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(71) Applicant: **VOLVO CONSTRUCTION EQUIPMENT AB** [SE/SE]; SE-631 85 Eskilstuna (SE).

(72) Inventors; and
(71) Applicants *(for US only)*: **RUDGE, Brian** [US/US]; 107 Bellows Dr., Carlisle, Pennsylvania 17015 (US). **WAGNER, Bradley** [US/US]; 1074 Heritage Avenue, Shippensburg, Pennsylvania 17257 (US).

(74) Agents: **SCHIVLEY, G. Gregory** et al.; HARNESS, DICKEY & PIERCE, P.L.C., P.O. Box 828, Bloomfield Hills, Michigan 48303 (US).

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(54) Title: CONVEYOR OVERLOAD CONTROL SYSTEM FOR A CONSTRUCTION MACHINE

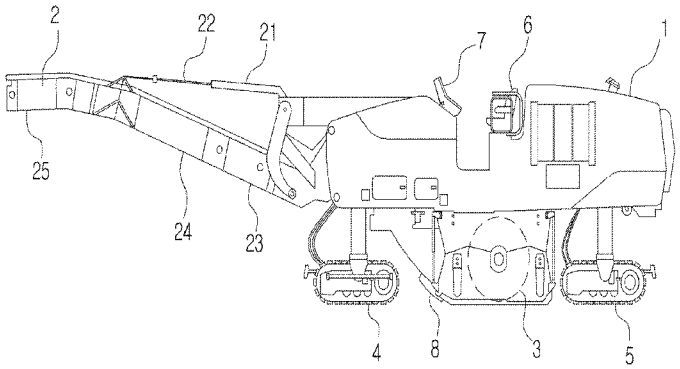


Figure 1

(57) Abstract: The present invention provides a controlling method and device to warn an operator when the conveyor speed is reached to a preset speed, which is a certain percentage of a desired speed, inputted by the operator and also controls to slow down the cutting mechanism so that the conveyor would have time to discharge the milled material and do not have to stop the machine or run the conveyor in reverse direction to clear the milled material.

CONVEYOR OVERLOAD CONTROL SYSTEM FOR A CONSTRUCTION MACHINE

Technical Field

The present invention related to a construction machine, in particular, a conveyor overload control system for a road milling machine.

Background Art

Generally, a road milling machine is configured for use in degrading formations. The road milling machine comprises a rotary degradation drum disposed on the underside of the machine and arranged transverse to the working direction. The rotary degradation drum comprises a plurality of picks. In milling operation, such road milling machines traverse over ground, with the milling rotor submerging into the ground and milling off the soil material with the help of the milling picks arranged on the rotating milling rotor. In milling operation, the road milling machine thus moves in the working direction and traverses over the soil to be processed. Such road milling machines are also preferably designed as self-propelled machines, thus eliminating the need for separate transporting vehicles.

An important aspect in the operation of such road milling machines is the handling of the milled material, i.e. the material milled by the cutting drum. In many areas of application, it is necessary that the milled material is transported away from the milling location by means of a suitable transport device, for example, a truck. To this end, the road milling machines usually has a conveyor by means of which the milled material can be transported during the milling operation of the road milling machine from the area of the milling rotor to the transport container of the transport vehicle.

Various embodiments are known in the industry regarding the specific arrangement of the conveyor device to the transport vehicle. Apart from the possibility that the conveyor transports the milled material to the real to the real (real-loader) or to the side (side-loader), a conveyor belt directed to the front(front-loader) has particularly proven suitable for milling devices designed as road milling machines. Front-loader has the advantage that during milling operation the transport vehicle may drive in front of the milling device on the ground still to be milled.

However, especially front-loader normally places heavy requirements on the milling machine operator. For example, the visibility of the preceding transport trucks is poor and the milling machine operator cannot see the loading trough in full. The driver of the transport vehicle cannot see the loading conveyor as well. Further, the operator is also responsible for safe work process, particularly road safety and personal safety. In the mean time, the operator has to precisely control the loading process for proper removal of the milled material.

Disclosure

Technical Problem

Prior art road milling machines usually designed in a way that even if the conveyor of a road milling machine is pushed to the point of stalling the conveyor system, the cutting system would continue to pack milled material into the discharge area of the conveyor to the point where raising and backing the machine out of the cut is required to stop the entire machine. It is possible for the operator to reverse the conveyor rotation direction to discharge the milled material but there is no alarm or control system which can prevent this condition at the first point. Also, when the conveyor discharges the milled material, the conveyor is usually designed to discharge it on the job site so the ground workers have to clean them.

US7,793,772 discloses a conveyor system using a sensor for detecting that a conveyed good is driven onto the segment, and a controlling unit coupled to the sensor in order to move and stop the conveying means dependent on the detection signal of the sensor, and adapted to determine a geometrical length along the conveying direction of incoming conveyed goods, and to not move further the conveying means dependent on the determined length, if the segment cannot receive other conveyed goods any longer.

However, US 7,793,772 does not disclose these conveyor using in a construction machine e.g. road milling machine. Thus, there is no feature of controlling cutting drum function keep sending the milled material to the conveyor. Further, this does not disclose the feature of the present invention that an operator can input a desirable driving speed and/or conveyor speed so that the microprocessor detects whether the current speeds are met with the desirable ones and if not provide warnings to the operator. Thus, operator cannot have a better control to prevent conveyor overload. The road milling machine is different from traditional conveyor means thus once conveyor overload happens, it is hard to get rid of the milled material from the conveyor thus efficiency and safety are greatly deteriorated.

Further, there is a need of warning system to notify the operator that the conveyor overloading has begun. Further, there is a need to prevent the entire road milling machine stoppage due to the conveyor overload by stopping or slowing down the cutting operation.

Technical Solution

In order to achieve the aforementioned objects, the present invention employs the following arrangement.

According to one aspect of the present invention, there is provided a method of controlling a conveyor load of a road milling machine, wherein the road milling machine comprises a conveyor through which milled material is transported to a transporting container,

driving motors which drives the machine in a desired manner, a microprocessor which controls said machine, and sensors to detect speeds of said conveyor and said driving motors comprising the steps of:

a) inputting desired machine set parameters including at least one driving motor speed and at least one conveyor speed;

b) detecting current conveyor speed and/or driving motor speed by said sensors;

c) determining whether the current conveyor speed has reduced to set parameter of step a) which is a certain percentage of the maximum or desirable parameters for said machine; and

d) activating alarm when the current conveyor speed is below the set parameters of step a).

It is preferable that said method, further comprising the step of:

e) automatically controlling the conveyor overload by slowing down or stopping the machine forward driving motor and/or cutting drum motor by said microprocessor, so as to give some time to clear the milled material out of said conveyor.

It is preferable that said method, further comprising the step of:

f) the automatic control mode of step e) automatically returns to an operator operating mode after a predetermined period of time although an operator still has a control during the automatic control mode.

It is preferable that conveyor speed comprising:

1) the discharge conveyor speed that is measured near said transporting vehicle side of said conveyor; and

2) the gathering conveyor speed that is measured near said cutting drum side of said conveyor.

It is also preferable wherein, the machine parameters further comprising forward travel driving motor speed and engine speed.

It is also preferable that in step d), the alarm including visual alarm and/or audible alarm.

It is preferable that in step d), said alarm further including warning message on control panel.

According to another aspect of the present invention, a control system for a construction machine with a conveyor, comprising:

a main body which contains mechanical components of said machine;

a cutting drum which submerges into the ground and mills off the soil material;

a driving mechanism having a plurality of driving motors which drives moving parts of said machine,

a conveyor through which milled material is transported to a transporting vehicle;

sensors to detect speeds of said driving motors including forward driving motor, and at least one conveyor speed; and

a microprocessor getting input from the operator of said machine of set parameters and determines whether the current speeds detected by said sensors are below said set parameters so as to warn the operator of possibility of overload of said conveyor and to control said parameters of said machine to prevent overload of said conveyor.

It is preferable that said set parameters comprising;

discharge conveyor speed detected at a discharge portion of said conveyor near a transporting vehicle;

gathering conveyor speed detected near a gathering portion of said conveyor near said cutting drum of said machine;

forward driving motor speed; and

said machine engine speed.

It is also preferable that wherein, said warning including warning message on a control panel.

It is preferable that wherein, said warning including audible or visual alarm.

It is also preferable that wherein, said set parameters are certain percentages of desirable or maximum parameters of said machine so that the operator could be warned before the conveyor overload occurs.

According to yet another aspect of the present invention, a method of controlling a conveyor load of a road milling machine, wherein the road milling machine comprises a conveyor through which milled material is transported to a transporting container, driving motors which drives the machine in a desired manner, a microprocessor which controls said machine, and sensors to detect speeds of said conveyor and said driving motors comprising the steps of:

a) inputting desired machine set parameters including at least one driving motor speed and at least one conveyor speed;

b) detecting current conveyor speed and/or driving motor speed by said sensors;

c) determining whether the current conveyor speed has reduced to set parameter of step a) which is a certain percentage of the maximum or desirable parameters for said machine;

d) activating alarm when the current conveyor speed is below the set parameters of step a); and

e) automatically controlling the conveyor overload by slowing down or stopping the machine forward driving motor and/or cutting drum motor by said microprocessor, so as to give some time to clear the milled material out of said conveyor.

It is also preferred that the method further comprising the step of:

f) the automatic control mode of step e) automatically returns to an operator operating mode after a predetermined period of time although an operator still has a control during the automatic control mode.

It is also preferred that said conveyor speed comprising:

1) the discharge conveyor speed that is measured near said transporting vehicle side of said conveyor; and

2) the gathering conveyor speed that is measured near said cutting drum side of said conveyor.

It is also preferred that the machine parameters further comprising forward travel driving motor speed and engine speed.

It is also preferred that in step d), said alarm including visual alarm and/or audible alarm.

It is also preferred that in step d), said alarm further including warning message on control panel.

Advantageous Effects

The present invention provides the machine of its maximum potential by reducing its downtime by prohibiting the conditions that would lead to overloading the conveyor system,

If the conveyor is stalled due to overload, ground crew and special processes are required to clean up the material that is cleared from the overload conveyor. To clearing the conveyor, the conveyor had to be running in the reverse direction which discharges the material onto the jobsite. Thus, there will be a safer and cleaner job site with the present invention.

The present invention allows the machine operator and all crew members to wear hearing protection and/or communication headsets, as recommended by the manufacturer because they don't have to rely on their ears to hear whether the machine sounds odd. This improves awareness, communication, and safety while working in close proximity to dangerous parts of the machine and on hazardous portions of jobsites.

The present invention allows the machine to automatically react to an overload condition so that the operator focus more on the other responsibilities of machine operation including truck loading with proper weight distribution, visibility and avoidance of obstacles and ground crew, etc., thus increases operating efficiency.

Description of Drawings

Fig. 1 is a side view of a road milling machine according to the present invention.

Fig. 2 is a flow chart showing control method of the microprocessor according to the present invention.

Best Mode

Reference will be made in detail to embodiments of the present invention, examples of which are illustrated in the accompanying drawings. While the present invention will be

described in conjunction with the following embodiments, it will be understood that they are not intended to limit the present invention to these embodiments alone. On the contrary, the present invention is intended to cover alternatives, modifications, and equivalents which may be included within the spirit and scope of the present invention as defined by the appended claims. Furthermore, in the following detailed description of the present invention, numerous specific details are set forth in order to provide a thorough understanding of the present invention. However, embodiments of the present invention may be practiced without these specific details. In other instances, well-known methods, procedures, components, and circuits have not been described in detail so as not to unnecessarily obscure aspects of the present invention.

In referring Fig. 1 which is a side view of a road milling machine according to the present invention, the road milling machine comprises a main body 1, a conveyor 2 connected to the front part of the main body 1. The main body contains mechanical components of the machine, including engine. The main body 1 further comprises two sets of rotating wheels 4 and 5 under the machine part of the main body 1. Rotary cutting drum 3 with a plurality of picks is located between the front rotating wheels 4 and the rear rotating wheels 5 of the machine. An operator would sit on the operation seat 6 and would get the required information from the control panel 7. Thus, it is hard for the operator clearly see the end of the conveyor 25 and measure how much material is transported to a transporting vehicle which will be moving in front of the conveyor 2. Further, the operator cannot see inside of the transporting vehicle either. This practice would cause inefficient transporting and dangerous operation while the operator has to split his attention to the operation and measurement of milled material in the transporting vehicle.

The conveyor 2 is roughly divided by gathering portion 23 and discharging portion 25. The speed of each portion can be quite different since the gathering portion 23 directly receives milled material from the cutting drum 3. The milled material in the gathering portion 23 shows turbulent flow with generally higher speeds. However, passing through laminar portion 24 of the conveyor, the flow gets steadier till the discharge portion 25 of the conveyor. The conveyor can be folded around the end of holding rope 22 so that it can be carried easily while the machine moves to a job site. Thus, using the conveyor speed can be a good way to measure approximate load of a transporting vehicle without adding too much extra components.

Fig. 2 is a flow chart showing how the central processing unit determines lowered conveyor speed and controls to stop forward drive speed of the machine and thus gives warning to an operator.

First, the operator of a road milling machine inputs one or several parameters among which are set discharge conveyor speed, set gathering conveyor speed, set forward travel speed, and set

engine speed. The set parameters are usually a certain percentage (%) of maximum or desired speed of the particular parameters used in the road milling machine. If the operator puts 75% of the current conveyor speed, this speed will be a set conveyor speed which will be used as a basis for detection and warning. These percentages are also optimized per manufacturer's specifications. These percentages are also can be optimized according to the regulation of the working zone. These parameters can include more elements or fewer elements than described above, according to a desired function. However, at least one of conveyor speed and at least one among forward travel, cutting drum speed or engine speed would be required.

Operation of the present invention will be explained below. During an operation, sensors on the driving motors of the propulsion system and the conveyors relay feedback information to the microprocessor. The microprocessor (CPU) would determine whether current discharge conveyor speed and current gathering conveyor speed are lower than the set discharge conveyor speed and set gathering conveyor speed that the operator inputted earlier. If the current discharge conveyor speed and current gathering conveyor speed are lower than the set parameters, then the microprocessor would control the machine to stop forward driving of the machine and activate warning system.

The microprocessor would also control to stop or slow down cutting function of the road milling machine so that the conveyor would have time to clear overloaded milled material from the conveyor. If forward travel stops, the cutting function would stop but there could be some time difference, thus the microprocessor either controls the forward driving speed or the forward driving speed and the cutting function.

Warning system can provide warning messages on the control panel or alarms with audible or visual stimuli. It is preferable to have all three kinds of these warning signals but it is also understandable to have only one or two warning signals according to the working condition. When an operator is aware that there is a warning sign, he/she can work carefully to meet the maximum, if the microprocessor is not programmed to control to stop or slow down the cutting function. Thus, conveyor overload is prevented by warning signals. In any case, the operation does not have to be stopped due to jammed conveyor. Extra workers or time would be saved to clean up milled material on the road after unplugging and spilling the milled material on the road. After certain period of time, the operator would be given control of the machine operation parameters again, although an operator can still has a control during the automatic control mode.

Industrial Applicability

The present invention provides control system and control method thereof of the road milling machine to prevent conveyor overload by giving warning to the operator and automatically control the driving motor speeds of the machine.

Although the invention has been described with reference to the preferred embodiments in the attached figures, it is noted that equivalents may be employed and substitutions made herein without departing from the scope of the invention as recited in the claims.

CLAIMS

Claim 1 A method of controlling a conveyor load of a road milling machine, wherein the road milling machine comprises a conveyor through which milled material is transported to a transporting container, driving motors which drives the machine in a desired manner, a microprocessor which controls said machine, and sensors to detect speeds of said conveyor and said driving motors comprising the steps of:

a) inputting desired machine set parameters including at least one driving motor speed and at least one conveyor speed;

b) detecting current conveyor speed and/or driving motor speed by said sensors;

c) determining whether the current conveyor speed has reduced to set parameter of step a) which is a certain percentage of the maximum or desirable parameters for said machine; and

d) activating alarm when the current conveyor speed is below the set parameters of step a).

Claim 2 A method according to claim 1, further comprising the step of:

e) automatically controlling the conveyor overload by slowing down or stopping the machine forward driving motor and/or cutting drum motor by said microprocessor, so as to give some time to the machine to clear the milled material out of said conveyor.

Claim 3 A method according to claim 1, further comprising the step of:

f) the automatic control mode of step e) automatically returns to an operator operating mode after a predetermined period of time although an operator still has a control during the automatic control mode.

Claim 4 A method according to claim 1, wherein, said conveyor speed comprising:

1) the discharge conveyor speed that is measured near said transporting vehicle side of said conveyor; and

2) the gathering conveyor speed that is measured near said cutting drum side of said conveyor.

Claim 5 A method according to claim 1, wherein, the machine parameters further comprising forward travel driving motor speed and engine speed.

Claim 6 A method according to claim 1, wherein, in step d), said alarm including visual alarm and/or audible alarm.

Claim 7 A method according to claim 1, wherein, in step d), said alarm further includes warning message on control panel.

Claim 8 A control system for a construction machine with a conveyor, comprising:
a main body which contains mechanical components of said machine;
a cutting drum which submerges into the ground and mills off the soil material;
a driving mechanism having a plurality of driving motors which drives moving parts of said machine,
a conveyor through which milled material is transported to a transporting vehicle;
sensors to detect speeds of said driving motors including forward driving motor, and at least one conveyor speed; and
a microprocessor getting input from the operator of said machine of set parameters and determines whether the current speeds detected by said sensors are below said set parameters so as to warn the operator of possibility of overload of said conveyor and to control said parameters of said machine to prevent overload of said conveyor.

Claim 9 A control system according to claim 8, wherein, said set parameters comprising;
discharge conveyor speed detected at a discharge portion of said conveyor near a transporting vehicle;
gathering conveyor speed detected near a gathering portion of said conveyor near said cutting drum of said machine;
forward driving motor speed; and
said machine engine speed.

Claim 10 A control system according to claim 8, wherein,
said warning includes warning message on a control panel.

Claim 11 A control system according to claim 8, wherein,
said warning includes audible or visual alarm.

Claim 12 A control system according to claim 8, wherein,
said set parameters are certain percentages of desirable or maximum parameters of said machine so that the operator could be warned before the conveyor overload occurs.

Claim 13 A method of controlling a conveyor load of a road milling machine, wherein the road milling machine comprises a conveyor through which milled material is transported to a transporting container, driving motors which drives the machine in a desired manner, a microprocessor which controls said machine, and sensors to detect speeds of said conveyor and said driving motors comprising the steps of:
a) inputting desired machine set parameters including at least one driving motor speed and at least one conveyor speed;
b) detecting current conveyor speed and/or driving motor speed by said sensors;
c) determining whether the current conveyor speed has reduced to set parameter of step a) which is a certain percentage of the maximum or desirable parameters for said machine;
d) activating alarm when the current conveyor speed is below the set parameters of step a); and
e) automatically controlling the conveyor overload by slowing down or stopping the machine forward driving motor and/or cutting drum motor by said microprocessor, so as to give some time to clear the milled material out of said conveyor.

Claim 14 A method according to claim 13, further comprising the step of:
f) the automatic control mode of step e) automatically returns to an operator operating mode after a predetermined period of time although an operator still has a control during the automatic control mode.

Claim 15 A method according to claim 13, wherein, said conveyor speed comprising:
1) the discharge conveyor speed that is measured near said transporting vehicle side of said conveyor; and
2) the gathering conveyor speed that is measured near said cutting drum side of said conveyor.

Claim 16 A method according to claim 13, wherein, the machine parameters further comprising forward travel driving motor speed and engine speed.

Claim 17 A method according to claim 13, wherein, in step d), said alarm including visual alarm and/or audible alarm.

Claim 18 A method according to claim 13, wherein, in step d), said alarm further includes warning message on control panel.

Figure 1

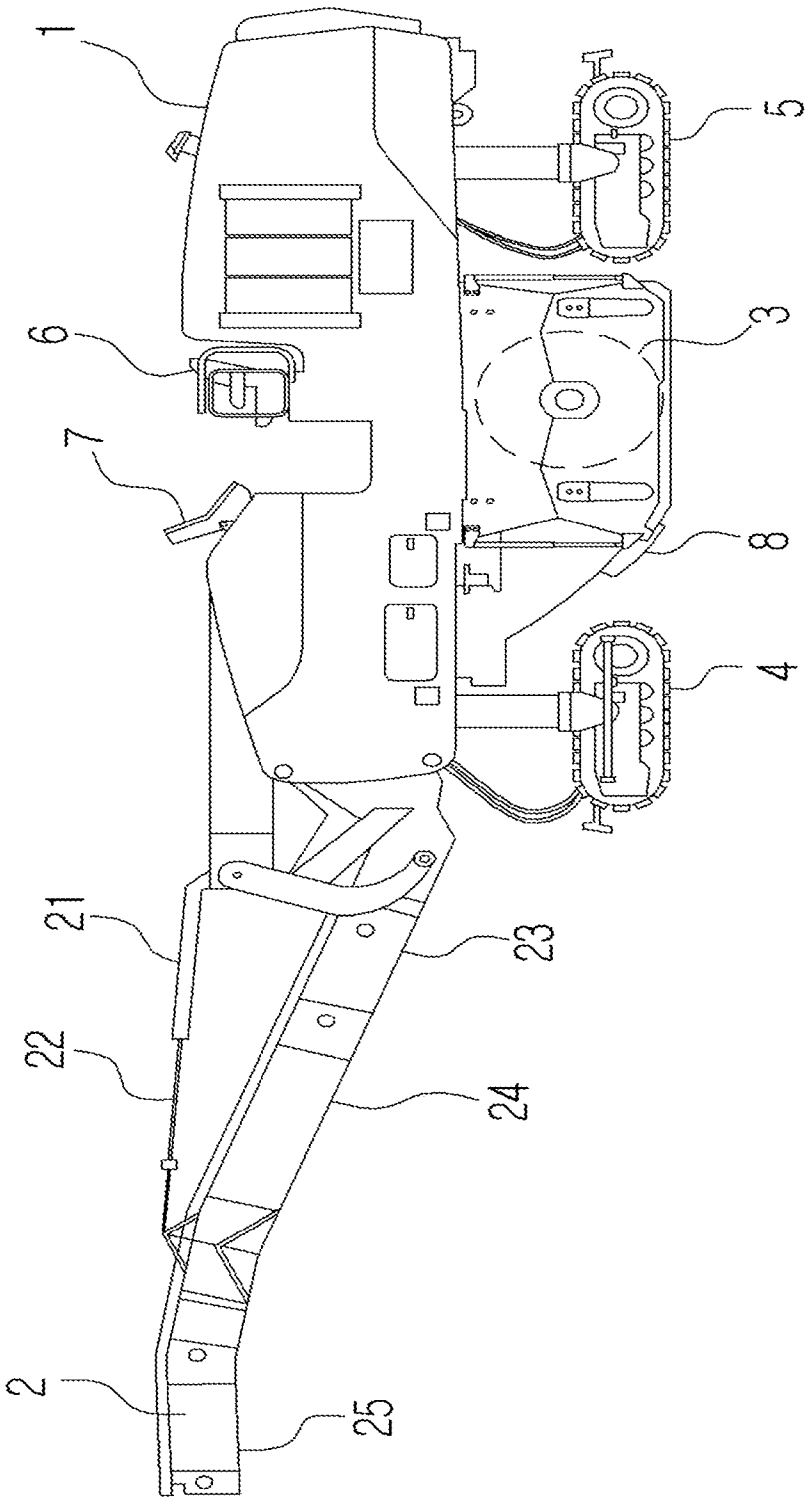
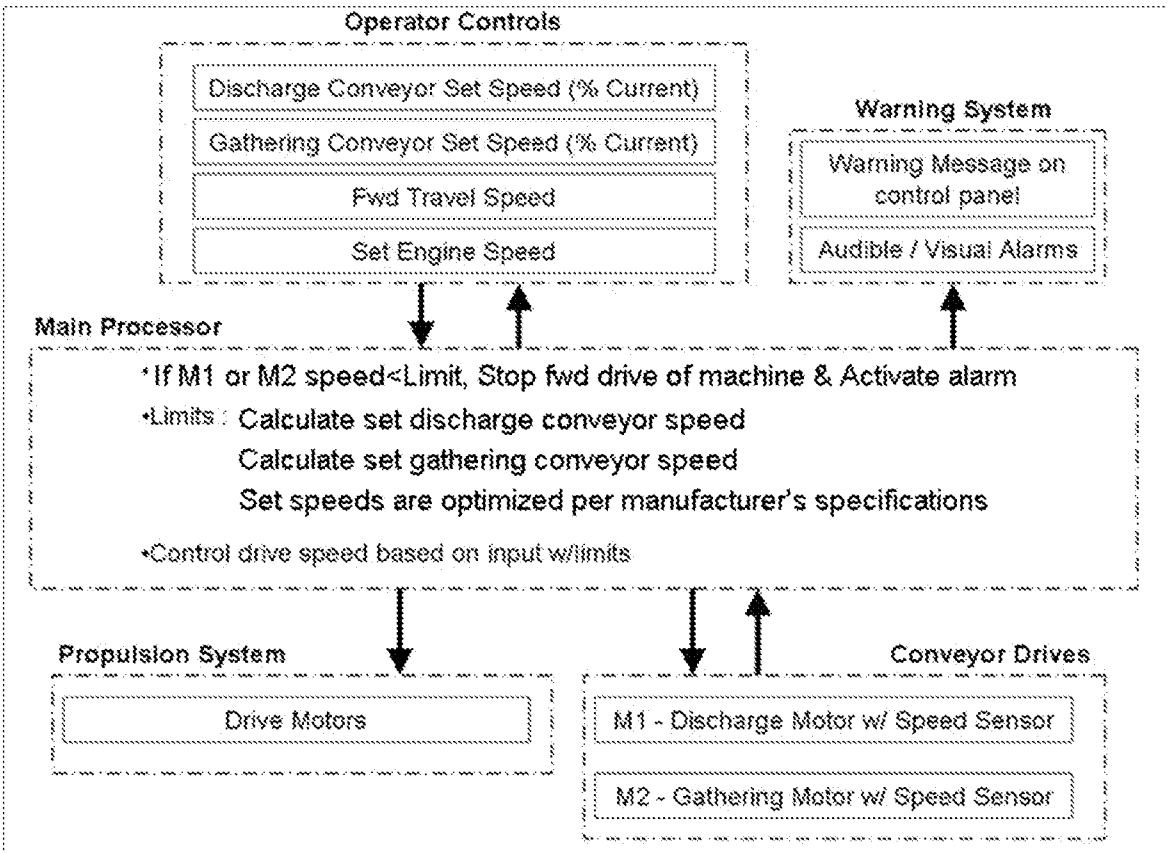


Figure 2


Operator Controls
Discharge Conveyor Set Speed (% Current)
Gathering Conveyor Set Speed (% Current)
Fwd Travel Speed
Set Engine Speed
Warning System
Warning Message on control panel
Audible / Visual Alarms
Main Processor
•If M1 or M2 speed<Limit, Stop fwd drive of machine & Activate alarm
•Limits : Calculate set discharge conveyor speed
Calculate set gathering conveyor speed
Set speeds are optimized per manufacturer's specifications
•Control drive speed based on input w/limits
Propulsion System
Drive Motors
Conveyor Drives
M1 - Discharge Motor w/ Speed Sensor
M2 - Gathering Motor w/ Speed Sensor

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/058221

A. CLASSIFICATION OF SUBJECT MATTER

E01C 23/088(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
E01C 23/088; B60T 8/32; B65G 67/04; E01C 23/16; E21C 25/06; E01C 23/12; E01C 21/00; E01C 19/20

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & Keywords: conveyor, milling machine, speed, alarm, and sensor

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2013-0080000 A1 (VON DER LIPPE et al.) 28 March 2013 See paragraphs [0006], [0009], [0013], [0017]-[0019], [0026], [0037], [0045]-[0049], claim 7, and figures 5a-6.	1-18
A	US 2010-0014917 A1 (WILLIS et al.) 21 January 2010 See paragraphs [0021]-[0022], claims 1-3, and figure 3.	1-18
A	US 2011-0121633 A1 (HALL et al.) 26 May 2011 See paragraphs [0020]-[0021], [0034]-[0037] and figures 1, 5a-6.	1-18
A	CN 202547760 U (XCMG CONSTRUCTION MACHINERY CO., LTD.) 21 November 2012 See paragraphs [0021]-[0022], claims 1-3, and figure 3.	1-18
A	EP 1012396 B1 (WIRTGEN GMBH) 19 June 2002 See claims 1-3, 7-9 and figures 1-2.	1-18

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:
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"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 May 2014 (13.05.2014)	**14 May 2014 (14.05.2014)**

Name and mailing address of the ISA/KR
International Application Division
Korean Intellectual Property Office
189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701,
Republic of Korea
Facsimile No. +82-42-472-7140

Authorized officer
CHOI, Hyun Goo
Telephone No. +82-42-481-8288

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/US2013/058221

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