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Bidanset

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[54] **BAND TYPE BRAKE FOR A CHAIN SAW**

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[51] **Int. Cl.²**.. **F16D 49/04**

[58] **Field of Search**............... 188/77 R, 77 W, 166; 192/81 C; 30/380, 381, 382, 383

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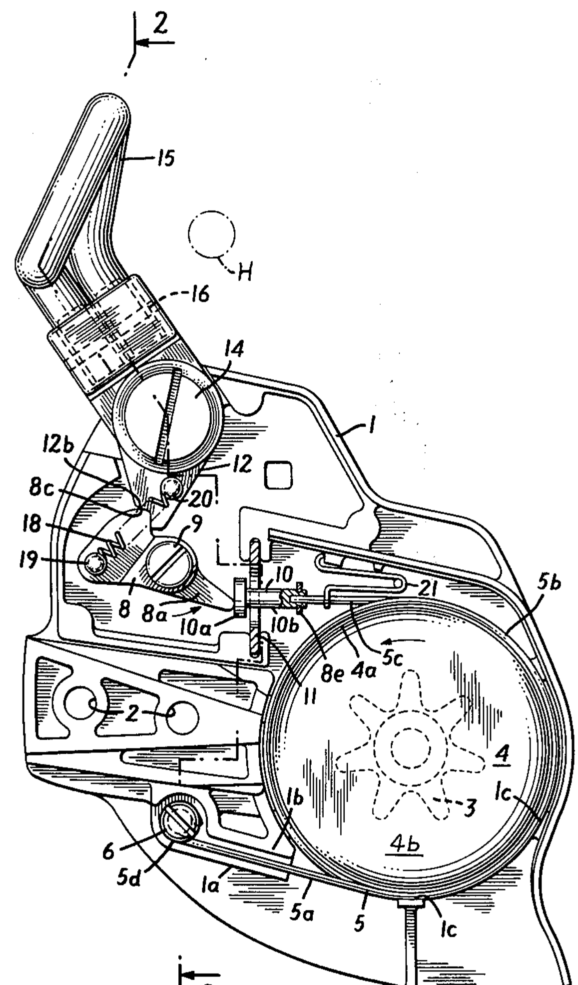
[57] **ABSTRACT**

An inertial-manual actuating safety brake for a chain saw in which a mechanical integrator distinguishes between relatively long duration accelerations developed by a "kickback" producing impulse and normal operating accelerations associated with operational and vibratory forces. The operation of the integrator causes the nullification of the operational and vibratory forces. Occurrences of a "kickback" impulse, developing a force of required magnitude, direction, and duration causes a spring-mass accelerometer to change from a brake released to a brake applied condition, applying a braking torque to the saw chain. The accelerometer utilizes a pivotable hand guard as the actuating mass. The hand guard also provides for manual operation. In manual operation the release force is applied manually.

11 Claims, 4 Drawing Figures



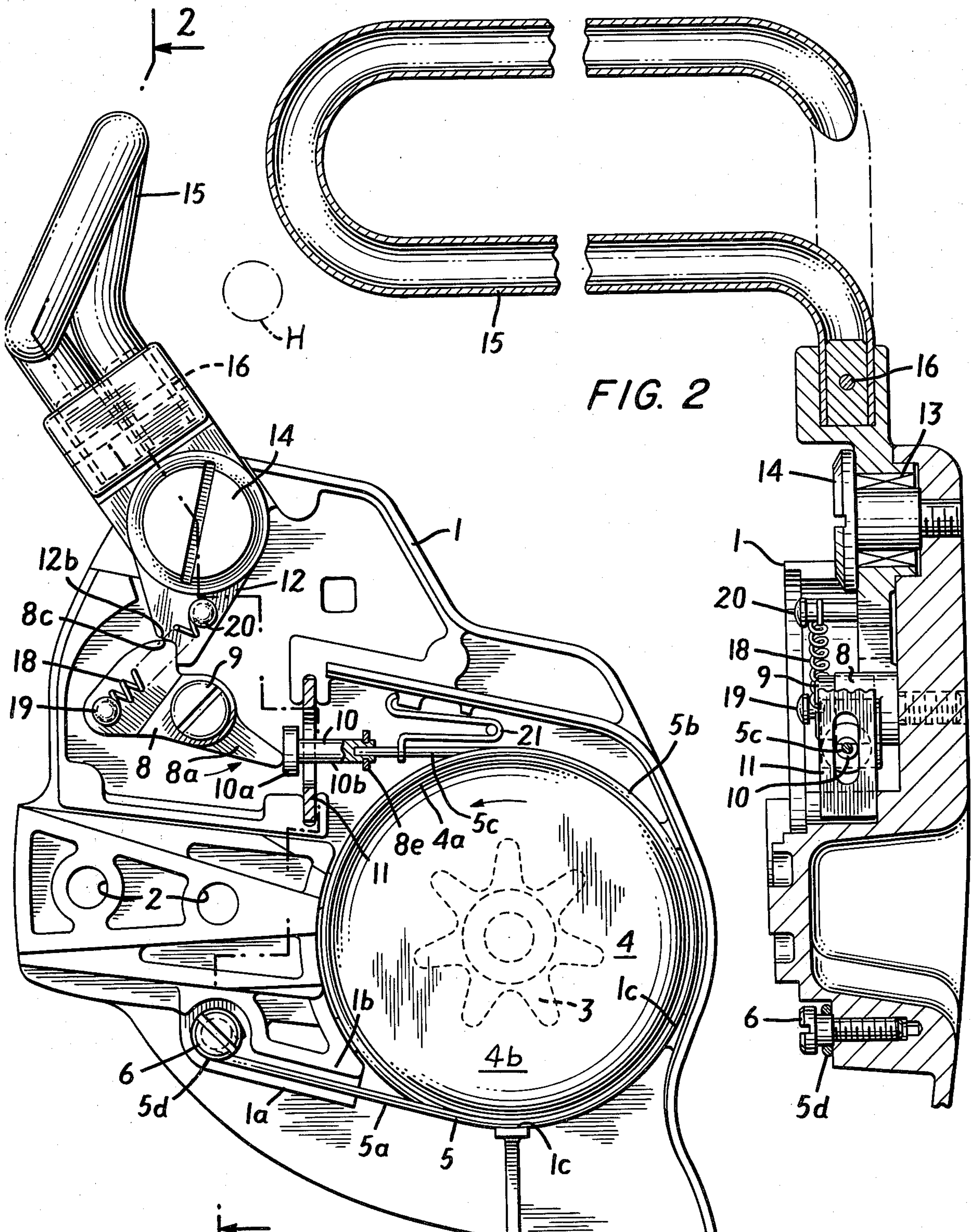

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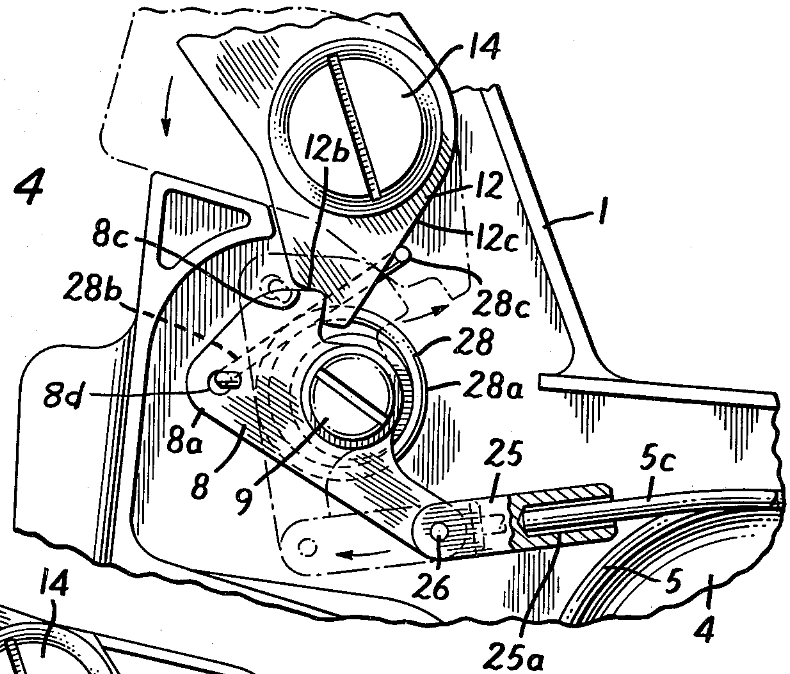
FIG. 2

FIG. 1

FIG. 4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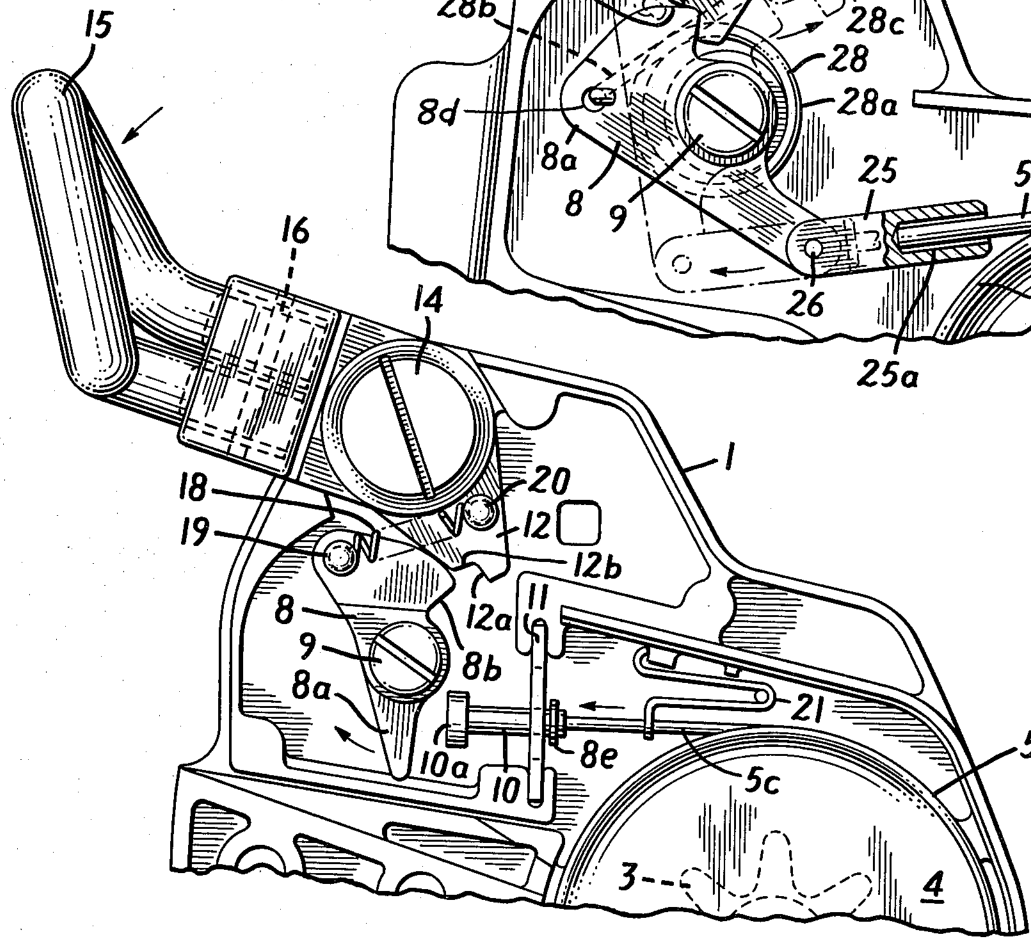
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FIG. 3

BAND TYPE BRAKE FOR A CHAIN SAW

FIELD OF THE INVENTION

The present invention relates to hand held power tools utilizing a rotating or rapidly translating cutting element and particularly to means for bringing the cutting element to a stop in the event of reaction forces that cause an uncontrollable hazardous condition that might cause injury to the user or nearby co-workers. In application to a chain saw, the invention relates to means for sensing the occurrence of an uncontrollable kickback, or other rapid motion directed away from the cutting surface toward the operator and thereupon bringing the chain to a stop.

BACKGROUND OF THE INVENTION

The widespread use of portable power tools in the construction, lumbering, and consumer markets has emphasized the need for effective user safeguards. Lighter weight, reduced vibration, and higher power have resulted in very efficient cutting tools that are used in increasing applications by skilled and semi-skilled operators, and as with any powered machine they present a potential hazard to the user. In the case of chain saws a potential hazard is presented by the phenomenon known as "kickback." A "kickback" can be produced by a chain saw when the cutting elements on the chain momentarily stop cutting and are seized by the work material. The kinetic energy of the chain normally used to remove the material is suddenly transferred to the chain bar imparting a force to the chain bar that causes it to kick up toward the operator. The magnitude of the "kickback" force is related to the speed of the chain and the nature of engagement of the chain with the work material.

Presently, safety devices place a manually operated hand guard actuator in a position to be contacted by the back of the hand or wrist of the operator in the event of a "kickback" and thereupon actuate a chain brake device manually to apply the brake and stop the saw chain. The clearance between the front handle and the brake actuator necessary to allow convenient operation of the chain saw requires a large angle of rotation of the saw about the wrist before actuation occurs. This large angle of rotation allows the driven chain to approach the user a considerable distance before actuation of the brake occurs. Additionally, the operator in attempting to protect himself may remove his hand from the hand grip without actuating the brake. Another possibility is for the user to firmly grip the chain saw during the "kickback," so that the user's arms and chain saw act as a rigid body rotating about an external point. In this case, the relative motion between the hand guard and the users wrist necessary to actuate the brake may never occur. During the felling of a tree, a user holds the saw by a side portion of the usual wrap-around front handle so that his hand is not near the hand guard. Hence the brake would not be actuated by a kickback.

SUMMARY OF INVENTION

It is an object of the present invention to provide an improved safety braking device for a portable power tool and in particular for a chain saw. A braking device in accordance with the invention comprises three basic components; a mechanical integrator, a spring-mass accelerometer inertial sensor, and a brake. Several of the parts serve a duality of function. Due to the multiplicity of cutting conditions and unpredictability of operator reaction, it is impossible to predict the motion of the saw during a "kickback." It is reasonable though to assume that during the throw impulse, i.e. that duration of time the saw chain and work material are in contact during the production of a kickback, and shortly thereafter, the motion is confined to the plane of the cutting bar. Realizing that the "kickback" producing acceleration is confined to a single plan during the production impulse simplifies the task of inertially sensing the "kickback" motion. This invention utilizes this concept inertially to sense a potentially hazardous motion produced by the kickback production impulse directed toward the user, and to initiate a sequence and apply a brake to the clutch drum and sprocket driving the saw chain. Inertially sensing the production impulse to initiate the braking sequence eliminates human reaction from the braking function and provides the maximum available time to stop the motion of the chain.

The mechanical integrator provides an integrating device to nullify extraneous motion of the accelerometer mass produced by vibration and normal cutting forces. The integrator distinguishes between these short duration forces and the relatively long duration force developed during the production of a "kickback" by sensing the direction, magnitude, and duration of the sustained force. The integrating accelerometer consists of a pivotable hand guard and rotatable control member in cooperative operation with an operating member and a control spring. The integrator-accelerometer obeys the equation of motion for a single degree of freedom system expressed by the second order differential equation of motion:

$$I\ddot{\theta} + C\dot{\theta} + K\theta = Q$$

where

Q = Actuating torque

I = Moment of inertia of rotatable member and hand guard about pivot

$\ddot{\theta}$ = Angular acceleration

$C\dot{\theta}$ = Viscous damping due to integrator interface

$K\theta$ = Actuating lever control spring restoring force.

Briefly explaining the operation of the integrator-accelerometer, vibratory and spurious accelerations acting at the center of mass of the hand guard produce small rotational impulses above the pivot. These short duration impulses are incapable of exceeding the control spring force and consequently the control member remains stationary, or if displaced, is returned to its initial position by the control spring. Over a period of time the net displacement of the control member from its initial position is zero.

A torque generated by a "kickback" impulse acting on the accelerometer with the required direction, magnitude, and duration will be sufficient to overcome the control spring force and produce a rotational displacement capable of initiating the braking sequence. Once the braking sequence is initiated, the inertial property of the hand guard-rotatable control member causes it to remain stationary with respect to the inertial reference while the chain saw rotates through the "kickback" arc. The relative motion between the hand guard and the chain saw causes the brake to be applied.

During this portion of the sequence the inertial torque acting on the hand guard-pivotable control member assembly is determined by the equation:

$$Q = \text{inertial torque} = I\ddot{\theta}$$

The spring wrap brake design is determined by the equation:

$$M_t = (e^{\mu\alpha} - 1)\,M$$

where

M_t = Total braking moment
M = Moment per coil
μ = Coefficient of friction
α = Contact angle between brake element and brake drum.

The total braking torque developed by this configuration may be varied to meet specific applications by varying M, μ, or θ. Braking pressures may be varied by adjusting M or A, where A represents the contact area between the brake band and the clutch drum. The brake band may have any suitable cross sectional configuration but in some applications it is desirable to minimize the contact area to control the brake pressures. In a lubricated environment, a square or rectangular cross sectional brake band may allow a hydrodynamic oil film to exist between the brake band and brake drum, creating in effect a journal bearing. A round cross sectional brake band providing an equivalent braking torque will produce higher braking pressures due to the smaller contact area, and effectively break through an existing oil film, thereby increasing the occurrence of contact between the brake band and drum surfaces. The cross sectional shape is not limited to a round section, but may be shaped to suit the particular application.

Another brake band configuration compatible with the inertial sensing features described above consists of an untempered multi-turn element, firmly anchored at one end and externally tensioned by an operating member. This design obeys the equation:

$$M_t = (e^{\mu\alpha} - 1)\,FR$$

where

M_t = Total braking moment
μ = Coefficient of friction
α = Contact angle between brake element and brake drum
F = External tensioning force
R = Radius of application of force, F.

In accordance with the invention as herein described by way of a preferred example, the brake comprises a narrow spring brake band which is wrapped in a helical coil around the drum of a centrifugal clutch through which the chain is driven. For example the brake band wraps 1¼ turns and preferably between 1½ and 2½ turns around the clutch drum. In an unrestrained condition, the inside diameter of the helical coil of the spring brake band is less than the outside diameter of the clutch drum so that the brake band tends inherently to grip the drum. The leading end of the spring brake band is anchored while the trailing end is controlled by an operating member which is rotatably supported for movement between a brake releasing position in which the helical coil of the spring brake band is expanded so as to free the clutch drum and a brake applying position in which the helical coil of the spring brake band contracts so that the band grips and brakes the drum to bring it quickly to a stop. The operating member is controlled through a mechanical integrator by a spring-mass accelerometer inertial sensor which is responsive to predetermined acceleration of the chain saw. During normal operation of the saw, the inertial sensor acting through the mechanical integrator retains the operating member in brake releasing position. However, in the event of a kickback, the inertial sensor senses the acceleration of the saw and initiates movement of the operating member to brake applying position, thereby applying the brake quickly to stop the saw chain. In a preferred embodiment of the invention the inertial device comprises a rotatable control member carrying an eccentric mass. In the event of kickback of the chain saw, the inertial property of the sensor causes the rotatable member to remain stationary in space while the chain saw experiences an acceleration. The resulting relative motion causes an apparent relative rotation of the control member in a direction to initiate movement of the operating member from a brake releasing position to a brake applied position. The eccentric mass is preferably in the form of a handle portion which provides for manual operation, both to trip and to reset the brake controlling mechanism.

BRIEF DESCRIPTION OF DRAWINGS

The nature, objects and advantages of the present invention will appear more fully from the following description of preferred embodiments shown by way of example in the accompanying drawings in which:

FIG. 1 is a side view of a chain brake in accordance with the present invention and associated portions of a chain saw, the chain brake being shown in released condition;

FIG. 2 is a sectional view taken approximately on the line **2—2** in **FIG. 1**;

FIG. 3 is a side view with the chain brake in applied condition;

FIG. 4 is a side view corresponding to a portion of **FIG. 1** but showing another embodiment.

DESCRIPTION OF PREFERRED EMBODIMENT

In FIG. **1** of the drawings, a chain brake in accordance with the present invention is shown by way of example installed on the drive case cover **1** of a chain saw. The drive case cover can for example be a suitable casting of the configuration shown in the drawings. A guide bar (not shown) is mounted on the saw chain chassis by bolts passing through holes **2** in the drive case cover. A cutting chain (not shown) which runs on the guide bar is driven by a sprocket **3** on the drum **4** of a centrifugal clutch, the expansible rotor of which is driven by the chain saw engine. The centrifugal clutch has the characteristic that when the engine is running at idling speed, the rotor is disengaged from the drum so that the drum, sprocket and cutting chain are not driven. When the engine speed controlled by the usual hand throttle trigger exceeds a selected value, for example **3500** rpm, the centrifugal clutch engages so as to drive the drum **4** and hence the chain. The clutch drum **4** has a cylindrical rim portion **4***a* at the periphery of a radial wall portion **4***b* on which the sprocket **3** is mounted. In smaller chain saws, the clutch drum may for example have a diameter of about **2½** to **3** inches with a rim portion about **0.7** inches wide. For larger chain saws, the diameter of the clutch drum and the width of the rim are appropriately increased. A brake band **5** is wrapped around the peripheral rim **4***a* of the drum **4** of the centrifugal clutch. The brake band **5** comprises a narrow spring band or ribbon having a cross sectional shape providing limited contact with the drum. For example, the band may be of round or oval cross section. The band is preformed so as to provide a lower straight portion **5***a*, a central portion **5***b* which is wrapped helically around the brake drum and a straight upper portion **5***c*. The lower straight portion **5***a* of the brake band is anchored to the drive case cover **1** by means of a screw **6** which passes through a loop **5***d* formed at the end of the band. Moreover, the loop **5***d* is sufficiently large to be captured between projecting flange portions **1***a* and **1***b* of the drive case cover so as to be held even if the screw **6** should come loose. The central portion **5***b* of the brake band is formed as a helical coil which surrounds the clutch drum **4**. As seen in FIG. **1**, the clutch drum turns in a counterclockwise direction so that when the brake band engages the drum, frictional forces acting on the band tend to provide a self-activating force to pull the band tighter on the drum. In order to provide suitable braking action as hereinafter described, the brake band **5** should preferably make at least 1¼ turns abound the clutch drum. On the basis of present experience good results are obtained by using 1½ turns to 3½ turns. In the construction shown by way of example in the drawings, the brake band wraps around the clutch drum approximately 2½ turns. The brake band is preferably preformed so that the internal diameter of the helically coiled portion **5***b* in a relaxed condition is smaller than the external diameter of the clutch drum. Hence, unless held in an expanded condition, the helically coiled portion of the brake band contracts so as to grip the clutch drum. As seen in FIG. **1**, the straight end portions **5***a* and **5***b* of the brake band extend essentially tangentially of the clutch drum.

Provision is made for expanding the helically coiled portion of the spring brake band so as to hold it free of the clutch drum during normal operation of the saw. In the embodiment shown in FIGS. **1** to **3** of the drawings, expansion of the brake band coil is effected by an operating member **8** which is rotatably mounted by means of a shouldered screw **9** which is screwed into a tapped hole provided in the drive case cover. An arm **8***a* of the operating member **8** is adapted to engage the head **10***a* of a button **10** provided on the end of the upper straight portion **5***c* of the brake band **5.** A stem portion **10***b* of the button is received in an elongated slot in a guide plate **11** and is retained by a snap ring **8***e*. The plate **11** guides the end of the brake band laterally while permitting movement tangentially of the clutch drum and also movement toward and away from the drum. The operating member **8** is angularly movable about its axis of rotation between two positions as illustrated respectively in FIG. **1** and in FIG. **3.** In the position shown in FIG. **1**, the arm **8***a* of the operating member **8** presses on the button **10** provided on the trailing end of the spring brake band so as to expand the helically coiled portion **5***b* of the brake band and thereby disengage the brake band from the clutch drum. The drive case cover is provided with suitable abutment portions **1***c* which engage the brake band when in expanded condition and assist in positioning it so that the helically coiled portion of the brake band is concentric with and spaced from the periphery of the clutch drum. The brake is thus released and the clutch drum is free to turn. In the position shown in FIG. **3**, the operating member **8** has turned in a clockwise direction so as to relieve the pressure on the button **10** on the trailing end of the spring brake band. Hence, the brake band by its inherent resilience contracts and grips the clutch drum. Assuming that the drum is rotating in a counterclockwise direction, frictional forces which are generated when the brake band engages the clutch drum produce a self-activating force that pulls the helically coiled portion of the brake band still tighter on the clutch drum so as to provide a strong and effective braking action which quickly stops rotation of the drum.

Operation of the operating member **8** to release or to apply the brake is controlled by an inertial sensor device which is responsive to predetermined acceleration of the chain saw. During normal operation of the saw, the inertial device retains the operating member **8** in brake releasing position so that the clutch drum **4** is free to turn. However, upon predetermined acceleration of the saw, as for example when the cutting chain at the end of the guide bar snags on a branch or limb to produce a kickback impulse, the inertial device releases the operating member **8** so as to move to the position shown in FIG. **3** thereby applying the brake and quickly stopping the clutch drum.

In the embodiment illustrated in FIGS. **1** to **3** of the drawings, the inertial sensor comprises a control member **12** rotatably mounted on the drive case cover for rotation about an axis which is parallel to and spaced from the axis of rotation of the operating member **8.** As illustrated by way of example in FIGS. **1** and **2** the control member **12** is rotatably mounted by means of an antifriction bearing **13** on a shouldered screw **14** which is screwed into a tapped hole in the drive case cover. The control member **12** is rotatable relative to the drive case cover by inertia responsive means comprising a mass or weight disposed eccentrically of the axis of rotation of the control member and a control spring. In the drawings the eccentric mass or weight is shown by way of example as comprising a handle or guard member **15** in the form of a tube bent in loop configuration. Ends of the tube are received in sockets provided in an upwardly extending portion of the control member **12** and are secured by a pin **16.** As the center of gravity of the mass comprising the member **15** and its connections to the control member **12** is eccentric of the axis of the control member, sudden acceleration of the saw results in movement of the saw relative to the control member and eccentric mass which tend to remain stationary by reason of their inertia. The result is an apparent rotation of the control member **12** and guard member **15** with respect to the saw. For example, in the event of a kickback whereupon the saw is moved angularly in a clockwise direction as viewed in FIG. **1**, inertial force acting on the eccentric mass result in relative rotation of the control member **12** in a counterclockwise direction.

Moreover, the guard member **15** provides a handle by means of which the control member **12** can be rotated manually. The member **15** extends across the front upper portion of the power head of the saw and is located in front of and somewhat higher than the front handle by which the saw is held. In FIG. **1**, the location of the front handle is indicated by the circuit H. By reason of this location, the guard member **15** is engageable by the hand or wrist of the operator when the saw kicks up, thereby resulting in rotation of the control member 12 in a counterclockwise direction relative to the saw. The guard member 15 also provides convenient handle means for manually rotating the control member 12 in a clockwise direction to reset it to its normal position as shown in FIG. 1.

Operative connections are provided between the control member 12 and the operating member 8 so as to provide for control of the braking action by the inertial sensor. The operating member is retained in a brake releasing position by the control member 12 during normal operation of the chain saw. In the event of predetermined acceleration of the saw, an inertial force acting through the inertial sensor comprising the guard member 15 and control member 12, cause the operating member to rotate to brake applying position. The operative connections between the control member 12 and the operating member 8 are shown in the drawings as comprising an abutment 12a on the control member engageable with an abutment 8b on the operating member 8 to move the operating member in a counterclockwise direction when the control member is moved in a clockwise direction. Moreover, a tension spring 18 extends between a pin 19 on the operating member 8 and a pin 20 on the control member 12. The location of the pins 19 and 20 is such that when the operating member 8 and the control member 12 are in "set" position as illustrated in FIG. 1, the spring holds the abutment *12a* of the control member and the abutment *8b* of the operating member in engagement with one another and also holds a peripheral surface *8c* of the operating member against a peripheral surface *12b* of the control member 12. The surface *12b* is of constant radius concentric with the axis of rotation of the control member 12. With the control member 12 in the positions shown in FIG. 1, the operating member 8 is retained in brake releasing position. In this position the brake band 5 is disengaged from the drum 4 as explained above. In the event that torque in a counterclockwise direction applied to the control member 12 by an inertial force or manually or both is sufficient to overcome the force of the spring 18, the control member is rotated in a counterclockwise direction relative to the drive case cover to the position shown in FIG. 3. By reason of the forces exerted by the spring band 5 and the spring 18, the operating member 8 follows the control member and rotates in a clockwise direction to the position shown in FIG. 3. The brake band 5 thereupon contracts so as to grip and stop the drum 4 as explained above. The control member 12 and operating member 8 remain in the position shown in FIG. 3 until reset. Resetting is effected by rotating the control member in a clockwise direction by means of the handle 15. Abutment *12a* of the control member thereupon engages the abutment *8b* of the operating member 8 to rotate the operating member in a counterclockwise direction to the set position shown in FIG. 1.

The operating member 8, control member 12 and spring 18 comprises a mechanical integrator by means of which the braking action is controlled so as to apply the brake only when movement of the saw as sensed by the inertial sensor is of a predetermined direction, rate of acceleration and duration. The mechanical integrator discriminates between short duration sinusoidal accelerations generated by the engine and long duration accelerations caused by a kickback producing impulse. In the event of a short duration acceleration sufficient to produce minor displacement of the control member 12 and operating member 8 but insufficient to trip the mechanism, the spring 18 acts between the members 8 and 12 to restore them to brake releasing condition. The brake applying mechanism is hence not tripped by vibration occurring during operation of the saw or by normal manipulation of the saw such as occurs in use. Moreover, movement of the guide bar in a direction away from the operator does not actuate the brake. However, in the event of a kickback or other substantial sudden movement of the saw in a direction to move the guide bar toward the operator, the sustained acceleration as sensed by the inertial sensor results in quick and effective application of the brake. With other parameters remaining the same, the value of the inertial force required to trip the mechanism and apply the brake can be selected by adjusting or selecting the force exerted by the control spring 18.

In the construction illustrated in FIGS. 1 to 3 of the drawings, a leaf spring 21 bears on the end portion *5c* of the brake band 5 to bias it toward the drum 4. The force applied by the spring 21 assists in overcoming the inertia of the brake band 5 and the button 10 when the latter is disengaged by the operating member 8, thereby increasing the speed of application of the brake. It will be seen that the slot in the guide plate 11 is long enough to avoid restricting inward movement of the end portion of the brake band. Moreover, when the operating member 8 in in brake applying position, the arm 8a is spaced from the button 10 to assure complete freedom of movement of the button 10.

The system comprising the operating member 8, control member 12 and spring 18 is bistable. When the members are in the position shown in FIG. 1, the line of action between the engaging surfaces of members 8 and 12 is to the left of the axis of member 12 so that the members stay in this position until a force is applied to move them. When the members are in the position shown in FIG. 3, the line of action is to the right of the axis of the member 12 and hence the members likewise remain in this position until a force is applied to return them to the position shown in FIG. 1.

The operation of the mechanism in accordance with the present invention will be readily understood from the foregoing description. During normal operation of the chain saw the operating member 8 is retained in set position as shown in FIG. 1 by the control member 12. In this position, the arm *8a* of the operating member engages the button 10 on the trailing end portion *5c* of the spring brake band 5 to expand the helically coiled portion *5b* of the brake band so as to disengage the clutch drum 4. The clutch drum is thereby free to turn. In the event of predetermined acceleration of the chain saw, for example if the guide bar kicksback toward the operator, an inertial force acting on the control member 12 by reason of the eccentric mass comprising the guard member 15 causes an apparent rotation of the control member in a counterclockwise direction relative to the saw. This releases the operating member 8 to rotate in a clockwise direction to the position shown in FIG. 3. The spring brake band 5 is thereby permitted to contract so as to grip the brake drum 4. The frictional forces generated between the clutch drum and the brake band tend to pull the brake band still tighter so that the clutch drum and hence the cutting chain are brought quickly to a step. If, in the event of a mishap other than a kickback, the inertial force acting on the control member 12 is not sufficient to rotate the control member relative to the saw from set position before the guard member **15** engages the hand or wrist of the operator, the additional force resulting from such engagement assures rotation of the control member. Thus, a double safety factor is provided by inertial and manual operation.

When it is desired to reset the chain saw for normal operation, the control member **12** is rotated in a clockwise direction by means of the guard member **15** from the position shown in FIG. **3** to that shown in FIG. **1.** The operating member **8** is thereby reset so as to release the brake.

A modified construction is illustrated on FIG. **4** in which corresponding parts are designated by the same reference numerals. In this embodiment a sleeve **25** pivotally connected to the operating member **8** by a pin **26** is provided with a blind bore **25***a* receiving the trailing end portion **5***c* of the brake band **5.** The bore **25***a* is of such depth that when the operating member **8** is in brake releasing position as shown in solid lines in FIG. **4,** the sleeve **25** pushes on the end of the brake band **5** to expand the brake band and thereby free the clutch drum. When the operating member is in brake applying position as shown in broken lines in FIG. **4,** the bottom of the bore **25***a* of the sleeve **25** is spaced from the end of the brake band so that the brake band is free to contract to grip the drum.

A control spring acting between the operating member **8** and the control member **12** is shown as a torsion spring **28** having a helically wound portion **28***a* coaxial with the operating member **8.** One arm **28***b* of the control spring has an angularly bent portion received in a hole **8***d* of the operating member **8** while a second arm **28***c* has an angularly bent portion bearing on an edge **12***c* of the control member **12.** The arm **28***b* of the control spring thus biases the operating member **8** in a clockwise direction while the arm **28***c* biases the control member **12** in a clockwise direction. The line of action of the force exerted by the control spring is such that when the operating member **8** and the control member **12** are in "set " position as illustrated in solid lines in FIG. **4,** the spring tends to hold them in set position. The force exerted by the control spring is such that the operating member **8** and control member **12** are retained in set position despite vibration and normal movements occurring in the operation of the saw. However, in the event of predetermined acceleration of the saw produced by a kickback, the inertial force acting through the inertial sensor comprising the guard member **15,** control member **12** and the control spring **28** causes the operating member to rotate to the brake applying position illustrated in broken lines in FIG. **4.** When the operating member **8** and control member **12** are in brake applying position, as illustrated in broken lines in FIG. **4,** the line of action of the force of the control spring **28** is such as to retain the members in this position. Hence, the system comprising the operating member **8,** control member **12** and control spring **28** is bistable. As described above, the system can be reset to brake releasing position by means of the guard member **15.**

While preferred embodiments of the invention have been shown by way of example in the drawings, it will be understood that modifications in the various parts may be made while retaining the principles of operation. Thus, for example the brake band **5** instead of being of round or oval cross sectional shape can be of other cross section which provides an area of engagement with the drum that will produce a braking pressure capable of penetrating any film of oil or other lubricant and provide a dry contact surface during braking. Still other modifications will occur to those skilled in the art.

What I claim is:

1. In a chain saw having a rotatable drum and a coaxial chain-driving sprocket rotationably fixed relative to the drum; a chain brake for stopping the cutting chain of the chain saw quickly, comprising a brake band engageable with said drum, means anchoring one end of said brake band, said band extending around said drum from said anchoring means in the direction of rotation of the drum, operating means at the other end of said brake band and movable between a brake releasing position in which said operating means acts on said band to release the drum for rotation and a brake applying position in which said brake band engages the drum and thereby applies a braking effect to the drum, and inertial means operatively associated with said operating means and responsive to predetermined acceleration of the chain saw to cause movement of said operating means from brake releasing position to brake applying position and thereby apply a braking effect to the drum, said operating means comprising a first rotatable member having an abutment and operable to act on said other end of said brake band to move it in a direction opposite to the direction of rotation of said drum to thereby disengage said brake band from said drum when said operating means is moved to brake releasing position, and said inertial means comprising a second rotatable member operatively associated with said first rotatable member to control its movement from brake releasing position to brake applying position, said second rotatable member having an abutment which is engageable with said abutment of said first rotatable member to move said first rotatable member from brake applying position to brake releasing position and to retain it in brake releasing position until operation of said inertial means to apply the brake, and a spring acting between said first rotatable member and said second rotatable member to bias said members to whichever position they are in and thereby tending to retain them in such position.

2. In a chain saw, a chain brake according to claim **1,** in which said brake band comprises a spring band wrapped around said drum in a helical coil which in free condition has an inside diameter smaller than the outside diameter of the drum so that said spring band is inherently biased toward a condition in which it grips the drum, and in which said first rotatable member has a second abutment portion which acts on said other end of said spring brake band to move it in a direction opposite to the direction of rotation of said drum and thereby expand the helical coil of said band when said operating means is moved to brake releasing position.

3. In a chain saw, a chain brake according to claim **1,** in which said inertial means further comprises an eccentric mass connected to said second rotatable member and acting on said second rotatable member to rotate it upon predetermined sudden movement of the chain saw.

4. In a chain saw, a chain brake according to claim **3,** in which said eccentric mass comprises a handle portion for manual movement of said second rotatable member.

5. In a chain saw, a chain brake according to claim 4, in which said second rotatable member is movable in one direction to move said operating means from brake applying to brake releasing position and is movable in the opposite direction to cause movement of said operating means from brake releasing position to brake applying position.

6. In a chain saw, a chain brake according to claim 1, comprising means for manually rotating said second rotatable member in one direction to move said first mentioned rotatable member to brake releasing position and in the opposite direction for movement of said first mentioned rotatable member to brake applying position.

7. In a chain saw, a chain brake according to claim 1, comprising means for calibrating said inertial means to determine the acceleration to which it is responsive upon sudden movement of the chain saw.

8. In a chain saw having a rotatable drum and a chain driving sprocket rotationally fixed relative to the drum, a chain brake for stopping the cutting chain of the chain saw quickly, comprising a flexible brake band wrapped more than one turn around said drum in a helical coil, means anchoring one end of said brake band, said brake band extending around said drum from said anhcoring means in the direction of rotation of the drum, operating means acting on the other end of said brake band alternatively to expand and to contract said helical coil of said brake band, said operating means being movable between a brake releasing condition in which the helical coil of said brake band is expanded so that the drum is free of said brake band and a brake applying condition in which the helical coil of said brake band is contracted to grip and thereby apply a braking action to said drum, inertial means operatively associated with and controlling said operating means, said inertial means being responsive to predetermined acceleration of the chain saw to cause movement of said operating means from brake releasing condition to brake applying condition and thereby apply a braking

action to the drum, spring means acting between said inertial means and said operating means to retain said inertial means and operating means in brake releasing condition, to restore said inertial means and operating means to brake releasing condition in the event of movement from brake releasing condition by an acceleration of the chain saw less than said predetermined acceleration, and to retain said inertial means and operating means in brake-applying condition when moved thereto, and means for manually actuating said inertial means to move said operating means from brake applying condition to brake releasing condition, an initial portion of such movement being against the bias of said spring means and a further portion of such movement being assisted by said spring means.

9. In a chain saw, a chain brake according to claim 8, in which said operating means comprises a first rotatable member and said inertial means comprises a second rotatable member and a mass fixed relative to said rotatable member and disposed eccentrically thereof so as to be responsive to acceleration to rotate said second rotatable member upon said predetermined acceleration of the chain saw, said spring means comprising a spring action between said first and second rotatable members.

10. In a chain saw, a chain brake according to claim 9, in which said eccentric mass comprises handle means for manually rotating said rotatable member to move said operating means to brake released condition.

11. In a chain saw, a chain brake according to claim 8, in which the operative association between said inertial means and said operating means comprises integrating means responsive to the direction, magnitude and duration of forces acting on said inertial means, to cause movement of said operating means from brake releasing position to brake applying position only when said forces are of predetermined direction, magnitude and duration.

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