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## BRAKING MECHANISM

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This invention relates generally to braking systems and more particularly to a braking mechanism for controlling the rotational speed of a drum or reel.

Simple braking mechanisms in the form of friction clutches are well known for controlling the rotation of drums and reels. Many of these systems simply employ a friction brake which may be manually adjusted so that a line payed out will not become entangled should the tension on the line suddenly cease.

In the case of fishing reels, for example, it is desirable that the reel be capable of spinning with relatively no friction when rotating at high speeds in order that effective casting may be achieved. On the other hand, when the tension in the line lets up such that the reel slows to a given lower rotational speed, it is equally important that sufficient friction be provided to bring the reel to a quick stop in order to avoid tangling of the line. If a frictional braking system is adjusted such that a reel will be stopped relatively rapidly when the tension on the line is relieved, this same friction will be present when it is desired that the reel spin freely. If the effect of the friction brake is decreased sufficiently to permit the reel to spin freely, or as free as is deemed necessary, then sufficient friction will not be present to brake the reel when tension has been decreased in the line.

One means of overcoming the above problem is to set the brake mechanism to a given friction which is sufficient to stop the reel when tension on the line is ceased. A manual means is then provided for entirely removing this given friction from the reel while it is spinning at high speeds. When the operator desires that the friction be applied, he simply releases the manual control whereby the frictional braking of the reel is effective to slow the reel down. In this respect, the operator must hazard a guess as to when the tension will drop on the line so that he will know when to release the manual control.

Bearing the above in mind, it is a primary object of the present invention to provide a vastly improved braking control mechanism for a reel in which the reel, when spinning at relatively high speeds, may do so with substantially no friction and yet when the rotational speed of the reel slows down to a given rate, the reel will automatically be braked to a standstill in a short period of time.

Another object is to provide a braking mechanism of the above type which is fully automatic and responsive to the rotational speed of the reel and yet which is extremely durable, reliable in operation, does not employ complicated parts subject to wear, and which is relatively economical to manufacture.

These and many other objects and advantages of the present invention are attained by providing a stationary end plate adjacent at least one end of the reel or drum to be controlled. Preferably, this end plate is rigidly secured to a shaft means about which the reel rotates. A braking disc is in turn resiliently mounted to the one end of the reel adjacent the braking plate such that it will

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rotate with the reel and is also capable of limited axial movement towards and away from the stationary end plate. The resilient means preferably biases the braking disc into face to face engagement with the stationary end plate.

In a preferred embodiment, permanent magnets are secured to the stationary end plate and exert a magnetic drag force on the braking disc when in face to face engagement with the stationary end plate whereby sufficient friction is provided to bring the rotating reel to a standstill in a relatively short period of time. The braking disc itself is provided with an air scoop means wherein upon extremely rapid rotation of the reel, air is forced into the space between the stationary end plate and the disc. As a result, a dynamic air pressure is built up tending to separate the opposing faces of the disc and plate. This dynamic air pressure is sufficient to overcome the bias exerted on the braking disc by the resilient mounting thereof when the reel is rotating at a high rate of speed. Thus, with sufficient rotational speed, the braking disc is separated from the stationary plate and the reel may continue to rotate with relatively little friction. When the rotational speed drops below a given value, however, the resilient means biases the braking disc into face to face engagement with the stationary end plate and the magnetic drag force is then effective to provide sufficient friction to bring the reel to a standstill.

A better understanding of a preferred embodiment of the invention will be had by referring to the accompanying drawings, in which:

Figure 1 is an exploded perspective view of a reel incorporating the braking mechanism of the present invention;

Figure 2 is a cross sectional view of the stationary end plate taken in the direction of the arrows 2—2 of Figure 1;

Figure 3 is a plan view of the plate taken in the direction of the arrows 3—3 of Figure 2;

Figure 4 is an elevational view, partly in cross section of the braking disc and reel portion taken in the direction of the arrows 4—4 of Figure 1; and

Figure 5 is another cross-sectional view of the braking disc of Figure 4 taken in the direction of the arrows 5—5.

Referring to Figure 1, there is illustrated a reel or drum 10 provided with stationary end plates 11 and 12. The end plate 11 is shown disconnected from one end of the drum 10 in order to clearly illustrate the braking mechanism of the invention. As shown in Figure 1, the reel may be employed for supporting a line 13 such as a fishing line.

In accordance with the invention, there is provided a braking disc 14 resiliently secured to one end of the drum 10 as shown. The disc 14 includes a series of openings 15 the purpose for which will become clearer as the description proceeds. Preferably, the central portion of the braking disc 14 is apertured as at 16 to accommodate a supporting means in the form of a journal 17 rigidly secured to the inner part of the reel and adapted to rotate about a shaft 18 axially passing through the central aperture 16.

The end plate 11 is provided with a pair of annular cavities 19 and 20, respectively, defined by the outer peripheral portion of the plate 11 and two concentric annular flanges 21 and 22. The center of the end plate 11 is provided with an opening 23 adapted to receive and secure the end plate to the shaft 18 when in assembled position.

In Figure 1, the depth of the annular cavities 19 and 20 has been greatly exaggerated for purposes of clarity. Preferably, the inner face surface of the annular cavity

20 includes detented portions 20' to provide pockets effectively increasing the depth of the cavity. The purpose of these pockets 20' will become clearer as the description proceeds.

The co-operation of the end plate 11 with the braking disc 14 as illustrated in Figure 1 will be better understood by reference to Figures 2, 3, and 4. In Figures 2 and 3, it will be noted that the rear end of the plate 11 is provided with a recessed portion 24 accommodating a series of permanent magnets 25, 26, 27, and 28. Preferably, these magnets are arranged in a uniform square array within the recess 24 as clearly illustrated in Figure 3 and are permanently secured to the back of the stationary end plate 11. While these magnets are described herein as permanent magnets, they may be electromagnets energized by a suitable portable battery.

The end plate 11 is preferably made of copper or other non-magnetic material, such that the magnetic fields established by the magnets may pass directly therethrough.

In Figure 4, it will be noted that the end of the reel includes a conical flared portion 29 serving as a cowl or housing for the braking disc 14. This conical portion 29 is rigidly secured to a backing plate 30 recessed axially inwardly of the end of the conical portion. The backing plate 30 in turn supports the journal bearing 17 through which the stationary shaft 18 extends to rotatively mount the reel 10 on the shaft 18. The braking disc 14 is resiliently mounted to the backing plate 30 by means of a series of springs 31, eight of which are provided as an illustrative example and as clearly indicated in Figure 5. These springs resiliently mount the braking disc 14 in such a manner that the disc 14 will rotate with the reel 10 and will also be capable of limited axial movement, as indicated by the double headed arrow, whereby the disc 14 may move towards and away from the end of the reel.

As seen in both Figures 2 and 4, the diameter of the braking disc 14 is somewhat less than the diameter of the extreme end of the conical portion 29 such that when the end plate 11 is inserted on the shaft 18 in assembled position, there will be a space 32 providing a communication between the backing plate 30 and the rear of the disc 14 with the exterior of the reel through the annular cavity 19. The annular flange 21, on the other hand, is positioned such as to abut the peripheral portion of the braking disc as at 34 when the braking disc and plate are in face to face engagement. Further, the annular flange 22 is positioned to abut the peripheral edge of the central opening 16 in the braking disc 14 whereby the annular cavity 20 is confined by the face of the braking disc 14. When the braking disc 14 is moved inwardly against the force of the springs 31, the plate 11 and disc 14 will be separated slightly whereby the annular cavity 20 will be placed in communication with the annular cavity 19 past the peripheral edge 34 of the braking disc and thence through the annular opening 32 to the outside. The shaft 18 is rigidly secured to the end plate 11 by any suitable nut means 35, as indicated in Figure 2 so that the spacing of the end plate 11 with respect to the reel 10 is held fixed and the only axially movable element is the braking disc 14.

As shown clearly in Figure 5, the various openings 15 in the braking disc 14 include air scoop means 33 opening to the rear of the disc. These air scoops are arranged such that when the reel is rotating in a counter clockwise direction as viewed from the right in Figure 4 or as viewed in plan in Figure 5, air will be scooped through the openings 15 to enter into the annular cavity 20 and exert a dynamic air pressure between the disc and plate tending to urge the braking disc 14 inwardly or away from the end plate 11.

The operation of the braking mechanism of this invention will be clear from the above description. Initially, the magnets 24, 25, 26, and 27 will pull against the braking disc 14, which is made of iron or other magnetic

material. Thus, the annular flange 21 will engage the peripheral face portions 34 of the braking disc and the annular flange 22 will engage the inner peripheral edge of the center opening 16 in the braking disc so that the annular cavity will be closed. The disc 14 and end plate 11 are held in face to face engagement by the magnetic forces exerted on the braking disc.

When the reel 10 is caused to rotate as by a tension on the line 13, twisting forces will initially be exerted on the springs 31 since the disc is temporarily held against rotation. These twisting forces will increase the tension in the springs until sufficient rotating force is transmitted to the braking disc to overcome the magnetic attraction of the end plate. When the magnetic forces have been overcome, the potential energy stored in the springs as a result of the initial twisting will be transferred to the disc resulting in a sudden "snapping free" action of the disc. The sudden initial rotation of the disc and release of the friction on the reel so that it continues to rotate at relatively high speed, will in turn result in air suddenly being scooped by the scoops 33 and forced between the plates into the annular cavity 20. The resultant dynamic air impact in the cavity 20 will serve to positively separate the plates. Actually, the plates are "bounced" apart by this sudden surge of air into the annular cavity 20. The provision of the indents or pockets 20', as illustrated in Figure 1, actually serve to "catch" the air forced into the annular cavity thereby increasing the effectiveness of the separation of the braking disc from the end plate 11. Once the initial separation is achieved, the reel is free to rotate with substantially no friction and air pressure will be maintained between the disc and plate. As a consequence of the separation, the magnetic drag exerted by the magnets 25, 26, 27, and 28 is substantially nil.

The braking disc will remain separated from the end plate 11 for as long a time as the reel is rotating at or above a given speed. When tension on the line 13 is relaxed, the reel will gradually slow down until such time that its rotational speed is not sufficient to provide a dynamic air pressure between the plates sufficient to hold the disc apart from the end plate. At this time, the magnetic attraction and biasing springs will urge the braking disc 14 into engagement with the end plate 11 and sufficient friction will be exerted on the disc to slow the reel to a standstill relatively rapidly. When tension is again applied to the line to increase the rate of rotation of the reel, air pressure will again build up in the annular cavity 20 and the pockets 20' to hold the plates apart and permit the reel to rotate with substantially no friction.

It will be apparent, therefore, that the present invention provides in a fully automatic manner a system for braking a reel when the reel rate of rotation has dropped below a certain value and yet permit the reel to rotate substantially friction free when the reel rotational rate has increased above a certain value.

The stiffness of the springs 31 and the shape and size of the opening 15 and air scoops 33 may all be adjusted such that the braking action will take effect at a desired rotational speed, whereby the braking mechanism may be adapted for effective operation on a variety of reel or drum type devices. Further, the plate may be held in a floating arrangement by telescopic supports such that a small amount of free axial play is provided, the magnetic field acting through this free play distance. Either simple stops and/or springs may then be provided to limit the axial movement towards the reel. The expression "biasing means" is herein meant to include either or both magnetic and spring action.

Thus, while the invention has been described with particular reference to a preferred embodiment, it should be kept in mind that minor modifications may be made and that it may equally as well be suited to the automatic braking of any type of rotating drum or reel. Other

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modifications within the scope and spirit of the present invention will occur to those skilled in the art. This invention is, therefore, not to be thought of as limited to the particular detailed braking system schematically set forth in the drawings for illustrative purposes only.

What is claimed is:

1. A braking mechanism for controlling the rotation of a reel comprising, in combination: a stationary plate; a braking disc; means for resiliently securing said disc to one end of said reel for rotation therewith; biasing means axially biasing said disc into face to face engagement with said plate; and air scoop means on said disc adapted to pass air between the opposing faces of said plate and disc upon rapid rotation of said reel such that the dynamic air pressure between said opposing faces is increased sufficiently to separate said disc from said plate.

2. A braking mechanism according to claim 1, in which said biasing means includes magnetic means secured to said stationary plate whereby a magnetic drag is exerted on said disc when in face to face engagement with said plate.

3. A braking mechanism comprising, in combination: a rotating element; a braking disc; resilient means securing said braking disc to one end of said element such that said disc normally rotates with said element and is capable of limited axial movement towards and away from said one end; a stationary end plate; shaft means secured to said end plate and passing axially through said rotating element; means journaling said element to said shaft means; said stationary plate and said braking disc defining an annular space between their opposing faces when in face to face engagement; magnetic means secured to said stationary plate and adapted to exert a magnetic drag force on said braking disc when said stationary plate and said braking disc are in face to face

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engagement; and air scoop means secured to said braking disc and communicating with said annular space whereby upon rapid rotation of said element, dynamic air pressure will build up in said annular space and separate said braking disc from said stationary plate to overcome the effect of said magnetic drag force.

4. A braking mechanism according to claim 3, in which the face of said stationary end plate includes indented portions serving as air pockets whereby said plates are bounced apart upon a sudden initial increase in dynamic air pressure therein.

5. A braking mechanism for controlling the rotation of a reel comprising, in combination: a support means for rotatably mounting said reel; a stationary end plate secured to said support means adjacent one end thereof; a braking disc; means for resiliently mounting said braking disc to one end of said reel between said one end and said stationary end plate such that said disc is capable of rotation with said reel and is capable of limited axial movement towards and away from said stationary end plate; concentric annular flanges on the inner face of said stationary end plate adapted to define an annular cavity with the opposing surface of said braking disc when said disc and plate are in face to face engagement; magnetic means secured to said end plate adapted to exert magnetic drag forces on said braking disc when said plate and disc are in face to face engagement; and air scoop means on said disc communicating with said annular cavity whereby upon rapid rotation of said reel, dynamic air pressure will build up in said annular cavity to separate said braking disc from said stationary end plate and overcome said magnetic drag forces.

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