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(54) **AUTOMATIC TAMPING MECHANISM CONTROL**

(76) Inventors: **Timothy A. Feucht**, Edelstein, IL (US); **Evant T. Graham**, Minnetonka, MN (US); **Timothy M. Gutzwiller**, Peoria, IL (US)

Correspondence Address:
CATERPILLAR INC.
100 N.E. ADAMS STREET
PATENT DEPT.
PEORIA, IL 616296490

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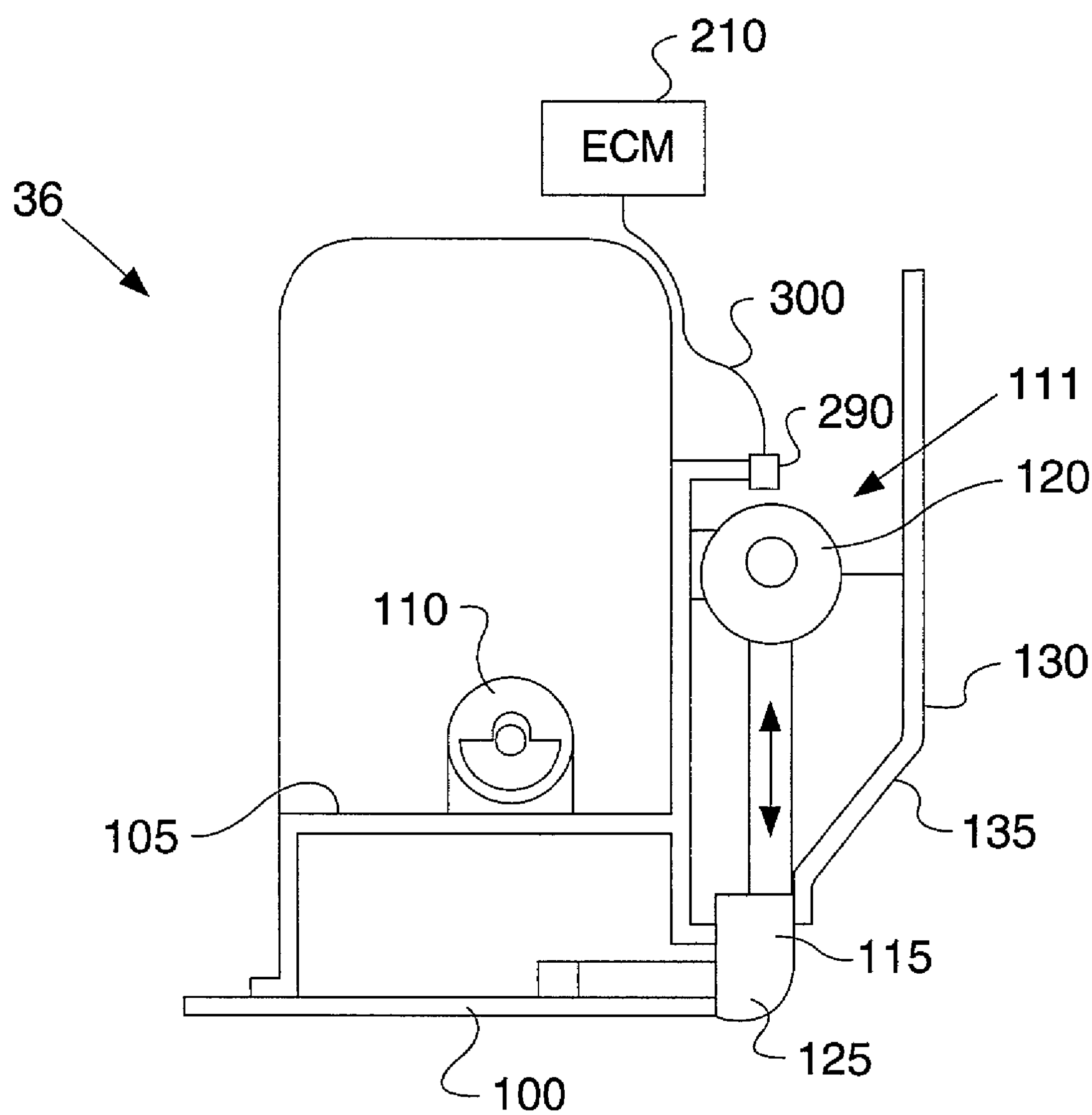
(57) **ABSTRACT**

A control system for use with an asphalt paving machine receives inputs from an operator interface for inputting a desired tamping frequency or a desired tamping rate (tamps/ft) and a speed sensor that produces a signal indicative of the speed of the asphalt paver. The control system includes an automatic mode and when in automatic mode the system modifies the tamping frequency to better achieve a desired number of tamps per foot traveled irrespective of speed.



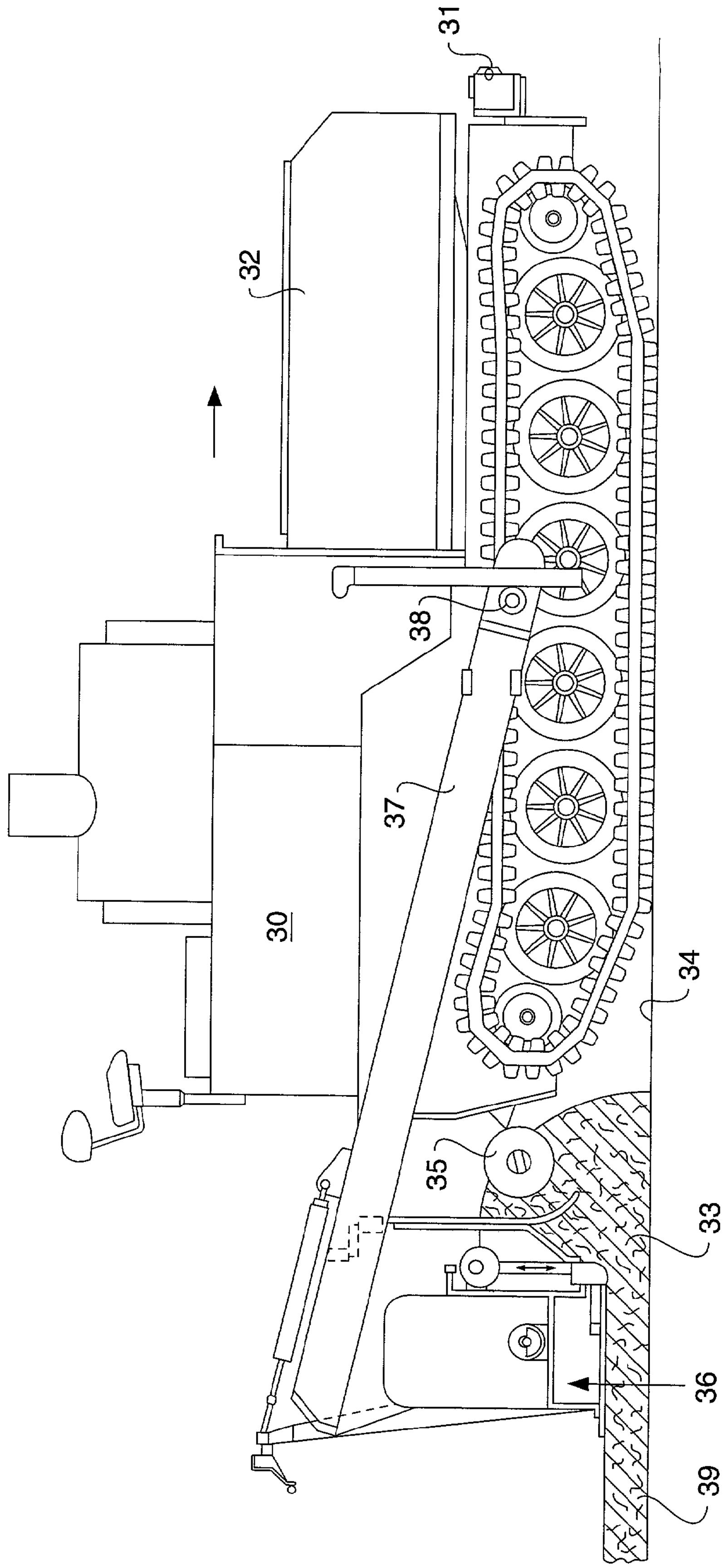


Fig - 1 -

Fig. 2

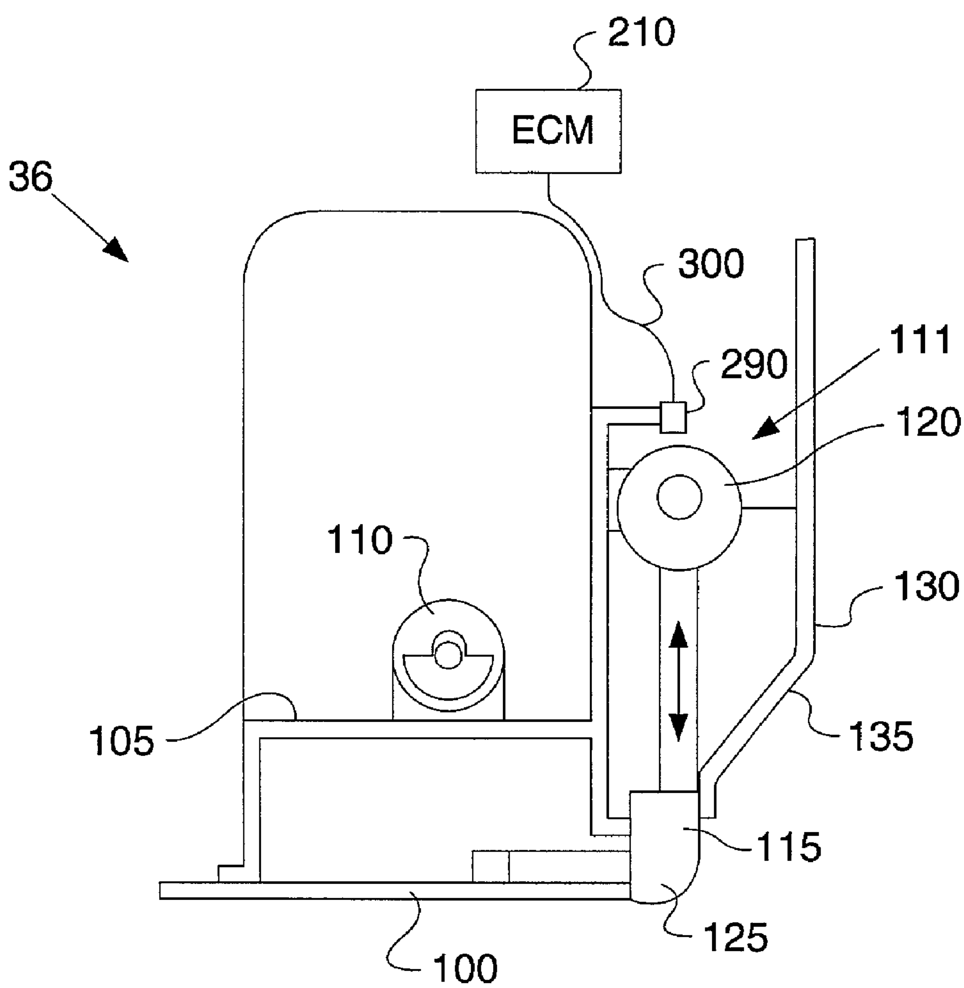


Fig. 3

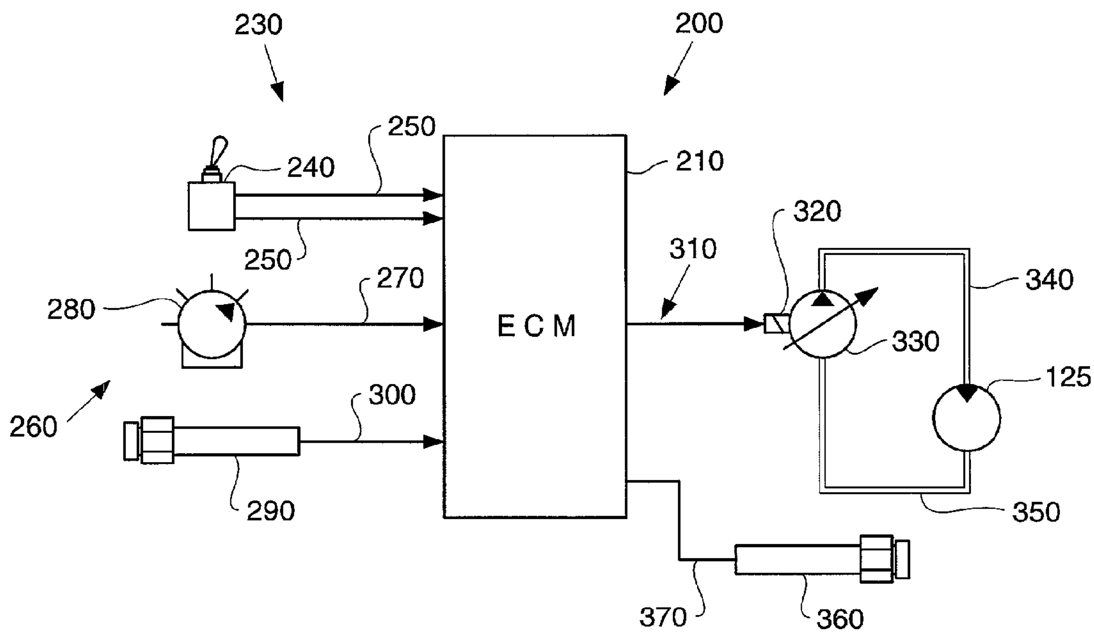
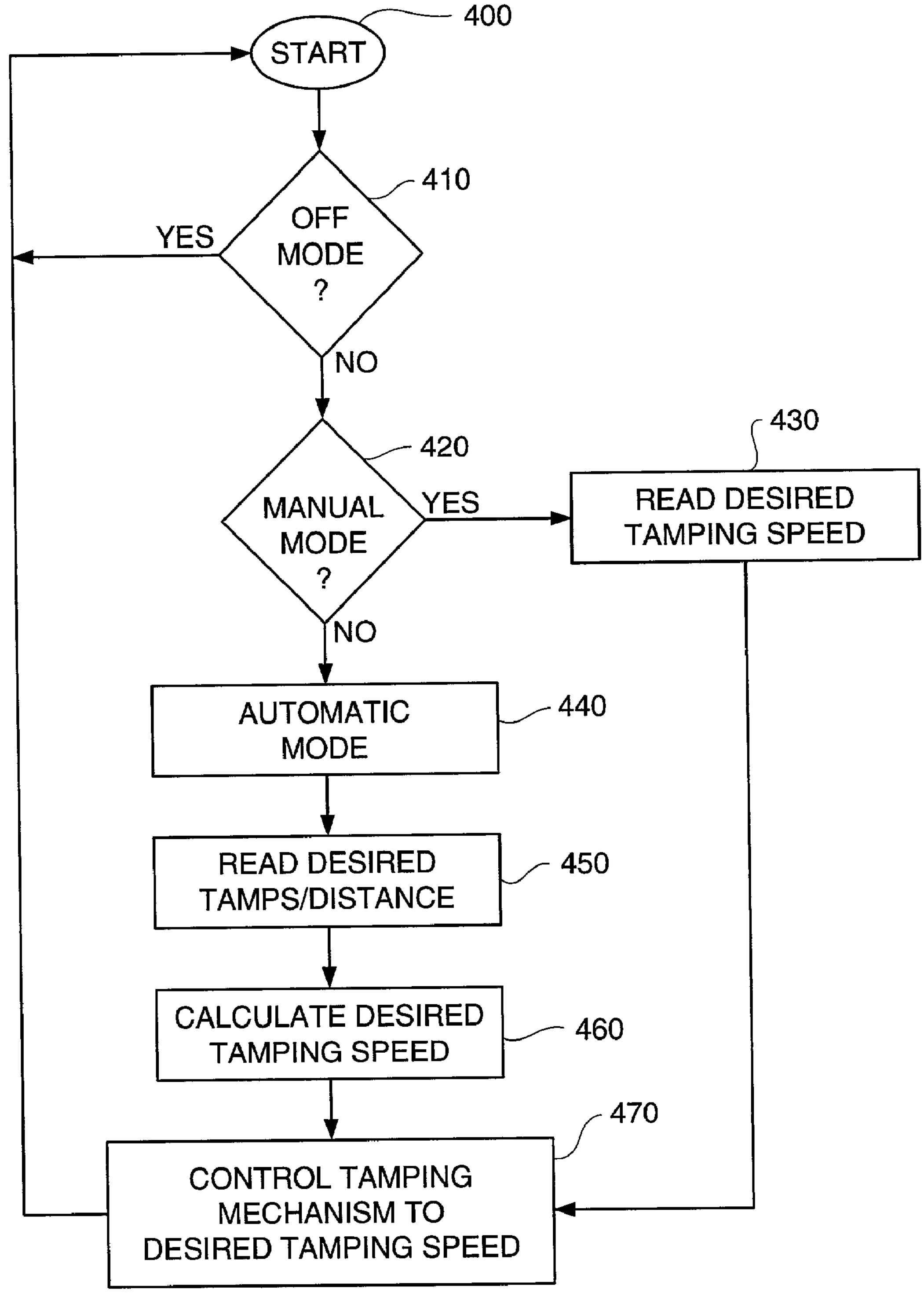

230
200
250
240
210
250
320
310
340
280
270
ECM
330
125
260
300
290
350
370
360

Fig. 4


400
START
410
OFF MODE ?
YES
NO
420
MANUAL MODE ?
YES
NO
430
READ DESIRED TAMPING SPEED
440
AUTOMATIC MODE
450
READ DESIRED TAMPS/DISTANCE
460
CALCULATE DESIRED TAMPING SPEED
470
CONTROL TAMPING MECHANISM TO DESIRED TAMPING SPEED

AUTOMATIC TAMPING MECHANISM CONTROL

TECHNICAL FIELD

[0001] The present invention generally relates to asphalt paving machines, and more particularly to a control for a tamping mechanism on an asphalt paving machine.

BACKGROUND

[0002] Asphalt paving machines are used to spread asphalt relatively evenly over a desired surface. These machines are regularly used in the construction of roads, parking lots and other areas where a smooth durable surface is required for cars, trucks and other vehicles to travel. An asphalt paving machine generally includes a hopper for receiving asphalt material from a truck and a conveyor system for transferring the asphalt from the hopper for discharge on the roadbed. Screw augers spread the asphalt transversely across the road bed in front of a floating screed, which is connected to the paving machine by pivoting tow arms or draft arms. The screed smoothes and somewhat compacts the asphalt material and ideally leaves a roadbed of uniform depth and smoothness. The screed is sometimes equipped with an eccentric bar that rotates and thereby causes the screed to vibrate, which assists with the compaction. Although the screed compacts the asphalt material to some degree, it is often desirable to exert greater compaction force on the asphalt. To do so, some screeds include a tamping mechanism which often includes a tamping bar, located in front of the screed, relative to the direction of travel of the paving machine, and transversely to the direction of travel. The tamping bar moves up and down, striking the asphalt on each downward stroke thereby imparting increased compaction force on the asphalt. The speed with which the tamping bar moves upward and downward is generally controlled by an operator input device such as a control knob.

[0003] It is desirable to have the asphalt on the roadbed compacted uniformly so that the density of the roadbed is consistent from one place to another. Prior art tamping systems control only the frequency of the up and down motion of the tamping bar thereby causing the screed to tamp at a fixed rate. If the asphalt paving machine is moving at a constant speed the tamping bar will strike the asphalt the same number of times per unit distance traveled. Because the tamping bar strikes the asphalt the same number of times for every foot traveled, it is more likely to produce a uniformly dense roadbed. However, if the operator changes the speed of the asphalt paving machine the number of times the tamping bar strikes the asphalt per foot traveled will change, thereby increasing the likelihood that the density of the roadbed will be inconsistent.

[0004] It would be preferable to have an automatic tamping control that would deliver a uniform number compaction strokes for each unit distance traveled, irrespective of the speed of the asphalt paving machine.

SUMMARY OF THE INVENTION

[0005] The present invention includes a control system for use with a tamping mechanism on an asphalt paver. The control system preferably includes an electronic control module that is connected with an operator input device for inputting a desired tamping frequency. The electronic control module is also connected to a speed sensor that produces a signal indicative of the speed of the asphalt paver. The electronic control module controls the speed of the tamping mechanism as a function of the operator input and the asphalt paver speed.

[0006] These and other advantages of the present invention will be apparent upon reading the detailed description in connection with the drawings and appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The drawings are provided to assist in the understanding of the present invention and represent a preferred embodiment of practicing the invention. Other embodiments could be created that will fall within the scope of the present invention as defined by the appended claims.

[0008] **FIG. 1** is a side view of an asphalt paving machine;

[0009] **FIG. 2** is a side view of a screed including a tamping mechanism associated with the asphalt paving machine of **FIG. 1**;

[0010] **FIG. 3** is a block diagram of a control system of preferred embodiment of the present invention; and

[0011] **FIG. 4** is a flowchart of preferred software control of the control system of the present invention.

DETAILED DESCRIPTION

[0012] A preferred embodiment of the best mode of practicing the present invention is described herein. Referring first to **FIG. 1, a** typical form of track-laying, floating screed asphalt paver **30** is shown. In accordance with well known practice, the paver is provided with push rollers **31** at the front, for engaging and pushing forwardly on the wheels of a truck loaded with asphalt paving material. The paving material is arranged to be discharged progressively from the truck into a hopper **32** at the front of the paver. Conveyor means (not shown) controllably transport the paving material to the rear of the paver and deposit it in a mass **33** on the prepared paving bed **34**. Screw augers **35** distribute the paving material laterally in front of a screed, generally designated by the numeral **36**. The screed is towed behind the paver and connected thereto by a pair of elongated, forwardly extending tow bars **37** connected at their front ends to the chassis of the paver. In accordance with known practice, by controlling the elevation of the tow points **38** and the angle of attack of the bottom surface of the screed **36**, a level, uniform paving mat **39** is laid behind the paver as it advances forwardly.

[0013] Referring now to **FIG. 2, a** screed **36** of the type used in connection with the asphalt paver **30** is shown. The screed **36** comprises a baseplate **100** which is configured to float on paving material **33** laid upon a prepared paving bed **34** and to "smooth" or level and compact the paving material on the base surface, such as for example a roadway or roadbed. The base plate **100** is connected, preferably by means of a carrier **105**, to a vibrating shaft **110** coupled to a vibratory drive (not depicted). As is known to those skilled in the art, the vibratory shaft **110** generally includes weights placed eccentrically so that when the vibratory drive rotates the vibrating shaft **110**, the shaft **110** causes the screed **36** to vibrate. The vibrating screed **36** to some degree improves compaction and quality of the asphalt mat being laid on the prepared paving bed **34**.

[0014] The screed also includes a tamping mechanism **111** which includes a tamping bar **115** arranged in front of the baseplate **100** and extending generally transversely to the paving direction over substantially the entire width of the baseplate **100**. The tamping bar **115** is configured to be driven so as to move alternately in upward and downward directions (i.e., generally toward and away from the base surface). Preferably, the tamping bar **115** is driven by an eccentric drive **120** and is configured to be adjustably displaceable by the amount of an adjustable stroke of the eccentric drive **120**. A speed sensor **290** is preferably located adjacent the eccentric drive and produces a speed signal on an electrical connector **300** that is an input to an electronic control module **210**, described in more detail below with reference to **FIGS. 3 and 4**. Further, the tamping bar **115** has a lead-in slope **125** located at the front edge of the bar **115**. The angle of the lead-in slope **125** is preferably between 30 degrees and 70 degrees, so as to ensure an optimum feed of the paving material.

[0015] The screed **36** has preferably includes a front wall **130** disposed proximal to the screw auger **35** (shown in **FIG. 1**), the screw auger **35** functioning to spread paving material falling off the end of a conveyor mounted on the paver **30** The front wall **130** includes a lower guide portion **135** which is preferably inclined relative to the tamping bar **115** and which terminates adjacent to the bar **115**, such that the guide portion **135** directs paving material from the auger **35** to the tamping bar **115**. The angle of inclination of the guide portion **135** preferably corresponds approximately to the angle of the lead-in slope **125** of the tamper bar **115**.

[0016] Referring now to **FIG. 3, a** block diagram of a preferred embodiment of an electronic control system **200** for use with the tamping mechanism **111** is shown. The electronic control system preferably includes an electronic control module ("ECM") **210** connected with the various system components shown. A tamper bar mode selector **230** is connected with the ECM **210**. In the drawing, the tamper bar mode selector is shown as a three position toggle switch **240**. Those skilled in the art will recognize that other devices, including rotary switches, depressible button switches and the like could readily and easily be substituted for the three position switch. As described in more detail below with reference to **FIG. 4**, the mode selector **230** preferably includes three positions corresponding to an off mode, a manual mode and an automatic mode. The operator of the asphalt paving machine preferably places the mode selector **230** in a position corresponding to the desired mode. The mode selector then produces a mode signal on electrical connectors **250** indicative of the selected mode.

[0017] A tamper bar desired speed input **260** is connected with the ECM **210** by connector **270**. Although this input is described herein as a desired speed input, it also controls the desired number of tamps per unit distance when the system is in the automatic mode. As shown in the drawing, the tamper bar desired speed selector is shown as a rotary dial **280**. Preferably there are markings on the dial indicating to the operator a general desired tamping bar rotational velocity (when in manual mode) or a desired number of tamps per foot (when in automatic mode). The operator of the asphalt paving machine moves the dial to a position corresponding to the desired rotational speed of the tamping bar or number of tamps per foot and the rotary dial **280** produces a signal on connector **270** indicative of the desired tamping bar speed or tamps per foot.

[0018] A tamping bar speed sensor **290** is associated with the eccentric drive **120** of the tamping mechanism **111** and produces a tamping bar speed signal on connector **300** indicative of the rotational velocity of the eccentric drive **120**. Preferably, the tamping bar speed sensor is a passive sensor, such as a magneto restrictive type sensor. However, other types of speed sensors can be used without deviating from the scope of the present invention.

[0019] The ECM **210** produces a tamper bar control signal **310** to control the rotational speed of the shaft eccentric drive **120**. As shown in the drawing, the tamper bar control signal **310** is received by a solenoid **320** connected with a hydraulic pump **330** associated with the hydraulic motor **125**. The tamper bar control signal **310** controls the flow of hydraulic fluid through conduits **340,350** and thereby controls the rotational speed of the hydraulic motor **125** and eccentric drive **120** of the tamper bar. Although the preferred embodiment shows the use of a hydraulic pump **330** and motor **125** to control the rotational speed of the eccentric drive **120**, other power sources could readily and easily be substituted for the hydraulic motor without deviating from the scope of the present invention. For example, in some applications it might be preferable to replace the hydraulic motor with an electric motor and controllably power the motor with electric power through associated power circuitry.

[0020] Also connected with the ECM **210** is a asphalt paving machine speed sensor **360** that produces a signal on connector **370** indicative of the speed that the asphalt paving machine is travelling. The speed sensor is preferably associated with a driveline on the asphalt paving machine, which connects the engine to the tracks, or other ground engaging device. The speed sensor produces a signal indicative of the speed of the track, or other ground engaging device, which can be readily converted by the ECM **210** to ground speed. Any of a variety of well known speed sensors could be used in connection with the present invention.

[0021] Referring now to **FIG. 4, a** block diagram of a preferred embodiment of the software control associated with the ECM **210** of the present invention is shown. Software control begins in block **400** and passes to block **410**.

[0022] In block **410** the ECM **210** reads the signal on connectors **250** and determines whether the operator has placed the tamper bar mode selector **230** in the position corresponding to off mode. If the mode selected is the off mode then software control returns to block **400**. Otherwise, program control continues to block **420**.

[0023] In block **420**, software control determines whether the operator has placed the tamper bar mode selector **230** in the position corresponding to manual mode. If the mode selected is the manual mode then software control passes to block **430**. Otherwise, software control passes to block **440**.

[0024] In block **430**, the ECM **210** reads the desired tamping speed signal on connector **270** produced by the tamping bar desired speed input **260**. Program control then passes to block **470**. In block **470**, the ECM produces a tamper bar control signal as a function of the desired connector **270**. In a preferred embodiment of the invention the speed of the tamper bar shaft **122** is controlled open loop. However, as will be apparent to those skilled in the art, the ECM **210** could readily and easily use the electrical connector **300** as feedback to implement a closed loop tamper bar speed control. From block **470** program control returns to block **400**.

[**0025**] Returning to block **420**, as described above if the position of the mode selector **230** does not correspond to the manual position, then software control passes to block **440** and the control system is in automatic mode.

[**0026**] Software control passes from block **440** to block **450**.

[**0027**] In block **450**, the ECM **210** reads the signal on connector **270**, which in the automatic mode corresponds to a desired number of tamps per foot (or other unit distance) that the asphalt paving machine travels. Program control then passes to block **460** where the ECM determines a corresponding desired tamping speed. To do this, the ECM preferably reads the asphalt paving machine speed signal on connector **370** and calculates the desired tamping bar speed. In a preferred embodiment, the control system of the present invention uses two asphalt paving speed sensors **360** and averages the signals of those two sensors. Program control then passes to **470**.

[**0028**] As described above, in block **470**, the ECM produces a tamper bar control signal as a function of the desired connector **270**. In a preferred embodiment of the invention the speed of the tamper bar shaft **122** is controlled open loop. However, as will be apparent to those skilled in the art, the control could readily and easily use the electrical connector **300** as feedback to implement a closed loop tamper bar speed control. From block **470** program control returns to block **400**.

INDUSTRIAL APPLICABILITY

[**0029**] The control described in the present application permits the operator of the asphalt paving machine to select between three modes of tamping: an off mode; a manual mode; and an automatic mode. In the off mode, the screed will not tamp the asphalt material. In the manual mode the operator can select a desired tamping speed which produces a desired tamping rate (i.e., a desired number of tamps per unit time). In the automatic mode the operator can select a desired number of tamps per unit distance. In the automatic mode the control will automatically adjust the tamping speed as a function of the speed that the asphalt paving machine is moving. This will allow the operator to better achieve consistent compaction from the tamper bar with minimum operator action.

What is claimed is:

1. A control for a tamping mechanism on an asphalt paver, including:

a speed sensor, said speed sensor sensing the speed of said asphalt paver;

a desired tamping speed input;

an electronic control module that controls the speed of said tamping mechanism as a function of said tamping speed input and said speed sensor.

2. The control according to claim 1, including:

a mode selector having a manual mode selection and an automatic mode selection; and

wherein said electronic control module controls the speed of said tamping mechanism in response to said desired tamping speed input when said mode selector is in said manual mode.

3. The control according to claim 1, wherein:

said electronic control module control increases the speed of said tamping mechanism in response to an increase in the speed of said asphalt paver.

4. The control according to claim 1, wherein:

said electronic control module control decreases the speed of said tamping mechanism in response to a decrease in the speed of said asphalt paver.

5. An electronic control for an asphalt paver, said paver having a screed with a tamping mechanism, said electronic control including:

an asphalt paver speed sensor, said sensor outputting a signal as a function of the speed of said asphalt paver;

a mode selector including a plurality of tamping mechanism mode selections, said mode selector outputting a signal as a function of the mode selection;

a desired tamping speed selector, wherein said speed selector outputs a signal indicative of a desired tamping speed selected by an operator of said asphalt paver;

an electronic controller receiving said speed sensor signal, said mode selector signal and said desired tamping speed signal and outputting a tamping mechanism control signal, wherein said tamping mechanism control signal is a function of said asphalt paver speed sensor signal, said mode selector signal and said desired tamping speed signal;

said tamping mechanism receiving said tamping mechanism control signal and controlling the speed of said tamping mechanism as a function of said tamping mechanism control signal.

6. The electronic control according to claim 5 wherein said mode selector includes an automatic mode selection, a manual mode selection and an off selection.

7. The electronic control according to claim 6, wherein: said electronic control produces said tamping mechanism control signal as a function of said asphalt paver speed sensor signal and said desired tamping speed signal when said mode selector is in said automatic mode selection.

8. The electronic control according to claim 6, wherein said electronic control produces said tamping mechanism control signal as a function of said desired tamping speed signal when said mode selector is in said manual mode selection.

9. The electronic control according to claim 6, wherein said electronic control produces a tamping mechanism control signal indicative of no desired movement of the tamping mechanism when said mode selector is in said off mode selection.

10. The electronic control according to claim 6, wherein:

said electronic control produces said tamping mechanism control signal as a function of said asphalt paver speed sensor signal and said desired tamping speed signal when said mode selector is in said automatic mode selection;

said electronic control produces said tamping mechanism control signal as a function of said desired tamping speed signal when said mode selector is in said manual mode selection; and

said electronic control produces a tamping mechanism control signal indicative of no desired movement of the tamping mechanism when said mode selector is in said off mode selection.

11. A method of controlling a tamping mechanism on an asphalt paving machine, said method including the steps of:

determining a velocity of said asphalt paving machine;

determining a desired speed of said tamping mechanism;

controlling said tamping mechanism in response to said velocity of said asphalt paving machine and said desired speed of said tamping mechanism.

12. The method according to claim 11, wherein said step of controlling includes:

controlling the speed of said tamping mechanism to be proportional to the speed of the asphalt paving machine.

13. The method according to claim 11 wherein said step of controlling includes:

controlling said tamping mechanism to provide a relatively constant number of tamping strokes per unit of distance traveled by said asphalt paver.

14. The method according to claim 11, wherein said step of controlling includes:

controlling said tamping mechanism in response to said desired frequency when said asphalt paver is stationary and increasing the speed of said tamping mechanism in response to an increasing velocity of said asphalt paver.

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