US 20060123960A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2006/0123960 A1**

Gass et al. (43) **Pub. Date: Jun. 15, 2006**

(54) **SAFETY SYSTEMS FOR POWER EQUIPMENT**

(76) Inventors: **Stephen F. Gass**, Wilsonville, OR (US); **David A. Fanning**, Vancouver, WA (US); **J. David Fulmer**, Tualatin, OR (US); **David S. D'Ascenzo**, Portland, OR (US); **Jonathan N. Betts-LaCroix**, Chatsworth, CA (US); **Robert L. Chamberlain**, Raleigh, NC (US); **Joel F. Jensen**, Redwood City, CA (US); **Andrew L. Johnston**, Redwood City, CA (US); **Sung H. Kim**, Palo Alto, CA (US); **Anwyl M. McDonald**, Palo Alto, CA (US); **Benjamin B. Schramm**, Los Gatos, CA (US)

Correspondence Address:
SD3, LLC
25977 S.W. Canyon Creek Road, Suite G
WILSONVILLE, OR 97070 (US)

(21) Appl. No.: **11/353,423**

(22) Filed: **Feb. 13, 2006**

Related U.S. Application Data

(63) Continuation of application No. 10/785,361, filed on Feb. 23, 2004, now Pat. No. 6,997,090, which is a continuation of application No. 10/215,929, filed on Aug. 9, 2002, now abandoned.

(60) Provisional application No. 60/312,141, filed on Aug. 13, 2001.

Publication Classification

(51) **Int. Cl.**

B26D 1/00	(2006.01)
B27B 13/00	(2006.01)
B27B 27/04	(2006.01)

(52) **U.S. Cl.** **83/13**; 83/62.1; 83/477.2

(57) **ABSTRACT**

A saw with a safety system is disclosed. The safety system includes a detection system adapted to detect contact between a person and a blade while the blade is moving. The safety system further includes a brake system adapted to engage the blade and to stop the blade when the detection system detects contact between the person and the blade.

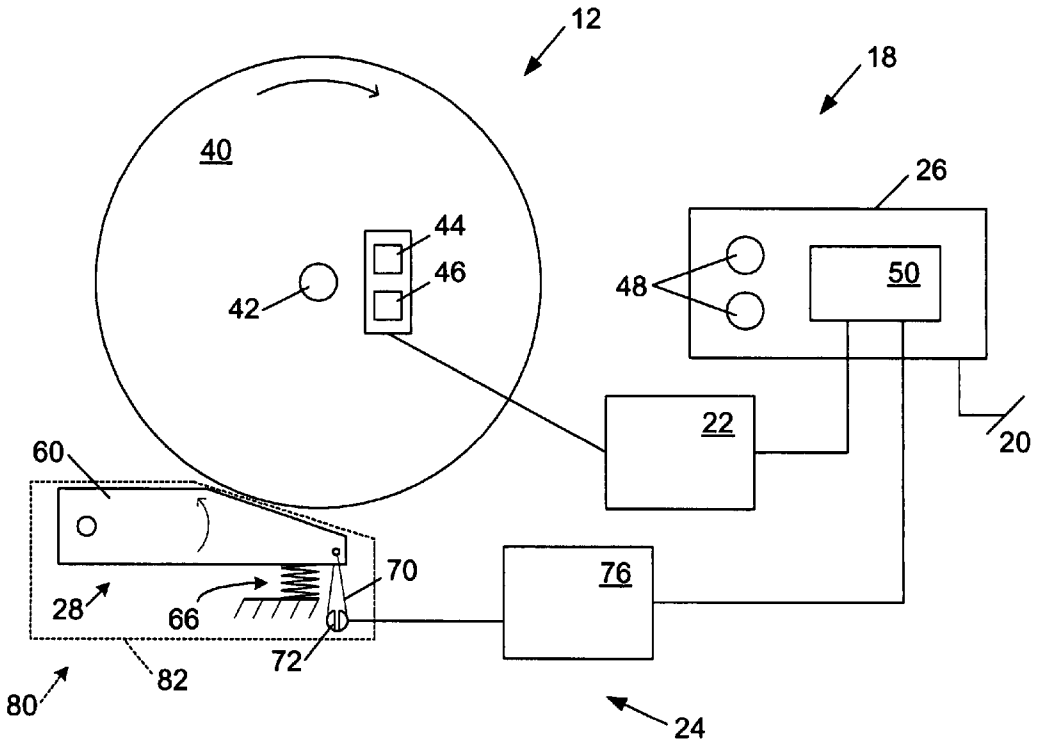
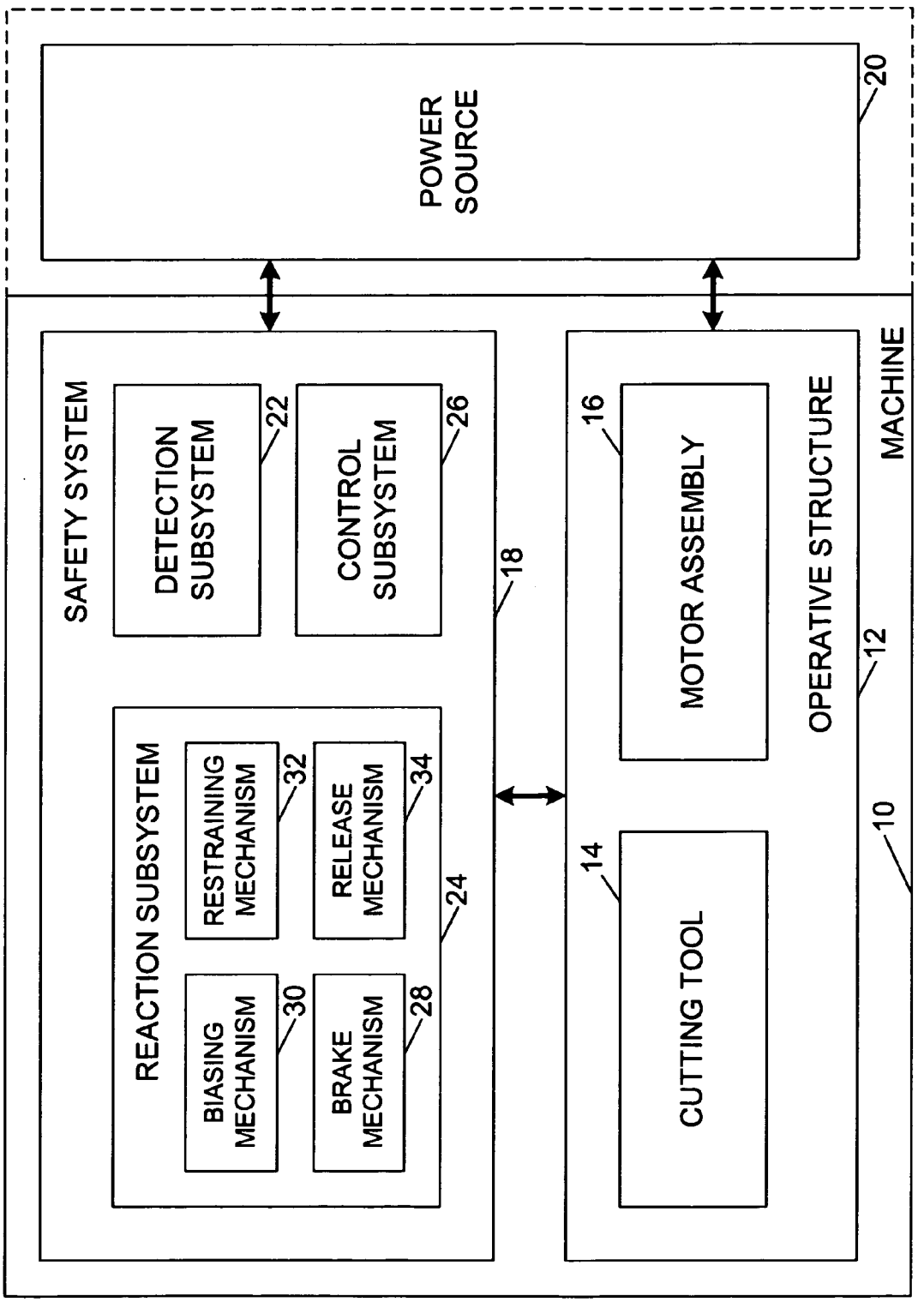


Fig. 1


POWER SOURCE
20
MACHINE
10
SAFETY SYSTEM
DETECTION SUBSYSTEM
22
CONTROL SUBSYSTEM
26
18
REACTION SUBSYSTEM
RESTRAINING MECHANISM
32
RELEASE MECHANISM
34
BIASING MECHANISM
30
BRAKE MECHANISM
28
24
OPERATIVE STRUCTURE
12
MOTOR ASSEMBLY
16
CUTTING TOOL
14

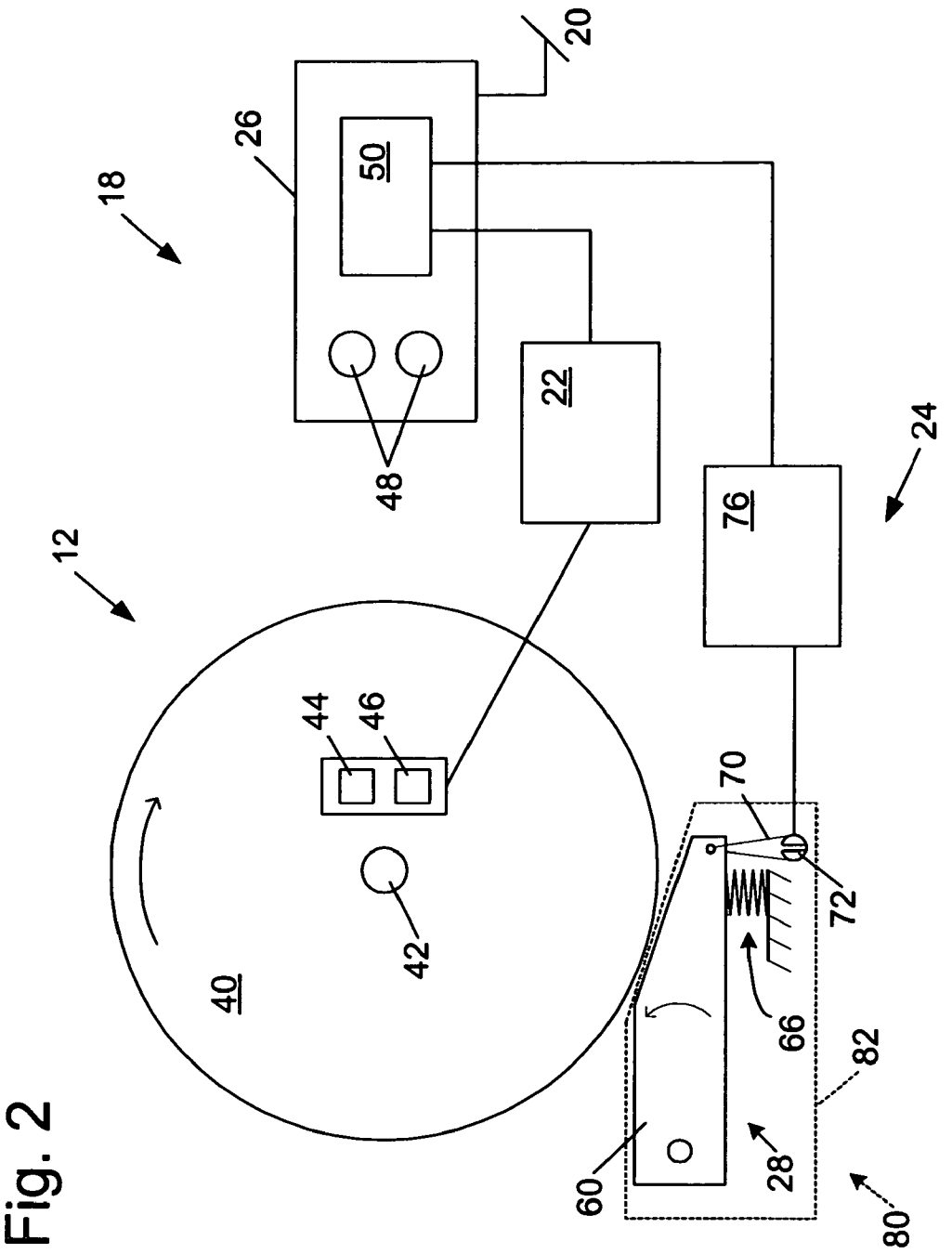


Fig. 2

SAFETY SYSTEMS FOR POWER EQUIPMENT

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation of U.S. patent application Ser. No. 10/785,361, issuing as U.S. Pat. No. 6,997,090 on Feb. 14, 2006, which is a continuation of U.S. patent application Ser. No. 10/215,929, filed Aug. 9, 2002, which claimed the benefit of and priority from U.S. Provisional Patent Application Ser. No. 60/312,141, filed Aug. 13, 2001. All of the above applications are hereby incorporated by reference in their entirety for all purposes.

BACKGROUND

[0002] Beginning with the industrial revolution and continuing to the present, mechanized equipment has allowed workers to produce goods with greater speed and less effort than possible with manually-powered tools. Unfortunately, the power and high operating speeds of mechanized equipment creates a risk for those operating such machinery. Each year thousands of people are maimed or killed by accidents involving power equipment.

[0003] As might be expected, many systems have been developed to minimize the risk of injury when using power equipment. Probably the most common safety feature is a guard that physically blocks an operator from making contact with dangerous components of machinery, such as belts, shafts or blades. In many cases, guards are effective to reduce the risk of injury, however, there are many instances where the nature of the operations to be performed precludes using a guard that completely blocks access to hazardous machine parts.

[0004] Various systems have been proposed to prevent accidental injury where guards cannot effectively be employed. For instance, U.S. Pat. Nos. 941,726, 2,978,084, 3,011,610, 3,047,116, 4,195,722 and 4,321,841, the disclosures of which are incorporated herein by reference, all disclose safety systems for use with power presses. These systems utilize cables attached to the wrists of the operator that either pull back a user's hands from the work zone upon operation or prevent operation until the user's hands are outside the danger zone. U.S. Pat. Nos. 3,953,770, 4,075,961, 4,470,046, 4,532,501 and 5,212,621, the disclosures of which are incorporated herein by reference, disclose radio-frequency safety systems which utilize radio-frequency signals to detect the presence of a user's hand in a dangerous area of the machine and thereupon prevent or interrupt operation of the machine.

[0005] U.S. Pat. Nos. 4,959,909, 5,025,175, 5,122,091, 5,198,702, 5,201,684, 5,272,946, and 5,510,685 disclose safety systems for use with meat-skinning equipment, and are incorporated herein by reference. These systems interrupt or reverse power to the motor, or disengage a clutch, upon contact with a user's hand by any dangerous portion of the machine. Typically, contact between the user and the machine is detected by monitoring for electrical contact between a fine wire mesh in a glove worn by the user and some metal component in the dangerous area of the machine. Although such systems are suitable for use with meat skinning machines, they are relatively slow to stop the motion of the cutting element because they rely on the operation of solenoids or must overcome the inertia of the motor. However, because these systems operate at relatively low speeds, the blade does not need to be stopped rapidly to prevent serious injury to the user.

[0006] U.S. Pat. Nos. 3,785,230 and 4,026,177, the disclosures of which are herein incorporated by reference, disclose a safety system for use on circular saws to stop the blade when a user's hand approaches the blade. The system uses the blade as an antenna in an electromagnetic proximity detector to detect the approach of a user's hand prior to actual contact with the blade. Upon detection of a user's hand, the system engages a brake using a standard solenoid. Unfortunately, such a system is prone to false triggers and is relatively slow acting because of the solenoid. U.S. Pat. No. 4,117,752, which is herein incorporated by reference, discloses a similar braking system for use with a band saw, where the brake is triggered by actual contact between the user's hand and the blade. However, the system described for detecting blade contact does not appear to be functional to accurately and reliably detect contact. Furthermore, the system relies on standard electromagnetic brakes operating off of line voltage to stop the blade and pulleys of the band saw. It is believed that such brakes would take 50 ms-1 s to stop the blade. Therefore, the system is too slow to stop the blade quickly enough to avoid serious injury.

[0007] None of these existing systems have operated with sufficient speed and/or reliability to prevent serious injury with many types of commonly used power tools. Although proximity-type sensors can be used with some equipment to increase the time available to stop the moving pieces, in many cases the user's hands must be brought into relatively close proximity to the cutting element in the normal course of operation. For example, many types of woodworking equipment require that the user's hands pass relatively close to the cutting tools. As a result, existing proximity-type sensors, which are relatively imprecise, have not proven effective with this type of equipment. Even where proximity sensors are practical, existing brake systems have not operated quickly enough to prevent serious injury in many cases.

[0008] In equipment where proximity-type detection have not proven effective, the cutting tool must stop very quickly in the event of user contact to avoid serious injury. By way of example, a user may feed a piece of wood through a table saw at a rate of approximately one foot per second. Assuming an average reaction time of approximately one-tenth of a second, the hand may have moved well over an inch before the user even detects the contact. This distance is more than sufficient to result in the loss of several digits, severing of vital vessels and tendons, or even complete severing of a hand. If a brake is triggered immediately upon contact with the saw's blade, the blade must be stopped within approximately one-hundredth of a second to limit the depth of injury to one-eighth of an inch. Standard solenoids or other electromagnetic devices are generally not designed to act in this time scale, particularly where significant force must be generated. For instance, in the case of solenoids or electromagnetic brakes that operate on 60 hz electrical power, it is possible that the power line will be at a phase that has low voltage at the time the brake is triggered and several milliseconds may elapse before the voltage reaches a sufficient level even to begin physical displacement of the brake, much less achieve a complete stoppage of the blade or cutting tool.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] **FIG. 1** is a schematic block diagram of a machine with a fast-acting safety system according to the present invention.

[0010] **FIG. 2** is a schematic diagram of an exemplary safety system in the context of a machine having a circular blade.

DETAILED DESCRIPTION

[0011] A machine according to the present invention is shown schematically in **FIG. 1** and indicated generally at **10**. Machine **10** may be any of a variety of different machines adapted for cutting workpieces, such as wood, including a table saw, miter saw (chop saw), radial arm saw, circular saw, band saw, jointer, planer, etc. Machine **10** includes an operative structure **12** having a cutting tool **14** and a motor assembly **16** adapted to drive the cutting tool. Machine **10** also includes a safety system **18** configured to minimize the potential of a serious injury to a person using machine **10**. Safety system **18** is adapted to detect the occurrence of one or more dangerous conditions during use of machine **10**. If such a dangerous condition is detected, safety system **18** is adapted to engage operative structure **12** to limit any injury to the user caused by the dangerous condition.

[0012] Machine **10** also includes a suitable power source **20** to provide power to operative structure **12** and safety system **18**. Power source **20** may be an external power source such as line current, or an internal power source such as a battery. Alternatively, power source **20** may include a combination of both external and internal power sources. Furthermore, power source **20** may include two or more separate power sources, each adapted to power different portions of machine **10**.

[0013] It will be appreciated that operative structure **12** may take any one of many different forms, depending on the type of machine **10**. For example, operative structure **12** may include a stationary housing configured to support motor assembly **16** in driving engagement with cutting tool **14**. Alternatively, operative structure **12** may include a movable structure configured to carry cutting tool **14** between multiple operating positions. As a further alternative, operative structure **12** may include one or more transport mechanisms adapted to convey a workpiece toward and/or away from cutting tool **14**.

[0014] Motor assembly **16** includes one or more motors adapted to drive cutting tool **14**. The motors may be either directly or indirectly coupled to the cutting tool, and may also be adapted to drive workpiece transport mechanisms. Cutting tool **14** typically includes one or more blades or other suitable cutting implements that are adapted to cut or remove portions from the workpieces. The particular form of cutting tool **14** will vary depending upon the various embodiments of machine **10**. For example, in table saws, miter saws, circular saws and radial arm saws, cutting tool **14** will typically include one or more circular rotating blades having a plurality of teeth disposed along the perimetrical edge of the blade. For a jointer or planer, the cutting tool typically includes a plurality of radially spaced-apart blades. For a band saw, the cutting tool includes an elongate, circuitous tooth-edged band.

[0015] Safety system **18** includes a detection subsystem **22**, a reaction subsystem **24** and a control subsystem **26**. Control subsystem **26** may be adapted to receive inputs from a variety of sources including detection subsystem **22**, reaction subsystem **24**, operative structure **12** and motor assembly **16**. The control subsystem may also include one or more sensors adapted to monitor selected parameters of machine **10**. In addition, control subsystem **26** typically includes one or more instruments operable by a user to control the machine. The control subsystem is configured to control machine **10** in response to the inputs it receives.

[0016] Detection subsystem **22** is configured to detect one or more dangerous, or triggering, conditions during use of machine **10**. For example, the detection subsystem may be configured to detect that a portion of the user's body is dangerously close to, or in contact with, a portion of cutting tool **14**. As another example, the detection subsystem may be configured to detect the rapid movement of a workpiece due to kickback by the cutting tool, such as is described in U.S. Provisional Patent Application Ser. No. 60/182,866, filed Feb. 16, 2000, and U.S. Pat. No. 4,267,914, the disclosures of which are herein incorporated by reference. In some embodiments, detection subsystem **22** may inform control subsystem **26** of the dangerous condition, which then activates reaction subsystem **24**. In other embodiments, the detection subsystem may be adapted to activate the reaction subsystem directly.

[0017] Once activated in response to a dangerous condition, reaction subsystem **24** is configured to engage operative structure **12** quickly to prevent serious injury to the user. It will be appreciated that the particular action to be taken by reaction subsystem **24** will vary depending on the type of machine **10** and/or the dangerous condition that is detected. For example, reaction subsystem **24** may be configured to do one or more of the following: stop the movement of cutting tool **14**, disconnect motor assembly **16** from power source **20**, place a barrier between the cutting tool and the user, or retract the cutting tool from its operating position, etc. The reaction subsystem may be configured to take a combination of steps to protect the user from serious injury. Placement of a barrier between the cutting tool and teeth is described in more detail in U.S. Provisional Patent Application Ser. No. 60/225,206, filed Aug. 14, 2000, entitled "Cutting Tool Safety System," the disclosure of which is herein incorporated by reference. Retraction of the cutting tool from its operating position and/or the stopping of translational motion of the cutting tool are described in more detail in the following U.S. Provisional Patent Applications, all the disclosures of which are herein incorporated by reference: Ser. No. 60/225,089, filed Aug. 14, 2000, entitled "Retraction System For Use In Power Equipment," Ser. No. 60/270,941, filed Feb. 22, 2001, entitled "Power Saw with Improved Safety System," Ser. No. 60/270,942, filed Feb. 22, 2001, entitled "Miter Saw with Improved Safety System," Ser. No. 60/273,177, filed Mar. 2, 2001, entitled "Table Saw With Improved Safety System," Ser. No. 60/273,178, filed Mar. 2, 2001, entitled "Miter Saw with Improved Safety System," Ser. No. 60/273,902, filed Mar. 6, 2001, entitled "Miter Saw with Improved Safety System," Ser. No. 60/275,594, filed Mar. 13, 2001, entitled "Miter Saw with Improved Safety System," Ser. No. 60/275,595, filed Mar. 13, 2001, entitled "Safety Systems for Power Equipment," Ser. No. 60/279,313, filed Mar. 27, 2001, entitled "Miter Saw with Improved

Safety System," and Ser. No. 60/292,081, filed May 17, 2001, entitled "Translation Stop for Use in Power Equipment."

[0018] The configuration of reaction subsystem **24** typically will vary depending on which action(s) are taken. In the exemplary embodiment depicted in **FIG. 1**, reaction subsystem **24** is configured to stop the movement of cutting tool **14** and includes a brake mechanism **28**, a biasing mechanism **30**, a restraining mechanism **32**, and a release mechanism **34**. Brake mechanism **28** is adapted to engage operative structure **12** under the urging of biasing mechanism **30**. During normal operation of machine **10**, restraining mechanism **32** holds the brake mechanism out of engagement with the operative structure. However, upon receipt of an activation signal by reaction subsystem **24**, the brake mechanism is released from the restraining mechanism by release mechanism **34**, whereupon, the brake mechanism quickly engages at least a portion of the operative structure to bring the cutting tool to a stop.

[0019] It will be appreciated by those of skill in the art that the exemplary embodiment depicted in **FIG. 1** and described above may be implemented in a variety of ways depending on the type and configuration of operative structure **12**. Turning attention to **FIG. 2**, one example of the many possible implementations of safety system **18** is shown. System **18** is configured to engage an operative structure having a cutting tool in the form of a circular blade **40** mounted on a rotating shaft or arbor **42**. Blade **40** includes a plurality of cutting teeth (not shown) disposed around the outer edge of the blade. As described in more detail below, braking mechanism **28** is adapted to engage the teeth of blade **40** and stop the rotation of the blade. U.S. Provisional Patent Application Ser. No. 60/225,210, filed Aug. 14, 2000, entitled "Translation Stop For Use In Power Equipment," and U.S. Provisional Patent Application Ser. No. 60/233,459, filed Sep. 18, 2000, entitled "Translation Stop For Use In Power Equipment," the disclosures of which are herein incorporated by reference, describe other systems for stopping the movement of the cutting tool. Although the embodiment depicted in **FIGS. 1 and 2** schematically illustrate machine **10** as a generic woodworking machine, it will be appreciated that safety system **18** may be incorporated into virtually any specific type of woodworking machine. For example, the following U.S. Provisional Patent Applications, the disclosures of which are herein incorporated by reference, describe safety system **18** in the context of various specific types of machines such as table saws, miter saws, radial arm saws, band saws, pneumatic up-cut saws, routers, etc.: U.S. Provisional Patent Application Ser. No. 60/225,058, filed Aug. 14, 2000, entitled "Table Saw With Improved Safety System," U.S. Provisional Patent Application Ser. No. 60/225,057, filed Aug. 14, 2000, entitled "Miter Saw With Improved Safety System," U.S. Provisional Patent Application Ser. No. 60/233,459, filed Sep. 18, 2000, entitled "Translation Stop For Use In Power Equipment," U.S. Provisional Patent Application Ser. No. 60/270,941, filed Feb. 22, 2001, entitled "Power Saw With Improved Safety System," U.S. Provisional Patent Application Ser. No. 60/270,942, filed Feb. 22, 2001, entitled "Miter Saw With Improved Safety System," U.S. Provisional Patent Application Ser. No. 60/273,177, filed Mar. 2, 2001, entitled "Fable Saw With Improved Safety System," U.S. Provisional Patent Application Ser. No. 60/273,178, filed Mar. 2, 2001, entitled "Miter Saw With Improved Safety System," U.S. Provisional Patent Application Ser. No. 60/273,902, filed Mar. 6, 2001, entitled "Miter Saw With Improved Safety System," U.S. Provisional Patent Application Ser. No. 60/275,594, filed Mar. 13, 2001, entitled "Miter Saw With Improved Safety System," U.S. Provisional Patent Application Ser. No. 60/275,595, filed Mar. 13, 2001, entitled "Safety Systems For Power Equipment," U.S. Provisional Patent Application Ser. No. 60/279,313, filed Mar. 27, 2001, entitled "Miter Saw With Improved Safety System," U.S. Provisional Patent Application Ser. No. 60/292,081, filed May 17, 2001, entitled "Translation Stop For Use In Power Equipment," U.S. Provisional Patent Application Ser. No. 60/292,100, filed May 17, 2001, entitled "Band Saw with Improved Safety System," U.S. Provisional Patent Application Ser. No. 60/298,207, filed Jun. 13, 2001, entitled "Apparatus And Method For Detecting Dangerous Conditions In Power Equipment," and U.S. Provisional Patent Application Ser. No. 60/306,202, filed Jul. 18, 2001, entitled "Router With Improved Safety System."

[0020] In the exemplary implementation, detection subsystem **22** is adapted to detect the dangerous condition of the user coming into contact with blade **40**. The detection subsystem includes a sensor assembly, such as contact detection plates **44** and **46**, configured to detect any contact between the user's body and the blade. The detection subsystem is adapted to transmit a signal to control subsystem **26** when contact between the user and the blade is detected. Various exemplary embodiments and implementations of detection subsystem **22** are described in more detail in U.S. Provisional Patent Application Ser. No. 60/225,200, filed Aug. 14, 2000, entitled "Contact Detection System For Power Equipment," U.S. Provisional Patent Application Ser. No. 60/225,211, filed Aug. 14, 2000, entitled "Apparatus And Method For Detecting Dangerous Conditions In Power Equipment," U.S. Provisional Patent Application Ser. No. 60/270,011, filed Feb. 20, 2001, entitled "Contact Detection System for Power Equipment," U.S. Provisional Patent Application Ser. No. 60/292,100, filed May 17, 2001, entitled "Band Saw With Improved Safety System," U.S. Provisional Patent Application Ser. No. 60/298,207, filed Jun. 13, 2001, entitled "Apparatus And Method For Detecting Dangerous Conditions In Power Equipment," and U.S. Provisional Patent Application Ser. No. 60/302,937, filed Jul. 2, 2001, entitled "Discrete Proximity Detection System," the disclosures of which are herein incorporated by reference.

[0021] Control subsystem **26** includes one or more instruments **48** that are operable by a user to control the motion of blade **40**. Instruments **48** may include start/stop switches, speed controls, direction controls, etc. Control subsystem **26** also includes a logic controller **50** connected to receive the user's inputs via instruments **48**. Logic controller **50** is also connected to receive a contact detection signal from detection subsystem **22**. Further, the logic controller may be configured to receive inputs from other sources (not shown) such as blade motion sensors, workpiece sensors, etc. In any event, the logic controller is configured to control operative structure **12** in response to the user's inputs through instruments **48**. However, upon receipt of a contact detection signal from detection subsystem **22**, the logic controller overrides the control inputs from the user and activates reaction subsystem **24** to stop the motion of the blade. Various exemplary embodiments and implementations of control subsystem **26** are described in more detail in U.S.

Provisional Patent Application Ser. No. 60/225,059, filed Aug. 14, 2000, entitled "Logic Control For Fast Acting Safety System," and U.S. Provisional Patent Application Ser. No. 60/225,094, filed Aug. 14, 2000, entitled "Motion Detecting System For Use In Safety System For Power Equipment," the disclosures of which are herein incorporated by reference.

[0022] In the exemplary implementation, brake mechanism **28** includes a pawl **60** mounted adjacent the edge of blade **40** and selectively moveable to engage and grip the teeth of the blade. Pawl **60** may be constructed of any suitable material adapted to engage and stop the blade. As one example, the pawl may be constructed of a relatively high strength thermoplastic material such as polycarbonate, ultrahigh molecular weight polyethylene (UHMW) or Acrylonitrile Butadiene Styrene (ABS), etc., or a metal such as aluminum, etc. It will be appreciated that the construction of pawl **60** will vary depending on the configuration of blade **40**. In any event, the pawl is urged into the blade by a biasing mechanism in the form of a spring **66**. In the illustrative embodiment shown in **FIG. 2**, pawl **60** is pivoted into the teeth of blade **40**. It should be understood that sliding or rotary movement of pawl **60** may also be used. The spring is adapted to urge pawl **60** into the teeth of the blade with sufficient force to grip the blade and quickly bring it to a stop.

[0023] The pawl is held away from the edge of the blade by a restraining mechanism in the form of a fusible member **70**. The fusible member is constructed of a suitable material adapted to restrain the pawl against the bias of spring **66**, and also adapted to melt under a determined electrical current density. Examples of suitable materials for fusible member **70** include NiChrome wire, stainless steel wire, etc. The fusible member is connected between the pawl and a contact mount **72**. Preferably member **70** holds the pawl relatively close to the edge of the blade to reduce the distance the pawl must travel to engage the blade. Positioning the pawl relatively close to the edge of the blade reduces the time required for the pawl to engage and stop the blade. Typically, the pawl is held approximately 1/32-inch to 1/4-inch from the edge of the blade by fusible member **70**, however other pawl-to-blade spacings may also be used within the scope of the invention.

[0024] Pawl **60** is released from its unactuated, or cocked, position to engage blade **40** by a release mechanism in the form of a firing subsystem **76**. The firing subsystem is coupled to contact mount **72**, and is configured to melt fusible member **70** by passing a surge of electrical current through the fusible member. Firing subsystem **76** is coupled to logic controller **50** and activated by a signal from the logic controller. When the logic controller receives a contact detection signal from detection subsystem **22**, the logic controller sends an activation signal to firing subsystem **76**, which melts fusible member **70**, thereby releasing the pawl to stop the blade. Various exemplary embodiments and implementations of reaction subsystem **24** are described in more detail in U.S. Provisional Patent Application Ser. No. 60/225,056, filed Aug. 14, 2000, entitled "Firing Subsystem For Use In Fast Acting Safety System," U.S. Provisional Patent Application Ser. No. 60/225,170, filed Aug. 14, 2000, entitled "Spring-Biased Brake Mechanism for Power Equipment," and U.S. Provisional Patent Application Ser. No. 60/225,169, filed Aug. 14, 2000, entitled "Brake Mechanism For Power Equipment," U.S. Provisional Patent Application Ser. No. 60/279,313, filed Mar. 27, 2001, entitled "Miter Saw With Improved Safety System," U.S. Provisional Patent Application Ser. No. 60/292,081, filed May 17, 2001, entitled "Translation Stop For Use In Power Equipment," U.S. Provisional Patent Application Ser. No. 60/292,100, filed May 17, 2001, entitled "Band Saw With Improved Safety System," U.S. Provisional Patent Application Ser. No. 60/302,916, filed Jul. 3, 2001, entitled "Actuators For Use With Fast-Acting Safety Systems," and U.S. Provisional Patent Application Ser. No. 60/307,756, filed Jul. 25, 2001, entitled "Actuators For Use With Fast-Acting Safety Systems," the disclosures of which are herein incorporated by reference.

[0025] It will be appreciated that activation of the brake mechanism will require the replacement of one or more portions of safety system **18**. For example, pawl **60** and fusible member **70** typically must be replaced before the safety system is ready to be used again. Thus, it may be desirable to construct one or more portions of safety system **18** in a cartridge that can be easily replaced. For example, in the exemplary implementation depicted in **FIG. 2**, safety system **18** includes a replaceable cartridge **80** having a housing **82**. Pawl **60**, spring **66**, fusible member **70** and contact mount **72** are all mounted within housing **82**. Alternatively, other portions of safety system **18** may be mounted within the housing. In any event, after the reaction system has been activated, the safety system can be reset by replacing cartridge **80**. The portions of safety system **18** not mounted within the cartridge may be replaced separately or reused as appropriate. Various exemplary embodiments and implementations of a safety system using a replaceable cartridge are described in more detail in U.S. Provisional Patent Application Ser. No. 60/225,201, filed Aug. 14, 2000, entitled "Replaceable Brake Mechanism For Power Equipment," U.S. Provisional Patent Application Ser. No. 60/225,212, filed Aug. 14, 2000, entitled "Brake Positioning System," U.S. Provisional Patent Application Ser. No. 60/279,313, filed Mar. 27, 2001, entitled "Miter Saw With Improved Safety System," U.S. Provisional Patent Application Ser. No. 60/306,202, filed Jul. 18, 2001, entitled "Router With Improved Safety System," U.S. Provisional Patent Application Ser. No. 60/302,916, filed Jul. 3, 2001, entitled "Actuators For Use With Fast-Acting Safety Systems," and U.S. Provisional Patent Application Ser. No. 60/307,756, filed Jul. 25, 2001, entitled "Actuators For Use With Fast-Acting Safety Systems," the disclosures of which are herein incorporated by reference.

[0026] Additional variations and modifications of safety system **18** are described in U.S. Provisional Patent Application Ser. Nos. 60/182,866, filed Feb. 16, 2000, and 60/157,340, filed Oct. 1, 1999, both entitled "Fast-Acting Safety Stop," the disclosures of which are herein incorporated by reference.

[0027] It is believed that the disclosure set forth above encompasses multiple distinct inventions with independent utility. While each of these inventions has been disclosed in its preferred form, the specific embodiments thereof as disclosed and illustrated herein are not to be considered in a limiting sense as numerous variations are possible. The subject matter of the inventions includes all novel and non-obvious combinations and sub-combinations of the various elements, features, functions and/or properties dis-

closed herein. No single feature, function, element or property of the disclosed embodiments is essential to all of the disclosed inventions. Similarly, where the claims recite "a" or "a first" element or the equivalent thereof, such claims should be understood to include incorporation of one or more such elements, neither requiring nor excluding two or more such elements.

[0028] It is believed that the following claims particularly point out certain combinations and sub-combinations that are directed to one of the disclosed inventions and are novel and non-obvious. Inventions embodied in other combinations and sub-combinations of features, functions, elements and/or properties may be claimed through amendment of the present claims or presentation of new claims in this or a related application. Such amended or new claims, whether they are directed to a different invention or directed to the same invention, whether different, broader, narrower or equal in scope to the original claims, are also regarded as included within the subject matter of the inventions of the present disclosure.

1. A method of operating a saw comprising:

providing a blade configured to move to cut a work piece, where the blade includes a cutting edge;

providing a motor adapted to move the blade;

providing a detection system adapted to detect a dangerous condition between a person and the blade while the blade is moving and to distinguish that dangerous condition from proximity between green wood and the blade by imparting a signal to the blade and monitoring that signal for a predetermined change indicative of the dangerous condition;

providing a reaction system adapted to take some action to mitigate possible injury if the detection system detects the dangerous condition; and

moving the blade to cut a work piece while the detection and reaction systems are active.

2. The method of claim 1, where the dangerous condition is contact between a person and the blade.

3. The method of claim 1, where the dangerous condition is proximity between a person and the blade.

4. The method of claim 1, where the predetermined change indicative of the dangerous condition is a predetermined rate of change.

5. The method of claim 1, where the reaction system includes a retraction mechanism to retract the blade.

6. The method of claim 1, where the reaction system includes a brake to decelerate the blade.

7. The method of claim 6, where the brake includes a pawl and a system to move the pawl into contact with the blade.

8. The method of claim 7, where the system to move the pawl into contact with the blade causes the pawl to contact the blade within **10** milliseconds after the detection system detects the dangerous condition.

9. The method of claim 1, where the saw is a table saw.

10. The method of claim 1, where the saw is a miter saw.

11. The method of claim 1, where the saw is a hand-held circular saw.

12. A method of operating a saw comprising:

providing a blade configured to move to cut a work piece, where the blade includes a cutting edge;

providing a motor adapted to move the blade;

providing a detection system adapted to detect a dangerous condition between a person and the blade while the blade is moving and to distinguish that dangerous condition from contact between green wood and the blade by imparting a signal to the blade and monitoring that signal for a predetermined change indicative of the dangerous condition;

providing a reaction system adapted to take some action to mitigate possible injury if the detection system detects the dangerous condition; and

moving the blade to cut a work piece while the detection and reaction systems are active.

13. The method of claim 12, where the dangerous condition is contact between a person and the blade.

14. The method of claim 12, where the dangerous condition is proximity between a person and the blade.

15. The method of claim 12, where the predetermined change indicative of the dangerous condition is a predetermined rate of change.

16. The method of claim 12, where the reaction system includes a retraction mechanism to retract the blade.

17. The method of claim 12, where the reaction system includes a brake to decelerate the blade.

18. The method of claim 12, where the saw is a table saw.

19. The method of claim 12, where the saw is a miter saw.

20. The method of claim 12, where the saw is a hand-held circular saw.

* * * * *