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(56) Documents Cited:  
**WO 2009/050316 A** **FR 002844623 A**  
**JP 050112977 A** **US 7298258 A**  
**US 20080018472 A** **US 20070205861 A**

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INT CL **F16P, G06K**  
Other: **Online: WPI & EPODOC**

(54) Title of the Invention: **A safety system for a machine, particularly an earth excavation vehicle or the like**  
Abstract Title: **Safety system having detectors to detect any transponders within a detection zone, and restrict an apparatus in response to detection of a transponder**

(57) A machine having a system configured to control operations of tools (such as shovel 11) and/or locomotion functions of the machine; at least one detector 10, such as an RF transmitter/receiver, mounted to the machine, the detector 10 being in communication with the control system. At least one transponder, such as a passive RF/UHF transmitter is carried by a person or by a vehicle (other than said machine), preferably the transponder 14 is mounted in or on a protective helmet 12 to be worn by each person on site. The detector(s) 10 detect the presence of any transponder 14 within a predetermined detection zone of the said detector (e.g. 3 metres) and upon detecting, signal the control system to cause a restriction (e.g. disablement) of the operation of the tool or to the locomotion functions of the machine.

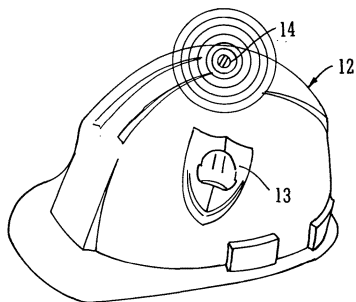


FIG. 1

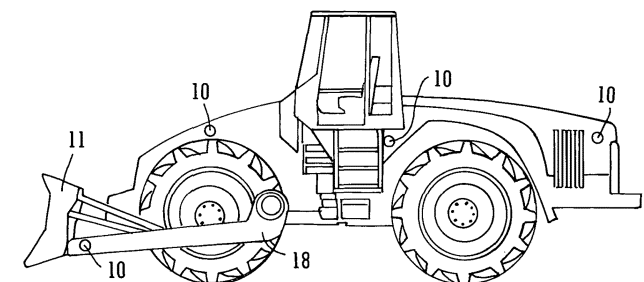


FIG. 2

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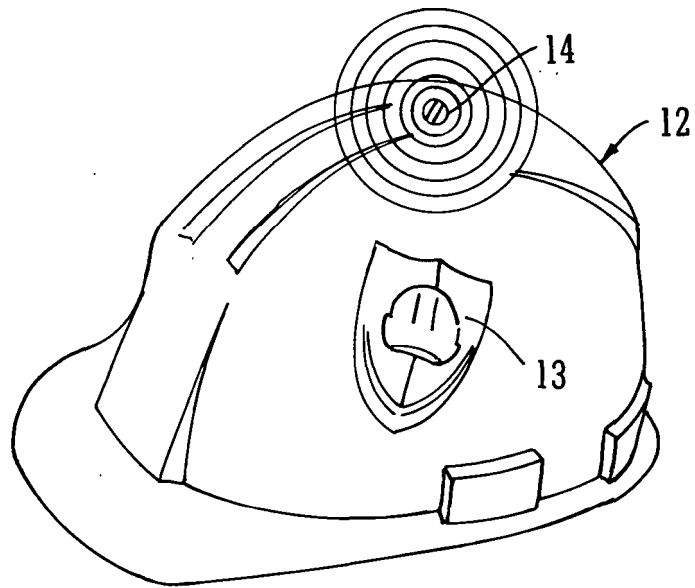


FIG. 1

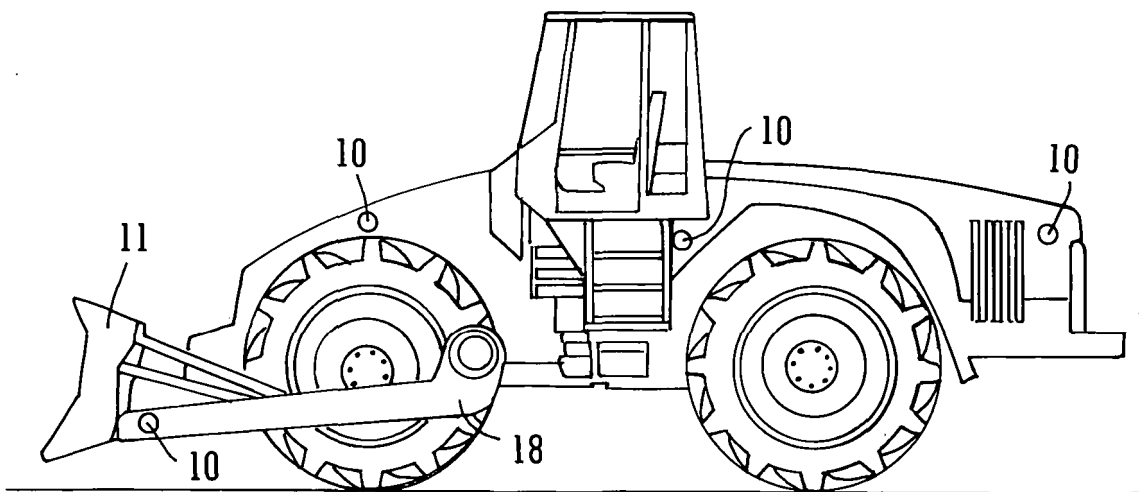


FIG. 2



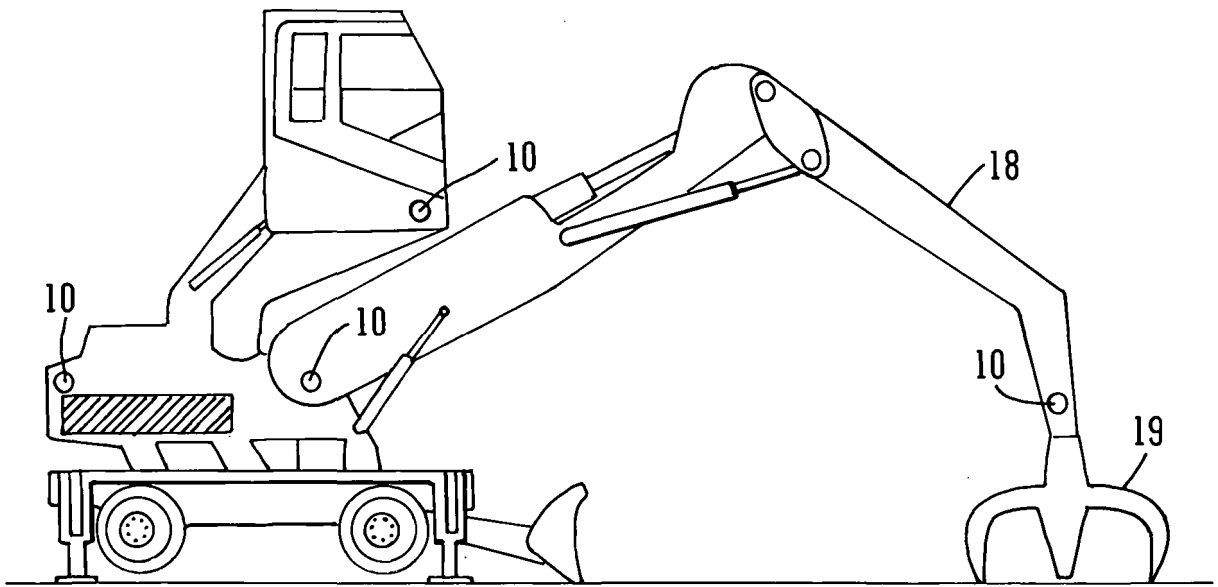


FIG. 3

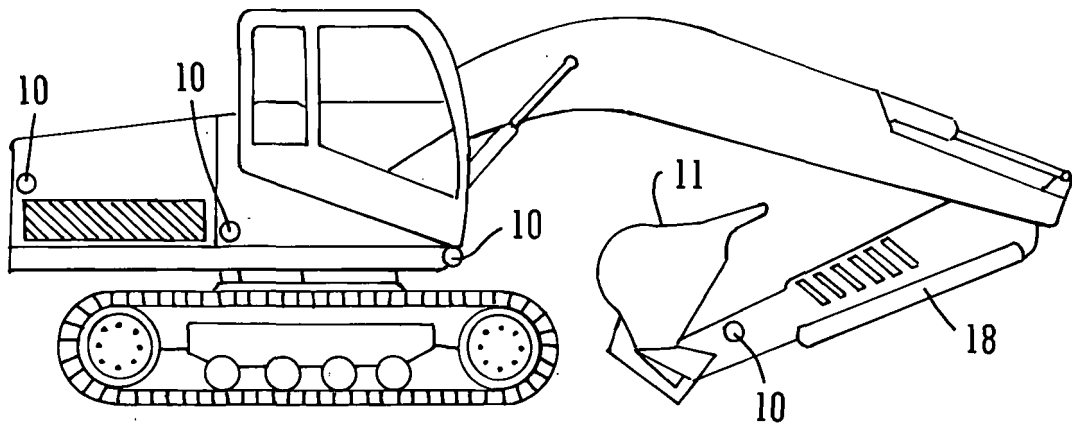


FIG. 4

20 5 12

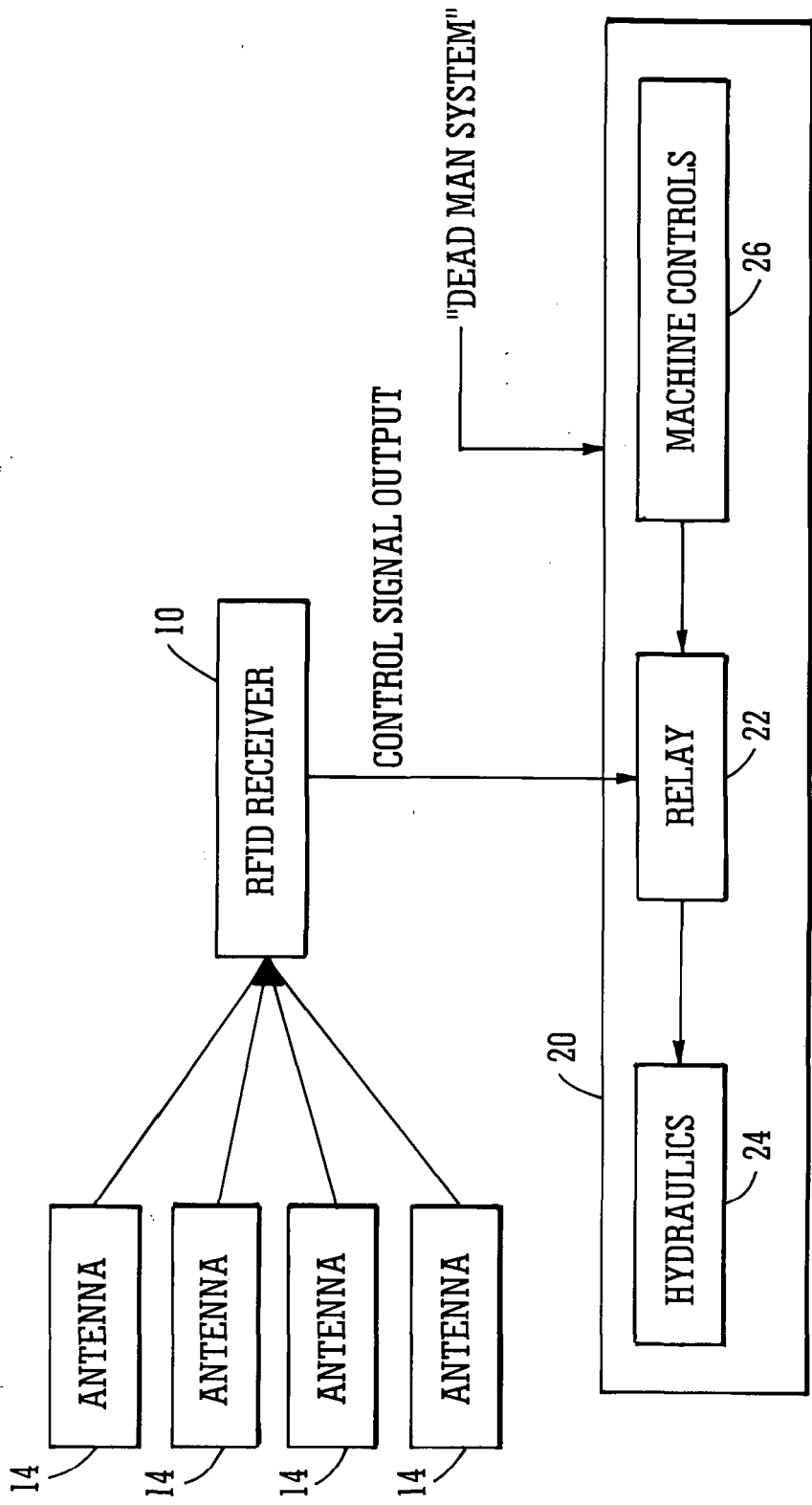


FIG. 5

39 5 12

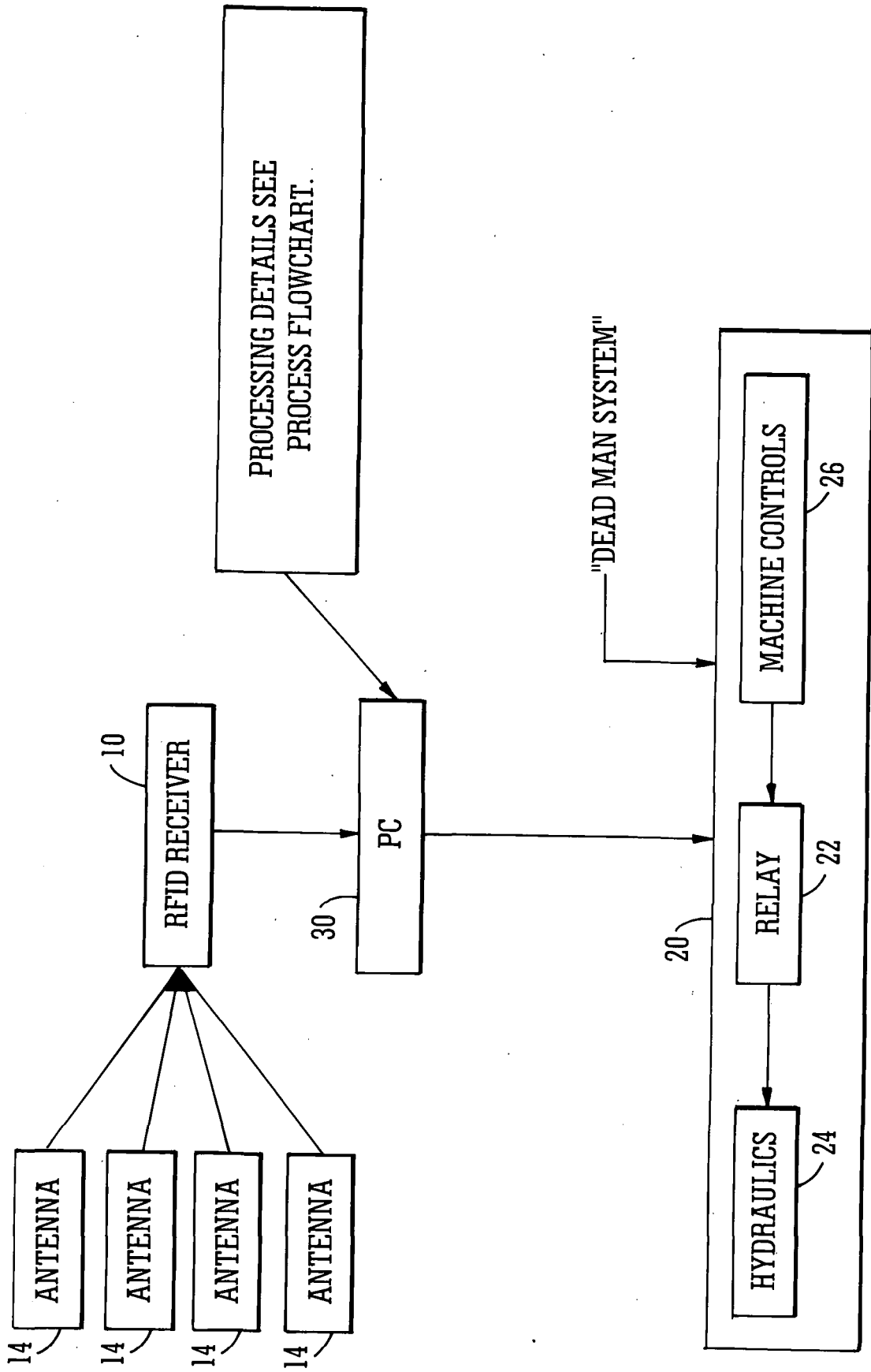


FIG. 6

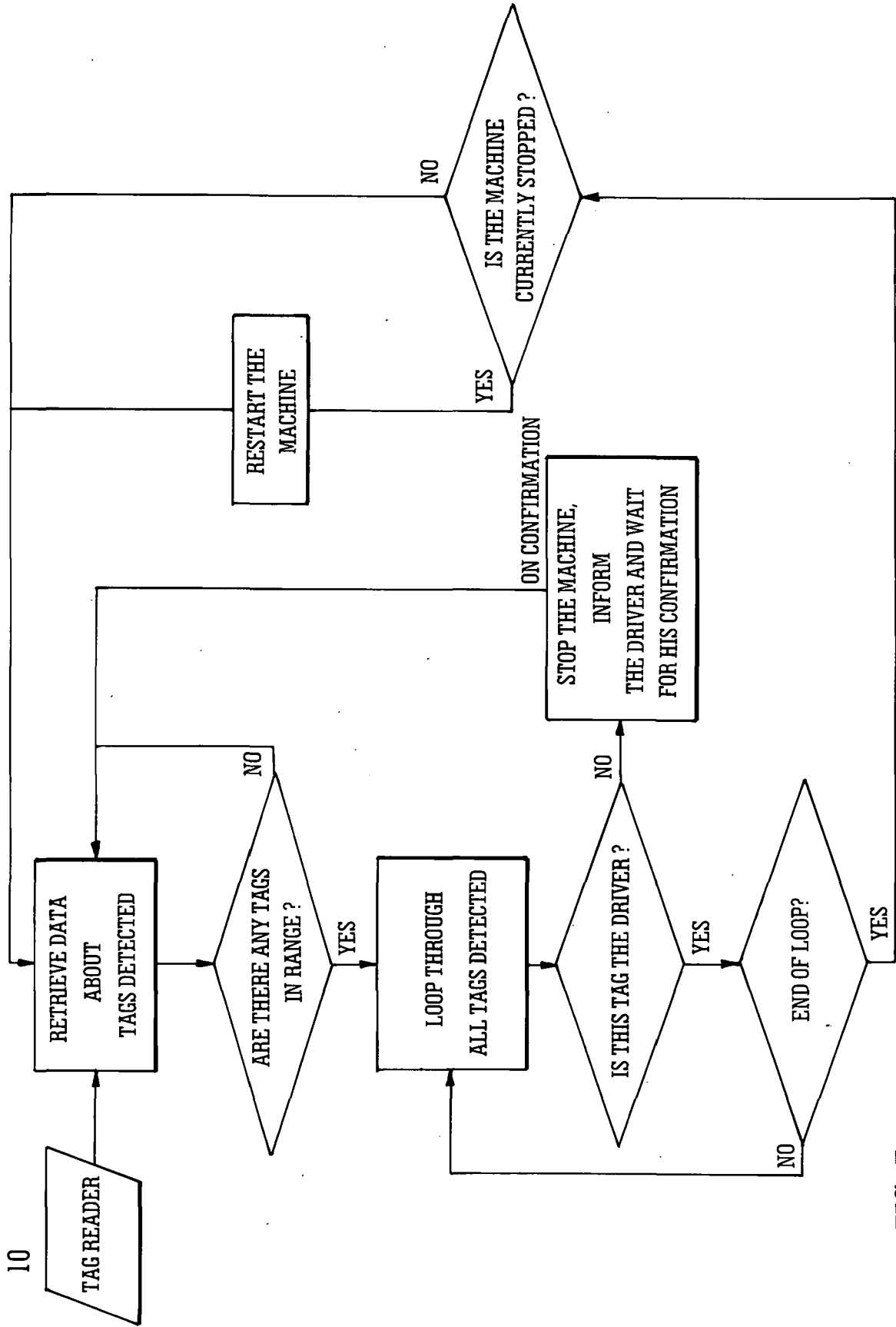


FIG. 7

**A safety system for a machine, particularly an earth excavation vehicle or the like**

**[0001]** This invention relates to a safety system for plant and vehicles for the protection of site operatives and visitors. It is particularly applicable in respect of vehicles used on demolition and construction sites and fitted with any one or more movable tools for breaking, loosening, digging, compacting, and transporting earth. However, it may also find use in relation to vehicles, such as forklift trucks and small cranes, used for lifting, manipulating and/or transporting materials and objects. Thus, it may also find application in the warehouse environment. It may also find use in relation to stationary machines fitted with moving tools or tool components.

**10 BACKGROUND**

**[0002]** Despite current safety measures, procedures and rules, several thousand people per year are killed in workplace accidents, and the majority of these concern interaction with vehicles. Thus, people may be struck or run over by moving vehicles, or be struck by objects falling from vehicles. Moreover, people may be struck by, and killed or injured by movable tools mounted to demolition/construction site vehicles, particularly where these are mounted upon swingable or pivotable arms.

**[0003]** In order to prevent some accidents most construction site and warehouse machinery are provided with a so-called "dead man" disablement system. Such machinery has a central electronic management system configured and programmed to control operation of the tools when operated by an authorised operator. Thus a defined operation sequence is typically required. Additionally, in order to prevent inadvertent operation or inadvertent movement (locomotion) of the vehicle itself when the operator is climbing in or dismounting, a "dead man" is provided, typically a lever which extends in the path of entry to the vehicle operator seat and which is operatively linked to the central management system. Whenever this lever is raised, or lowered, to allow the operator to climb in or dismount, the central management system is triggered to disable operation of tools and vehicle locomotion. Only when the lever is in its predetermined position, as sensed by or signalled to the central management system, and the machine is otherwise switched on can vehicle be operated.

**[0004]** In a similar manner, a central electronic management system of a heavy goods vehicle may prevent a tractor unit from driving away if a trailer is to be towed and the coupling and locking means for the coupling are not detected as being secured.

**[0005]** An object of the present invention is to provide means to disable operation of the machine, namely of the machine tools and/or locomotion of the machine itself, when ever personnel approach too closely for safety. Thus, to provide means to avoid human errors

and/or failure to obey existing regulations concerning avoidance of approach to operating vehicles/site machinery.

### **BRIEF SUMMARY OF THE DISCLOSURE**

5 **[0006]** In accordance with the present inventions there is provided a safety system for a machine having a central electronic management system configured to control operation of tools and/or locomotion functions of the machine, the system comprising at least one detector mounted to the machine or to a tool carried by the machine and in operative communication with the central management system, at least one transponder carried by a person or by a vehicle (other than the machine), the or each detector being adapted to  
10 detect the presence of the or any one of the transponders within a predetermined detection zone of the said detector, and upon detecting same to signal such detection to the central management system, which upon receipt of such signal, causes a restriction to the operation of the tool or to the locomotion functions of the machine.

15 **[0007]** The invention can be implemented by adaptation of currently known proximity badge reader technology. Thus in preferred embodiments of the present invention the or each detector is a radio frequency identification (RFID) reader device mounted to a predetermined location on the exterior of the machine or a tool mounted to the machine and operatively linked to the central management system of the machine, and specifically linked to cause operation of the safety cut off circuitry when the presence of a "badge" is  
20 detected within the predetermined detection zone. Each "badge" in such embodiments is preferably an ultrahigh frequency (UHF) passive tag, namely incorporating a UHF radio transmitter which does not require any separate battery power source, but incorporates an integrated circuit which generates sufficient capability to transmit upon receipt of a signal from an associated transmitting Reader device.

25 **[0008]** Although it would be possible for each authorised person on site to carry, as a separate item, as a designated transponder of the system, a respective badge (hereinafter referred to as "a tag") detectable by the reader, it is preferred that such a tag is mounted in or on a protective helmet, as it is already a well established regulation that every person on site must wear such a helmet. This ensures that at the same time every person on site will  
30 be carrying a relevant tag, thus obviating possible human error in omitting to carry a separate tag.

**[0009]** However, since accidents may also arise from vehicle to vehicle collisions, other embodiments of the safety system of the invention involve mounting the relevant tag directly onto another vehicle which is operated on the same site.



**[0010]** In a development of the system of the invention, the predetermined detection zone in which the detector detects the presence of the or any one of the transponders to effect disablement of operation of the machine, which will typically be an area extending about 3 m from the detector, is supplemented by a second, larger predetermined detection zone, probably extending for up to in the region of 10 m from the detector, at which the detector detects the presence of the or any one of the transponders and causes actuation of an audible and/or visual alarm in the operator cab of the machine. This simply informs the operator and allows him to proceed with caution, and makes him aware that operation may be about to be disabled in the event that closer approach by the relevant person subsequently triggers the disablement signal.

### **[0011] BRIEF DESCRIPTION OF THE DRAWINGS**

Embodiments of the invention are now described with reference to the accompanying drawings, in which:

Figure 1 is a perspective view of a protective helmet provided with a tag as used in preferred embodiments of the present invention;

Figure 2 is a schematic side view of a first earthmoving vehicle fitted with detectors in accordance with the system of the present invention;

Figure 3 is a similar schematic side view of a second vehicle, as used in excavations, fitted with detectors in accordance with the system of the present invention;

Figure 4 is a similar schematic side view of a third excavation vehicle fitted with detectors in accordance with the system of the present invention;

Figure 5 is a diagram of a first exemplary system in accordance with the present invention;

Figure 6 is a diagram of a second exemplary system in accordance with the present invention; and

Figure 7 is a flow chart showing processing steps in an exemplary system in accordance with the present invention.

### **DETAILED DESCRIPTION**

**[0012]** Firstly, figures 2, 3 and 4 depict three types of conventional heavy vehicles frequently used on demolition and/or construction sites, to which the system of the present invention may be applied. Each of these is shown schematically fitted with a plurality of detectors in the form of RFID readers 10, one at the front, one at the rear, one on each of

the left and right sides of the vehicle, and one on the arm or tool. Thus, in figures 2 and 4 a respective reader 10 is mounted in the vicinity of the shovel attachment 11 on the respective pivotal arm 18, while in figure 3 a respective reader 10 is mounted in the vicinity of the grab tool 19 (**or is this a piling attachment?**). The exact preferred mounting position of readers for retrofitting to each type and model of vehicle, or for fitting at the time of manufacture of each vehicle in order to achieve best area coverage by the system will vary and will be determined for each type of vehicle and indicated with fitting instructions.

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[0013] Figure 1 shows a conventional hard hat 12 which it is obligatory to wear in accordance with safety regulations by all personnel on demolition/construction sites and other dangerous working sites. A badge 13 is depicted for representative purposes only. In practice, a tag 14 compatible with the RFID readers mounted on the vehicles, for example a passive UHF transmitter, will be mounted into or onto each hat used on a particular site. The tag 14 may be embedded into the material of the hat or may be applied as a self-adhesive tag which could be applied on site. It may suitably then be mounted on the top of the exterior of the hat (as shown schematically only) as that should provide best all-round reception of signal from the readers 10 attached to the vehicles and best all round transmission which can be picked up by those readers then.

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[0014] These vehicles each have a central electronic management system configured to control operation of the tools and locomotion, subject to driver input. Also, each has a so-called "dead man system" typically provided by a lever which extends in the path of entry to the driver's seat and which is operatively linked to the central management control system so that when the lever is raised to allow the driver to climb in or dismount, the management system disables vehicle locomotion and operability of tools. This is obviously to prevent accidents which could be caused by inadvertent operation of the vehicle. The central management control system is represented schematically at 20 in figures 5 and 6 and shown to include a relay 22 which operates the hydraulic system 24 of the vehicle under machine controls 26 to which the driver also has input by actuators on the dashboard or control box of the vehicle.

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[0015] In a first exemplary system in accordance with the invention, as shown in figure 5, the RFID receiver, namely any one of the readers 10 mounted on the vehicle is operatively linked to the vehicle central management control system 20 to provide control signal output to the relay 22. The reader 10 is triggered to send such a control signal to disable operation of the vehicle (just as in the dead man system) upon receipt of a radio signal from any one of the tags 14 (referred to in figures 5 and 6 as "antenna") mounted in the protective hat of each person on site. The operating range of such tags 14 can be chosen so that they are only capable of transmitting signal when they come within a predetermined

distance of a respective reader 10. Therefore, by appropriate choice of components, the system may operate so that vehicles are disabled when anyone wearing such a protective hat 12 approaches within a range of, say, anything from 1 m to 10 m of a respective reader 10. Where the reach of a machine tool is relatively large, then a relatively large distance, which may be over 10 m, should be chosen as the detection range to reduce risk of any accident or injury by contact of the moving vehicle or a moving/operating tool with any person. On the other hand, this must be balanced with not disabling the vehicle unnecessarily when people are safely moving close by, not within an area of risk.

**[0016]** In a modified system, as shown in figure 6, the readers 10 mounted on a particular vehicle are all in operative connection with a common processor unit 30 which is configured to send control signal output to the central management control system 20 of the vehicle. This is appropriate where the system is to be retrofitted by connection to the existing central management control system of the vehicle. The CPU 30 can then be suitably pre-programmed and connected into the central management control system 20.

**[0017]** The flow chart in figure 7 indicates exemplary operating sequence of such a common processor 30.

**[0018]** The tags 14 are programmed to include specific identifiers in their transmission signal and the readers 10 are similarly programmed in corresponding manner so that only transmission from the site specific tags 14 are recognised by the readers 10.

**[0019]** The vehicle operator will, of course, also be wearing a protective hat 12 and, in accordance with the proposed scheme of the invention, it will also be a hat 12 which includes a relevant tag 14, recognition of which by the readers 10 will disable the vehicle. However, the positioning of the readers 10 on the vehicle will be such that once the operator/driver is seated at the controls, the tag 14 in his hard hat will be in such a location that it will not be triggered by the readers to transmit. Additionally or alternatively any transmissions from the tag 14 at that location (the operator's seat) will not be in the direction which can be detected by the readers 10. Yet another alternative is to provide specific hats containing tags with specific identification codes for the drivers/operators of the vehicles/machines. These will be recognised by the readers 10 or the CPU 30 as operator hats and differentiated from the tags 14 carried in the hats of other site personnel so that the presence of the operator himself in the operator seat or nearby does not trigger disablement of the vehicle.

**[0020]** Many variations are possible and will be readily devised by those skilled in the art. In particular, other known or yet to be devised detectors (readers) and transponders (tags), including those which operate using ultrasound and tags which require battery power source may be used in place of the readers and tags of the type described above. The

invention is not, of course, restricted to specific details of the aforesaid exemplary embodiments.

**[0021]** Features described in conjunction with a particular embodiment or example of the invention are to be understood to be applicable to any other embodiment or example  
5 described herein unless incompatible therewith. All of the features disclosed in this specification may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

claims

1. A safety system comprising:

a machine having a central electronic management system configured to control operation of tools and/or locomotion functions of the machine;

5 at least one detector mounted to the machine or to a tool carried by the machine and in operative communication with the central management system;

at least one transponder carried by a person or by a vehicle (other than said machine);

the or each detector being adapted to detect the presence of the or any one of the transponders within a predetermined detection zone of the said detector, and upon

10 detecting same to signal such detection to the central management system, which upon receipt of such signal indicative of the transponder being within the predetermined detection zone causes a restriction to the operation of the tool or to the locomotion functions of the machine.

2. A safety system according to claim 1 wherein the or each transponder is mounted

15 in or on a protective helmet to be worn by a person.

3. A safety system according to claim 1 or 2 wherein the machine is a vehicle adapted for earth excavation.

4. A safety system according to claim 1 or 2 wherein the machine is a vehicle adapted for lifting and transporting materials or objects.

20 5. A safety system according to any preceding claim wherein the central management system controls operation of tools and locomotion functions of the machine.

6. A safety system according to any preceding claim wherein the central management system includes safety cut off circuitry for disablement of the operation of tools, this

circuitry being actuated upon receipt by the central management system of a signal

25 indicative of the or one of the transponders being within the predetermined detection zone of the or one of the detectors.

7. A safety system according to any of claims 1 to 5 wherein the central management system includes safety cut off circuitry to prevent locomotion of the machine, this circuitry

being actuated upon receipt by the central management system of a signal indicative of

30 the or one of the transponders being within the predetermined detection zone of the or one of the detectors.

8. A safety system according to any preceding claim wherein the predetermined detection zone extends for 10 metres or less than 10 metres from the or each of the detectors.
9. A safety system according to claim 8 wherein the predetermined detection zone  
5 extends for approximately 3 m from the or each of the detectors.
10. A safety system according to any preceding claim wherein the detector or each of the detectors is *in operative communication* with the central management system of the machine by way of a processor unit/a common processor unit which is configured to operate the detector or detectors, to process signals received from the detector or  
10 detectors and to transmit control signals based thereon to the central management system of the machine.
11. A safety system according to claim 10 wherein the or each detector comprises a radio frequency transmitter and receiver, operation of which is controlled by the processing unit.
12. A safety system according to claim 11 wherein the or each transponder comprises  
15 a radio frequency receiver and transmitter, the transmitter being operative only when the receiver has received and recognised a signal emitted by the or one of the detectors of the system.
13. A safety system according to claim 10 wherein the or each detector comprises a  
20 radio frequency receiver.
14. A safety system according to claim 13 wherein the or each transponder comprises an integrated circuit, operable on receipt of a signal from the or one of the detectors, and a radio frequency transmitter.
15. A safety system according to claim 10 wherein the or each detector comprises an  
25 ultrasound transmitter and receiver, operation of which is controlled by the processing unit.
16. A safety system according to claim 15 wherein the or each transponder comprises an ultrasound reflector.
17. A protective helmet incorporating a transponder for use in a safety system according to any preceding claim.
18. A protective helmet according to claim 17 wherein the transponder is a UHF  
30 passive radio transmitter.
19. A protective helmet according to claim 17 or 18 wherein the transponder is mounted inside the helmet.

20. A protective helmet according to claim 17 or 18 wherein the transponder is mounted on the exterior of the helmet, at a location on top of the helmet.

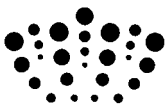
21. A safety system for a machine having a central electronic management system configured to control operation of tools and/or locomotion functions of the machine, the  
5 system comprising:

at least one detector adapted for mounting to the machine or to a tool carried by the machine and adapted for operative communication with the central management system of said machine;

10 at least one transponder to be carried by a person or by a vehicle (other than said machine);

the or each detector being adapted to detect the presence of the or any one of the transponders within a predetermined detection zone of the said detector, and upon detecting same, indicative of the transponder being within the predetermined detection zone, to signal such detection to the central management system thereby to cause a  
15 restriction to the operation of the tool or to the locomotion functions of the machine.

22. A safety system for a machine having a central electronic management system configured to control operation of tools and/or locomotion functions of the machine substantially as hereinbefore described with reference to the accompanying drawings.



**Application No:** GB1110845.3

**Examiner:** Jason Clee

**Claims searched:** 1-22

**Date of search:** 26 October 2011

**Patents Act 1977: Search Report under Section 17**

**Documents considered to be relevant:**

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1-21	US 2008/018472 A (DASILVA et al.) see whole document
X	1, 6, 8-16 & 21	US 2007/205861 A (NAIR et al.) especially see the abstract, figures and paragraph 0038
X	1, 3, 6, 8-10 & 21	JP 05112977 A (FUJITA CORP) especially see the figures and abstract
X	1, 4, 7-11 & 21	FR 2844623 A (ANJOU ETUDE) especially see the figures and abstract WPI AN 2004-272131 [26]
X	1 & 21 at least	WO 2009/050316 A (GRUPO EMPRESAS DADREV GABINETE TECNICO, S.I.) especially see the figures and abstract
Y	2 & 17-20	US 7298258 A (HUDGENS et al.) especially see the abstract and figures

**Categories:**

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

**Field of Search:**

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC<sup>X</sup> :

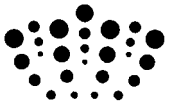
Worldwide search of patent documents classified in the following areas of the IPC

F16P; G06K

The following online and other databases have been used in the preparation of this search report

Online: WPI & EPODOC





**International Classification:**

<b>Subclass</b>	<b>Subgroup</b>	<b>Valid From</b>
F16P	0003/14	01/01/2006