG. 3 may be connected in a circuit with a solenoid such as the solenoid illustrated at **26** in FIGS. 1 and 2. Specifically, the contact **94** may be connected to the winding **30** through the lead **58** and the winding **92** may be connected to the terminal means **56** through the lead **62**.

Of course, it is understood that the braking force may have any desired load characteristic including a straight line function. Although the gear **102** and the pinion gear **104** are herein illustrated as circular, it is to be understood that the gears may be elliptical in shape or have other irregular contour to obtain any desired variation of torque according to a predetermined variable function of the diameter of the reel **10**. Moreover, the braking torque may readily be varied in relation to the diameter of the material on the reel by the use of a Semotor which has its stator mounted relative to a disk in such a manner that the stator can be moved radially of the disk in response to the winding diameter of the reel. The torque resulting on the shaft of the Semotor will vary as a function of the position of the stator along the radius of the disk. This is based upon the fact that the tangential force exerted by the Semotor stator upon the disk remains constant as long as the voltage and frequency applied to this Semotor is kept constant. Therefore, by moving the Semotor stator radially in and out relative to the winding diameter of the reel it is possible to obtain a variable torque output on the motor shaft. The Semotor stator could, for example, replace the rheo-

stat 50 in the embodiment of FIGS. 1 and 2, being mounted at contact 48 thereof to move in and out relative to the diameter of the winding reel 10.

FIGS. 4 and 5 illustrate an improved variable torque brake wherein the brake is mechanically applied by a spring and wherein a portion of the spring bias is counterbalanced in relation to the winding diameter of the reel. Similar parts of the embodiment of FIGS. 4 and 5 and of the preceding embodiments are designated by the same numerals as in the preceding embodiments. Referring now to FIGS. 4 and 5, there is provided the winding reel 10 keyed or otherwise secured to the shaft 12 and adapted to have wound and unwound thereon a suitable windable material, therein illustrated as the wire rope 14. The winding reel 10 includes the hub 10*a* interconnected by the pair of spaced sides 10*b* so that the wire rope 14 as it is wound on the hub 10*a* forms a plurality of layers of side-by-side strands so as to fill the hub 10*a* between varying diameters as the wire rope 14 is wound upon the reel 10.

In order to control the shaft 12 and to stop a winding or unwinding operation of the reel 10, a friction brake assembly 116 is operatively associated with the shaft 12. Specifically, the friction brake assembly 116 includes a brake drum 118 keyed or otherwise secured to the shaft 12, and a complementary brake shoe 122 frictionally engageable with the brake drum 118 and containing a friction material 124 on its inner surface engageable with the drum 118.

In order to apply the friction brake assembly 116 to control the shaft 12, there is provided a brake arm 136 pivotally mounted intermediate its length about a fixed pivot pin 138 and pivotally supporting the brake shoe 122 through a pivot pin 140. A tension spring 142 is provided interconnecting one end 136*a* of the brake arm 136 and a stationary portion of the brake assembly 116 to bias the brake arm 136 counterclockwise, as viewed in FIG. 5, about the fixed pivot pin 138. Of course, it is to be understood that means (not shown) may be provided for holding the brake shoe 122 out of engagement with the brake drum 118 against the bias of the tension spring 142 when it is desired that the brake assembly 116 be in a released condition.

According to the present invention, means are provided for counterbalancing the brake applying force of the tension spring 142 in relation to the winding diameter of the reel 10. Specifically, such means includes a sensing device for gauging the winding diameter of the reel 10 including a sensing arm 144 pivotally mounted at one end about a fixed pivot pin 146. The other end of the sensing arm 144 is provided with a weight 148 which rides on the surface of the material on the reel 10. A counterbalancing compression spring 150 interconnects an intermediate portion of the sensing arm 144 and an overhanging end 136*b* of the brake arm 136. It will be appreciated that the force of the spring 150 tends to bias the brake arm 136 clockwise, as viewed in FIG. 5, in the opposite direction from the spring 142, thereby being effective to counterbalance a portion of the force from the spring 142.

From the above detailed description, the operation of the improved variable torque brake is believed clear; however, briefly, it is understood that during the process of winding and unwinding the winding diameter of the reel 10 varies between the fully wound position illustrated in phantom in FIG. 5 and identified as A, to, for example, an intermediate position illustrated in solid therein and identified as B, to a minimum radius wherein the reel 10 is unwound. It will be appreciated that if a continuous pull is applied to the wire rope 14, the torque necessary to stop the shaft 12 will be substantially in proportion to the winding diameter of the reel 10 and therefore to the amount of the material wound on the reel 10. Moreover, during the process of winding and unwinding, the weight 148 on the sensing arm 144 moves over the surface of the rope 14 wound on the reel 10, pivoting the sensing arm 144 about the pivot pin 146. This movement of the sensing arm 144 is effective incrementally to vary the load exerted on the brake arm 136 by the compression spring 150, thereby to incrementally vary the effective setting load on the brake assembly 116. The weight 148, of course, must be sufficient to always ride on the surface of the rope 14 so as continuously to apply the force of the spring 150 against the brake arm 136. As the counterbalancing force of the spring 150 is varied in relation to the winding diameter of the reel 10, the stopping torque applied to the shaft 12 by the friction brake assembly 116 will be approximately proportional to the winding diameter of the reel 10.

While several preferred embodiments have been illustrated, many modifications will occur to those skilled in the art. For example, when winding or unwinding a reel at a constant speed of material, the angular velocity of the reel is inversely proportional to the winding diameter of the wound material; therefore, by mounting a ball speed governor on the reel shaft it is possible to adjust a brake according to the speed of the shaft and, consequently, to apply a braking torque in relation to the winding diameter on the reel. It is therefore intended in the appended claims to cover all such modifications as fall within the true spirit and scope of this invention.

What is claimed as new and is desired to be secured by Letters Patent of the United States is:

1. A variable torque brake operatively connected to a winding reel of the type adapted to hold a variable amount of material at a varying diameter, said brake including a friction brake assembly operatively connected to control said reel and spring means for setting the brake, means for continuously sensing the winding diameter of the material on the reel, and additional spring means connected between said brake and the said means for sensing the winding diameter for counterbalancing a portion of the force of the first-mentioned spring means in response to the winding diameter of said reel to vary the torque of said brake in approximate proportion to the winding diameter of said reel.

2. In combination, a rotatable shaft, a reel on said shaft adapted to hold material thereon, the winding diameter of said reel varying in response to the amount of material wound thereon, a brake drum operatively connected to said shaft, a brake shoe operatively positioned to frictionally engage said brake drum, spring means operatively connected with said shoe for biasing said shoe into frictional engagement with said drum, sensing means including a weight riding on the surface of the material on said reel for sensing the winding diameter of said reel, and means including additional spring means operatively connected between said brake shoe and said sensing means for counterbalancing a portion of the setting force of the first-mentioned spring means and actuated by the said sensing means to vary the bias of said shoe against said drum in response to the size of the winding diameter of said drum.

3. A variable torque brake operatively connected to a winding reel of the type adapted to hold a variable amount of material at a varying diameter, said brake including a brake drum for controlling the winding reel; a brake arm pivotally mounted about a pivot means intermediate its length; a brake shoe mounted on said brake arm on one side of said pivot means and operatively positioned to frictionally engage said brake drum, tension spring means operatively connected to said one side of said brake arm for biasing said shoe into frictional engagement with said drum; sensing means for sensing the winding diameter of said reel and including a sensing arm pivotally mounted at one end, and a weight on the other end of said sensing arm riding on the surface of the material on said reel responsive to the winding diameter of said reel; and compression spring means in-

terposed between said arms operatively engaging the other end of said brake arm and connected intermediate said sensing arm to counterbalance a portion of the setting force of the first-mentioned spring means for varying the bias of said shoe against said drum in response to the size of the winding diameter of said drum.

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